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Towards a Philosophical Reconstruction of the Dialogue between Modern Physics and Advaita Vedānta: An Inquiry into the Concepts of *ākāśa*, Vacuum and Reality

par

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Abstract

Toward the end of the 19th century, the Hindu monk and reformer Swami Vivekananda claimed that modern science was inevitably converging towards Advaita Vedānta, an important philosophico-religious system in Hinduism. In the decades that followed, in the midst of the revolution occasioned by the emergence of Einstein's relativity and quantum physics, a growing number of authors claimed to discover striking "parallels" between Advaita Vedānta and modern physics. Such claims of convergence have continued to the present day, especially in relation to quantum physics. In this dissertation, an attempt is made to critically examine such claims by engaging a detailed comparative analysis of two concepts: *ākāśa* in Advaita Vedānta and vacuum in quantum physics. What is examined is the claim that both concepts would refer to the same reality — an enduring, subtle and all-pervading physical substratum out of which the constituents of the world come into existence and to which they ultimately return. Based on this study, the dissertation argues that comparisons relying on conceptual affinities alone generally fall short of establishing a productive dialogue between Advaita Vedānta and modern physics. Another approach is to bring into focus the epistemological limits respectively encountered by these systems when attempting to define the content of "reality-in-itself" or "ultimate reality." Emphasis is given to epistemology and the problem of reality in Advaita Vedānta, and scientific realism and philosophical implications of nonseparability in quantum physics.

Keywords: Dialogue; Natural Sciences; Eastern Spiritual Traditions; Advaita Vedānta; Modern Physics; Philosophy of science; *ākāśa*; Vacuum; Reality; Epistemology.

Résumé

Vers la fin du 19ème siècle, le moine et réformateur hindou Swami Vivekananda affirma que la science moderne convergeait vers l'Advaita Vedānta, un important courant philosophique et religieux de l'hindouisme. Au cours des décennies suivantes, suite aux apports scientifiques révolutionnaires de la théorie de la relativité d'Einstein et de la physique quantique, un nombre croissant d'auteurs soutenaient que d'importants "parallèles" pouvaient être tracés entre l'Advaita Vedānta et la physique moderne. Encore aujourd'hui, de tels rapprochements sont faits, particulièrement en relation avec la physique quantique. Cette thèse examine de manière critique ces rapprochements à travers l'étude comparative détaillée de deux concepts: le concept d'*ākāśa* dans l'Advaita Vedānta et celui de vide en physique quantique. L'énoncé examiné est celui selon lequel ces deux concepts pointeraient vers une même réalité: un substratum omniprésent et subtil duquel émergent et auquel retournent ultimement les divers constituants de l'univers. Sur la base de cette étude comparative, la thèse argumente que des comparaisons de nature conceptuelle favorisent rarement la mise en place d'un véritable dialogue entre l'Advaita Vedānta et la physique moderne. Une autre voie d'approche serait de prendre en considération les limites épistémologiques respectivement rencontrées par ces disciplines dans leur approche du "réel-en-soi" ou de la "réalité ultime." Une attention particulière sera portée sur l'épistémologie et le problème de la nature de la réalité dans l'Advaita Vedānta, ainsi que sur le réalisme scientifique et les implications philosophiques de la non-séparabilité en physique quantique.

Mots-clés: Dialogue; Sciences naturelles; Traditions spirituelles orientales; Advaita Vedānta; Physique moderne; Philosophie des sciences; *ākāśa*; Vide; Réalité; Épistémologie.

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Abbreviations

AitBr	*Aitareya Brāhmaṇa*
AU	*Aitareya Upaniṣad*
BhG	*Bhagavad-Gītā*
BS	*Brahmasūtra*
BrU	*Bṛhadāraṇyaka Upaniṣad*
BSB	*Brahmasūtrabhāṣya*
ChU	*Chāndogya Upaniṣad*
KaU	*Kaṭha Upaniṣad*
KsU	*Kauṣītaki Upaniṣad*
MaU	*Māṇḍūkya Upaniṣad*
MtU	*Maitrī Upaniṣad*
NS	*Nyāyasūtras*
PD	*Pañcadaśī*
PaU	*Paiṅgala Upaniṣad*
PDS	*Padārthadharmasaṃgraha*
PU	*Praśna Upaniṣad*
QFT	Quantum field theory
RV	*Ṛgveda*
SB	*Siddhāntabindu*
ŚBr	*Śatapatha Brāhmaṇa*
SK	*Sāṃkhyakārikā*
SPB	*Sāṃkhyapravacanabhāṣya*
TU	*Taittirīya Upaniṣad*
Upad	*Upadeśasāhasrī*
VP	*Vedānta Paribhāṣā*
VS	*Vaiśeṣikasūtras*

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Preface

Questions regarding the mystery of the world and its meaning have always fascinated me since my early days. I remember putting down some of my thoughts at the age of thirteen on Big Bang and black holes in a "book" which I called *The Universe: This Misunderstood Soul*. It was during my Bachelor in Physics (Laval University, 2000-03) that my interest for Eastern spiritual traditions, and especially Advaita Vedānta, took shape. After my Masters in Science (McGill University, 2003-05), I decided to go into interdisciplinary studies and started in 2005 a Ph.D. in Religious Studies at the University of Montreal. It is with my main advisor, Prof. Trichur S. Rukmani, that I read my first books and articles on Indian philosophy and had my first course on this topic at Concordia University. I then started learning Sanskrit at McGill University for two years (2003-05) before being awarded a one year doctoral fellowship by the Indo-Canadian Shastri Institute (Alberta, Canada) to study Indian philosophy and Sanskrit in India under the guidance of a traditional teacher (*guru*) in the Advaita Vedānta tradition, Prof. K. Ramasubramanian. With him, I had the chance to study primary texts in Advaita Vedānta, and to get a glimpse of the vastness and richness of Hindu culture and religion. Himself a Ph.D. in Physics, Prof. Ramasubramanian was of real help in shaping my ideas at the intersection of modern science and Advaita Vedānta. The present dissertation is the outcome of my five-year doctoral research, and in a sense a fulfillment of my continuous questioning about the universe and its ultimate significance.

Chapter 1

Introduction

Prior to the Scientific Revolution in the 16th century, questions about the nature, meaning and origin of the universe and life used to be the near-exclusive province of religion and natural philosophy. But soon modern science also proved to be an effective way of engaging life's deepest questions. Physics perhaps more than other natural sciences, has played a significant role in that regard. The basic goal of modern physics is to provide a description of the basic structures and processses at work in the physical world in terms of theories and mathematical models that can be used to generate empirically testable predictions. Since at least the late eighteenth century, much progress has been made by physicists in understanding a wide range of physical phenomena. The complex physics underlying electricity, magnetism and light has been elucidated. Fundamental concepts such as mass, forces, energy, atoms and fields have been introduced. In 1900, the study of heat radiation led Max Planck to lay down the foundations of quantum theory, a revolutionary theory describing the behavior of matter and energy at the atomic and subatomic levels. In 1905, Albert Einstein challenged two centuries of scientific belief by welding together space, time, energy and matter in his special theory of relativity. A decade later, his insights resulted in the first comprehensive theory of gravitation since Newton, a theory that would open the way to the field of modern scientific cosmology and shed light on the origin, development and structure of the universe. Since then, several other theories and ideas have emerged at the forefront of physics — quantum field theory, chaos theory, quantum cosmology, superstring theory and other approaches to the so-called Theory of Everything. These new approaches have deepened but also challenged our understanding of the physical world.

Since its beginnings, physics has been concerned with questions of a philosophical nature. Basically, metaphysical assumptions are constitutive of the conceptions of the physical world derived from physical theories.[1] This is perhaps more true today than ever before. Topics that were traditionally reserved exclusively to metaphysics — such as causation, determinism, laws of nature, the nature of space, time, matter and to some extent even the nature of consciousness — have become commonplace in theoretical physics and philosophy of physics. To the extent that it is concerned with the natural world, metaphysics as a branch of philosophy cannot but reflect on physics itself. As Tim Maudlin says: "Physical theories provide us with the best handle we have on what there is, and the philosopher's proper task is the interpretation and elucidation of those theories."[2] In other words, philosophers can no more ground their systems solely on their own thinking but must also take into account knowledge coming from natural sciences. In the view of leading quantum physicist Bernard d'Espagnat, "*any* tentative philosophical approach to a world-view should

[1] As explained by the philosopher of science Tian Yu Cao: "...a conception of the physical world involves a model of the constitution and workings of nature, and includes assumptions about the mechanisms for fundamental interactions among the ultimate constituents of matter, and an interpretation of the nature of space and time. That is, the conception involves what philosophers usually call metaphysical assumptions...Metaphysical considerations are of crucial importance for path-breaking physicists in their investigations. One reason for this is that these considerations constitute essential ingredients of their conceptual frameworks." See: Cao, *Conceptual Developments of 20th Century Field Theories*, xiii.

[2] Maudlin, *The Metaphysics Within Physics*, 1.

take information coming from contemporary physics into account quite seriously."[3] It is obvious that philosophers, even while reflecting on general matters not related to nature, often rely on concepts and notions pertaining to classical physics such as locality, distinguishability, continuity, and absolute space and time. Most of these notions, however, are either no more valid or have a restricted domain of validity in today's physics.

Naturally, the findings of contemporary science have also challenged religious accounts of nature and existence in many ways. With the increasing importance of science and technology in modern society and the accompanying change in how one views nature, the credibility of some central religious beliefs has been also seriously questioned. The challenge posed to religion is twofold: epistemologically, modern science has provided us with remarkable predictive models and methods whose efficiency has been confirmed with the development of powerful new technologies; ontologically, modern science has yielded knowledge of many previously inaccessible domains of nature, sometimes with characteristics radically different from those assumed by religion.[4] Further, since views of nature influence the way we treat nature and ourselves, science has also affected human values and goals as understood and framed by religion. Consequently, there has been an enormous interest in what might be called the *dialogue* between science and religion. How should we view science, religion and their relationship in modern society? What is the place of religion in an age of science? Such and similar questions have been debated by scientists, philosophers, theologians and scholars of all cultures and denominations particularly in the last decades. For historical reasons, however, most scholarly discussions on this topic have been focusing on themes pertaining to Western religious traditions (especially Christian) such as world creation, faith, theism and divine agency. Less studied in academic circles has been the encounter between modern science and Eastern spiritual traditions.[5] It

[3] d'Espagnat, *On Physics and Philosophy*, 1.

[4] Barbour, *Religion and Science: Historical and Contemporary Issues*, xiii-xiv.

[5] In this dissertation, we will use the term "Eastern spiritual traditions" to refer to the various

is with a segment of this particular encounter that this dissertation is concerned.

The encounter between modern science and Eastern thought is not a recent phenomenon. Already in the Enlightenment period some scholars were noting the "scientific" and rationalist character of the Confucian ethics, and claims of compatibility between science and Buddhism were made by European intellectuals during the 19th century.[6] Such claims have persisted well into the 20th century and have continued to the present day, including in relation to other schools as well, such as Taoism and Vedānta in Hinduism. In the last century in particular, several influential thinkers, including some world-renowned scientists, have found in the natural philosophies of China and India elements that seem compatible with modern science. But this encounter has not always been warmly welcomed by Western scholars. As John James Clarke explains:

> The latter [Eastern spiritual traditions] have often been perceived in the West as displaying an endemic mystical bent and a pervasive irrationalist tendency, and their role within Western orientalist discourse has sometimes appeared to be to act precisely as a counterweight to Western scientism and positivism.[7]

For this reason, several scholars have been reluctant to tackle the debate between science and religion from the angle of Eastern traditions. However, the perception of East as being essentially "mystical" and "irrational," often contrasted with West perceived as scientific, analytical and rational, is based on many prejudices. Recent scholarship has shown how such stereotypes, essentialising East and West into two simple and contrastive categories, have served many agendas in the West from religious, political to intellectual propaganda.[8] Many scholars still ignore or simply refuse to acknowledge the richness and depth of Eastern thought and thereby fail to under-

religious, cultural and intellectual traditions of India and China in general (esp. Hinduism, Buddhism and Taoism).

[6] Clarke, *Oriental Enlightenment: The Encounter Between Asian and Western Thought*, 165.

[7] *ibid.*

[8] See: Said, *Orientalism*; Halbfass, *India and Europe: An Essay in Understanding*; Clarke, *op.cit.*

stand its important role in the development of the Western intellectual tradition. Not only are there strong rational, logical and empiricist elements in Eastern traditions, but throughout the modern period from the time of the Renaissance onwards, the East has exercised a significant influence on Western cultural and intellectual life.[9]

On the other hand, claims of compatibility between modern science and "Eastern mysticism" have sometimes functioned as apologetics and as a means for criticizing the strong positivistic bent of Western scientific tradition, or to dismantle central beliefs pertaining to the Judeo-Christian tradition. They have also been used to improve the image of science and scientists as a counterpoint to anti-science movements, or as a means for advocates of diverse religions to justify and promote their own ways of believing and behaving. Apologetics, either for science or religion, underlies several recent writings relating to modern science and Eastern thought.[10] There is also the question whether it is historically and conceptually relevant to put modern science and Eastern traditions on a par. After all, one may argue, the "Scientific Revolution" took place in the West and not in the East. It might then be more appropriate to approach the science-religion debate by considering Western religions only. We cannot hold this position for several reasons. Firstly, there is the obvious fact that historically the development of modern science has been inextricably linked to non-Western cultures: to the Islamic and before it the Greek, Indian, ancient Iranian as well as Mesopotamian and Egyptian cultures.[11] Merely equating modern science with "Western science" and then setting the latter in opposition to Eastern thought is incorrect. Secondly, Eastern spiritual traditions are concerned with natural philosophy far more than Western religions. In Taoism, Buddhism and Hinduism, cosmological speculations about the origin, evolution and constitution of the universe are often

[9] Clarke, *op.cit.*, 5.

[10] See: Restivo, *The Social Relations of Physics, Mysticism, and Mathematics: Studies in Social Structure, Interests and Ideas*; Nanda, *Prophets Facing Backward: Postmodernism, Science, and Hindu Nationalism*; Drees, *Religion and Science in Context: A Guide to the Debates.*

[11] Nasr, *The Need for a Sacred Science*, 72.

closely intertwined with metaphysical inquiries into the meaning of human life and transcendence. Given that modern science itself developed out of natural philosophy, significant points of comparison could emerge while exploring Eastern spiritual traditions. Thirdly, there are currently several books and articles written on the subject that advocate either an over-simplified or misunderstood picture of the dialogue between modern science and Eastern thought. In view of all this, it is historically relevant to address these issues with careful scrutiny.

It seems imperative to further critical reflections on the ways modern science and Eastern thought can interact meaningfully. Such reflections would allow us to clarify the claims of compatibility raised in both scientific and religious literature, while simultaneously contributing to the broader science-religion debate with new theoretical approaches, methods and categories of thought. For instance one could address modern science using a different philosophical paradigm. Since its beginnings, philosophy of science has been embedded mostly in Western philosophical methods and categories of understanding. A consideration of Eastern thought, especially its philosophical features, could therefore provide alternative tools, concepts and methods with which to reflect on science and broaden our understanding of the kinds of premises about nature, human existence and reality that are characteristic of the Western tradition. In his book *Oriental Enlightenment*, Clarke aptly demonstrates how Eastern thought, throughout history, has often been

> an instrument of serious self-questioning and self-renewal, whether for good or ill, an external reference point from which to direct the light of critical inquiry into Western traditions and belief systems, and with which to inspire new possibilities.[12]

Hence, the general idea in the encounter with Eastern ways of thinking would not be to adopt wholesale ideas and principles from the East and deny contributions from the Western intellectual tradition. The underlying motivation could rather be to engage

[12] Clarke, *op.cit.*, 6.

in a *dialogue* with Eastern thought as a way to critically reflect on the Western tradition itself. Through comparison and fertile cross-referencing, one can rethink Western assumptions by placing them in a wider context and actually gain a greater understanding of the various ways in which humankind reflect about the world. Such a comparative approach appears to be desirable and academically relevant. In this dissertation, we therefore use *comparative philosophy* as a method and apply it to two other philosophical enterprises: philosophy of science and philosophy of religion.

Strictly speaking, comparative philosophy is not an independent discipline or a philosophy in itself but a comparison of existing philosophies. In his *Methodologies of Comparative Philosophy*, Robert. W. Smid defines comparative philosophy as

> an attempt to move across the boundaries of otherwise distinct philosophical traditions — especially insofar as these traditions are divided by significant historical and cultural distance — thus enabling a comparison of what lies on either side of the boundary.[13]

A direct by-product of comparative philosophy would then be, as Raimundo Panikkar puts it, to make "us acutely aware that we cannot do philosophy in a vacuum or only 'among ourselves."[14] In a continuous and open-ended fashion, comparative philosophy aims to learn from the views of others in contrasting them with one's own views. Paradoxically, it also ends up radically criticizing the comparative enterprise itself. Thus, an informed usage of comparative analysis involves hermeneutical reflexiveness as well, that is, a reflexive and self-critical understanding of the nature and validity of the comparative process. What is often lacking in comparisons involving modern science and Eastern thought is precisely a clarification of the problems that are likely to arise in approaching distinct philosophical traditions. Discussing the study of Eastern philosophy from a Western perspective, Hans-Georg Gadamer noted in a paper published in 1949:

[13]Smid, *Methodologies of Comparative Philosophy: The Pragmatist and Process Traditions*, 2.

[14]Panikkar, R., "What Is Comparative Philosophy Comparing?" In: Larson and Deutsch (eds.), *Interpreting Across Boundaries: New Essays in Comparative Philosophy*, 135.

> Although in the meantime the research in Eastern philosophy has made further advances, we believe today that we are further removed from its philosophical understanding. The sharpening of our historical awareness has rendered the translations or adaptations of the texts... fundamentally problematic... We cannot speak of an appropriation of these things by the Occidental philosophy. What can be considered established is only the negative insight that our own basic concepts, which were coined by the Greeks, alter the essence of what is foreign.[15]

Gadamer refers here to the importance of developing awareness of our own perspectives and presuppositions in the act of comparison itself. In other words, understanding the "other" does not mean thinking or seeing like the "other" but recognizing "otherness" while being aware of one's own biases and prejudices. One way of addressing this problem is to promote active academic collaboration and personal encounter between scholars from foreign traditions. During my doctoral project, I have myself undergone this process by spending more than one year in India studying under the guidance of a traditional teacher. Through him, I became acquainted with primary texts and methods in classical Indian philosophy and became familiar with Indian culture and religion. My in-depth interaction with Indian thought and praxis demonstrated for me the benefits of cross-cultural understanding and its usefulness in interdisciplinary studies.

The comparative enterprise is *not* a universalist project. In the context of a East-West dialogue, universalism has been defined "as the search for a single world philosophy, one which brings together and synthesises the diverse philosophical traditions of East and West."[16] In this view, the comparative approach would aim to specify basic assumptions, concepts, doctrines and ideas that these traditions hold in common, in order to forge a global philosophy or a "universal categorial structure that would be common to the philosophical texts of diverse cultures."[17] However, the problem arises as to how to translate one conceptual structure in terms of another

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[15] Quoted from: Halbfass, *India and Europe: An Essay in Understanding*, 164.
[16] Clarke, *op.cit.*, 119.
[17] *ibid.*, 121.

without favoring a particular conceptual framework. In his *Introduction to Comparative Philosophy*, Ulrich Libbrecht notes that comparison at the level of concepts and ideas (what he calls *surface structures*) is necessarily based on criteria that refer to pre-established conceptual frameworks. But there is no philosophical reason why a particular framework should be favored against another. Libbrecht suggests to situate the comparative enterprise at the level of *deep structures*. In his view, deep structures are ideally paradigm-free and stand out from all the existing cultures and philosophies.[18] The main task of comparative philosophy would not be to invent a new philosophy but to identify those deep structures and ask how they can be described. Though utopic in some ways, the thought and vision of Libbrecht has helped me in framing academic discussions in this dissertation.

Scope of the dissertation

This dissertation is a critical study of the current dialogue between the system of Advaita Vedānta in Hinduism and one of the most fundamental developments in modern physics, namely quantum physics. The Vedānta tradition has been recognized as an important and perhaps the most well-known tradition of theological and philosophical thinking in India. It has exerted a strong influence on all Indian religious traditions throughout history and still continues to attract a significant following all over the world. Under Vedānta there are a number of sub-schools, among which the most influential is arguably the non-dualistic school of Advaita Vedānta, primarily associated with the name of Śaṅkara, a philosopher and theologian who lived in India probably around the 8th century CE. As a theological system, Advaita Vedānta relies on the exegetical interpretation of a number of *Upaniṣads* and other texts which are

[18]Libbrecht, *Within the Four Seas: Introduction to Comparative Philosophy*, 87-89. According to Libbrecht, a deep structure that is fundamentally paradigm-free and universal could be "energy" (e.g., Greek *energeia*: that which lies in works; Chinese *ch'i*: that which fills the entire universe). See: *ibid.*, 92.

foundational to this tradition. The ultimate aim of the Advaita Vedānta system is the attainment of spiritual liberation, which is conceived to arise with the knowledge of one's own real nature. The term *advaita* means "non-dual" and refers to the absolute monist stance of the school. Thus, Advaita Vedānta holds that all distinctions are ultimately unreal and that there exists only one Reality, called *Brahman*, whose nature is pure consciousness. Liberation, therefore, comes with the realization that our innermost self is non-different from the one, all-comprehending and spiritual *Brahman*.

Toward the end of the 19th century, the Hindu monk Swami Vivekananda claimed that modern physics was inevitably converging towards Advaita Vedānta. In the following decades, in the midst of the revolution occasioned by the emergence of Einstein's relativity theory and quantum physics, a growing number of authors claimed to discover striking "parallels" between the worldviews of Vedānta and modern physics, especially quantum physics. Such claims of convergence have continued to the present day, not without being severely criticized by some other scholars. For Meera Nanda, for instance, the parallels drawn between physics and Vedānta amount to nothing but pure apologetics for Hinduism. In her book *Prophets Facing Backward: Postmodernism, Science, and Hindu Nationalism*, she declares that parallels are

> . . . most radical declarations that respect neither the integrity of physics nor the authenticity of mysticism that is the heart of Vedānta: physics is turned into mysticism and Vedānta is made to sound as if it were chiefly concerned with understanding the material world, which it never was.[19]

Nanda refers here to declarations made by representatives of the Hindutva ideology in India who would invoke convergence between Vedānta and natural sciences so as to promote the superiority of Hinduism over other religions. The intent behind such declarations is not a genuine encounter of Vedāntic thought and modern science but the creation of "a science of nature that does not contradict the sacred teachings of

[19] Nanda, *Prophets Facing Backward: Postmodernism, Science, and Hindu Nationalism*, 108.

the Vedas."[20]

That apologetics forms an important aspect of "science and religion" has been aptly demonstrated by Willem B. Drees in his recent book *Religion and Science in Context: A Guide to the Debates*. Drees describes how the encounter between science and religion is not always done for its own sake but often serves as apologetics for either science or religion, or as ammunition in the competition for authority within religious traditions.[21] The case discussed by Nanda goes in that sense as advocates of a specific religion here seek authority over other religions by having science on their side. But apologetics and competition between religious communities is not the whole story in the encounter between science and religion. One could also engage the dialogue, says Drees, for challenging nonsense and the pursuit of truth. He mentions the need both in the academic and public spheres to distinguish science from pseudo-science, and genuine spirituality from superstition. He is concerned about "promoting quality" and "avoiding multiplication of nonsense" in reflections on science, religion and their relationship.[22]

The purpose of this dissertation is *not* an attempt to discover the findings of modern physics in Vedānta or to show how modern physics is deeply "spiritual." Rather, the first objective of this dissertation is to provide a critical and philosophical examination of some claims of convergence recently made between quantum physics and Advaita Vedānta. As the field is vast, we have narrowed the detailed comparison to two specific concepts whose affinities have already been noticed by some authors: *ākāśa* (often translated as "space") in Advaita Vedānta and vacuum in quantum physics. What will be examined is the conceptual claim that both terms would refer to the same reality — an enduring, subtle and all-pervading physical substratum out of which the constituents of the world come into existence and to which they

[20] Nanda, M., "Vedic Science and Hindu Nationalism: Arguments against a Premature Synthesis of Religion and Science." In: Bagir (ed.), *Science and Religion in a Post-colonial World*, 27.

[21] Drees, *Religion and Science in Context: A Guide to the Debates*, 11.

[22] *ibid.*, 39.

ultimately return. Such a claim is paradigmatic of what we often find in parallelist literature. The other reason for working out this specific parallel is because of the assumption that a genuine dialogue between physics and Advaita Vedānta is possible and worth engaging. Unlike other concepts, *ākāśa* and quantum vacuum have been chosen as relevant for engaging in philosophical reflections on the *nature of reality*. The second objective of this dissertation is precisely to attempt a reconstruction of the encounter between modern physics and Advaita Vedānta along those lines.

In the last decades, modern physics has given new shape to philosophical ideas on the nature of matter, physical interaction, determinism and measurement. More significant is the fact that based on recent insights in quantum physics, some philosophers have been reinvestigating the old problem of realism in science and the nature of scientific knowledge as well. Ongoing reflections have been taking place on the inherent epistemological limitations of science in attempting to define the content of reality, and incidentally on the nature and relevance of the concept of "reality" in science. The nature of reality as a whole, and the role of reason and perception in disclosing knowledge of the "ultimate reality" (or *Brahman*) are also important issues in Advaita Vedānta. In such a context, a dialogue with Advaita Vedānta could provide alternative tools, concepts and methods from which to reflect on or approach the broader problem of reality in philosophy of physics. In turn, current knowledge in philosophy of physics could contribute significantly to adapt Advaita Vedānta to recent discoveries in science, and perhaps raise issues that could be relevant for both its theology and spirituality in the modern era. In contrast with Nanda and others, our approach to the encounter between modern physics and Advaita Vedānta is thus philosophical at the expense of socio-cultural and historical. Philosophical concepts and ideas are given more emphasis than human intentions, attitudes and contexts. Though one can hardly neglect human context in a cultural-historical sense, we take for granted that there is something worthwhile in exploring how both traditions can meet in philosophical terms.

Methodology and outline of the dissertation

In this dissertation, comparative philosophy is the general methodological framework in which the proposed philosophical reconstruction is developed. As outlined earlier, the very nature of comparative philosophy is about comparing existing philosophies; the two distinct philosophical traditions considered here are philosophy of religion on the one hand, and philosophy of physics on the other hand. The task of philosophy of religion is to provide a philosophical examination of the central themes and concepts involved in religious traditions. It is applied here to Advaita Vedānta in order to articulate its main philosophical concepts and doctrines, and particularly to situate the concept of *ākāśa* within a coherent philosophical framework. Philosophy of physics is a branch of philosophy reflecting on basic metaphysical and epistemological questions posed by physics. It is here applied to quantum physics in a way to understand some of its major philosophical implications, and particularly to address how philosophers today conceive the nature of quantum vacuum. As far as the issue of "reality" in philosophy of physics is concerned, emphasis is laid on the views of the French theoretical physicist and philosopher of science Bernard d'Espagnat. D'Espagnat is widely recognized as a leading authority in the field of interpretation of quantum physics and particularly renown for his works on realism in physics. His recent book *On Physics and Philosophy* was described by the physicist Roland Omnès as "surely the most complete book to have been written on this subject [philosophy of quantum physics] and one likely to last a long time..."[23] While presenting his views, however, it will be relevant to consider the views of two other French philosophers of science, Michel Bitbol and Hervé Zwirn, who also bring light to the problem of "reality" in philosophy of physics.

The dissertation is divided into five chapters. The first chapter, as just presented, introduced the topic of the dissertation, its context, scope, methodology and objec-

[23] Quoted from the backcover of Bernard d'Espagnat's book *On Physics and Philosophy*.

tives. In Chapter 2, we introduce in a critical manner the kinds of "parallels" drawn between Advaita Vedānta and quantum physics. Theoretical issues such as the role of the observer in measurement, holism and the ground of existence are examined. We also look into the various problems that are likely to arise when bringing together ideas from different disciplines (a practice that will be called "parallelism"), and discuss the different ways in which the relation between science and religion has been understood. In Chapters 3 and 4, we study in detail the two concepts under scrutiny in our comparative analysis: vacuum in quantum physics (Chap. 3) and *ākāśa* in Advaita Vedānta (Chap. 4). In Chapter 3, we first introduce briefly the diverse conceptions of vacuum in the Western world from Antiquity to the modern period. The rest of the chapter is concerned with philosophical issues in quantum physics, and particularly with the assessment of quantum vacuum in philosophy of physics. In Chapter 4, we investigate the concept of *ākāśa* in Hindu philosophical thought from the Upaniṣadic to the classical period with a focus on Śaṅkara's Advaita Vedānta. Advaita Vedānta has been approached from a philosophical standpoint along with references to primary texts wherever necessary. In the first part of Chapter 5, we engage in a detailed comparative analysis of quantum vacuum and *ākāśa* and draw some general conclusions about the nature and relevance of conceptual parallels. In the second part, we lay the basis for a philosophical reconstruction of the dialogue between modern physics and Advaita Vedānta. Emphasis is given to epistemology and the problem of reality in Advaita Vedānta, and scientific realism and philosophical implications of nonseparability in quantum physics.

Chapter 2

Eastern Spiritual Traditions and Quantum Physics

A large number of books and articles relating modern physics and Eastern spiritual traditions were published in the last four decades.[1] The pioneer work in this domain is often quoted as Fritjof Capra's *The Tao of Physics*, a best-seller published in 1975 that has since been translated in 20 languages and is available today in more than 40 editions.[2] Capra's attempts to blend modern physics with Eastern thought was soon followed by many authors — scientists, laymen, media people, New Age followers, spiritual teachers as well as religious devotees from various Eastern traditions.[3]

[1]Some authors drawing parallels between these disciplines commonly use the term "Eastern mysticism" to denote the Eastern spiritual traditions. For the sake of convenience, this expression will often be used in this chapter. It must be noted, however, that this is an inadequate expression. Though mystical practice and contemplation play a crucial role in traditions like Taoism, Buddhism, Jainism and Hinduism, each tradition also includes religious features like rituals, beliefs, devotional exercises, etc., as well as doctrinal and philosophical features.

[2]Capra, *The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism.*

[3]To mention a few: Le Shan, *The Medium, the Mystic and the Physicist*; Zukav, *The Dancing Wu-Li Masters: An Overview of the New Physics*; Talbot, *Mysticism and the New Physics*; de

Overall, much work has been done examining the relationship between modern science and elements of Hinduism, Buddhism and Taoism.[4] Meetings between respected scientists and Eastern spiritual teachers have become more frequent, and a course about the "Tao of Physics" was even taught at the University of Toronto[5]. Various movements, research centers and foundations have emerged as an attempt to reconcile modern science with Eastern spiritual traditions, and an increasing number of international conferences have been held on the subject around the world.

Often referred to as "quantum mysticism,"[6] the practice that likens quantum physics principles and Eastern spiritual ideas was popularized in the 1970s with Capra's book and further revived by a number of authors. A movie, *What the Bleep Do We know!?*, was even produced on the subject in 2004. This film blends Eastern and New Age ideas with notions of quantum physics to illustrate that the material world is a form of consciousness and that human beings "create" their own reality.[7]

Riencourt, *The Eye of Shiva: Eastern Mysticism and the New Physics*; Weber, *Dialogues with Scientists and Sages*; Zohar, *The Quantum Self: Human Nature and Consciousness Defined by the New Physics*; McFarlane, *Einstein and Buddha: The Parallel Sayings*; Clarke, *Ways of Knowing: Science and Mysticism Today.*

[4]In particular, the relation between Buddhism and modern science has been discussed widely in the recent years. Buddhism would share several features with modern science: a shifting from beliefs and tradition, a commitment to understand all phenomena in a dispassionate and objective manner, an interest in human psychology and so forth. See: Jacobson, *Buddhism and the Contemporary World: Change and Self-Correction*; Hayward, *Shifting Worlds, Changing Minds: Where the Sciences and Buddhism Meet*; Wallace (ed.), *Buddhism and Science: Breaking New Ground*; Houshmand and Zajonc, *The New Physics and Cosmology: Dialogues with the Dalai Lama*; Ricard and Thuan, *The Quantum and the Lotus*; Lopez Jr., *Buddhism and Science: A Guide for the Perplexed.* Similarly, the organicist worldview found in Taoism — in which natural phenomena are seen as parts of a living organism rather than parts of a mechanical process — has been compared with some insights in modern science. See: Needham, *Science and Civilization in China.*

[5]Harrison, "Teaching the Tao of Physics."

[6]Wertheim, "Quantum Mysticism."

[7]The movie was successful and a second, substantially changed, extended DVD version was released in 2006: *What the Bleep!?: Down the Rabbit Hole.* However, the movie has been severely

Among the proponents of such ideas, many would draw their inspiration from famous physicists such as Niels Bohr, Erwin Schrödinger, Werner Heisenberg and Robert A. Oppenheimer, who all showed some interest for Eastern thought. Bohr was especially interested in Taoist philosophy, so much so that he chose the Taoist *yin-yang* symbol for his coat of arms. Heisenberg, famous for his *uncertainty principle*, visited Rabindranath Tagore in India in the 1930s. He later acknowledged that the deep discussions he had with him on Indian philosophy stimulated his own ideas in physics.[8] As for Oppenheimer, he was known for being well-versed in Indian philosophy (he especially appreciated the *Bhagavad-Gītā*) and familiar with the Sanskrit language.

Schrödinger stands as a particular case as he was probably (among the mentioned physicists) the most familiar with Indian philosophy. He knew quite well the writings of Arthur Schopenhauer — who was himself deeply involved in the philosophy of the *Upaniṣads* and Buddhism — and the works of German orientalists like Paul Deussen, Richard Garbe, Max Müller and others. He was especially attracted by the Hindu system known as Advaita Vedānta, which he described as a "foundation for his life and work."[9] In 1925, he published a book called *Meine Weltansicht* (*My View of the World*), in which he suggests that Advaita Vedānta may provide an adequate metaphysical grounding and religious framework to modern Western civilisation. Interestingly, Schrödinger wrote that intensely personal account of his philosophy of life just before his revolutionary paper on what would later be called the Schrödinger equation, such that the "time of introspection recorded in *Meine Weltansicht* was also the time during which his psychological resources were subconsciously marshalled for the creation of a new world of physics in the papers of 1926."[10] However, Schrödinger is not the only figure evoking a rapprochement between Advaita Vedānta and modern

criticized for misrepresenting science. See: Shermer, "Quantum Quackery"; Kuttner and Rosenblum, "Teaching Physics Mysteries Versus Pseudoscience"; Wertheim, "Quantum Mysticism."

[8]Wilber (ed.), *The Holographic Paradigm and Other Paradoxes: Exploring the Leading Edges of Science*, 218.

[9]Moore, *Schrödinger: Life and Thought*, 173.

[10]*ibid.*, 168.

science. A few decades earlier, the Hindu monk reformer Swami Vivekananda claimed at the Chicago's Parliament of Religions in 1893 that in his opinion the latest discoveries of science seemed like "echoes" from the "high spiritual flights of the Vedānta philosophy."[11] After coming back from the West, he claimed that:

> It seems to us, and to all who care to know, that the conclusions of modern science are the very conclusions the Vedānta reached ages ago; only, in modern science they are written in the language of matter.[12]

Although neither quantum physics nor Einstein's relativity were yet invented at that time, the vision of Vivekananda certainly inspired future generations of scholars and scientists to work towards the reconciliation of modern physics and Advaita Vedānta. A large number of books on the relationship between Advaita Vedānta and modern physics continues to be published to this day.[13]

In this chapter, we will be dealing especially with parallels between Advaita Vedānta and quantum physics. Our aim is not to argue in detail about the validity of such parallels but to offer a critical introduction to their content and nature. We have centered our discussion around two specific theoretical issues: 1. the role of the observer in measurement, and the correlative assertion that consciousness (or

[11] Quoted from: *The Complete Works of Swami Vivekananda* (Vol.1), Addresses at the Parliament of Religions, "Paper on Hinduism."

[12] Quoted from: *The Complete Works of Swami Vivekananda* (Vol.3), Lectures from Colombo to Almora, "The Mission of Vedānta." Vivekananda was confident that Advaita philosophy and discoveries of modern science would one day be in perfect agreement with each other. Apparently, he was himself working on such a problem: "I am working a good deal now upon the cosmology and eschatology of the Vedānta. I clearly see their perfect unison with modern science, and the elucidation of the one will be followed by that of the other." Quoted from: *The Complete Works of Swami Vivekananda* (Vol.5).

[13] Most Advaita scholars interested in this topic are attached to the Ramakrishna Mission, founded by Swami Vivekananda in 1897. For instance: Jitatmānanda, *Modern Physics and Vedānta*; Mukhyānanda, *Vedānta in the Context of Modern Science*. A large number of books have also been published by scientists and scholars attracted to the thought of Vedānta: Dobson, *Advaita Vedānta and Modern Science*; Goswami, *Self-aware Universe: How Consciousness Creates the Material World*; Panda, *The Vibrating Universe*; Panda, *Māyā in Physics*; Chandrasekharayya, *Vedānta and Modern Physics*.

mind) should be fundamental to our description of reality. In the view of some authors, quantum physics would advance that there is no separation between subject and object, that reality is essentially of the nature of consciousness, and that human consciousness "creates" physical reality; 2. holism in quantum physics, i.e., the idea that the physical universe is an undivided whole in which everything is interconnected. These two ideas are recurrent in parallels made with Advaita Vedānta as this system considers the plurality of empirical phenomena to be the expression of a unitive and underlying principle of existence and consciousness called *Brahman*. However, claims of convergence or compatibility between modern physics and Advaita Vedānta have given rise to a number of criticisms from scientists and academics. We have included some of them in our discussion as well as a reflection on the potential pitfalls related to the practice of "parallelism" as such. This introduction will thus serve to provide some methodological basis for and to put into context the comparative study undertaken in this dissertation.

2.1 Nature of the Parallels

The advent of quantum physics at the beginning of the 20th century radically changed the conception of the physical world which was prevailing in science at that time. Prior to that, and for about three centuries, classical physics constituted the foundation for science as a whole.[14] Classical physics worldview was simple, coherent and agreed with common sense. It made three major assumptions about the universe: 1. *realism*: the universe embedded in space and time exists apart from the observer; 2. *determinism*: knowing the initial state of a physical system, it is possible to know with certainty

[14]Classical physics is a term used to denote the different branches of physics before the formulation of relativity and quantum physics. It usually includes Newtonian mechanics, Boltzmann's thermodynamics as well as Maxwell's theory of electromagnetism. Sometimes, it also includes special and/or general theories of relativity and chaos theory (nonlinear dynamics).

any future state of this system; 3. *reductionism*: a complex system is nothing but the sum of its parts and its behavior can be known from the behavior of its parts.[15] The classical universe was a huge clockwork mechanism in which physical bodies moved with respect to each other according to precise natural laws. Matter, absolute space and time, and forces between bodies were the basic ingredients of the classical ontology; its epistemology was guided by the principle that an objective representation of the outside world is possible.

Quantum physics put into question these three major assumptions. In only three decades, starting with the pathbreaking work of Max Planck and Niels Bohr, quantum physics shattered the classical picture of the world, revealing classes of phenomena that classical physics could not : 1. the fact that certain physical quantities (ex: energy) are "quantized" in small discrete units; 2. the *wave-particle dualism*, or the fact that elementary particles behave like particles *and* waves; 3. the fact, stated in Heisenberg's uncertainty principle, that it is physically impossible to know both the position and momentum of a particle at the same time, implying indeterminism; and 4. *nonseparability*, i.e., the phenomenon by which the states of two or more quantum objects are entangled together so that the state of one object is related to the other in some way, whether or not the objects are spatially distant. In contrast with classical physics, quantum physics pays special attention to the process of measurement. Because it deals with small systems (e.g., atoms), interaction between observer and observed system obtains a fundamental importance in this theory. On this basis, some have alleged that classical realism does not hold anymore because of the prominent role played by the observer. Others have merged this idea with nonseparability, making the universe an undivided whole in which the observer and the observed are underlain by the same reality, that is, consciousness. Since such ideas are commonly found in Eastern spiritual traditions, it is no surprise that some parallels between the disciplines have been drawn.

[15] Barbour, *Religion and Science: Historical and Contemporary Issues*, 165.

2.1.1 The Role of the Observer

Heisenberg's uncertainty principle stands as a central feature in quantum physics. The impossibility of knowing with certainty both the position and momentum of a particle at the same time shakes the foundation of classical determinism, which affirms that we can predict a system's future state given a set of initial positions and momenta.[16] Because of the extreme smallness of an atomic system, no observation can be made without considerably affecting the system. However, this has been interpreted in different ways by scientists and philosophers of science. For some, the uncertainty in knowing the precise state of an atomic system merely indicates our own incapacity; we will eventually discover exact laws to construe exact knowledge of the system. But for most scientists uncertainty stands as an objective feature of nature itself. A possible implication of this view might be that no "independent" reality exists, that is, no reality independent of our measurement. The observer always interferes with the observed system and this very interference prevents him from knowing reality *as it is*. What quantum physics calls "objective reality" cannot be independent from the observer.

Some authors have argued that this view is in agreement with Eastern philosophies that postulate an intimate relationship between the observer and the observed. According to Capra, for instance, Heisenberg's principle shows that "there are no objective properties of nature independent of the human observer," an insight he sees as "one of the main parallels to mystical knowledge."[17] The observer-participant "is an idea well known to any student of mysticism."[18] In *Mysticism and the New Physics*,

[16] The principle can also be extended to other "conjugate variables" such as energy and time.

[17] Quoted from: Wilber (ed.), *The Holographic Paradigm and Other Paradoxes: Exploring the Leading Edges of Science*, 228.

[18] Nonetheless, Capra is aware that mysticism goes much farther than quantum physics in denying all differences between observer and observed whereas in quantum physics, the observer and the observed are still distinguished from each other. See: Capra, *The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism*, 141-42.

Talbot infers from Heisenberg's principle that the conscious observer influences quantum phenomena. He describes the quantum world as "omnijective," i.e., inextricably connected with the subjective consciousness of the scientist.[19] For Jitatmānanda, this discovery links "modern physics directly to the mystical traditions of Vedānta philosophy."[20] However, if Heisenberg's principle indeed highlights the primary role played by observation in quantum experiments, it does not claim anything about the observer himself influencing the observed system, or the subject-object duality being "transcended," as in some Eastern spiritual traditions. Strictly speaking, the interference is not between the conscious observer and the object, but between the object and the measuring device. This inevitable interaction is not new: whether classical or quantum, any experiment involves a form of manipulation. Quantum physics does not abolish the division between subject and object. Louis de Broglie, Nobel laureate for his formulation of wave mechanics, declared:

> [It has been said that] quantum physics reduces or blurs the dividing region between the subjective and the objective, but there is... some misuse of language here. For in reality the means of observation clearly belong to the objective side; and the fact that their reactions on the parts of the external world which we desire to study cannot be disregarded in microphysics neither abolishes, nor even diminishes, the traditional distinction between subject and object.[21]

It is significant that though a profound admirer of Eastern thought, Schrödinger was against the view that the subject correlates with the observed system in the measurement process:

> It is maintained that recent discoveries in physics have pushed forward to the mysterious boundary between the subject and the object. [...] We are given to understand that we never observe an object without its being modified or tinged by our own activity in observing it [...] Still I would not like to call this a direct influence of the subject on the object. For the subject, if anything, is that thing that senses and thinks. Sensations and

[19] Talbot, *Mysticism and the New Physics*, 1-2.

[20] Jitatmānanda, *Modern Physics and Vedānta*, 52.

[21] de Broglie, *Matter and Light*, 252.

> thoughts do not belong to the "world of energy." They cannot produce any change in the world of energy [...][22]

Nonetheless, the dividing line between subject and object has unquestionably *shifted* with quantum physics. Whereas the classical physics "subject" includes both the observer (mind, body, sense-organs) and the measuring device, quantum physics assigns the measuring device, sense-organs, etc. — i.e., everything except what "senses and thinks" — to the objective domain. Chandrasekharayya points out that in this sense, quantum physics is seemingly moving closer to the conception of the subject advocated in Advaita Vedānta. According to Śaṅkara, the major exponent of this philosophy, the external world (i.e., the "non-Self") includes the environment *and* the human body, senses as well as the instruments of "inner perception" (mind and other cognitive faculties). What remains as the subject (i.e., the "Self") is only the witnessing consciousness.[23]

Perhaps more conspicuous are the parallels involving the "measurement problem" in quantum physics, also called "the wavefunction collapse." Essentially, the wavefunction contains information about all the possible outcomes in a quantum experiment. Mathematically, it is expressed in terms of a "superposition of states," each state representing an alternative outcome. What is called the "wavefunction collapse" is the process by which a wavefunction, initially in a superposed state, appears to "collapse" to a single state (the one measured) following the measurement. The problem here is to understand the process by which this "collapse" occurs. The answer to this problem partly depends on the meaning we ascribe to the wavefunction. For some, the wavefunction has no physical or ontological significance: it simply encodes what *we know* about the physical system. Thus, the collapse expresses the fact that the observer has acquired additional information about the system during measurement. Others take the wavefunction to be physically real, and for them the collapse is a real

[22]Schrödinger, *Mind and Matter*, 49-50.
[23]Chandrasekharayya, *Vedānta and Modern Physics*, 330-32.

process: there must be a physical mechanism at the origin of the collapse. In this line of thinking, some distinguished scientists, like John von Neumann and later Eugene Wigner, proposed that the mechanism at the origin of the collapse is *consciousness* itself. Quantum results are fixed only when they enter somebody's consciousness. Von Neumann argued that a system's initial state of superposition is transferred to the measuring device during measurement. When measured by another system, the superposition is also transferred to this system and so forth. This is called the *von Neumann's Chain.* In 1939, Von Neumann, together with London and Bauer, suggested that since nothing can measure consciousness, the transfer would be stopped by a conscious observer.[24] Decades later, Eugene Wigner invoked similar arguments to explain how measurement takes place in quantum mechanical experiments. He maintained that unless a deeper study of consciousness was undertaken, solving the theoretical problems related to quantum physics would hardly be possible.[25]

The main problem with this interpretation is that, in practice, the outcome of a quantum experiment is the same for different observers. If the collapse to a specific state was caused by individual consciousness alone, how could the same state be measured by several individuals? Another renowned physicist, John A. Wheeler, proposed that the wavefunction collapse does not occur through individual consciousness but through *intersubjective agreement* between observers. What is crucial is not the observer's consciousness but the communication between the individuals involved. In his view, we are not only observers but *participators* as well in the evolution of the universe:

> ...The vital act is the act of participation. "Participator" is the incontrovertible new concept given by quantum mechanics. It strikes down the term "observer" of classical theory, the man who stands behind the thick glass wall and watches what goes on without taking part. It can't be done, quantum mechanics says.[26]

[24] Von Neumann, *Mathematical Foundations of Quantum Theory*; London and Bauer, *La théorie de l'observation en mécanique quantique.*

[25] Wigner, *Symmetries and Reflections.*

[26] Wheeler, Thorne and Misner, *Gravitation*, 1273.

The participation of the observer entails that we can no longer uphold the view of a world that exists out there, independently of a community of observers. Yet, it does not mean that consciousness has a direct influence on atomic phenomena, as claimed by Wigner and others. Wheeler himself declared that "consciousness... has nothing whatsoever to do with the quantum process."[27] Since Wheeler, however, some physicists have furthered interpretations of quantum physics in which matter is either conceived to interact with or be an expression of consciousness.[28]

Some authors have eagerly put forward consciousness-based interpretations to support their claim that quantum physics converges towards Eastern spiritual teachings. For instance, in *Mysticism and the New Physics*, Talbot maintains that "Wheeler's suggestion of the term 'participator' demonstrates the mystical nature of the new physics."[29] Zukav sees in Wheeler's above quotation an echo of the language used by Eastern mystics.[30] In *Māyā in Physics*, Panda claims that the Advaita Vedānta concept of "illusion" (*māyā*) — whose function is to explain the manifold and non-sentient character of phenomena — is "hidden in the concept of participation of the quantum physicist."[31] Jitatmānanda affirms that Wigner's explanation as to the role of consciousness in quantum experiments "brings modern physics almost at the door of Vedānta."[32] In the present context, it is worth mentioning Amit Goswami's

[27] Quoted from: Stenger, *The Unconscious Quantum: Metaphysics in Modern Physics and Cosmology*, 97. Ken Wilber notices that Wheeler considered "physics/mysticism attempts as "moonshine," "pathological science" and "charlatanism." (Wilber (ed.), *op.cit.*, 185) However, if Wheeler was indeed against any form of easy parallelism, he seemed to take ancient philosophies as important sources of inspiration in science, as it appears from the letter he wrote to Swami Jitatmānanda (available in Jitatmānanda's book *Modern Physics and Vedānta*).

[28] See: Stapp, *Mind, Matter, and Quantum Mechanics*; Stapp, *Mindful Universe: Quantum Mechanics and the Participating Observer*; Wolf, *Mind into Matter: A New Alchemy of Science and Spirit*; Wolf, *The Spiritual Universe: One Physicist's Vision of Spirit, Soul, Matter, and Self.*

[29] Talbot, *op.cit.*, 12, 25.

[30] Zukav, *The Dancing Wu-Li Masters: An Overview of the New Physics*, 54.

[31] Panda, *Māyā in Physics*, 307.

[32] Jitatmānanda, *op.cit*, 43.

views on the interpretation of quantum physics. In his book *The Self-Aware Universe*, Goswami suggests that the well-known paradoxes of quantum physics would find a satisfactory resolution only if we interpret consciousness in the non-dual sense of Advaita Vedānta.[33] Like von Neumann and Wigner, Goswami also believes that consciousness is responsible for collapsing the wavefunction. But in contrast with them, he is against any form of "psychokinesis," i.e., any kind of human consciousness application upon matter. In his view, the different outcomes of an experiment would exist as "waves of possibility" within a kind of transcendent consciousness. The process of collapse occurs when consciousness recognizes and then chooses one of the possibilities, which then becomes the "observed event."[34] His notion of consciousness is not limited to the individual but extends to that of a transcendent and unitive consciousness of which individual consciousness is only a partial manifestation.

However, from a scientific perspective there are serious problems with Goswami's interpretation.[35] Firstly, it is impossible to prove wrong his hypothesis of a consciousness transcendent to matter and mind: there is simply no way to measure or quantify such consciousness. Further, Goswami's thesis does not conclusively explain *how* this transcendent consciousness actually effects the collapse. Secondly, whether human consciousness alone has the ability to collapse the wavefunction or if any other form of consciousness has also this ability remains to be explicated. In the case where human consciousness alone could collapse the wavefunction, without someone to make it collapse, the world would have remained in a state of superposition for ages; unless atoms had the ability to collapse their own wavefunction with their own "consciousness," which is hardly admissible. Thirdly, the transcendental realm beyond space and time hypothetically contains the various possible outcomes encoded within the

[33] Goswami, *The Self-Aware Universe: How Consciousness Creates the Material World*. See also: *Science and Spirituality: A Quantum Integration*; *Quantum Creativity*; *God Is Not Dead: What Quantum Physics Tells Us About Our Origins and How We Should Live.*

[34] Goswami, "Physics Within Nondual Consciousness," 537.

[35] See: Novella, "Quantum Confusion: Does Modern Physics Support the Psychics?"; Stenger, "Quantum Quackery"; Shermer, "Quantum Quackery."

wavefunction. Yet, wavefunction in quantum physics is typically a function of space and time, and thus part of the phenomenal realm. Finally, consciousness is equated in Advaita Vedānta with *Brahman*, the all-comprehending reality. But the latter is by definition the subject *sui generis*, pure consciousnes; to describe it using conceptual categories is necessarily to make it an object of knowledge. Strictly speaking, to associate *Brahman*, or non-dual consciousness, with elements of a physical theory is to make a category mistake, to bring the non-conceptual into the conceptual domain.

Evidently, relying on consciousness to resolve paradoxes of quantum physics brings in multiple problems. For the renowned philosopher of science Karl R. Popper, "the intrusion [of consciousness] into the probabilistic theory of quantum mechanics seems. . . to be based on bad philosophy and on a few very simple mistakes."[36] It might be that the subjective nature of consciousness is incompatible with the mathematical formalism and experimental requirements of quantum physics. In its primary sense, consciousness might have more affinities with the domain of metaphysics than that of physics as such. Let us also recall that consciousness-based interpretations assume the wavefunction has a physical significance. But there are other viable interpretations of quantum physics that give a different meaning to the wavefunction and its collapse.[37] However, those claiming convergence between quantum physics and Eastern spiritual

[36]Popper, *Quantum Theory and the Schism in Physics*, 86.

[37]In David Bohm's pilot wave model, the wavefunction does not contain all the information about the system since there exist "hidden variables" (position, momentum, etc.) which dictate how the particles move in reality. There is no collapse here and the wavefunction remains in a state of superposition even after measurement. In Everett's multi-world interpretation, there is also no collapse of the wavefunction: the initial superposed state is considered to split into different macroscopic world-lines (or "universes") mutually independent from each other. More recently, the phenomenon of *decoherence* has been invoked to explain how wavefunction *apparently* collapses during measurement. The idea here is that the superposed nature of a quantum state is "leaked" into the macroscopic environment so that the superposition exists but is no more measurable. In all these interpretations, there is no need for introducing the notion of consciousness to explain the real or apparent collapse of the wavefunction.

traditions barely address these interpretive issues. Not only do they overlook arguments raised by physicists and philosophers of science against consciousness-based interpretations, but they also virtually ignore the theoretical complexity underlying the physics. In addition, in most cases (except perhaps in Goswami's case), when scientists discuss consciousness, they refer to something considerably different from the inner form of consciousness of Eastern spiritual traditions. Whereas in science it denotes awareness of external things and events, the spiritual traditions are especially concerned with introspective states of meditation.[38]

In sharp contrast with classical physics, quantum physics emphasizes the role of interaction in quantum experiments. The observer's inevitable influence on the observed system revealed in Heisenberg's principle has convinced most physicists of the inherent impossibility of knowing reality "as it is." In the view of British physicist Arthur Eddington, for instance, the most significant philosophical contribution of quantum physics is to show that "physical science is concerned with a world of shadows" and not with a *real* physical world.[39] Does this imply the end of realism in science? Should it be concluded that science deals with an illusory world, an arbitrary projection of the human mind? In Chapter 5, we will discuss an alternative version of scientific realism that keeps with the notion of a mind-independent reality while taking into account the most recent insights in quantum physics. In this context, the nature and implications of consciousness in relation to the empirical world stand as important issues. Consciousness may still have an important, though more subtle, role to play in contemporary interpretations of quantum physics.

[38]Scerri, "Eastern Mysticism and the Alleged Parallels with Physics," 690.

[39]Eddington, *The Nature of the Physical World*, 282.

2.1.2 Holism in Quantum Physics

Another topic that has generated much discussion and lent itself to analogies with Eastern spiritual traditions relates to the connections underlying the physical world described in quantum physics. Most Eastern schools of thought (as well as Western mysticism) teach the existence of a ground of being underlying the phenomenal world, an undifferentiated oneness experienced in the depth of contemplative meditation. Similarly, we are told, quantum physics shows the unity and interconnectedness of all events at the atomic level. Classical reductionism must be replaced by a holistic worldview in which the undivided whole is the fundamental reality. In this view, elementary particles are not the fundamental blocks of the physical world; they are simply epiphenomena of the whole. This worldview grew in importance with the development of quantum field theory — the application of quantum physics principles to classical field theory — in which the central element is the "quantum field" and not the particle. In particular, *nonseparability* in quantum physics has also challenged the idea that "quantum objects" are individualized and localized entities in space and time. We now discuss this important phenomenon.

Also called "quantum entanglement," nonseparability was revealed in a series of rigorous experiments aiming to test predictions made in a theorem formulated by John Bell in 1964. This theorem was itself a response to questions raised by the famous EPR ("Einstein-Podolsky-Rosen") thought experiment proposed by Albert Einstein, Boris Podolsky and Nathan Rosen in 1935. The EPR experiment raised an argument against the Copenhagen interpretation of quantum physics, which is historically the first general attempt to understand the atomic world represented by quantum physics. The interpretation, supported by Bohr, Heisenberg, Born and others, posits among other things that we cannot report the state of an atomic system *before* measurement. Prior to measurement, the system consists of different quantum states in superposition, and it is meaningless to speak about any property of the system as if it were real and uniquely defined. A physical property gains physical reality through the collapse of the wavefunction only after measurement. In other words, the conception of a world independent of our observation must be abandoned. The EPR thought experiment sought to challenge this view and prove that quantum physics is an incomplete physical theory.[40] Einstein and his collaborators believed that physical theory should describe nature *as it is* and not, as Bohr maintained, what we *can say* about nature: there must be a one-to-one correspondence between every element of a physical theory and elements of the physical reality described. The EPR experiment was an attempt to show that it is possible to know with certainty the value of a physical property without measuring it. In this case, the property would be precisely defined before measurement and known at the moment of measurement.

In one version of the experiment, a source breaks down in two particles that fly off in opposite directions. Initially, the system has a total "spin" equal to zero, so that the sum of the spins of each particle after disintegration remains equal to zero even when particles are far removed from each other.[41] If a detector is placed on the flight path of the first particle and measures a certain spin component, we can conclude that the same spin component for the second particle will have the opposite value, *without having to interact with the second particle*. However, if the spin of the second particle is defined only *after* measurement of the first particle, we must conclude instantaneous transmission of information between particles, thus contradicting the basic principle of the theory of relativity. To avoid the contradiction, one must presume the spin of

[40]Einstein, Podolsky and Rosen, "Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?" For more detailed descriptions of the EPR thought experiment, see: Pagels, *The Cosmic Code: Quantum Physics as the Language of Nature*; Selleri, *Quantum Mechanics Versus Local Realism: The Einstein-Podolsky-Rosen Paradox*.

[41]To give an intuitive representation of the spin of a particle, we can think of a ball rotating on itself. The spin would be the equivalent of the kinetic momentum of rotation, i.e., a vector with a length proportional to the angular velocity of rotation and having the same direction than the axis of rotation. However, the spin is fundamentally a quantum property since it is quantized, i.e., it can only take some precise and discrete values.

the second particle (called a "hidden variable" because it is described by quantum physics) well-defined in flight. Quantum physics is unable to define such a state, thus we must accept that quantum physics is an incomplete theory. Einstein, Podolsky and Rosen based their arguments on two main assumptions: 1. *classical realism*, i.e., particles possess well-defined properties independently of observation; and 2. *locality*, i.e., as relativity prescribes, there can be no transmission of information between two systems faster than the speed of light.

Three decades later, in 1965, Bell formulated a theoretical inequality to test the above assumptions against the predictions of quantum physics.[42] Between 1980-82, Alain Aspect and collaborators performed the required experiments and showed that some of them violated Bell's inequality, indicating that quantum physics was right and that one of Einstein's assumptions was wrong.[43] In 1997, a group of physicists in Geneva obtained the same results with photons distanced more than 10 kilometers apart.[44] Violation of Bell's inequality implies that if classical realism is maintained — i.e., quantum physics is incomplete and a yet unknown "hidden-variable" theory exists — the assumption of locality cannot hold true. In other words, no classically realistic local theory can ever reproduce all of the predictions of quantum physics. In this situation, two different options can be drawn: either, like Bohr, we give up classical realism and keep locality; or, like David Bohm later proposed, we hold to realism and give up locality.

Most physicists have since followed Bohr and abandoned the idea that atomic systems have well-defined properties before measurement. It is meaningless to speak about the quantum world in realistic terms, independently of the observer. In the EPR experiment, the distant particles must be regarded as a single system prior to measurement. Though apart from each other, they form an inseparable whole and

[42] Bell, "On the Problem of Hidden Variables in Quantum Mechanics."

[43] Aspect *et al.*, "Experimental Tests of Realistic Local Theories via Bell's Theorem"; "Experimental Test of Bell's Inequalities Using Time-Varying Analyzers."

[44] Tittel *et al.*, "Violation of Bell Inequalities by Photons More than 10km apart."

possess no individuality of their own: they are "nonseparable" or "entangled" together. At measurement, we acquire knowledge about the state of one of the particles and deduce that of the other particle: the initial "entangled" wavefunction collapses to individual wavefunctions. At this moment, each particle somehow "acquires" an individuality. But this is a matter of inference only because another observer could not reach this conclusion unless he is aware of the results of the measurement. In other words, the collapse does not represent objective reality but the observer's knowledge of reality, which brings us back to Bohr and his view of quantum physics as an interpretation rather than a description of nature.

If a majority of physicists have tended to favour Bohr's interpretation, a few have argued that nonseparability can still admit a realism different from classical realism. Among others, the physicist and philosopher of science Bernard d'Espagnat has proposed such a view:

> The violation of separability seems to imply that in some sense all these objects constitute an indivisible whole. Perhaps in such a world the concept of an independently existing reality can retain some meaning, but it will be an altered and one remote from everyday experience.[45]

Unlike Bohr, d'Espagnat does not totally reject realism in his interpretation of quantum physics. In his view, nonseparability reveals the existence of an underlying reality though not real in the classical sense — i.e., something that can be measured or accommodated within the reductionist approach of classical physics. Such reality would not be embedded in space and time, and would remain beyond the domain of scientific investigation. Unlike Einstein's, this version of realism does not take a one-to-one correspondence between physical theory and reality for granted. We will come back in Chapter 5 on d'Espagnat's arguments in favour of such kind of scientific realism in quantum physics.

Other physicists have tried to address nonseparability by defending classical re-

[45] D'Espagnat, "The Quantum Theory and Reality." Quoted from: Scerri, *op.cit.*, 690.

alism at the expense of locality. Louis de Broglie was the first with his 1927 "pilot wave theory." Like Einstein, de Broglie firmly believed in an independent reality constituted of entities with well-defined properties. As against Bohr, he believed the wavefunction had a physical significance: it was not simply a mathematical tool for calculating probabilities, but a real entity that was guiding or *piloting* the movement of the particle. This was a realistic model because it assumed both wave and particle as entities that exist independent of the observer, with well-defined properties before measurement. De Broglie's model was the first attempt towards a hidden variable theory of quantum physics. But the theory generated several problems and was abandoned till the 1950s when David Bohm took it up and developed it further. In Bohm's model, as in the Copenhagen interpretation, the wavefunction defines the probability of finding the particle in a given state. But the model also introduces the notion of *quantum potential*, a mathematical function similar to that of de Broglie's "pilot wave." This potential is a function filling all spacetime that encodes information about distant particles and events; the trajectory (position and momentum) of each particle can thus be derived from this quantum potential.

Bohm's theory features an *implicate realm* or *implicate order* — a medium through which the particles communicate instantaneously with each other.[46] Underlying the *explicate realm* of separate things is an undivided implicate order available to each and every explicate part. Things and events seem separate in space and time, but they actually are deeply interconnected for they emerge from the same implicate order. In this view, physical reality is deeply nonlocal because it allows for the existence of instantaneous causal relations between physically separated entities. Yet, no superluminal transfer of information is necessary since no event actually interacts with another event *within the explicit realm*. In this manner, it is possible to explain how measuring the spin of one particle can "affect" the spin of the other without

[46]Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of Hidden Variables"; Bohm, *Wholeness and the Implicate Order*; Bohm and Hiley, *The Undivided Universe: An Ontological Interpretation of Quantum Theory.*

contradicting the theory of relativity. Bohm's interpretation of quantum physics thus reveals a holistic, mutually interpenetrating and interacting view of the world. However, the whole model relies on the implicate realm existence which is not testable, and therefore the model's validity is impossible to test.[47] Worth noting is that while d'Espagnat argues for realism, he does not connect the "underlying reality" with the physical theory elements like Bohm does with his "quantum potential" but considers it to be essentially "non-conceptualizable."

The holistic worldview of Bohm's interpretation has encouraged many parallels with Eastern thought in literature. For instance, Capra declares in *The Tao of Physics* that the basic oneness of the universe — referred to as *Brahman* in Hinduism, *Dharmakaya* in Buddhism and *Tao* in Taoism — "is not only the central characteristic of the mystical experience, but is also one of the most important revelations of modern physics."[48] In his view, Bohm's interpretation suggests that the universe should not be regarded as "a collection of physical objects, but rather as a complicated web of relations between the various parts of a unified whole." This view, he says, is quite similar to the experience "Eastern mystics" have described through the ages.[49] According to Zukav, "all Eastern religions are compatible in a very fundamental way with Bohm's physics and philosophy. All of them are based upon the experience of a pure, undifferentiated reality which is that-which-is."[50] Similarly, Zohar has linked the emergence of Bohm's interpretation to "the general revival of Eastern mysticism and its emphasis on the oneness of all things."[51]

Others have combined Bohm's hypothesis with the idea that consciousness plays a prominent role in quantum physics, and thereby proposed that the universe is

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[47]Kafatos and Nadeau, *The Conscious Universe: Parts and Wholes in Modern Physical Theory*, 136.

[48]Capra, *op.cit.*, 132.

[49]*ibid.*, 138.

[50]Zukav, *op.cit.*, 326.

[51]Zohar, *The Quantum Self: Human Nature and Consciousness Defined by the New Physics*, 74.

an undivided whole in which the observer and the observed are underlain by the same reality, i.e., consciousness. An example of such would be Goswami's interpretation with its non-dual unitive consciousness as the underlying ground for the whole phenomenal world. In *Mysticism and the New Physics*, Michael Talbot depends on Bohm's model for a "holographic model of consciousness" that posits consciousness as a "field" whose vibration leads to the organization of matter. This way of relating consciousness to matter elucidates the relationship between the observer and the observed. In Talbot's words, the holographic model of consciousness is perhaps "the closest physics can come to mysticism without the two losing their identities."[52] Similar remarks have also been made in the context of the Advaita Vedānta tradition. For instance, Jitatmānanda claims that Bohm's implicate order is identical to *Brahman*, pure consciousness, "the substratum of all things, living and nonliving, described in the Upanishad."[53] Panda also correlates the Vedāntic *Brahman* to the implicate order in Bohm's model.[54]

However, as far as Bohm is concerned, he was clearly opposed to the introduction of mind or consciousness into the formalism of quantum physics.[55] He aimed to describe the implicate order "without bringing in the observer in any fundamental role." In his view, "the introduction of the conscious mind into physics... is motivated by certain quite general considerations that have little to do with quantum mechanics itself."[56] Despite his interest in Eastern spirituality, Bohm remained a realist and

[52] Talbot, *op.cit.*, 41-42. See also: Talbot, *The Holographic Universe*.

[53] Jitatmānanda, *op.cit.*, 144.

[54] Panda, *Māyā in Physics*, 320.

[55] It is well known that Bohm was greatly interested in Eastern thought. We may notice his long-term collaboration with Indian spiritual teacher Jiddu Krishnamurti, with whom he had deep discussions about the nature of the mind. But Bohm never argued for any kind of convergence between his interpretation of quantum physics and Eastern thought. See: Krishnamurti and Bohm, *The Wholeness of Life*; *The Ending of Time*; *The Future of Humanity: A Conversation*; *Limits of Thought: Discussions*.

[56] Quoted from: Wilber (ed.), *The Holographic Paradigm and Other Paradoxes: Exploring the Leading Edges of Science*, 168.

refused to take the world as a creation of the mind or consciousness:

> It is difficult to believe that the evolution of the universe before the appearance of human beings depended fundamentally on the human mind... Of course, one could avoid this difficulty by assuming a universal mind. But if we know little about the human mind, we know a great deal less about a universal mind. Such an assumption replaces one mystery by an even greater one.[57]

Bohm's interpretation suggests that the external world rests upon a subtle and all-pervading implicate realm of which matter is only an aspect. But this implicate realm implies nothing mystical or transcendental; it remains a description of the realm of matter and energy. As Wilber puts it:

> In fact, the implicate realm does not transcend matter — it subscends matter and expresses a coherence, unity and wholeness of the entire physical plane... It does indeed go beyond explicate matter, but in a subscending or underlying manner, not a transcending one. As a matter of fact, the concept explicitly *excludes* any higher realms such as mind and consciousness.[58]

It is true that quantum physics provides a more holistic picture of the world than classical physics. As discussed earlier, it also pinpoints the crucial importance played by the observer in quantum experiments. But what the equations of quantum physics describe is still part of the physical world, and is not something spiritual or mental in nature. Quantum physics does not address biological or mental phenomena, even less pure consciousness. What it does reveal is the basic interconnectedness of the physical world, not the pervasiveness of consciousness. Furthermore, the wholeness described in quantum physics is highly structured, subject to strict constraints and symmetry principles, whereas the unity of consciousness experienced by the mystic is usually one in which all distinctions are obliterated.[59] Thus, it seems irrelevant to

[57]Quoted from: Stenger, *The Unconscious Quantum: Metaphysics in Modern Physics and Cosmology*, 124.
[58]Wilber (ed.), *op.cit.*
[59]Barbour, *op.cit.*, 189.

identify the implicate order with the *Brahman* of the *Upaniṣads* (which is identical to pure consciousness) or for that matter, any kind of transcendental state of being.

2.1.3 *Ākāśa*, Fields and Quantum Vacuum

An issue closely connected to holism relates to the fundamental ground of existence. As far as physics is concerned, quantum field theory (QFT) is at stake here. Historically, QFT originated in the late 1920s with the need for a quantum theory of the classical electromagnetic field. Since the concept of "field" implies a continuous ontology — the field being an entity extending throughout the whole of space — QFT worldview has been said to bear affinity with Eastern traditions that affirm the holistic nature of reality. Further, concepts of "quantum field" and "quantum vacuum" in QFT have something to do with the fundamental "stuff" of the world, i.e., with the idea of a primary substance underlying the physical world. Some authors have claimed convergence on these issues between QFT and Advaita Vedānta. In particular, similarities have been noted between quantum field and vacuum, and concepts of Advaita Vedānta such as *ākāśa*, *Brahman* and *avyakta*. Since these are the parallels that motivated this comparative study, they deserve a special attention here. However, we shall postpone a critique of these approaches to Chapter 5.

Underlying QFT is the basic idea that each individual particle is the *quantum* of a peculiar kind of field, called a *quantum field*: the photon is the quantum of the electromagnetic quantum field; the electron of the electronic field, and so on. In this theory, particles have no independent existence apart from their associated field. The quantum field is the "basic stuff" from which particles are created and to which they return at the end of their short existence, the basis of all particles and of their mutual interactions.[60] As Weinberg said, "the essential reality [in QFT] is a set of fields

[60] As we shall see in Chapter 3, there is a good deal of discussion in literature as to what is the basic ontology of QFT. Several physicists and philosophers of science have opted for a "field ontology," in

subject to the rules of special relativity and quantum mechanics; all else is derived as a consequence of the quantum dynamics of those fields."[61] Therefore, the quanta associated with the quantum field are not "classical particles" because they do not possess any permanent existence or individuality; they are epiphenomena of the field itself. Consequently, there can be no "empty space" separating "particles": the whole physical world is composed of quantum fields interacting with each other in such a way that it leaves no space in the universe where there is no field.

What about the vacuum state in QFT? Referred to as "quantum vacuum," this state has a specific meaning in QFT: it is the fundamental state of a quantum field characterized by a null number of particles. However, quantum vacuum differs considerably from the ideal vacuum of classical physics, which is absolutely empty. According to Heisenberg's principle, a minimal energy associated with the quantum vacuum exists. Einstein's law of equivalence between mass and energy says that this energy can be transformed into particles with a very short lifetime, called *virtual particles*.[62] An unlimited number of these particles continuously come into being and vanish again into the vacuum. Hence, the quantum vacuum is no empty space but a potentially rich and dynamic medium with a very significant role in the microscopic world. Another central feature of this concept is its encompassing and holistic character. At the origin of all particles, and by extension presumably of all molecules as well as more evolved forms of life, the vacuum removes the dichotomy between living and

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which the field stands as the basic entity and the particles as mere epiphenomena of the field. Others have argued in favour of a "particle ontology," which makes particles the only real existents and the field an abstract and useful mathematical object with no physical reality of its own. There also exist other ontologies which shall be briefly mentioned later. In general, those who make parallels with Eastern thought emphasize the field ontology when discussing quantum field theory. Accordingly, we will take this ontology for granted in the following discussion.

[61] Quoted from: Pagels, *The Cosmic Code: Quantum Physics as the Language of Nature*, 239.

[62] Such transient particles cannot be recorded using any instrument but their existence can be inferred from physical effects such as Lamb and Casimir effects. Please refer to Chapter 3 for a more detailed description of these effects.

non-living things in the universe. In some sense, it highlights the oneness and interconnectedness of the total physical world.[63] Further, unlike Bohm's implicate order, the existence of the quantum vacuum has been assessed in several experiments. We will come back in great detail on this concept in Chapter 3.

It has been said that the worldview derived from QFT, with its emphasis on the "field" as the basic stuff of the universe, has much more in common with Eastern spiritual traditions than the Newtonian conception of an independent space populated by distinct entities interacting with each other.[64] According to Capra, "the conception of physical things and phenomena as transient manifestations of an underlying fundamental entity is not only a basic element of quantum field theory, but also a basic element of the Eastern world view."[65] Capra, like a few others,[66] compares the concept of quantum field with insights pertaining to Eastern mysticism. In his view, the intuition behind the physicist's quantum field "is closely paralleled by that of the Eastern mystic who interprets his or her experience of the world in terms of an ultimate underlying reality."[67] Capra concedes that the mystic's fundamental reality, which is beyond all concepts, cannot be *identified* with the physicist's quantum field, a well-defined physical concept. Two radically different levels of reality are in opposition here, and we can hardly imagine how they can possibly be compared in terms of experience or intuition. He is however less careful when he equates the ultimate reality of Eastern traditions — such as the *Brahman* of the Hindus, the *Dharmakaya* of the Buddhists and the *Tao* of Taoists — with the "unified field" of modern physics.[68]

[63]Sreekantan, *The Quest for Ultimate Reality*, 255.

[64]Jones, *Science and Mysticism: A Comparative Study of Western Natural Science, Theravāda Buddhism and Advaita Vedānta*, 185.

[65]Capra, *op.cit.*, 211.

[66]For instance, Lynne McTaggart and Deepak Chopra have brought in this concept to explain how mind and matter are interrelated together in the human being. See: McTaggart and Chopra in the bibliography.

[67]Capra, *op.cit.*, 211.

[68]*ibid.* The term "unified field theory" was coined by Einstein while he was working towards the unification of his general theory of relativity with electromagnetism. Modern unified field theories

Here also, two different levels of reality are involved, and a direct comparison seems inappropriate. As Richard H. Jones notices, it is incorrect to equate the unified field with *Brahman*, which is not an extended and structured field embedded in the space-time continuum (as the unified field) but pure consciousness "beyond" space, time and even mind.[69]

In *The Tao of Physics*, Capra makes other comparisons of that kind. Discussing the dynamic nature of the quantum vacuum, he compares it to Shiva's cosmic dance of creation and destruction in Hinduism.[70] He also compares the potential and creative nature of the vacuum to the "Void of Eastern mysticism":

> Here then, is the closest parallel to the Void of Eastern mysticism in modern physics. Like the Eastern Void, the "physical vacuum" — as it is called in field theory — is not a state of mere nothingness, but contains the potentiality for all forms of the particle world. These forms, in turn, are not independent physical entities but merely transient manifestations of the underlying Void.[71]

Capra neither mentions what exactly is the "Eastern Void" nor states explicitly the Eastern tradition he is referring to. But he must be alluding to the Buddhist tradition since he quotes from a Buddhist *sūtra* ("Form is emptiness, and emptiness is indeed form") — which also serves the same purpose in Zukav's *Dancing Wu-Li Masters*.[72] The 14th and current Dalai Lama, Tenzin Gyatso, also spoke of the "unmistakable resonance between the notion of emptiness and the new [quantum] physics."[73]

Anyhow, Capra remains vague as to what he means by "Eastern mysticism," and this creates a problem because the Eastern concepts he refers to are not always found

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attempt to bring the four fundamental forces of the universe — strong nuclear, electromagnetic, weak nuclear, gravitational — into a single framework. Until now, there exists no unified field theory accepted by all of the scientific community.

[69] Jones, *op.cit.*, 203-04.

[70] Capra, *op.cit.*, 242.

[71] *ibid.*, 222.

[72] Zukav, *op.cit.*, 258.

[73] Gyatso, *The Universe in a Single Atom: The Convergence of Science and Spirituality*, 50.

in all Eastern spiritual traditions. For instance, there is no equivalent for "Eastern Void" in the Hindu tradition of Advaita Vedānta. Rather than emptiness or void, this school favours an all-pervasive "plenum" called *ākāśa*, from which the entire universe would have originated. As we shall see, *ākāśa* plays a crucial role in Advaita cosmology because it is the first physical element (*bhūta*) created and also the primordial source for the other physical elements. In his book *Māyā in Physics*, Panda remarks that this concept resembles in many ways the quantum vacuum described in QFT. Both concepts relate to a substantial and non-perceivable medium with the capacity to produce the various physical constituents of the world.[74] Though vacuum cannot be perceived, its existence can be inferred from the perceivable particles it generates. Similarly, *ākāśa* is too subtle to be actually perceived, yet it is inferred from the elements it gives rise to. Both concepts represent, in their respective framework, the one fundamental entity that explains and underlies the appearance of the multifarious world. Thus, modern physics and Advaita Vedānta have in common a monistic approach, which seeks to explain the many in terms of the one.[75]

In the West, the Hungarian philosopher of science and systems theorist Ervin László also noted such similarities. In *Science and the Akashic Field: An Integral Theory of Everything*, published in 2004, he posits the existence of an all-pervasive "information field" that would inform every part of the universe, from particles and cells to galaxies and human consciousness. László relates this information field to the quantum vacuum of QFT. More than a huge reservoir of energy, the vacuum is primarily a subtle and all-pervasive medium that contains information about each and every part of the universe, past and future. In several of his books, László refers to the information field (or vacuum) as the *A-field* or *akashic field* because, in his view, it has much in common with the ancient Hindu concept of *ākāśa*. In *Science and the Reenchantment of the Cosmos*, he says:

[74] Panda, *op.cit.*, 160-61.

[75] *ibid.*, 313.

> The latest cosmologies re-discover the cyclically self-renewing universe, a cosmos that takes off from, and returns to, an enduring fundamental medium. The ancient Hindu cosmology can be restated in contemporary scientific terms simply by substituting "quantum vacuum" for *ākāśa*.[76]

László observes that under the guise of quantum vacuum, modern physics has "rediscovered" the idea of an all-pervasive and substantial medium from which the whole physical world emerges and to which it ultimately returns. However, as he points out, the concept of a substance permeating the whole universe is not new in science. Before Einstein's theory of relativity, space was presumably filled with a hypothetical substance called *luminiferous ether*, whose function was to allow the propagation of light, believed impossible in empty space.[77] It is noteworthy that the famous inventor and electrical engineer Nikola Tesla (1856-1943), probably under the inspiration of Vivekananda (whom he had met at the Chicago's Parliament of Religions in 1893), compared the Hindu *ākāśa* to the luminiferous ether of classical physics. As for Vivekananda, he referred to matter and energy (or force) as equivalent to the Hindu concepts of *ākāśa* and *prāṇa*, respectively.[78] The concept of *ākāśa* has since been paralleled with other concepts of physics, such as gravity and spacetime continuum.[79]

Following on the same lines, the Vedāntic concept of *avyakta* (or *avyākṛta*) has been compared to the concept of quantum field. The term *avyakta* in Advaita Vedānta denotes the primal and unmanifest state preceding the emergence of the universe

[76] László, *Science and the Reenchantment of the Cosmos: The Rise of the Integral Vision of Reality*, 89-90.

[77] The concept of a luminiferous ether was first proposed by Young and Fresnel in the early 1800s to explain the transmission of light waves in space. Ether was conceived as an elastic and invisible fluid permeating all space. Later, physicists like Faraday, Thompson and Maxwell thought that the ether was the seat of electromagnetic phenomena. The negative results obtained in the Michelson-Morley experiment led Einstein to reject ether in his special theory of relativity in 1905. For more details, please refer to Chapter 3.

[78] Jitatmānanda, *op.cit.*, 69.

[79] Dobson, *Advaita Vedānta and Modern Science*; Chapple and Tucker, *Hinduism and Ecology: The Intersection of Earth, Sky, and Water*, 30; Lalye, *The Pañca-mahabhūtas*, in: Vatsyayan (ed.), *Prakṛti: The Integral Vision* (Vol.4), 108; Panda, *The Vibrating Universe*, 71.

(including *ākāśa*) in the evolutionary scheme of creation. In *Vedānta and Modern Physics*, Chandrasekharayya holds that since *avyakta*'s function in Advaita cosmology is to manifest the various "names and forms" (*nāma-rūpa*) of the perceptible universe, it shares common features with the quantum field, which has the potential for manifesting the various kinds of particles in observed universe.[80] In particular, he compares the uncertainty typical of the atomic world to the ephemeral nature of names and forms as understood from the standpoint of Advaita. Similarly, Jitatmānanda sees in Wheeler's *quantum foam* (which, according to him, describes what would resemble the spacetime geometry at the quantum scale) a modern physics translation of the Advaita idea of the "manifestation of all names and forms in the entity called *Brahman*."[81] Since quanta have no independent existence, no reality apart from the field, the world of particles can be considered unreal (with respect to the field) just like the whole phenomenal world characterized by names and forms in Advaita (with respect to *Brahman*). Such analogies may be superficial ontologically speaking, but they reflect an awareness of the ephemeral and relative nature of physical phenomena in both disciplines.

In this section, we have seen how violation of Bell's inequality led some physicists to propose the existence of a physical medium interconnecting particles with each other in order to maintain classical realism. QFT has also revealed the holistic character of atomic and subatomic phenomena through concepts like quantum field and quantum vacuum. Some authors have inferred from these results that everything is interconnected at every level of physical reality, from matter to consciousness. Others have noted profound similarities between concepts of QFT and holistic ideas pertaining to Eastern spiritual traditions. We have seen how problematic such parallels could be. However, as far as the Advaita Vedānta tradition is concerned, there seems to be an interesting point of contact with modern physics on the question of *reality*. Today, if most physicists contend with Bohr that classical realism must be abandoned in

[80] Chandrasekharayya, *op.cit.*, 408-09.

[81] Jitatmānanda, *op.cit.*, 32.

quantum physics, some have argued that a different form of realism can be reasonably maintained. As noted earlier, Bernard d'Espagnat believes that Bell's experiments suggest the existence of an underlying reality, an "indivisible whole," whose nature is far remote from everyday experience. Unlike Bohm's implicate order, this underlying reality could never be disclosed through scientific investigation. The Advaita Vedānta tradition seems to have come up with similar insights when it claims that the existence of *Brahman*, the "non-dual reality," comprehends and sustains all reality and being and yet remains beyond the scope of empirical knowledge. We shall come back to this important issue in Chapter 5.

2.2 Hopes and Pitfalls of Parallelism

So far, we have examined the nature and content of the parallels generally drawn between quantum physics and Eastern spiritual traditions. The rest of this chapter tries to analyse the problems that are likely to arise when one examines parallel ideas from different disciplines. This practice, referred to as "parallelism" by the sociologist Sal Restivo, has attracted the attention of an increasing number of people in recent years. Authors from various backgrounds — from New Age authors and Eastern scholars to scientists and laymen interested in science and religion — have made personal contribution to this field. However, few scholars, and even less parallelists, have reflected critically on the practice of parallelism as such. Yet, such an analysis is methodologically essential to obviate the common problems tied to this enterprise. In the following, issues such as contextuality, ideology and lack of precision and method in drawing parallels will be briefly discussed. More generally, we will try to understand what is meant by the claim that physics "returns to" or "converges towards" Eastern mysticism. Do such claims signify that there are profound affinities between the scientific and mystical worldviews? How do people interested in parallel ideas and other scholars understand the relation between modern physics and Eastern spiritual traditions, Advaita Vedānta in particular?

2.2.1 Parallelism in Practice

In this dissertation, we use the word "parallelism" specifically to denote the practice of drawing parallels between claims of modern physics and Eastern spiritual traditions. Restivo describes parallelism on the basis of two arguments raised by Capra in *The Tao of Physics*: 1. "a consistent view of the world is beginning to emerge from modern physics which is harmonious with Eastern wisdoms"; and 2. "Eastern mysticism provides a consistent and beautiful philosophical framework which can accommodate our most advanced theories of the physical world."[82] Thus, parallelist claims are basically rhetorical statements employed to emphasize either affinities, harmony or identity between the worldview of modern physics and that of Eastern mysticism. The underlying argument is usually the following: if *claims* about the nature of reality are similar, it implies that their conceptual content is similar, and that the experience of reality is also similar among physicists and mystics. Thus, at a basic level the practice of parallelism involves comparison, translation and communication.

In his extensive study on the subject, Restivo identifies a series of potential problems related to the practice of parallelism:[83]

1. *Contextuality*: When no contextual data is provided to justify the comparison of a particular text or passage to another, misinterpretations can easily occur. For instance, it is a mistake to conclude from Schrödinger's quotations on Advaita Vedānta that he sought a convergence between both disciplines. In fact, as we shall see below, Schrödinger was against any convergence between science and mysticism (or religion);

2. *Comparison and translation*: It is difficult to compare statements that are derived from the specialized language of physics (mathematical formalism, abstract concepts) and from meditative insights by mystics. No conceptual anal-

[82] Restivo, *The Social Relations of Physics, Mysticism, and Mathematics: Studies in Social Structure, Interets and Ideas*, 22.

[83] *ibid.*, 23-26.

ogy can really explain a quantum field to someone who is not familiar with mathematics, as no words can fully express the essence of a mystical experience. Other difficulties lie in translating original texts from a particular Eastern tradition into modern languages, and also in comparing claims made at different times, sometimes centuries apart;

3. *Contamination*: Prior to drawing parallels, modern mystics may already be aware of modern physics concepts. Conversely, physicists may also be familiar with the ideas and concepts of Eastern spiritual traditions. For instance, the new generations of scholars have a science tainted understanding of Advaita and they customarily borrow English terms from natural sciences — such as force, energy, etc. — for the translation of Sanskrit texts;

4. *Language*: If common language is well established in science as a medium of communication, it is not the case in mysticism where its function is totally different. In science, language is more or less taken to refer to "physical reality" as such, whereas in mysticism it is an imperfect (though necessary) medium for communicating a hardly describable mystical experience to others. The different functions of language render difficult a comparison in terms of concepts and ideas;

5. *Experience*: Without any experience or knowledge in physics or mysticism, it is even more difficult to translate a certain experience/concept/idea in simple words, or simply to talk meaningfully about these subjects.[84]

To these pitfalls, Restivo also adds ideology. As a sociologist, he understands science as an inherently sociocultural activity and adopts a similar position when discussing parallelism. In his view, the practice of parallelism would be an intellectual strategy intended to promote a certain ideology. Restivo quotes Capra who says that his "book aims at improving the image of science by showing that there is an essential harmony between the spirit of Eastern wisdom and Western science."[85] Here, mysticism is used as apologetics for science. Going back to the 1960s, indeed, many young people disillusioned with the whole ethos of science and technology, became interested in Eastern mystical and philosophical thought. Capra's message was that modern science (especially physics) contains a beauty and a mystery just as liberating as

[84]Lack of knowledge can sometimes result in funny statements. For example, Michael Talbot, in *Mysticism and the New Physics* (p.84): "...the fact that the names of the mathematician who first theorized that space and time are a continuum, Hermann Minkowski, and the greatest of the historical Brahmin sages, Advaita, are interchangeable, demonstrates once again the confluence of mysticism and the new physics." No doubt, Advaita is not the name of a Brahmin sage but that of a major philosophical school of Hinduism.

[85]Capra, *op.cit.*, 25.

Eastern mysticism. In this case, Restivo says, parallelism "function[s] as a defensive justification for and explanation of the scientific approach, and a device for improving and supporting the image of science and scientists."[86] Willem B. Drees also agrees that parallels between religious convictions and scientific insights can be useful for making science acceptable to a certain audience. This is the case with Capra who, by conveying the message that modern physics presents a worldview similar to Eastern traditions, "contributed substantially to the acceptance of physics among advocates of an alternative lifestyle."[87]

Parallelism can also work the other way around and promote religious views. In *Prophets Facing Backward*, Meera Nanda shows how today some Hindu nationalists use modern science to promote the supremacy of the Hindu Vedic tradition.[88] In the last few years, a number of Indian and Western scholars have claimed that Vedic literature contains much material that is "scientific" in nature. Political leaders and other Hindu nationalists have followed and pleaded that the most sacred texts of Hinduism like the *Vedas* and the *Upaniṣads* are, in fact, scientific treatises that describe in holistic manner proper to Hinduism the findings of modern science. Unlike modern science with its reductionist and empirical approach to reality, the so-called "Vedic science" endorses a holistic approach that encompasses the whole of reality. While modern science does not recognize the existence of other levels of consciousness beyond sense-perception and logical reasoning, Vedic science includes this dimension of reality based on the contemplative experience of mystics through the ages. Despite these obvious differences, proponents of Vedic science uphold that traditional Vedic knowledge systems are of the same nature as modern science. In Nanda's view, the hidden agenda is to place the Hindu Vedic tradition on an equal footing with modern science without having to submit its basic tenets to scientific knowledge and

[86] Restivo, *op.cit.*, 39.

[87] Drees, *Religion and Science in Context: A Guide to the Debates*, 17.

[88] Nanda, *Prophets Facing Backward: Postmodernism, Science, and Hindu Nationalism.*

experimental verification.[89]

There certainly is more to parallelism than a mere disinterested quest for knowledge, and a variety of complex factors — ranging from ideological, cultural to political and historical — are closely tied to this enterprise. In fact, claims of parallels between Eastern thought and modern science cannot be understood apart from the East-West's historical relationship over the last few centuries. In his book *Orientalism*, Edward Said demonstrates how Western study of Eastern thought and culture, or "orientalism," has been intimately related to the West's own political, commercial and colonial interests in Asia.[90] In his view, the "Orient" construed by Western scholars is a Western construction, a "system of ideological fictions" aimed to reinforce and justify Western power over the East.[91] Though this claim can be nuanced in different ways, it can hardly be denied that underlying the Western intellectual approach to Eastern thought is an important element of power. Thus it would be wrong to only see an objective pursuit of knowledge in orientalism. This phenomenon has also its counterpart in the East. In the context of parallelism, Richard H. Jones notices how Eastern thinkers can sometimes put Western thought on a pedestal to justify their own views, and how problematic such attempt can be:

> [When making parallels] it could be that Western thought is unconsciously or consciously being taken as the supreme standard, with a corresponding lack of sensitivity to other interests: Asian thought must be shown to be positivistic in a time when positivism was in vogue, or existential for those who value existentialism... Or it must share our moral values, if not our beliefs. The various traditions cannot stand on their own terms but must be related to a Western standard. The danger here is in distorting the fundamental nature of these traditions in order to fulfill this demand rather than in understanding them in their own milieu.[92]

[89] *ibid.*, 110.

[90] See: Said, *Orientalism.* However, this book is mostly concerned with Western study of the Islamic world of the Middle East, and not with Hinduism, Buddhism and other Eastern spiritual traditions of East and South Asia. But there is no reason to believe that Said's arguments cannot be extended to those traditions as well.

[91] Quoted from: Clarke, *op.cit.*, 8.

[92] Jones, *op.cit.*, 172-73.

Jones also identifies other difficulties related to the practice of parallelism. For instance, parallelists often overlook the diversity among and within Eastern schools of thought, and disregard the fact that each school has its own historical and interpretive issues.[93] As a consequence, parallels remain at a superficial level not taking into account the complexity behind the different Eastern traditions. Similarly, when discussing quantum physics, parallelists rarely address the different interpretations that exist in literature. In *Modern Physics and Vedānta*, Jitatmānanda refers indistinctly to Copenhagen and Everett's multiworld interpretations, without taking note of their basic differences. A related issue is that parallelists, especially those from the spiritual or religious side, often quote scientists with enormous respect as if they had discovered an unshakable truth. Any scientific theory presented becomes a ready-made worldview.[94] Not surprisingly, then, some parallelists barely consider the scientific arguments raised against the theory or interpretation they promote. This attitude perhaps reflects a purely religious background, or an unfamiliarity with the process of scientific progress. Anyhow, these problems are reminders that a certain expertise in the compared disciplines, as well as a fair knowledge of their historical and theoretical issues, are indispensable.

Eric Scerri considers a major problem that "parallelists seem to imply not mere analogies, but a meaningful identity between the findings of physics and Eastern mysticism."[95] Claims that disregard the richness and complexity of both disciplines, and especially their differences in terms of aims and methods are indeed improper. Barbour complains that Capra says little about differences in the goals and methods of physics and mysticism. In Barbour's view, the intent behind mysticism is not only to expound a metaphysical system but to transform one's personal life and guide one toward enlightenment. In contrast, science is about explaining the physical world around us, not about living a better and wiser life.[96] Considering that the

[93] *ibid.*, 171.

[94] *ibid.*

[95] Scerri, "Eastern Mysticism and the Alleged Parallels with Physics," 691.

[96] Barbour, *op.cit.*, 189-90. In Clarke's view, however, such criticism misses the central point in

two disciplines also involve different methods or means of knowledge, it is highly improbable that their claims about reality will be *identical* in terms of content. The terms may be the same (notwithstanding the translation issue) but the concepts they stand for disagree.

Another problem in pushing parallelism to its extreme is the confusion between the ephemeral nature of scientific discoveries and the perennial truths of mysticism. Scientific discoveries ceaselessly change and alter; it is inadequate to make them equivalent with the "timeless" truths conveyed by mysticism. As Jeremy Bernstein said: "If I were an Eastern mystic the last thing in the world that I would want would be a reconciliation with modern science." In his opinion, since "the most valuable commodity that we have in science is doubt. . . ," "to hitch a religious philosophy to a contemporary science is a sure route to its obsolescence."[97] Conversely, to elevate a scientific theory to the rank of a metaphysical system takes us beyond the realm of science. We have seen such an example with Goswami's interpretation of quantum physics. Although metaphysical assumptions intervene in the scientific theoretical process, the practice of physics must be kept within the defined boundaries of scientific epistemology. Otherwise, there is no way to differentiate between pseudo-science and scientific facts.

All things considered, is it even meaningful to draw parallels between modern physics and Eastern spiritual traditions? Certainly, one cannot overlook the ideological, cultural and political factors involved in those parallels. In particular, the colonial history linking Western countries with Asia over the last centuries, and the immense impact it had on their mutual cultural and intellectual exchanges, is a most important factor to consider. However, as Clarke rightly points out, power consti-

Capra's argument. Capra is not really concerned with a synthesis of these disciplines (which would indeed require a serious consideration of their differences) but with demonstrating, by using Eastern concepts and ideas, how some deep-rooted philosophical beliefs in Western philosophy are now at odds with modern physics. See: Clarke, *op.cit.*, 171.

[97] Bernstein, "A Cosmic Flow," 6-8.

tutes only one of the numerous factors in the East-West equation.[98] Regardless of the numerous problems related to the practice, consistent parallelism might have the capacity to elucidate aspects and presuppositions not immediately perceived from the perspective of a single culture or discipline. As physicist Werner Heisenberg noted:

> It is probably true quite generally that in the history of human thinking the most fruitful developments frequently take place at those points where two different lines of thought meet. These lines may have their roots in quite different parts of human culture, in different times or different cultural environments or different religious traditions; hence if they actually meet, that is, if they are at least so much related to each other that a real interaction can take place, then one may hope that new and interesting developments will follow.[99]

In such a spirit, this dissertation brings two major traditions of knowledge together — modern physics and the Advaita Vedānta system in Hinduism — so that they share their common wisdom. We now examine how parallelists and other scholars have been perceiving and articulating the interaction between these systems, and more generally between science and religion.

2.2.2 Convergence, Conflict or Independence?

The interaction between science and religion is complex and involves multiple intertwined issues. How should we think about science, religion and their relationship in modern society? Are these enterprises compatible or at odds with each other? Do they converge toward the same worldview or are they concerned with different realms

[98] Clarke, *op.cit.*, 27. Clarke adopts a more liberal approach to orientalism than Said. He is himself clear on this point when he says that if "Said is right in his claim that no human knowledge is apolitical, the association of orientalism with colonising power can represent only one part of the story." In history, interest for Eastern thought has often taken place outside the colonial context. A clear example is Germany that had no colonial interests in India or China but whose scholars have played a central role in orientalist studies from the early 19th century. See: Clarke, *ibid.*, 26-27.

[99] *ibid.*, 187.

of reality? Answers to those questions necessarily vary in accordance with the contexts and assumptions shaping the questions, and the criteria used to answer them.[100] In the following, we propose only a broad list of the most common stances found in literature pertaining to the interaction between science and religion:[101]

1. *Conflict*: Either the claims of religion *or* the claims of science are true. Among the proponents of this view, we may think of those scientists who look upon religion as pure superstition and to religious fundamentalists who adopt a literal interpretation of scriptures, denying validity to any scientific theory that contradicts scriptural statements;

2. *Independence*: Scientific and religious claims refer to separate and independent realms. Science deals with the empirical constitution of the physical world, and religion deals with ethical and spiritual values. Thus, their respective claims can be "true" without conflicting with each other. If science and religion both say something meaningful about reality, their respective contributions cannot be integrated under a common worldview;

3. *Complementarity*: The idea is that science and religion each reveals something of reality that the other cannot. But unlike the previous stance, where science and religion deal with different and independent domains, here both approach the *same* domain in different (and mutually exclusive) ways. Both have an equal cognitive value and benefit from each other in order to provide a more complete picture of reality. This is a common stance among parallelists (like Capra for instance) who maintain that Eastern mysticism and modern physics are complementary approaches to the same reality;

4. *Convergence*: Closely related to the previous one, and perhaps less specific, this position maintains that science and religion are *converging* towards the same total worldview. This stance is often based on the observation that science and religion exhibit concepts that are similar or that function in a similar manner. What science discovers supports religion, and what religion claims does not contradict scientific theories. For instance, evolution theory serves to accommodate the idea of an "intelligent design"; the Big Bang model suggests the presence of a Creator or some creative intelligence; etc.

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[100] Drees, *Religion and Science in Context: A Guide to the Debates*, 1.

[101] This list is based on Wilber (1998, 2000), Barbour (1997) and Jones (1986). Barbour and Wilber discuss the relationship between science and religion in general. By "religion," they mean Western monotheistic religions as well as Eastern spiritual traditions like Hinduism and Buddhism. Jones focuses on specific schools within Hinduism and Buddhism, namely Advaita Vedānta and Theravāda Buddhism. In our classification, we use the word "religion" to denote Western religions as well as Eastern spiritual traditions.

The position where science denies religion, or vice-versa, has been and is still maintained by several authors, scientists and religious fundamentalists (Sigmund Freud, Karl Marx, Richard Dawkins, Francis Crick, etc.). Most often, conflicts arise when scientific and religious claims both overlap and differ. In many cases, what religion says about the nature and origin of the universe differs considerably from what science tells us about the world. The current debate between creationists and evolutionists is a patent example. However, a growing number of scholars and religious figures are now working towards reconciliation. Science and religion are omnipresent forces in today's world. While religions create value and meaning for billions of people, science is our most powerful tool to discover truth about the natural world in which we live. For this reason, it is highly desirable that science and religion peacefully co-exist.

One way of looking upon co-existence is to assume that science and religion deal with two independent realms: science deals with nature whereas religion is concerned with human ethical and spiritual values. A clear representative of this view is the paleontologist Stephen Jay Gould who argued that science and religion are *non-overlapping magisteria*.[102] What science reveals about the natural world has nothing to do with what humans may think or feel about themselves, or envisage as the most ethical way of behaving in society. However, Wilber explains that if we take this distinction for granted, we necessarily create a rigid and arbitrary dualism between nature and human.[103] On one side, there would be the natural world disclosed by science, and on the other side, the human values advanced by religion. In his view, this is not a tenable position. A human is not just an ethical and spiritual being but also a product of nature with a physical body and sensations. Science has revealed, though not fully explained, the intimate connection between inner life and physical constitution: our thoughts and feelings have physical correlates in the human body and brain. Conversely, an individual's values have a direct influence on the envi-

[102]Gould, *Rocks of Ages: Science and Religion in the Fullness of Life.*

[103]Wilber, *A Theory of Everything: An Integral Vision for Business, Politics, Science and Spirituality*, 63.

ronment as they dictate his behavior towards nature and other human beings. The distinction between human and nature is not so clear-cut, and the same is true with science and religion. Thus, it is difficult to agree with Gould when he says that science and religion are two different and nonoverlapping domains.

Desirous to overcome this dualism, some have proposed that science and religion are in fact complementary (and thus mutually exclusive) ways of looking upon the same reality. With respect to Eastern mysticism, Capra stands as the main proponent of the complementary view with many followers in his steps. In Capra's view, Eastern mysticism is in harmony with modern physics because it provides "a consistent and beautiful philosophical framework which can accommodate our most advanced theories of the physical world."[104] Basically, he believes that modern physics and Eastern mysticism are converging towards the same worldview through different approaches related to the different ways in which the human mind apprehends the world:

> I see science and mysticism as two complementary manifestations of the human mind; of its rational and intuitive faculties. The modern physicist experiences the world through an extreme specialization of the rational mind; the mystic through an extreme specialization of the intuitive mind. The two approaches are entirely different and involve far more than a certain view of the physical world. However, they are complementary, as we have learned to say in physics. Neither is comprehended in the other, nor can either of them be reduced to the other, but both of them are necessary, supplementing one another for a fuller understanding of the world.[105]

If the physicist has recourse to rationality to inquire into the nature of the physical world, the mystic is concerned with an intuitive apprehension of reality. Yet, the physicist and the mystic essentially arrive at the same worldview: both see the world as a unified whole in which everything is interconnected. However, modern physics and mysticism propound different versions of interconnectedness. Whereas mysticism perceives it in the everyday world (trees, mountains, etc.) at the macroscopic level, modern physics makes it only a feature of the microscopic realm.[106] From the view-

[104] Capra, *op.cit.*, 12.
[105] *ibid.*, 306.
[106] Jones, *op.cit.*, 202.

point of physics, macroscopic objects are separate from each other and it would be wrong to say, at least in regard to this aspect, that mystics and physicists converge towards the *same* worldview. Moreover, as noted earlier, the wholeness described in physics is concerned with the physical world only whereas that of mysticism is one in which all distinctions, including that between object and subject, are obliterated.

In the above quotation, Capra mentions complementarity as a theme also dear to physicists. One special feature of atoms (and light) is that in some experiments they behave like particles, and in others like waves. According to Bohr, this suggests that we can only talk about an atomic system in relation to an experimental setup. What we actually observe in nature is dependent upon the type of experiment we choose to perform. In quantum physics, we can either choose wave *or* particle models, never both together. The wave and particle models are two mutually exclusive approaches, but taken together they give a fuller picture of quantum reality. Capra and others have extended Bohr's Complementarity principle to the relation between science and Eastern mysticism. In this view, the two mutually exclusive approaches are, on the one hand, the ordinary dualistic or rational viewpoint of science (based on conceptual models and observational data) and, on the other, the non-dualistic or intuitive viewpoint of mysticism (based on non-conceptual and contemplative experiences).

A problem here is that no rigid boundary exists between these two modes of knowing. Thinking in dualistic terms is not only specific to science but common to many other approaches of reality including mystical experiences. It is reasonable to assume that there exists a variety of mystical experiences still having some conceptual or sensory content. Moreover, the scientific approach is not only "rational": intuition and imagination are also known to play an important role in the development of science, especially in theoretical physics where creativity and abstraction are crucial for the formulation of new theories.[107] Science and mysticism are not different enough in terms of knowing to be considered mutually exclusive approaches. Barbour agrees

[107]See, for instance: Holton, *The Scientific Imagination*.

with the application of complementarity to other fields than physics, but with some caution. Models are complementary when they refer to the *same entity* and are of the *same logical type*. But these conditions, he says, do not apply to science and religion that operate in different contexts with different purposes. Barbour notices that complementarity may sometimes serve to circumvent inconsistencies between different models, thus creating obstacles to the search of a more unifying model.[108] It could be that some parallelists have brought up complementarity — consciously or not — as a way to overlook basic differences between modern science and Eastern mysticism.

It is worth noting that the founders of quantum physics and other great theoretical physicists opposed the view of a physics that complemented or supported mysticism, and vice-versa. In *Quantum Questions: Mystical Writings of the World's Great Physicists*, Wilber gathered the writings of various physicists on the nature and relation of science and religion (especially mysticism). He points out that though these physicists were all interested in mysticism in one way or another, they were virtually unanimous in declaring that modern physics offers no positive support whatsoever for mysticism.[109] As mentioned earlier, Schrödinger, though deeply committed to Advaita Vedānta in his own life, dismissed the idea that quantum physics reveals or supports a mystical worldview. Physical science is concerned with the physical world only, and cannot provide any significant knowledge about mind, consciousness or God:

> The world of science lacks, or is deprived of, everything that has a meaning only in relation to the consciously contemplating, perceiving, and feeling subject... All this is not only absent but it cannot, from the purely scientific point of view, be inserted organically. If one tries to put it in or on,..., it will not fit... No personal god can form part of a world-model that has only become accessible at the cost of removing everything personal from it.[110]

[108]Barbour, *When Science Meets Religion*, 77.

[109]Wilber (ed.), *Quantum Questions: Mystical Writings of the World's Great Physicists*, 5.

[110]Quoted from: Wilber (ed.), *ibid.*, 89.

Schrödinger believed that to derive mysticism from the data of physics is to misunderstand the role and nature of both. In *Science, Theory, and Man*, he said:

> Physics has nothing to do with it [mysticism]. Physics takes its start from everyday experience, which it continues by more subtle means. It remains akin to it, does not transcend it generically, it cannot enter into another realm.[111]

Other great physicists shared the same view. Einstein, quite known for having said that "science without religion is lame, religion without science is blind," still found reprehensible the attempts to apply axioms of physical science to human life.[112] Eddington, famous for one of the earliest experimental confirmations of relativity, was "wholly opposed" to any attempt to "prove" religion on the grounds of modern physics.[113] According to Planck, the father of quantum physics, science and religion deal with two different orders of reality that can neither conflict nor accord. He thought that attempts to unify these domains were "founded on a misunderstanding, or, more precisely, on a confusion of the images of religion with scientific statements."[114] It proves problematic that those viewpoints are rarely taken into consideration by those who make parallels and quote quantum physicists to support their own views.

In *Science and Mysticism*, Jones challenges the complementary view on another basis. He objects that complementary viewpoints are assumed to have an equal cognitive value. Yet, from the standpoint of mysticism, the mystical experience or worldview has more cognitive significance than that of science.[115] According to the Vedic science proponents, modern science is a "lower" kind of knowledge because it is concerned with matter only whereas Vedic science encompasses consciousness also. Hence, Vedic science is a "better, a more whole natural science that will cure the

[111]Schrödinger, *Science, Theory, and Man*, 204.
[112]Wilber (ed.), *op.cit.*, 5.
[113]Eddington, *New Pathways in Science*, 307-08.
[114]Quoted from: Heisenberg, *Physics and Beyond*, 82-83.
[115]Jones, *op.cit.*, 177.

reductionism and matter-spirit dualism of Western science."[116] A similar position has been held by scholars interested in the relation between modern physics and Advaita Vedānta. In *Vedānta in the Context of Modern Science*, Swami Mukhyānanda says:

> Strange as it may seem, many of the conclusions of modern science are corroborating those of ancient Vedānta, though they follow different methods [...] Both science and philosophy [Vedānta] gather facts, analyse experience, systematize knowledge, and try to find a unity which is the source and explanation of all this diversified phenomena. They do it in their own way, with this difference that whereas science so far has restricted its field to the external phenomena, and mostly to the inanimate part of it, Vedānta understood long ago the fact that partial data will give only partial truth and we must study experience as a whole, both external and internal, including the investigator — man himself [...][117]

In Mukhyānanda's view, Advaita Vedānta approaches reality in a more encompassing manner than science because it investigates man's deepest consciousness. From the Advaita's perspective, science makes an ontological mistake from the very start: it takes the world of becoming, i.e., the realm of space and time, as real. According to Advaita, this is a false belief arising from one's ignorance (*avidyā*) of the non-dual and eternal nature of reality (*Brahman*). Under the spell of *māyā* (broadly, "illusion"), science cannot transcend the realm of change to realize what is "beyond" change. As Schrödinger noticed, science cannot really transcend the realm of everyday experience, which it carries with more subtle means of observation. Of course, science has full authority in its own domain — that of sense-experience and logical reasoning — but is limited as far as the transcendental domain is concerned. Since Advaita is concerned with this "ultimate knowledge" (*parāvidyā*), it has greater cognitive value than modern science. Thus, this view differs from a complementary approach in which Advaita and science would have the *same* cognitive value. Yet, it seems to have a more balanced approach as far as it accepts that there are epistemological differences between physics and Advaita.

[116] Nanda, *op.cit.*, 66.

[117] Mukhyānanda, *Vedānta in the Context of Modern Science*, 10.

Other Indian scholars have discussed the relation between modern physics and Advaita Vedānta, but their approach appears deficient in many ways. In *Modern Physics and Vedānta*, Jitatmānanda traces a great number of parallels between modern physics and Advaita Vedānta, but does not pay the least attention to epistemological and methodological issues. The approach taken by Chandrasekharayya in his book *Vedānta and Modern Physics* is no more satisfying. Although he seems to be quite familiar with Advaita and certain Sanskrit texts, his presentation of modern physics lacks in details. His comparisons between concepts of Advaita and modern physics are often superficial, such as when he compares the concept of *prakṛti* with that of "field" in physics.[118] In Panda's works such as *Māyā in Physics* and the *The Vibrating Universe*, we find a pretty good introduction to physics and modern science in general. The problem here lies in his giving too much importance to Advaita in the physical realm. In his view, "all modern theories of science can be assimilated by Advaita Vedānta."[119] The latter encompasses all the phenomena described by modern physics, from the Big Bang to the formation of particles. However, Advaita Vedānta does not explain how particles interact with each other, how gravity behaves, etc. Clearly, "encompassing" in a metaphysical sense does not mean "explaining" in a physical sense, a criticism that applies to Mukhyānanda's approach as well.

It is then clear that all these approaches, including that of Mukhyānanda, fail to satisfy in the end. In practice, as noticed earlier, modern physics and Advaita overlap with each other in terms of method and content. Intuition and reasoning play an important role in both enterprises, though in different ways and degrees. Both give a description of the physical world (ex: Advaita develops its own cosmology) and are concerned with the fundamental nature of reality (ex: quantum physics questions the status of empirical reality). Therefore, to confine each discipline within its own domain, making Advaita "encompass" physics, is not enough. To look upon physics as complementing or supporting mysticism seems inappropriate as well. Is it not

[118] Chandrasekharayya, *op.cit.*, 59-62.

[119] Panda, *op.cit.*, 440.

possible, then, to think of an approach that would reconcile modern physics with Advaita yet take into account their differences as well? Jones, Wilber and Barbour have come up with different models as an attempt to integrate science and religion in such a way. In Chapter 5, we will partly rely on those models to propose a more consistent model for a dialogue between modern physics and Advaita Vedānta. In order to lay the basis of this model, however, it is first necessary to undertake the comparative analysis of the concepts of quantum vacuum and *ākāśa*, both of which have been brought into parallel by some authors.

Chapter 3

The Vacuum in Modern Science

Since Antiquity, the notion of vacuum has engaged the attention of many scientists and philosophers in the West. As a subject of philosophical enquiry, it appears quite early in Greek philosophy in the works of Aristotle and atomists like Leucippus, Democritus and Epicurus. Early Greek speculations about vacuum are essentially concerned with questions of an ontological nature: is vacuum, like atomists maintain, the passive receptacle of material bodies, something immutable on which is played the physical world drama? Or is it an entity actively participating and subject to phenomenal changes taking place in the universe? Such questions and others have remained subjects of vivid debates over the millennia. In the early modern period, the concept of vacuum started to attract the attention of scientists both as a theoretical and experimental object. Since then, it has featured in various theories concerned with the nature of the physical world and has contributed significantly to the scientific elaboration of a coherent picture of the universe. In particular, the formulation of Einstein's theory of relativity and quantum physics in the 20th century has had an important impact on our understanding of the vacuum. From the mere conception of vacuum as a spatial region empty of matter, physicists have ended up with the view that it is something substantial and deeply involved in the functioning and evolution of the universe.

The historical evolution of the scientific concept of vacuum has been semantically rich and complex. Given the variety of scientific theories proposed to explain the physical world, different views of the vacuum have been advanced. With Newton, the vacuum is more or less identified with absolute space: it is a passive and ideal container in which bodies move about with respect to each other. As against that, vacuum appears in the various ether theories of classical physics as an all-filling and subtle substance involved in the transmission of light and electromagnetic waves. In the early 20th century, ether theories were rejected and replaced with a more consistent theory: Einstein's special theory of relativity. Here, light is again conceived to travel in empty space but in contrast with the Newtonian absolute space, Einstein's space is interpreted as a relative quantity intertwined with the notion of time. Vacuum loses its substantiality and becomes identified with the spacetime continuum devoid of matter. In its general version, relativity theory explains gravity in terms of the geometrical structure of spacetime, so that vacuum obtains here an ontological status closely connected with the gravitational field. More recent developments in quantum theory have looked upon the "quantum vacuum" as some kind of substratum from which constituents of matter emerge and return to. The phrase *avatars du vide* (vacuum avatars) has been coined by Lachièze-Rey to highlight the various ways in which the concept of vacuum has been approached in the history of science.[1]

We come across a number of studies in the last decades which attempt to understand better the philosophical status of vacuum in relativity and quantum physics, the two pillars of today's theoretical physics. In this chapter, we are concerned with the philosophical underpinnings of vacuum in contemporary physics with a focus on the perspectives taken in philosophy of quantum physics. But it will be appropriate to first assess the historical development of the vacuum conceptions prior to contemporary physics. Following Paty, it is useful to think of this development in terms of four periods:[2]

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[1] Lachièze-Rey, *Les avatars du vide*, 6.

[2] Paty, M., "Le vide matériel, ou la matière crée l'espace." In: Gunzig and Diner (eds.), *Le vide:*

1. From Antiquity to Renaissance: a period of philosophical speculations about vacuum, concerned mainly with ontological arguments;
2. From Renaissance to 17th century: empirical evidence for the physical existence of vacuum and its integration in Galilean/Newtonian mechanics and Newton's gravitation theory;
3. From 17th century to 1900s: reflections on vacuum as an "etheric" medium and rejection of ether theories with Einstein's special theory of relativity (1905);
4. From 20th century onwards: formulation of general theory of relativity and quantum physics (including QFT), in which the vacuum is endowed with some substantiality.

The first part of this chapter is mainly concerned with the first three periods and partially with the fourth period. To begin with, we will briefly review conceptions of vacuum held by the early Greek philosophers like Milesian and atomist philosophers, Pythagoras and Aristotle. This is followed by a discussion on the early modern conceptions of vacuum held by natural scientists like Galileo Galilei, Descartes and Newton. In this period, the vacuum becomes the object of scientific enquiry. Experiments are first conducted that will significantly contribute to understand the vacuum in physical terms. The next section deals with ether conceptions ranging from Aristotle's *aither* to ether scientific theories formulated between the 17th and 19th centuries, and extends the discussion to the concept of field in physics. The last section discusses the vacuum concept from the perspective of Einstein's special and general theories of relativity. The second part of the chapter will be devoted to the notion of vacuum as understood from the perspective of quantum physics.

3.1 The Vacuum: From the Milesians to Einstein

The current scientific outlook can hardly be assessed without considering early philosophical speculations on the themes of space and natural elements. Notwithstanding

univers du tout et du rien, 22.

contributions from other cultures, we cannot underestimate the impact of early Greek natural philosophers in this regard. It is well known that the Greek philosophical tradition has in many ways paved the way for the emergence of modern science in the West. The imprint of Euclid's geometry, Aristotle's natural philosophy and Epicurus's atomistic materialism on the development of scientific thought cannot be underestimated. Early modern period's essential concepts like atoms and ether can be traced back to the Greek constitution of the physical world. John Burnet, a well-known writer on Greek philosophy, described scientific enquiry as "thinking about the world in the Greek way."[3] Whether this statement is true or not can certainly be debated, yet it remains clear that speculations of early Greek philosophers have had a major impact on the Western scientific tradition in general.

3.1.1 Greek Speculations About Vacuum

At the center of most ancient natural philosophies lies the question of the origin and constitution of the universe: how did the world come into existence? Was it created from a sort of nothingness or does it originate from a basic substance or principle that still underlies its existence? In the view of pre-Socratic philosophers, the whole physical world originates from and is ultimately constituted by a unique substance. Thales of Miletus, considered to be the earliest Greek natural philosopher, believes that the universe is born from water and that all things are essentially manifestations of water. In his cosmology, there is no such thing as empty space or vacuum since water pervades everything. His successors also deny the existence of empty space though they differ as to the nature of the one substance underlying natural phenomena. For Anaximander, who was Thales's follower, water could not be the primary substance of the world if it also involves the creation of fire, its antithesis.[4] In his view, natural

[3]Quoted from: Schrödinger, *Nature and the Greeks*, 20.

[4]This argument appears in Aristotle's *Physics* (204 b 24 *ff*). See: Lloyd, *Early Greek Science: Thales to Aristotle*, 20.

elements being subject to change, they cannot constitute a stable foundation for the changing physical world. Rather, the universe has its source in an endless principle (*apeiron*), not subject to change, indefinable and beyond the range of perception. Anaximenes, student of Anaximander, agrees with his teacher that the source of all things (*arche*) has to be endless, yet considers air as the most basic element due to its infinite extension.[5]

Underlying the cosmological views of these three philosophers (Milesian school, 6th century BCE) is the denial of empty space in favour of a substance or principle underlying physical phenomena. In contrast with them, Pythagoras (6th century BCE) recognizes the existence of empty space. As is well known, the Pythagoreans locate the principle of all things in numbers. According to Aristotle (4th century BCE), they consider all things "to be modeled on numbers, and numbers to be first in all of nature [so that] they held the elements of numbers to be the elements of everything there is."[6] Interestingly, they probably are the first sources of the West to reflect on the relationship between numbers and space.[7] In their view, every object or body located in space can be described with numbers; conversely, in Pythagorean philosophy, numbers are endowed with a certain spatiality.[8] For instance, the Pythagoreans use numbers to enumerate the points along a straight line: each point is simply associated with a specific integer number. However, since there is no way to number *all* the points on a straight line — there being an infinity of such points —, there must remain a finite distance between the points. The Pythagoreans identify those spatial vacancies or interspaces with empty space itself. Eventually, the identification

[5]With Anaximenes, we seem to return to Thales's cosmological conception with the difference that water is replaced by air. However, unlike Thales, Anaximenes provides a more detailed explanation of how things develop from the primary substance (air) by having recourse to phenomena like rarefaction, condensation, etc. See: *ibid.*, 22.

[6]*Metaphysics* (1.5, 985b23-986aI). Quoted from: Furley, *The Greek Cosmologists: The Formation of the Atomic Theory and its Earliest Critics* (Vol.1), 51.

[7]Genz, *Nothingness: The Science of Empty Space*, 67.

[8]Jammer, *Concepts of Space: The History of Theories of Space in Physics*, 7.

between empty space and physical media like air or ether bestows empty space with a physical connotation. Therefore, in the Pythagorean view empty space more or less merges with matter.[9]

The school of atomism (5th century BCE) also accepts the existence of empty space but, in contrast with Pythagoreanism, conceives it as an entity distinct and somehow opposed to matter.[10] Unlike Parmenides who denies fundamental reality to change, atomists give a crucial place to natural changes in their philosophy. Change results from the motion of discrete units of matter called "atoms," which compose every physical body. The various properties of matter can in turn be explained through the various ways of combining atoms together. Atoms are eternal (i.e., neither created nor destroyed), infinite in number and also differ in shapes. In this system, the presence of empty space accounts for the motion of atoms. For atomists, as Jammer explains, the existence of empty space is "a logical conclusion of the assumption of the atomistic structure of reality."[11] It is an infinite receptacle in which the bodies, themselves composed of atoms, are allowed to move freely with respect to each other.[12] Here empty space is as real as matter but complementary to it and bounded by it.[13]

On the other side of the spectrum, Aristotle is a strong advocate of a view that negates the existence of empty space. In the history of Greek philosophy, says Furley, Aristotle was "an extremist in his refusal to accept the existence of void in the

[9] *ibid.*

[10] The doctrine of atomism was formulated by Leucippus around the 5th century BCE and then systematized by his student Democritus, and later Epicurus and Lucretius.

[11] Jammer, *op.cit.*, 9.

[12] Jammer explains that according to Democritus, space is infinite because there is an infinite number of atoms residing in it. It is believed that in order to explain the variety of physical properties and forms, one has to admit the existence of an infinity of atoms. Though indivisible, these atoms have a finite extension so that an infinite space is required to contain them. Later, Lucretius tried to prove the infinity of space by invoking the image of a man placed at the boundary of space who would try to stretch out his hand. See: *ibid.*, 8; 11.

[13] *ibid.*, 9.

universe."[14] Though he accepts the existence of elements, Aristotle does not believe they constitute a reasonable foundation for the physical world. The real nature or essence of a thing is to be found not in its constituting elements but in its "form" or *logos*, which is not derived from nor reducible to elements.[15] Rather than composed of indivisible and separate atoms, the world of Aristotle is endowed with continuity: the whole universe is a plenum continuously filled with substance. The atomistic thesis is rejected altogether with its notion of empty space. Also, in Aristotle's cosmological system, every element has a natural tendency to return to its original place, i.e., either upward (air, fire) or downward (earth, water). This occurence is dependent on the assumption that the universe is finite and has a center that marks directions. Space must then carry some qualitative information about the direction in which bodies naturally move. Therefore, such a thing as pure empty space cannot exist.

3.1.2 Vacuum as a Physical Entity

During the Middle Ages, the Islamic world became acquainted with the Greek philosophers and especially Aristotle, who is referred to as *al-failasūf*, the philosopher *par excellence*.[16] Between the 10th and 12th centuries, through the translated works of Ibn Sīnā (Avicenne), Moīse Ben Maimoun (Maïmonide) and Ibn Ruchd (Averroès), the philosophy of Aristotle regains immense popularity in the Western world, especially within European Christendom. At the turn of the 13th century, the Scholastics are busy reformulating Aristotle's thought in accordance with Christian dogma. Among them, Roger Bacon, Albert le Grand and Robert Grosseteste agree with Aristotle that empty space does not exist. The arguments provided are mainly theological: in order to ensure the Christian teaching of an omnipresent God (i.e., present in every

[14] Furley, *The Greek Cosmologists: The Formation of the Atomic Theory and its Earliest Critics*, 189.

[15] *ibid.*, 179.

[16] *ibid.*, 60.

point of space), the existence of vacuum has to be denied. In 1277, however, the bishop of Paris, Étienne Tempier, denounced this argument against the omnipotence of God: if God is really omnipotent, He could actuate the world into empty space if He so desired. But the Aristotelian worldview, and particularly its teaching about the non-existence of vacuum, had already acquired great importance within the Christian world. Less than a century later, in 1325, the Church revoked the decree of Tempier and declared valid the teachings of Aristotle. An influentiel philosopher and theologian in the tradition of scholasticism, Thomas Aquinas never endorsed the idea that empty space does not exist. It is noteworthy that on this point, Aquinas was departing from Aristotle whose teachings had exerted a profound influence on his own philosophy.[17]

In the early modern period, the Scientific Revolution led to significant changes in the Aristotelian worldview. Doctrines prevailing during the Middle Ages were now questioned and gradually replaced with emerging scientific ideas. Reflections about the universe no more centered on theological and ontological arguments but now focused on considerations of a physical nature. During this period, a major shift took place with regard to our understanding of vacuum. In line with the earlier insights of the Greek atomists, the idea of a vacuum with a physical existence of its own gains popularity again. The beginning of this new era in physical sciences is usually associated with the publication of Newton's *Philosophiae Naturalis Principia Mathematica* in 1687. With Newton, the vacuum truly becomes an object of physical investigation. Prior to him, however, a number of natural philosophers had already defended the physical character of vacuum on the basis of empirical arguments. Along with Francesco Patrizi and Giordano Bruno, Galileo Galilei is among the first to uphold, against Aristotle, that the vacuum exists. He is most famous for maintaining that nature abhors vacuum (*horror vacui*). In his view, water in a container could not be pumped beyond a certain level because the laws of nature prevent the formation of

[17]For a more detailed discussion about medieval conceptions of vacuum, the reader may refer to: Grant, *Much Ado About Nothing: Theories of Space and Vacuum from the Middle Ages to the Scientific Revolution*.

Figure 3.1: The experiment made by Torricelli. Gaspar Schott, *Technica curiosa, sive, Mirabilia artis*, Würzburg 1664. Source: Institute and Museum of History of Science, Florence, Italy (Source: http://www.imss.fi.it/vuoto/eesper2.html).

vacuum. Vacuum, for Galilei, is a physical milieu without resistance where all bodies, independently of their weight, fall at the same rate.[18]

On the basis of Galileo's analysis, other natural philosophers set off to create vacuum in experiments. It is one of his students, Evangelista Torricelli, who in 1644 first showed that the vacuum exists, by producing a region devoid of air in a tube filled with mercury. This experiment not only demonstrated beyond doubt that the principle of *horror vacui* is incorrect, but also that vacuum is simple to create. Such an insight, says Genz, truly "initiated a new era in the experimental and theoretical research on the vacuum."[19] In the following years, the more refined experiments of Blaise Pascal and Otto von Guericke also confirmed the existence of physical vacuum. Descartes, however, did not agree with these conclusions. In his view, Torricelli's airless space is filled with a fine form of matter, an idea that would find its way

[18]Lachièze-Rey, *op.cit.*, 22.
[19]Genz, *op.cit.*, 102.

in later ether theories. Space is not the passive container of bodies but is itself a body exhibiting *extension* like other bodies; and what possesses extension must be a substance.[20] For Descartes, empty space is akin to matter yet in a subtle or dilute form. Pierre Gassendi, a contemporary of Descartes, criticized this idea. A firm believer in ancient atomist conceptions — of which he is a foremost revivalist within the Church — Gassendi requires that empty space be the locus and the condition of atoms' motion. In his view, Torricelli's experiment constituted clear evidence of vacuum's physical reality.

In his celebrated *Principia*, Isaac Newton brings in the concept of *absolute space* as a universal frame of reference or backdrop setting for physical phenomena. Absolute space is immutable, homogeneous, infinite and uninfluenced by the physical changes taking place in it. Newton distinguishes this notion from that of *relative space*:

> Absolute space in its own nature, without relation to anything external, remains always similar and immovable. Relative space is some movable dimension or measure of the absolute spaces; which our senses determine by its position to bodies; and which is commonly taken for immovable space. . .[21]

If relative space is defined via the relative positions of bodies with respect to each other, absolute space has no relation whatsoever with the bodies it contains. The former space is apparent, common and relative; the latter is absolute, true and mathematical.[22] In Newton's view, absolute space is an essential requisite for the first law of motion: it stands as a *reference system* for bodies that are at rest or move in a uniform fashion.[23] However, in Newton's mechanics, there is no way to distinguish states of rest from states of uniform motion in absolute space: they are all equivalent.[24] His

[20]Paty, *op.cit.*, 27.

[21]*Principia*, p.6. Quoted from: Jammer, *op.cit.*, 97.

[22]Paty, *op.cit.*, 30.

[23]Newton's first law of motion states that every physical body remains in a state of rest or of straight uniform motion unless it is compelled to change by external forces.

[24]Unless there is a centrifugal force acting upon bodies, it is impossible to distinguish rest from

concept of absolute space is in result severely criticized by contemporaries such as Huygens, Leibniz and Berkeley.[25] It was left to Einstein who will later confirm, at the turn of the 20th century, the relative nature of space and put an end to the long reign of Newton's absolute space in physics.

Newton usually makes a clear distinction between physical and metaphysical matters in his works, yet his conception of space constitutes an exception. Jammer mentions that in his later years Newton became acquainted with Jewish cabalistic teachings and neo-Platonic thought (he was deeply influenced by his neo-Platonic predecessor, Henry More), which in turn had an important impact on his conception of space.[26] He sometimes considered absolute space as an emanation of God (*sensorium dei*) in the sense that it derives its existence from that of God or the first-existing being.[27] At other times, he conceived it as an attribute of God given its presumed eternality and omnipresence. In the second edition (1713) of his *Principia*, Newton declares:

> [God] governs all things, and knows all things that are or can be done.

uniform motion. Thus, Newton associates the existence of absolute space to accelerated or non-uniform motions. In his experience of the "rotating bucket," he tries to demonstrate that the rotational (and accelarated) motion cannot be defined with respect to surrounding bodies but only with reference to absolute space.

[25]Disalle explains: "For Leibniz and others, to say that "space is absolute" is to say that space is a substance, and thereby to attribute a distinct identity to each point of space. But if the locations of all things in space were shifted any distance in any direction, no real difference would be made; therefore, space cannot be absolute." See: Disalle, R., "Newton's philosophical analysis of space and time." In: Cohen and Smith (eds.), *The Cambridge Companion to Newton*, 39-40.

[26]Jammer, *op.cit.*, 108.

[27]As Newton wrote: "Space is an affection of a being just as a being. No being exists or can exist that does not have relation in some way to space. God is everywhere, created minds are somewhere, and a body in the space that it fills; and whatever is neither everywhere nor anywhere is not. And hence it follows that space is an emanative effect of the first-existing being, for if I posit any being whatever I posit space." Quoted from: Stein, H., "Newton's metaphysics." In: Cohen and Smith (eds.), *op.cit.*, 267-68.

> He is not eternity and infinity, but eternal and infinite; he is not duration or space, but he endures and is present. He endures for ever, and is everywhere present; and by existing always and everywhere, he constitutes duration and space.[28]

Such alliance between God and space may have served in Newton's thought as theological justification for the foundations of mechanics and mathematical physics.[29] For Newton absolute space is primarily a mathematical entity and mathematical laws somehow reflect God's perfection in this world. The postulation of absolute space in Newton's system, says Baker, suggests "the construction of mathematical entities which might be approached as limits of perfection on the description of physical facts."[30] Thus, absolute space is endowed with attributes reflecting cosmic perfection — eternity, infinity, immutability. As we shall see, the concept of *ākāśa* was also subject to similar philosophical and theological considerations centuries earlier in Śaṅkara's Advaita Vedānta philosophy.

3.1.3 Vacuum as a Medium

The question as to how physical actions like electricity, magnetism, light, heat and gravity are apparently transmitted at a distance was central at the time of Newton. The search for an efficient cause of actions at a distance was indeed a by-product of the then prevalent mechanical worldview, which sought to explain physical phenomena in terms of motion of material bodies. According to Cao, the mechanical explanation ultimately required "identifying permanent substances that underlay mechanisms, with which the cause was effectively transmitted, step by step, to the effect."[31] Thus, to explain action at a distance, several theories were formulated that involved different kinds of substances, from optical and gravitational ethers to various intangible fluids

[28] *Principia*, p.544. Quoted from: Jammer, *op.cit.*, 111.
[29] *ibid.*, 113.
[30] Baker, *An Historical and Critical Examination of English Space and Time Theories*, 30.
[31] Cao, *Conceptual Developments of 20th Century Field Theories*, 27.

permeating matter and space. Though he believed in the existence of empty space, Newton was among the first to propose an elaborate theory of ether. In his later years, he introduced the idea of an ethereal milieu to explain the transmission of gravity between material bodies. This medium was conceived as a subtle and spatially extended entity permeating space as well as bodies. Though not perceivable, it had the capacity to transmit forces from a point to the other, thus providing a viable mechanism to explain gravitational attraction between bodies. In introducing this gravitational ether, Newton was in fact following a long tradition of thinking going back to the Renaissance, medieval and Greek classical thinkers.

In ancient Greek philosophy, *aither* is associated with the upper part of the world beyond earth and sky. A purer kind of air, brilliant, filling all cosmos, it is also akin to human beings' souls.[32] In Aristotle's cosmology, *aither* features as an element beside the four elements — earth, water, fire and air — introduced earlier by Empedocles. Thus, *aither* is often referred to as the fifth element or *quinta essentia*.[33] The nature

[32] Cantor and Hodge (eds.), *Conceptions of Ether: Studies in the History of Ether Theories (1740-1900)*, 3.

[33] The fifth element was probably introduced in the Empedoclean list of four elements by the fifth-century Pythagorean Philolaus. In Pythagoreanism, the doctrine of five elements is connected with the doctrine of five cosmic solids: tetrahedron is associated with fire, octahedron with air, icosahedron with water, cube with earth and dodecahedron with *aither* (or the universe). In the *Heres*, Philolaus mentions *aither* to be the "purest of essences" and relates it to man's immortal soul whose nature is intellectual and celestial, in contrast with other four elements which constitute man's physical body. Before Aristotle, Plato also maintained a similar doctrine of elements. In the *Timaeus*, the four visible and concrete elements are associated with the four cosmic solids whereas the fifth element is also connected to the dodecahedron and to the notion of an all-containing space. In many places, Plato associates the *aither* with higher regions of the sky, or the heavenly world. Imperceptible, indestructible and formless, the *aither* is beyond any comparison with the sensible world; rather, it is the "support" on which the sensible things, which are reflections in the physical world of the intelligible world of Forms or Ideas, are imprinted and without which they would not exist or become. See: McEvilley, *The Shape of Ancient Thought: Comparative Studies in Greek and Indian Philosophies*, 308; Coomaraswamy, A.K., "The Concept of "Ether" in Greek and Indian cosmology." In: Strom (ed.), *Guardians of the Sun-Door: Late Iconographic Essays and Drawings*

of this element contrasts radically with that of others. Though it has the ability to change location, it cannot change in quality or quantity or simply merge with other elements. Why *aither* possesses the ability to move can be explained in terms of its connection with the circular motion of heavens in Aristotle's system: this element could only be attributed such motion since the other four elements could only move up and down, in straight line towards the centre or periphery of the spherical cosmos. In the first book of *De Caelo*, Aristotle explicitly assigns the *aither* to the outer circumference of his spherical universe and makes it the substance of which stars are made. In the same line of thinking, the Stoics (from the school of Stoicism founded by Zeno of Citium, 3rd century BCE) consider the world filled with an elastic substance called *pneuma*, a mixture of fire and air which they sometimes equate with *aither*. But if Aristotle's *aither* is somewhat passive, the *pneuma* of Stoics is active within all matter and gives cohesion (*hexis*) to the physical world. Moreover, Stoics do not believe in a finite world: the universe has no limits, no edge. In their view, *pneuma* keeps the world together and prevents it from diffusing into infinite space.[34]

Like the first reflections about vacuum, early conceptions of *aither* were mostly concerned with ontological questions. Acceptance of *aither* in cosmology was often a matter of belief and supposition. For instance, Aristotle's introduction of *aither* is mainly an attempt to justify the existence and function of heavens within his own cosmology. However, the ways in which such an entity gets actually involved with the empirical world are not specified. Only with natural scientists like Descartes and others in the 16th century is the concept of *aither* given a more physical interpretation. The relevance of René Descartes in the development of early scientific ether theories

of Ananda K. Coomaraswamy, 71-82.

[34]According to Stoics, *pneuma* is endowed with "tension" (*tonos*), which refers to the inherent capacity to transfer effects from a point to the next. In this sense, as Genz notices, the theory of *pneuma* anticipates aspects of modern field theories: each point in space is assigned a specific quantity and interacts with every other neighbouring point. Not surprising then that Stoics describe sound in terms of vibrations (of air), the latter concept being also an important feature of modern field theories. See: Genz, *op.cit.*, 82-83.

cannot be underestimated. As discussed earlier, Descartes' worldview presumes the existence of a world filled with substance, without any void. In his own *Principia Philosophiae*, Descartes identifies extension with matter and claims that extension is divisible without limit: there is no such thing as indivisible atoms. Empty space has no meaning for him: there is no space without bodies, and no bodies without space. Space is not the container of bodies, but a body itself and thus has extension. Therefore, space is synonymous, in his opinion, with a dilute form of matter which he calls "subtle matter" (*matière subtile*). He applies this notion to explain phenomena involving apparent action at a distance such as magnetism, gravity and so on. For instance, he explains magnetism with the presence of subtle matter within and around the magnet: subtle matter rarefies the air between magnet and iron so that both substances draw nearer with the pressure of external air. There is no action at a distance but a step-by-step transmission by contact through air particles.

Newton disagreed with Descartes' idea that spatial extension is a substance. According to him, space holds a higher ontological status: it is not a substance but the very condition of all substantial beings, even of God.[35] But he followed Descartes in his effort to explain physical action at a distance in terms of local motions and contacts. His introduction of ether as a causal explanation of gravity is in that direction. For Newton, gravitation is a force acting at a distance between every pair of material particles in the universe, proportionally to their mass and decreasing inversely proportional to the square of their distance. To explain this mutual action at a distance, he introduced the concept of a gravitational ether, a rarefied medium composed of hard, minute and impenetrable particles with the property of repelling each other as well as particles of gross matter. Apparent attraction at a distance between material bodies was then explained in terms of the repulsion forces exerted by the ether particles on ponderable bodies.[36] However, this theory did not abolish the problem of action at a distance. Transmission of gravity is explained in terms of forces between ether particles, yet these forces also imply action at a distance. A new

[35] Cantor and Hodge (eds.), *op.cit.*, 13.
[36] Cao, *op.cit.*, 27.

ontological basis was thus needed to account for the transmission of physical actions in space.

At the time of Newton, a controversy arose regarding the nature of light, questioning whether it is a wave or a current of particles. Newton himself believed that light was corpuscular in nature because it spread along straight lines and reflected off surfaces. Yet, Newton's theory hardly accounted for well-known phenomena of refraction and diffraction. In his *Opticks* (1704), Newton tried to explain these phenomena with the existence of an ethereal medium transmitting vibrations faster than the speed of light. Prior to Newton, Christiaan Huygens had posited that light is made up of waves vibrating up and down perpendicular to the direction of propagation. Almost a century later, Thomas Young's interference experiments would show that light interfers just like sound waves, thus vindicating Huygens' wave theory. But like sound, light also requires a propagation medium. Thus, Young proposed that light waves travel in space in some kind of elastic fluid called *luminiferous ether*. In 1816, Auguste Fresnel refined this hypothesis, making ether an elastic solid to allow transverse vibrations. Light as a transverse wave rather than a longitudinal wave, better explains phenomena like birefringence and diffraction. But it is still difficult to explain how ether could be transparent to all material bodies while remaining solid. Despite serious conceptual and theoretical problems and the repeated failure of experimentalists to detect its existence, the idea of ether persisted well into the twentieth century.[37]

Unlike Newton's ether whose mechanism is based on motion of particles and forces, luminiferous ether involves a step-by-step transmission of light through the undula-

[37]For a more detailed study of luminiferous ether theories, the reader may refer to: Cantor and Hodge (eds.), *op.cit.*; Doran, "Origins and Consolidation of Field Theory in 19th Century Britain: From the Mechanical to the Electromagnetic View of Nature"; Hirosige, "The Ether Problem, the Mechanistic Worldview, and the Origins of the Theory of Relativity"; Whittaker, *A History of the Theories of Aether and Electricity*.

tory motions of a continuous medium. A new concept ontologically different from both matter and ether was slowly making its way into physics that seemed to better explain how physical forces are transmitted throughout space: the field concept. The rise of field theories in the late 19th century is the outcome of two main developments in physics: first, as just noted, the emergence of luminiferous ether as ontological basis for explaining optical phenomena; and second, the insights of Faraday, Maxwell and others into the phenomena of magnetism and electricity.[38] Around the 1840s, as a result of his experimental studies on electricity and magnetism, Michael Faraday made the hypothesis that space *devoid of matter* is capable of physical action. He suggested the existence of "lines of force" emanating from charged bodies and magnets; distributed throughout space, these lines of force explain how magnetic and electrical forces continuously transmit from one region to the other. However, if for Faraday lines of force have an independent physical reality, it is not clear whether they are states of space or states of an ether similar to that of Young and Fresnel.

A major turn took place when James Clerk Maxwell introduced the field concept as a substitute for Faraday's lines of force. In his theory of electromagnetism (1864), electricity and magnetism become two different manifestations of a single entity: the electromagnetic field. By definition, the field consists of a set of physical quantities (mass, velocity, direction, etc.) defined at every point of space (or spacetime). For instance, the gravitational field determines the gravitational force acting on any particle at every point in space, and it receives contributions from all the material particles at every other point. In contrast to mechanistic conceptions where particles interact at a distance in empty space, the concept of field involves fullness of space and instantaneous transmission. The idea that field pervades all space is consistent with Maxwell's discovery that electromagnetic waves (or light waves) travel in space at a finite speed, the speed of light. However, though the electromagnetic field has a physical reality of its own it remains in Maxwell's thought a disturbance of a more fun-

[38] Cao, *op.cit.*, 30.

damental ethereal medium. The idea of ether underlying optical phenomena persists. But with the forthcoming works of Hertz, Wien, Thompson, Larmor and Lorentz, the ether gradually loses all its mechanical properties. In Lorentz's electromagnetic theory of electron, for instance, matter is given all electromagnetic properties (mass, charge, etc.) and ether is divested of all its physical properties except that of being at rest. Ether is fully demechanized and separated from matter. As such, it played the same role as absolute space in Newton's mechanics because it had no mechanical properties of its own. Meanwhile, the idea of a field as an entity in its own right was growing. All-pervading, non-mechanical and distinct from both matter and ether, the field paved the way for a new ontology in physics: the field ontology.[39]

3.1.4 Vacuum in the Theory of Relativity

We have seen how, from Newton to Lorentz, ether is progressively divested of its mechanical properties and replaced by the concept of field to explain apparent action at a distance. In this new picture, the vacuum is not filled with material ether but with the non-mechanical and all-pervading electromagnetic field. However, the dualism remains between the field and the ether-as-absolute space in Lorentz's theory. Another step had to be taken to divest ether from its last physical property: its absolute immobility. In 1887, Michelson and Morley conducted an experiment to detect the existence of the luminiferous ether. Considering that the moving Earth is not at rest with respect to ether — since ether is equated with absolute space — the flow of ether across the Earth should hypothetically produce a detectable "ether wind." Analyzing the return speed of light in different directions at different times of the year, it should be possible to detect a difference in the speeds measured depending whether light travels with the "ether wind" or against it. Detecting such difference

[39]Ontology in a physical theory relates to a certain picture or representation of the world, and can serve as a foundation on which a theory is based. For more details on ontology in the context of physical theories, see section 3.2.3.

would confirm that Earth is moving relatively to the ether. But the experiment showed that light had the same velocity whatever Earth's direction. In 1905, Albert Einstein's special theory of relativity provided the explanation for this phenomenon. According to Einstein, no definite state of motion or rest can be assigned to the ether: light travels in vacuum at a constant speed whatever the velocity of the observer. The ether hypothesis is simply irrelevant. What needs to change is the way we conceive the space and time coordinates of an event, which now depend on the velocity of the observer.

Unlike Newton's space and time centuries before, in Einstein's theory space and time are no more absolute entities: they are dependent on the motion of the observer, and as Minkowski would later show, they are different components of a single entity: the *spacetime continuum*. Thus, the vacuum of relativity cannot be equated with an absolute space of the Newtonian kind; it has no substantiality; it is a state of zero energy, zero momentum, zero charge, etc. Its role is purely geometrical as the locus where the observer defines his own reference system, that is, his own spacetime. As a consequence, it is spacetime, not field, that represents the main entity in this theory. Like in Lorentz's theory, the electromagnetic field is left without material medium to support it; but in Einstein's theory it remains supported by spacetime.[40] It must be noted that the redefinition of space and time has several other counter-intuitive consequences, all of which have been empirically proved to date: 1. *relativity of simultaneity*: two simultaneous events for some observer could not be so for another observer; 2. *time dilation*: an observer may find that another's clock is ticking more

[40]Cao, *op.cit.*, 45. As Einstein himself explains: "Here also [in special relativity], natural laws claim validity only when an inertial system is taken as the basis of spacetime description. The principle of inertia and the principle of the constancy of the velocity of light are valid only with respect to an *inertial system*. The field-laws also can claim to have a meaning and validity only in regard to inertial systems. Thus, as in classical mechanics, space [i.e., spacetime] is here also an independent component in the representation of physical reality. If we imagine matter and field to be removed, inertial-space or, more accurately, this space together with the associated time remains behind." See: Einstein, *Relativity: The Special and the General Theory*, 150.

slowly than his own; 3. *length contraction*: a measured length may be found to be shorter than that measured by another observer; and 4. *mass-energy equivalence* ($E = mc^2$): the mass of a body is a measure of its energy content.

A decade after the formulation of this theory, Einstein came out with a generalized version: the *general theory of relativity*. In this theory, spacetime obtains a rather different ontological status. If in special relativity, the principle of relativity is only valid for inertial frames of reference, it is extended to all arbitrary (i.e., inertial and non-inertial or accelerated) frames of reference in general relativity. Pivotal here is the *principle of equivalence* stating equivalence between inertial and gravitational masses. In short, it tells that accelerated or non-inertial states of motion cannot be discerned from states of rest in a gravitational field. As a result, the inertial frame of reference loses its objective significance. Laws of physics remain the same whether they are tested in an accelerated system or in a gravitational field. In this generalized form, the principle of relativity thus applies to any motion whatever the system of reference. With the principle of equivalence as its foundational basis, the general theory of relativity offered a radically new way of looking at the nature of gravitation and its relation to space, time and matter. Gravitation is explained in terms of change in the spacetime geometry: matter generates its own gravitational field by modifying the geometry of spacetime, and conversely spacetime acts upon matter by guiding its motion in the form of gravitational interaction. This relation is clearly expressed in the *Einstein field equations* where the geometrical structure of spacetime (i.e., its curvature or "metric") is related to the gravitational field and the content in matter and radiation present in a specific region of spacetime.

The interpretation of general relativity in terms of its ontology is controversial as it depends upon the selected basic entity — matter, spacetime or gravitational field. Gravity is no more a physical action propagating in empty space as in Newton's theory but a feature *of* spacetime itself. Gravitational field, matter and spacetime geometry become intimately connected. In the course of his research, Einstein adopted three main stances with regard to the basic ontology of general theory of relativity:[41]

1. *Matter ontology*: Under the influence of Ernest Mach, Einstein first considered ponderable bodies to determine the field and the geometrical structures of spacetime. But this view was soon rejected with the discovery of vacuum solutions to the Einstein field equations;
2. *Geometrical ontology*: In this view, the geometrical structures of spacetime are physically real and gravitational fields are reducible to them. Here, ontological dualism between matter and field is maintained;
3. *Field ontology*: This view, adopted by Einstein in his later years, posits the primacy of fields over spacetime structures: spacetime is seen as a structural quality of the field. It is a monistic view because the field determines both the behavior of spacetime and matter.

It is important to note that there is no definite agreement between philosophers of physics as to which ontology is the most consistent. Nevertheless, if we agree with the late Einstein, there is no such thing as empty space according to general theory of relativity. Whereas in special relativity spacetime has an existence independent from both matter and field — which implies that pure empty space has a meaning — in general relativity spacetime is inseparable from the substantial field. As Einstein explains, space (or spacetime) no more exists on its own but only as a structural quality of the field. Such commitment has enormous implications as to how we conceive the state of vacuum:

> I wish to show that spacetime is not necessarily something to which one can ascribe a separate existence, independently of the actual objects of physical reality. Physical objects are not in space, but these objects are spatially extended. In this way the concept 'empty space' loses its meaning.[42]

In a sense, we are back to the conception of an ethereal substance filling the vacuum. Although there is a wide belief that ether theories did not survive after 1905, in reality several such theories seeking compatibility with relativity theory have

[41] Cao, *op.cit.*, 16; 101.

[42] Quoted from: Cao, *op.cit.*, 95.

been proposed.[43] In an address delivered at the University of Leyden in 1920, Einstein conceded that a certain kind of ether may play a role in relativity theory:

> More careful reflection teaches us, however, that the special theory of relativity does not compel us to deny ether. We may assume the existence of an ether; only we must give up ascribing a definite state of motion to it, i.e., we must by abstraction take from it the last mechanical characteristic which Lorentz had still left it... To deny the ether is ultimately to assume that empty space has no physical qualities whatever. The fundamental facts of mechanics do not harmonize with this view... What is essential is merely that besides observable objects, another thing, which is not perceptible, must be looked upon as real, to enable acceleration or rotation to be looked upon as something real.[44]

Decades after Einstein, the interpretation of vacuum as a medium filled with substance remains important in the philosophy of physics. As we shall see, the worldview emerging with quantum field theory also leads to similar considerations.

3.2 Vacuum in Quantum Field Theory

Quantum field theory (QFT) is the mathematical and conceptual framework used for describing the atomic and subatomic constituents of the physical world and the laws that govern their interactions. Developed in the late 1920s, this theory results from the union of quantum mechanics and special theory of relativity, and particularly from the problem of formulating a quantum mechanical theory of the electromagnetic field.[45] After a period of decline in the 1930-40s, the theory rose in prominence again in the 1940-50s when a first consistent QFT of the electromagnetic field was

[43] Cantor and Hodge (eds.), *op.cit.*, 53.

[44] Einstein, *Sidelights on Relativity*, 13-17. At the end of his lecture, Einstein insisted: "According to the general theory of relativity space without ether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any spacetime intervals in the physical sense."

[45] We use the term "quantum mechanics" to denote the developments in quantum theory before the emergence of QFT in the late 1920s. The more generic term "quantum physics" is used to denote quantum mechanics, QFT and other developments in this direction.

proposed.[46] In the early 1970s, the bases of the "standard model" of elementary particle physics were established, which is currently the best theory we have to describe the building blocks of the universe (protons, neutrons, quarks, etc.) and their interactions. QFT has also played an important role in condensed matter physics and modern cosmology where it has "deeply penetrated into the current conception and imagination of the origin and evolution of the universe."[47] QFT is today recognized as the most fundamental theory of physics as well as the most successful one for it has vindicated the most accurate predictions in the history of physics. Of particular interest here is the fact that it has questioned again and from a different perspective the nature of the vacuum.

The aim of this section is to investigate the philosophical underpinnings of vacuum in QFT. In contrast with quantum mechanics, the philosophical significance of QFT has been largely ignored by philosophers of science up to early 1980s. QFT as an object of philosophical reflection only began to receive wider attention in the late 1980s. Since then, quite a few papers and books have been published on topics ranging from methodology to semantics and ontology.[48] As far as ontology is concerned, the main concern has been in investigating the status of entities and processes pertaining to the theoretical framework of QFT: quantum fields, vacuum, particles, quantum fluctuations, interaction, etc.[49] This specific topic will be addressed in the third part

[46]One of the major problems in QFT, noted for the first time in the early 1930s, was the presence of infinities in several kinds of calculations: self-energy of the electron, polarization of the vacuum, scattering of electrons by electric fields of atoms, etc. A method to overcome divergences in calculations, called "renormalization," was developed in the 1940s by Schwinger, Feynman and Tomonaga, for which they received in 1965 the Nobel Prize in Physics. On this basis, a first satisfactory quantum theory of electrons, positrons and electromagnetic field was formulated: quantum electrodynamics.

[47]Cao, *Conceptual Foundations of Quantum Field Theory*, 1.

[48]The main books dealing with philosophical aspects of QFT are: Brown and Harre, *Philosophical Foundations of Quantum Field Theory*; Auyang, *How is Quantum Field Theory Possible?*; Teller, *An Interpretive Introduction to Quantum Field Theory*; Cao, *Conceptual Foundations of Quantum Field Theory*; Kuhlmann, Lyre and Wayne (eds.), *Ontological Aspects of Quantum Field Theory.*

[49]Some physicists and philosophers have put into question the relevance of ontology in physics.

of this section. But before that, the quantum mechanical problem of wave-particle duality and the interpretation of the wavefunction will be discussed in sections 3.2.1 and 3.2.2, respectively. The reason for this arrangement is because these problems are foundational, both logically and historically, to ontological issues in QFT. In the last discussion, we will discuss the nature of quantum vacuum and examine some of the problems faced by philosophers of physics while addressing its status in QFT.

3.2.1 The Wave-Particle Duality

The essence of quantum physics lies in the recognition that atomic structures and processes present an essential discontinuity at their core. In the previous chapter, we addressed some of the major principles of quantum physics, among which were quantization of energy (and of other specific physical properties) and also Heisenberg's uncertainty principle. We also discussed the measurement problem and the phenomenon of nonseparability in order to bring in some of the parallels made in available literature between quantum physics and Eastern spiritual traditions. In the following pages, we briefly introduce the quantum mechanical problem of *wave-particle duality*. This topic is particularly relevant here since QFT overcomes this problem by removing the dichotomy between classical concepts of discrete particle and continuous field; thus, this discussion has also an import with regard to the topic of ontology in QFT. Historically, wave-particle duality stems out from the debate, mentioned earlier, over the nature of light dating back to the 1600s. At that time,

In their view, such philosophical considerations have no empirical relevance and cannot help in investigating the fundamental aspects of nature. However, if ontology cannot contribute empirically to physics, it can be of heuristic value when a theory is being developed. Ontology helps in providing useful conceptual tools for addressing ontological questions in physics and also in suggesting new orientations for the further development of a theory. This is particularly relevant when the findings of physics do not fit into our common representation of the world. See: Cao, *Conceptual Developments of 20th Century Field Theories*, 10. See also: Kuhlmann, Lyre and Wayne (eds.), *Ontological Aspects of Quantum Field Theory*, 2-5.

competing theories of light were being proposed by Huygens and Newton: light is either constituted of waves (Huygens) or made up of particles of matter (Newton). The debate settled for a while with Young's interference experiments that vindicated Huygens' wave theory of light, until it came back to the fore with the works of Max Planck in the early 1900s.

In 1900, Planck solved the problem of black body radiation by showing that the laws of heat radiation required an element of discontinuity.[50] He proposed that the material of the black body consisted of a collection of small "vibrating oscillators" interacting with radiation only with certain states of vibration. The energy of a vibrating oscillator is *quantized* — that is, it is an integral multiple of an energy quantum, $h\nu$, where h is the Planck's constant and ν the frequency of the oscillator. In 1905, the same year his celebrated paper on special relativity appeared, Einstein applied Planck's idea of quantization to radiation itself by proposing that radiation comes in bundles of energy, called *photons*, each having an energy proportional to the radiation frequency. Thus, light consists of a finite number of energy quanta that can be produced or absorbed only as units.[51] According to Einstein, the electromagnetic field is conceived as a collection of particles: particles are the only reality, and the apparent fields can be reduced to interactions between particles.[52] But a few years later, he acknowledged the physical reality of the field as well, raising for the first time

[50] A black body is a theoretical object that absorbs all electromagnetic radiation that falls on it. Therefore it reflects or transmits no radiation and appears perfectly black when it is cold. However, when heated a black body will emit radiations of different wavelengths. According to the classical theory, an ideal black body at thermal equilibrium will emit radiation at infinite power. This is called the "ultraviolet catastrophe" because the problem occurs in the short wavelength region of the electromagnetic spectrum. The problem was solved when Planck redefined the law of black-body radiation.

[51] This hypothesis came as an explanation for the *photoelectric effect* in which individual electrons are ejected from a certain material (for instance, a metal plate) after they have absorbed energy from light projected on the material. The effect could be accounted for if we assumed that light consists of individual quanta having the sufficient energy (or frequency) to hit and then eject electrons.

[52] Cao, *op.cit.*, 130.

the idea of what was later called the wave-particle duality. In 1913, Niels Bohr relied on the ideas of Planck and Einstein to establish his theory of the atomic spectra. In his model, electrons are supposed to exist in distinct states with certain definite energies. When an electron jumps from an orbit to another, it either emits or absorbs a photon with a frequency equal to the difference of the energies of the initial and final atomic states.

In 1923, Arthur Compton performed a X-ray scattering experiment that showed that photons actually carry momentum and energy when colliding with electrons, thus confirming Einstein's hypothesis about light quanta. After this experiment, Einstein said that "there are therefore two theories of light, both indispensable, and without any logical connection": the corpuscular view underlying processes of interaction between light and matter, and the undulatory view known for long to explain phenomena like interference and diffraction.[53] The same year, the idea of wave-particle duality was applied to matter by Louis de Broglie. In the same way as light manifests particle-like properties, particles must also manifest wave-like properties. Any moving particle or object must be accompanied by a *matter wave*, whose frequency ν and wavelength λ are related to the particle's energy E and momentum p in the following manner:

$$E = h\nu \qquad p = h/\lambda,$$

where h is the Planck's constant. In 1927, the Davisson-Germer experiment was conducted to test de Broglie's hypothesis; it did that with success by diffracting electrons in a crystal lattice. The wave-particle duality was no more confined to light but to all particles and material objects.

In 1925, Erwin Schrödinger relied on de Broglie's idea to establish the basis of *wave mechanics*. Assuming the reality of matter waves, he ascribed to each particle a mathematical function called *wavefunction*. The wavefunction is solution to the *Schrödinger equation*, which describes how the matter wave associated with the par-

[53] *ibid.*, 132.

ticle (or a group of particles) propagates itself. A year later, Max Born proposed that this very wavefunction should not be conceived as a "real" entity but as a mathematical tool whose function is only to calculate the *probability* of finding a particle within a certain region. Unlike Schrödinger, Born assumed the reality of particles rather than waves. Together with Werner Heisenberg and Pascual Jordan, Born also contributed to develop the fundamentals of *matrix mechanics*, whose objective was to describe how quantum jumps occur in atoms by expressing properties of particles in terms of matrices evolving in time. Though wave and matrix mechanics emphasize different aspects of matter — the wave and particle aspects, respectively — Paul Adrien Maurice Dirac soon showed that both were valid and alternative frameworks for describing atomic phenomena.[54] Commenting on these theories, Jammer said that "it is hard to find in the history of physics two theories designed to cover the same range of experience which differ more radically than these two."[55] This equivalence implies that matter and waves both exhibit wave and corpuscular properties. Such feature is indeed counter-intuitive for it is difficult to conceive how a particle located in space and time, for instance, can at the same time be spread out in space like a wave.

The wave-particle duality is revealed clearly in the famous *double-slit experiment*. In this experiment, a coherent light source (or any source of particles) illuminates a plate with two parallel openings and behind which there is a screen detecting the impact of photons. When both slits are open, a typical wave interference pattern made of bright and dark bands appears on the screen. Though, at the screen, light seems to be absorbed as though it were made of discrete particles, we observe a pattern that reveals the wave aspect of light. Even more strange is the fact that the same pattern is observed when the experiment is conducted with photons arriving one at a time on the screen. Though we would expect the single photon to go either through one slit *or* the other, the resulting interference pattern suggests that it goes through *both*

[54] Dirac, *The Principles of Quantum Mechanics*.

[55] Jammer, *The Conceptual Development of Quantum Mechanics*, 271.

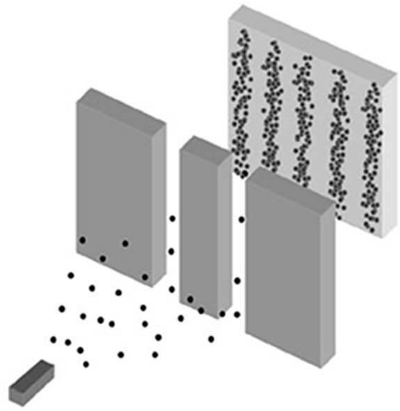

Figure 3.2: The double-slit experiment (Source: http://stephenwhitt.wordpress.com/2008/12/17/the-experiment-with-two-holes/).

slits at the same time. Here, the wave aspect of the photon is clearly in evidence. But when we try to observe the particle-like properties of the photon by detecting which slit it passed through, the interference pattern gets destroyed. Therefore, both wave and particle aspects cannot be revealed simultaneously in a single measurement: we either observe the interference pattern (the wave aspect) without knowing by which slit the particle has passed through; or we locate where the particle has gone but destroy its wavelike properties.

In 1927, Bohr introduced the *principle of complementarity* as an explanation for the wave-particle duality. Wave and particle aspects are neither contradictory nor paradoxical but *complementary* aspects of the same reality: both are necessary to give a total picture of reality and yet they are mutually exclusive to each other. As it appears from the double-slit experiment, we cannot observe both aspects together in a single experiment but only one at a time. As a result, it seems that what quantum mechanics describes should depend on the choice of the experiment. At the International Physics Congress held in 1927 in Italy, Bohr maintained that complementarity

> . . . implies the impossibility of any sharp separation between the behaviour of atomic objects and the interaction with the measuring instruments which serve to define the conditions under which the phenomena ap-

> pear... Consequently, evidence obtained under different experimental conditions cannot be comprehended within a single picture, but must be regarded as complementary in the sense that only the totality of the phenomena exhausts the possible information about the objects.[56]

Complementarity thus has a paramount epistemological implication: it is impossible to conceive properties of quantum objects independently of the interactions that manifest those properties. Notwithstanding such issues, however, from a theoretical viewpoint the problem remains as to which entity — particle or wave — should be considered most fundamental in quantum mechanics. In other words, what is the basic or fundamental ontology in this theory? Are matter and light fundamentally undulatory phenomena as suggested by Schrödinger's formalism? Or are they better understood in terms of particles, like Born's interpretation of the wavefunction suggests? As one scholar explains, "the conceptually incoherent fusion of a mathematical structure based on a field [or wave] ontology and a physical interpretation based on a particle ontology makes it extremely difficult to find a coherent ontology, in terms of classical particles or fields, for this theory."[57] As we shall see, it is only with further developments in QFT that this conceptual problem will find a consistent solution. Meanwhile, the problem of interpreting the wavefunction must be examined.

3.2.2 Interpretations of the Wavefunction

If many physicists consider ontological questions and issues of interpretation to be irrelevant to physics, many others believe in the value of interpreting properly the conceptual content of a physical theory. Interpretation in physics has been described as "the process of deriving, from the formal principles of a theory a logical representation of observable reality in a form that is compatible with common sense and which may be communicated in ordinary language; it must also conveniently describe

[56] Quoted from: Smith, *Introduction to Quantum Mechanics*, 250.
[57] Cao, *Conceptual Developments of 20th Century Field Theories*, 18.

the experiments that are performed in practice."[58] It seems especially relevant in quantum physics, given the fact that this theory radically puts into question some of the fundamental principles of classical physics. The main problems that face interpretations in quantum physics are: 1. the measurement problem; 2. nonseparability; 3. the intrinsically probabilistic character of quantum physics (contrasting with the deterministic nature of classical physics); 4. the completeness of quantum mechanics, i.e., whether this theory accounts for every element of physical reality or not; and 5. the nature of the wavefunction.[59] With reference to the last issue, the main debate has been whether wavefunction has some physical existence of its own or if it is merely a tool for calculating probabilities. Accordingly, we find two main trends of interpretation adopted by the founders of quantum physics: a realistic one in which wavefunction obtains a concrete and physical status, and a probabilistic one in which it has only a statistical function.

De Broglie and Schrödinger may be said to have held a realistic interpretation of the wavefunction in contrast with Born, who maintained a more probabilistic approach. More than others, being the father of wave mechanics, Schrödinger was a radical advocate of a *field ontology* in quantum mechanics.[60] As noted earlier, de Broglie's innovative idea had been to associate a matter wave to each moving material

[58]Omnes, *Quantum Philosophy: Understanding and Interpreting Contemporary Science*, 285.

[59]Several books have been written on the interpretation of quantum mechanics, to which the reader may refer for further details: Jammer, *The Conceptual Development of Quantum Mechanics*, *The Philosophy of Quantum Mechanics*; d'Espagnat, *Veiled Reality: An Analysis of Quantum Mechanical Concepts*, *On Physics and Philosophy*; Omnes, *The Interpretation of Quantum Mechanics*, *Understanding Quantum Mechanics*; Bitbol, *Mécanique quantique: une introduction philosophique*, *L'aveuglante proximité du réel: anti-réalisme et quasi-réalisme en physique*.

[60]A realistic interpretation of the wavefunction usually implies a field ontology rather than a particle ontology. The field is distinct from the discrete, individual and impenetrable particle by its continuity, extension and the superimposability of its different portions. This is however true only of "classical" field ontologies (like Schrödinger's) and not of quantum field ontologies in which the field displays some form of discreteness (see 3.2.3). See: Cao, *Conceptual Developments of 20th Century Field Theories*, 13.

particle. Schrödinger relied on such an idea to elaborate his wave mechanics. In de Broglie's theory, matter wave is conceived as a system of plane waves where each individual wave has the same mathematical form as ordinary light wave. For Schrödinger, this implied that de Broglie waves were as *real* and *substantial* as ordinary light waves. Accordingly, he also considered his wavefunction as a substantial entity endowed with continuous density of energy and momentum. In his view, not the particle but the wave represented by the wavefunction had to be taken as the ontological support of atomic processes. Schrödinger even tried to establish the whole quantum mechanics on this very basis, thinking that "a classical wave picture based upon continuous matter waves would provide the most satisfactory foundation for atomic physics."[61] He was radically against the idea that particles were the irreducible entities of quantum mechanics. Since quantum particles are neither individual, identifiable nor permanent objects like classical particles, it is innapropriate to maintain that quantum mechanics implies a particle ontology.[62]

De Broglie only partly agreed with this view. Like Schrödinger, he believed that matter wave was constituted of a sum of individual waves, each of which is real, three-dimensional and substantial. But he also conceded reality to particles as entities subsidiary to waves. In the 1950s, de Broglie proposed an interpretation of quantum mechanics based on the idea that both particle and wave have reality.[63] In his view,

[61] Moore, *Schrödinger: Life and Thought*, 208. Moore has suggested that Schrödinger's commitment to Vedāntic views may have had some impact on his radical advocacy of a wave ontology in quantum mechanics: "It would be simplistic to suggest that there is a direct causal link between his religious beliefs and his discoveries in theoretical physics, yet the unity and continuity of Vedānta are reflected in the unity and continuity of wave mechanics. In 1925, the world view of physics was a model of the universe as a great machine composed of separable interacting material particles. During the next few years, Schrödinger and Heisenberg and their followers created a universe based on superimposed inseparable waves of probability amplitudes. This new view would be entirely consistent with the vedantic concept of the All in One." See: *ibid.*, 173.

[62] Cao, *op.cit.*, 147.

[63] De Broglie gives an account of this "double-solution" theory in the following book: *Non-linear Wave Mechanics: A Causal Interpretation*, Amsterdam: Elsevier, 1960. It was first published in

the particle was intricately related to the wave as an energy concentration located in a singularity region of its non-linear part; the non-linear wave was in turn conceived to be guided by an extended linear wave.[64] Thus, though de Broglie held a realistic interpretation of the wavefunction, he may be said to have maintained a *field-particle ontology* in quantum mechanics. However, Schrödinger and de Broglie both agreed there were problems inherent to a purely realistic interpretation of wavefunction. First, as Schrödinger himself noticed, "the ψ-function [i.e., wavefunction] itself cannot and may not be interpreted directly in terms of three-dimensional space. . . because it is in general a function in ($3n$-dimensional) configuration space, not real space."[65] Thus, the wavefunction describing a system of particles necessarily requires a mathematical space with more than three dimensions, implying that the wavefunction has a non-physical meaning. It was also hard to reconcile the particle aspect of quanta with the fact that a wave tends to dissipate in the long run.[66] Given these difficulties, some other physicists argued in favour of an ontology based on the concept of particle.

The main representative of a particle ontology in quantum mechanics was Max Born. In line with Schrödinger and de Broglie, he recognized the crucial importance of the wavefunction in describing the state of an atomic system. But unlike them, he interpreted it in purely probabilistic terms. Mathematically, the wavefunction gives the probability of finding the particle in a certain state, the probability being proportional to the square of the modulus of the wavefunction.[67] It has no proper physical meaning: no energy, no momentum or any connection whatsoever with the

French: *Une tentative d'interprétation causale et non linéaire de la mécanique ondulatoire: la théorie de la double solution*, Paris: Gauthier-Villars, 1956. This model was refined by David Bohm in his "pilot wave model," which is still considered as a consistent interpretation of quantum mechanics.

[64] Cao, *op.cit.*

[65] Schrödinger, "Quantisierung, Vierte Mitteilung."

[66] Cao, *op.cit.*, 148.

[67] The square modulus of a complex quantity z (like the wavefunction) is equal to $|z|^2 = z\overline{z}$, where $\overline{z}$ is the complex conjugate of z (if $z = x + iy$, then $\overline{z} = x - iy$). The probability dP of finding a particle in a small volume dV in the vicinity of a point x is thus given by $dP = |\psi(x)|^2 dV$, where $\psi(x)$ is the wavefunction.

motion of particles. In Born's view, the main role is played by the particle, though he was aware that quantum particles differ from individual and well-defined particles of classical physics. Also, he still granted some reality to the probability wave insofar as it allows to predict physically observable results. For these reasons, it may be said that Born maintained an ontology somewhere between the non-classical particle and the wave.[68] One problem with this interpretation, however, is that it hardly accounts for the double-slit experiment in which particles seem to interfere with themselves. To account for such phenomenon, the wavefunction cannot only point to something real but must itself be a physically real entity. However, Born's introduction of probabilities within the framework of quantum mechanics has significant epistemological implications. Whereas classical probabilities merely express our lack of information about a given system, quantum probabilities assume that the precise knowledge of an atomic system cannot *in principle* be obtained.[69] Against quantum indeterminism, Einstein would later declare in a letter to Born that surely "God does not play dice with the universe."[70]

A third and alternative interpretation of the wavefunction was also proposed by Heisenberg. Since the probability wave propagates in space and time according to Schrödinger's equation, wavefunction has some objectivity and cannot be a mere mathematical device. On the other hand, referring to its statistical meaning, wavefunction is subjective insofar as it represents incomplete knowledge about an atomic event. Therefore, wavefunction describes statistical propensities or possibilities that are *actualized* during the process of measurement, that is, when there is interaction between the atomic system and the measuring device. As such, says Heisenberg, it has a "certain intermediate layer of reality, halfway between the massive reality of matter and the intellectual reality of the idea."[71] Compared to Born's, this in-

[68]Cao, *op.cit.*, 150.

[69]Omnes, *The Interpretation of Quantum Mechanics*, 10-11.

[70]Einstein and Born, *The Born-Einstein Letters: Friendship, Politics and Physics in Uncertain Times.* Letter from December 4, 1926.

[71]Heisenberg, *On Modern Physics*, 9-10. However, it is clear for Heisenberg that this reasoning

terpretation is more realistic because it gives some physicality to the wavefunction itself. Nevertheless, as Cao points out, it remains unclear *in which sense* exactly it is real. For instance, is the wavefunction of a single electron — which lives in a three-dimensional configurational space — as real and substantial as the radiation wave of ordinary light? Or does it represent some form of potentiality, thus having partial physical reality? Overall, then, there seems to be no consistent or at least definite ontology in quantum mechanics. But with the works that followed by Dirac, Jordan, Pauli and others, a new ontology soon made its appearance that shed new light on this problem: the quantum field ontology.

3.2.3 Ontology in Quantum Field Theory

Philosophically speaking, the aim of ontology is to get a coherent picture of the most general features, entities and structures of being. When applied to physical theories, ontology is concerned with the worldview supposed or derived from the conceptual structure of a given theory. What are the fundamental things in this physical world and how do they relate to each other? Are there some permanent features in nature or is everything a matter of change? In particular, one is interested in determining the *basic ontology* of a theory. Philosopher of science T.Y. Cao has defined it "as an irreducible conceptual element in the logical construction of reality [that] is concerned with a real existence, that is, with an autonomous existence without reference to anything external."[72] In general, as noted already, basic ontologies range from substances

applies to the physical world only and not to the psychological act of observation. Quantum theory certainly does not involve "genuine subjective features" in the sense of introducing the mind of the physicist as part of the atomic event. See: Hickey's *History of the Twentieth-Century Philosophy of Science* (2005) on the web: http://www.philsci.com/book4-2.htm.

[72]Cao, *Conceptual Developments of 20th Century Field Theories*, 10. It is to be noted that a realistic position with respect to theroretical entities is assumed here. In contrast with the instrumentalist, the realist assumes that some theoretical concepts represent physical reality while others have only a conventional role in the theory. This is a position commonly taken by philosophers of

like particles, fields, etc., to more abstract entities such as spacetime, mathematical relations, forces, processes, etc. Among the various candidates for the basic ontology of QFT, particle and field ontologies are particularly emphasized given their logical and historical connection with earlier considerations on wave-particle duality. We discuss these ontologies in more detail below, referring mostly to the views of philosopher of science T.Y. Cao. A number of other alternative ontologies have also been proposed, which shall however remain outside the scope of this discussion.[73]

QFT primarily consists in the application of principles of quantum mechanics to fields as opposed to particles only in quantum mechanics. In 1926, Born, Heisenberg and Jordan were the first to apply to the electromagnetic field the mathematical methods used by Planck in the blackbody radiation problem.[74] They treated the field as an oscillator and showed that the energy of each mode of oscillation is quantized — that is, the only allowed values were integral multiples of Planck's quantum $h\nu$. The physical interpretation was the following: the lowest state of energy corresponds to the radiation-free empty space with zero energy; the second state has energy $h\nu$, and corresponds to the state of a single photon with that energy; the next state has energy $2h\nu$, and corresponds to a state containing two photons with that energy; and so on.[75] This was a first step towards interpreting photons as quanta of the electromagnetic field. In his seminal paper of 1927, Dirac successfully applied this procedure to solve the problem of spontaneous emission of radiation from atoms.[76] In particular, this problem involved the creation of "particles" during the process, a

physics who are especially concerned with the world picture suggested by the conceptual structure of a theory. The determination of the basic ontology of a given theory has a most important role for the realist. See: Cao, *Conceptual Foundations of Quantum Field Theory*, 1-6.

[73]Beside particle and field ontologies, one finds set theory, process, fact, event, trope, possible worlds, factored ontologies, etc. An overview of these ontologies is available in: Kuhlmann, Lyre and Wayne (eds.), *Ontological Aspects of Quantum Field Theory*.

[74]Born, Heisenberg, and Jordan, "Zur Quantenmechanik II."

[75]Weinberg, "The Search for Unity: Notes for a History of Quantum Field Theory," 22.

[76]Dirac, "The Quantum Theory of Emission and Absorption of Radiation."

feature left unexplained in quantum mechanics: before emission, the system consisted of a single excited atom whereas after emission, it consisted of an atom in a lower state of energy plus one photon. It was then crucial to address this issue because if "quantum mechanics could not deal with processes of creation and destruction, it could not be an all-embracing physical theory."[77]

Without entering into the complex details of Dirac's paper, it is relevant to look at the ontological status of field and particles in Dirac's understanding. In 1927, the year when Bohr proposed his complementary principle, the wave-particle duality was at the forefront of reflections in quantum physics. What entity prevailed over the other? Is the field (or wave aspect) more fundamental than the particle, with the latter being a manifestation of the field? Or is the particle more important, and the field a mathematical abstraction without any physical meaning? According to Weinberg, Dirac's ontology embodies a clear dualism between particles and fields:

> ...the world [in Dirac's view] was still conceived to be composed of two very different ingredients — particles and fields — which were both described in terms of quantum mechanics, but in very different ways. Material particles like electrons and protons were conceived to be eternal; to describe the physical state of a system, one had to describe the probabilities for finding each particle in any given region of space or range of velocities. On the other hand, photons were supposed to be merely a manifestation of an underlying reality, the quantized electromagnetic field, and could be freely created and destroyed.[78]

In Weinberg's view, Dirac's photons are not permanent particles but quanta of the electromagnetic field. However, Cao has recently argued that Dirac seemed to interpret the quantized electromagnetic field in terms of independent and permanent light quanta carrying energy and momentum, rather than quanta that "could be freely created and destroyed." According to Dirac, indeed, the creation and annihilation of quanta in atomic processes is merely the appearance of their jump from or into the

[77] Weinberg, *op.cit.*

[78] Weinberg, *op.cit.*

zero state of energy.[79] In this sense, Dirac was an advocate of a particle ontology in QFT. But in Cao's view, he was conceptually wrong in taking such position. What is really quantized in Dirac's paper is the continuous electromagnetic field, which logically presupposes field as a substance. The derived quanta of energy in fact presuppose the existence of the field as the basic ontology: they can be created and destroyed as opposed to the permanently existing field. Therefore, argues Cao, the field and not the permanent particle was the basic ontology in early QFT, though Dirac interpreted things differently.[80] In any case, the dualism remained at that time between fields on the one hand, and particles like electrons and protons on the other hand. It is only with the 1928 paper of Jordan and Wigner that a "way was found out of this distasteful dualism toward a truly unified view of nature."[81]

In this paper, Jordan and Wigner generalize Dirac's quantization of the electromagnetic field to material or "fermionic" fields.[82] It is a standard view in QFT that there exists one fermionic field for each type of elementary particle: an electronic field for the electron, a quark field for each quark, and so on. Jordan and Wigner showed

[79] In his 1927 paper, Dirac explains: "The light-quantum has the peculiarity that it apparently ceases to exist when it is in one of its stationary states, namely, the zero state, in which its momentum, and therefore also its energy, are zero. When a light-quantum is absorbed it can be considered into this zero state, and when one is emitted it can be considered to jump from the zero state to one in which it is physically in evidence, so that it appears to have been created." Quoted from: Cao, *Conceptual Developments of 20th Century Field Theories*, 162.

[80] For the detailed discussion, see: Cao, *ibid.*, 160-67.

[81] Weinberg, *op.cit.*

[82] In particle physics, fermions are particles associated with ordinary matter as opposed to bosons whose role is to mediate the four fundamental forces of nature: strong, weak, electromagnetic and gravitational (see next footnote). According to the standard model, there are 24 fermions: six quarks (up, down, strange, charm, bottom and top), six leptons (electron, electron neutrino, muon, muon neutrino, tauon and tauon neutrino) and their respective antiparticles. Protons and neutrons are no more elementary particles as we used to believe since they are composed of quarks. At present, the most fundamental constituents of matter are the quarks and leptons. Unlike bosons, fermions obey Pauli's Exclusion Principle: only one fermion can occupy a given quantum state whereas several bosons can occupy the same state.

that fermions like electrons, quarks, etc., are quanta of their respective fermionic field just in the same way as photons are quanta of the electromagnetic field. In other words, fermions are no more permanent and real particles (as Dirac believed for instance) but quanta or excitations of underlying permanent fields. Moreover, just as photons are created when an atom changes its quantum state, material particles can be created out of excitations of their respective fields. An important difference, however, between fermions and photons is that photons are also "carriers" of the field. In QFT, interactions between fields are mediated through the exchange of "carriers" associated with these fields. These carriers are the photons for electromagnetism, the "colored" gluons for the strong-binding force, the intermediate bosons for the weak force, and the gravitons for gravity.[83] It is worth noting that among these carriers, gravitons still have a hypothetical status. Attempts to extend the standard model to include gravitons have run into serious difficulties so far. In fact, one of the major challenges in theoretical physics today is to combine general relativity — which rightly describes gravitational interaction — with quantum theory into a single "unified" theory. Although several "quantum gravity" theories have been proposed in the recent years, such as string theory and other so-called "theories of everything," there is still no complete and consistent quantum theory of gravity upto now.[84]

[83]In physics, four fundamental interactions or forces explain the ways in which particles interact with each other: 1. electromagnetism, which mediates interactions of particles with electrical charge; 2. the strong interaction, which is the force that keeps protons and neutrons bound together; 3. the weak interaction, that acts on the scale of the atomic nucleus and causes phenomena such as beta decay; 4. gravity, the attractive force that draws masses toward each other.

[84]Primarily, the problem of quantum gravity appears because we want a single theory unifying self-consistently all the forces of nature. But it also arises from the fact that both quantum physics and general relativity call for unification with the other theory. Indeed, each theory is confronted with a *problem of infinities* that may be solved by taking into account effects of the other theory. On the one hand, equations of general relativity break down for singularities, i.e., extremely small regions of spacetime in which the density of matter and the strength of the gravitational field become quickly infinite (like in black holes and at the moment of Big Bang). In quantum theory, infinities appear when trying to apply quantum mechanics to describe fields. Since a field has a value at every

The worldview emerging with QFT has radically changed our conception of particles, forces and fields. In contrast with previous mechanistic conceptions, ordinary matter is now conceived in terms of impermanent quanta of more fundamental fermionic fields. Also, there is no more action at a distance as forces are mediated through interacting fields and their respective carriers. For instance, charged particles do not interact at a distance via their respective classical electromagnetic fields, but by exchanging photons continually between them. Both field and particle aspects are intertwined with each other in this theory. Despite the fact that field obtains a more prominent status in QFT than in quantum mechanics, the question remains whether particles or fields should be given priority in understanding QFT. Historically, Dirac, the middle Heisenberg, Feynman and Wheeler seem to have opted in favour of a particle ontology, whereas Pauli, the early and later Heisenberg, Tomonaga and Schwinger have given prominence to fields.[85]

Today, the controversy still persists but with additional arguments that clarify the issue. According to some, QFT entails a particle ontology insofar as only particles, and not fields (except classical fields), are empirically observable. The field is here relegated "to the status of a convention, a device for generating particles and mediating their interactions."[86] However, important arguments have been raised against such interpretation:

1. In contrast with classical particles, quantum particles lack identity and spatial localizability. For assessing the notion of quanta in QFT, a radically new conceptual framework is required;
2. The Unruh effect has put into question the very notion of particle: a uniformly accelerating observer (or detector) feels himself immersed in a thermal bath of particles in the vacuum state. Thus, the notion of particle seems to depend

point of space, it means that there is an infinite number of variables to consider. Since each variable inevitably fluctuates (according to Heisenberg's principle), there is an infinite number of variables that fluctuate. The equations of quantum theory cannot deal properly with these infinities. See: Smolin, *The Trouble with Physics*, 5-6.

[85] Landsman, "Local Quantum Physics," 512.

[86] Cao, *Conceptual Foundations of Quantum Field Theory*, 8.

both on the nature of the detector and its state of motion, and not to be an objective feature of the theory;

3. Most important, if field quanta can be empirically registered yet they do not exhaust the physical content of the field. In particular, the various effects related to vacuum cannot be accounted for because vacuum is interpreted as a state of nothingness in this ontology (see next section).

Given the potential threats to a particle interpretation of QFT, others have opted for a field-based ontology. According to Cao, quantum field is the best candidate for being the basic ontology of QFT. In this view, particles have no longer an eternal and independent existence but are epiphenomena of the substantial quantum field. Though having an objective existence, quanta are not primitive entities but are subordinate to the fields: they manifest or characterize the various excited states of the field. In Cao's words, the particle functions as a "phenomenological indicator for the complicated structural features of the primary field manifested in various situations."[87] However, it is important to understand that the quantum field is different from the continuous field of classical physics. Not only is it able to "generate" substantial particles, but it has also no continuity being quantal in nature. Moreover, in contrast with classical fields, the field values attached to spacetime points have no direct physical significance in the case of quantum fields; also, these values are not definite given the inherently probabilistic nature of the theory.[88] Therefore, the quantum field ontology differs from classical particle and field ontologies. Yet, it synthesizes them both for it treats wavelike (or fieldlike) and corpuscular aspects of radiation as different manifestations of the same fundamental entity — the quantum field.

In early quantum mechanics, wave and corpuscular aspects are complementary yet exclusive to each other. In QFT, however, elementary particles are capable of being created and absorbed like quanta of the wave fields, and conversely fields exhibit their

[87] Cao, "Structural Realism and the Interpretation of Quantum Field Theory," 19.

[88] For more details on the differences between classical and quantum fields, see chapter 5 in: Teller, *An Interpretive Introduction to Quantum Field Theory.*

discrete existence by allowing the creation of particles. By bridging the dichotomy between the continuous field and the discrete particle, QFT thus offers a consistent solution to the riddle of wave-particle duality and possibly the first glimpses of a truly unified view of nature. According to Weinberg, QFT embodies a monistic conception of the material world with the field at its center:

> Thus, the inhabitants of the universe were conceived [in QFT] to be a set of fields — an electron field, a proton field, an electromagnetic field — and particles were reduced in status to mere epiphenomena. In its essentials, this point of view has survived to the present day, and forms the central dogma of QFT: the essential reality is a set of fields, subject to the rules of special relativity and quantum mechanics; all else is derived as a consequence of the quantum dynamics of these fields.[89]

Such view is consistent with Weinberg's reductionist approach to science. In his view, the ultimate aim of science is to reduce all nature to a set of basic and simple universal laws to which all other scientific laws would be reduced. Chemistry and physics should be reduced to basic principles of quantum mechanics, and all properties of elementary particles explained in terms of mathematical consequences of the standard model of QFT. However, though it is true that QFT endorses a view that tends more toward monism than quantum mechanics, yet it deals with a plurality of quantum fields and is still not in a position to include gravity within its scope. More important perhaps is that in order to maintain a consistent materialist monist position, it is also necessary to explain mental phenomena and ultimately consciousness itself in terms of the physical, an attempt that has met with serious difficulties upto now.[90]

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[89] Weinberg, *op.cit.*, 23

[90] Cao, T.Y., "Monism, But Not Through Reductionism." In: Cohen and Tauber (eds.), *Philosophies of Nature: The Human Dimension*, 42-46.

3.2.4 The Quantum Vacuum

By shifting emphasis from particle to field, QFT has paved the way to a radically new manner of conceiving the nature of vacuum. In classical physics and Einstein's special theory of relativity, vacuum is basically a state of nothingness: zero mass, zero energy, zero charge, zero momentum, etc. However, quantum theory tells us that such state *can* actually display non-null values for certain quantities. According to the standard QFT point of view, the quantum vacuum is a very complicated state of the quantum field that has the peculiar property of exhibiting fluctuations in space even in regions considered "empty," that is, devoid of matter and radiation. As such, it is structurally richer and more dynamic than classical and relativistic vacuua, and in a sense more akin to the vacuum-as-medium of classical ether theories. Insofar as it is identified with the lowest state of energy of the quantum field, also referred to as its *ground state*, vacuum obtains physicality in QFT.[91] Recent investigations of "vacuum phenomena" such as Casimir (see below) and Unruh effects have been taken as important evidence for the substantial nature of quantum vacuum. Such considerations have also deeply penetrated the fields of astrophysics and cosmology given the role played by vacuum in the cosmological constant problem.[92]

[91]In fact, the quantum vacuum represents the combination of the ground states of *all* fields associated to particles (electrons, quarks, photons, neutrinos, etc.). For the sake of simplicity, we often talk about one field instead of many, and thus denote the quantum vacuum to be the fundamental or ground state of *the* quantum field.

[92]The cosmological constant problem lies at the frontier between Einstein's general theory of relativity and QFT, and is now one of the most outstanding problems in theoretical physics. The cosmological constant was originally introduced by Einstein in his equations of general relativity to obtain a solution that would describe a static universe that neither expands nor contracts. However, recent observations have suggested that the universe has a small but positive cosmological constant, indicating that the expansion of the universe would be slowly accelerating. The precise causes for this acceleration have not yet been elucidated. One of the major problems is that QFT predicts various contributions to the vacuum energy density leading to a huge value for the cosmological constant. See, for instance: Rugh and Zinkernagel, "The Quantum Vacuum and the Cosmological

The first to propose a quantum mechanical model for the vacuum was Dirac. In the late 1920s, Dirac discovered that the equations featuring in his relativistic theory of the electron had solutions corresponding to states of negative energy. To account for this, he introduced the idea that the vacuum state is not empty but filled with a sea of negative energy electrons, the so-called *Dirac sea*. The problem was the following: if electrons can have negative energy, as Dirac's equations seemed to indicate, most electrons would have negative energy, for all physical systems tend to minimize their energy to become stable. Yet, we actually observe that most electrons have positive energy and not the opposite. Given that electrons follow Pauli's exclusion principle, a vacuum filled with an infinite number of electrons with negative energy would prevent electrons with positive energy from making transitions from positive to negative states of energy. The sea itself would be unobservable yet a "hole" in the sea could be observed if enough energy was given to lift up a negative energy electron into a positive energy state: the "hole" would behave just like ordinary electrons but with opposite electrical charge. Dirac thought at first that these "antiparticles" were protons but it was soon discovered that they were actually anti-electrons or positrons. Thus, Dirac's theory implied that antiparticles could be created out of vacuum under certain circumstances. Unlike classical and special relativistic vacuua, Dirac's vacuum was not truly empty but filled with substance.

From Dirac onwards, the picture gradually emerged that vacuum is filled with frantic activity in the form of quantum fluctuations. In fact, the existence of quantum fluctuations can be derived directly from Heisenberg's uncertainty principle. According to one formulation of the principle, the number N of field quanta associated with a given quantum field and the phase θ of the field amplitude are related like $\Delta N \Delta \theta \geq 1$. It means that if N is equated to zero, that is, if there is no particle in a given state, the field will still show certain fluctuations about its average value, which is equal to zero. Heisenberg's principle also holds between energy E and time

Constant Problem."

t, like $\Delta E \Delta t \geq 1$. This form of the principle implies that the energy of a system that exists for only a short period of time must be correspondingly highly uncertain. Given the equivalence between matter and energy, particles can thus be created in a spontaneous and unpredictable fashion out of the vacuum before being reabsorbed again very quickly.[93] Though they have a concrete effect on the "real" world, these short-lived particles are not directly observable, thus they are called *virtual particles*. Virtual particles are viewed as the quanta that describe fields of force interaction, and as such are mainly involved in interaction processes.[94] Quantum fluctuations in the form of virtual particles might also have a crucial role to play in the early development of the universe. In 1973, Edward Tryon proposed that the whole universe could have been created from a large-scale vacuum fluctuation.[95] In the *cosmological inflation* model, initially proposed by Alan Guth in 1980, vacuum fluctuations contribute to explain the origins of the large-scale structures of the universe.[96]

[93]Weinberg, "The Search for Unity: Notes for a History of Quantum Field Theory," 24.

[94]A common phenomenon is that of an electron-positron pair created out of the annihilation of a photon; or, conversely, the creation of a photon from the annihilation of this pair. Other pairs commonly observed in experiments are quark-antiquark pairs, muon-antimuon pairs and so on. During their short existence, particles and antiparticles interact with each other according to Einstein's law of mass-energy equivalence. This process can be mapped using the so-called *Feynman diagrams* (Fig. 3.3).

[95]Tryon, "Is the Universe a Vacuum Fluctuation?"

[96]According to this model, the universe would have entered a period of extremely fast expansion in the early period of its development. Such rapid expansion would explain why the whole universe is similarly structured over vast distances. During the inflationary period, quantum fluctuations in the vacuum are amplified in such a way to form the seeds for the growth of structure in the universe (ex: formation and evolution of galaxies). The first model of inflation, today named *old inflation*, is based on a transition from a "false vacuum" with a high energy density, which generates an exponential inflationary phase, into a "true vacuum" with zero energy density. The false vacuum is a metastable state (like water under the cooling point) which in due time can give rise, through quantum tunneling, to a true vacuum in the shape of "bubbles." In the following years, *new inflation* models appeared which relied on more complex kinds of phase transition involving thermal equilibrium. A third generation of models, called *chaotic inflation*, was initiated by Andrei Linde. In these models, our universe is conceived as one of many that grew as part of a multiverse; here, quantum fluctuations

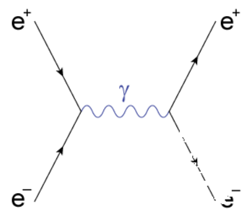

Figure 3.3: A Feynman diagram representing the annihilation of an electron (e^-) and positron (e^+) into a photon (γ) followed by the creation of a pair electron-positron out of the same photon. In this diagram, particles are represented by lines: the straight lines correspond to fermions (here electrons) and the wavy lines represent bosons (here photons) (Source: http://www.howgravityworks.org/Sub_Atomic_Particles.html).

Despite its remarkable insights into the nature of vacuum, Dirac's model was rejected a few years after it was proposed. In 1934, Furry and Oppenheimer[97] showed that the existence of antimatter could be accounted for without introducing Dirac's concept of a filled vacuum, and this without any fundamental change in Dirac's equations. The new formalism considered electrons and positrons as alternative states of a single particle and eliminated the need for an infinite negative energy density.[98] In the same year, Pauli and Weisskopf[99] proposed a quantum theory of the scalar field that also explained the existence of antiparticles without invoking any unobservable particles of negative energy. QFT could naturally incorporate the idea of antimatter and rightly describe the creation and annihilation of particles and antiparticles without having to posit any kind of substantial vacuum. For this reason, several scientists have upheld a non-substantialist conception of vacuum since then. Nevertheless, the presence of quantum fluctuations in the vacuum state remains a compelling evidence for the physicality of vacuum. Many have argued that the so-called *Casimir effect* also has this implication. This effect, initially predicted by H.B.G. Casimir in 1948,

in the empty spacetime give rise to "bubbles" of false vacuum that individually inflate into many universes with random properties. See: Langlois, D., "Lectures on Inflation and Cosmological Perturbations," (2010) 13-14 (Source: http://arxiv1.library.cornell.edu/abs/1001.5259).

[97]Furry and Oppenheimer, "On the Theory of the Electron and the Positron."

[98]Cao, *Conceptual Developments of 20th Century Field Theories*, 175.

[99]Weisskopf, "Über der Selbstenergie des Elektrons."

predicts the existence of an attractive force between two electrically neutral and perfectly conducting parallel plates placed in a vacuum. The displacement of plates has been interpreted to arise from the pressure exerted by surrounding electromagnetic vacuum fluctuations, thus confirming the non-null value of the vacuum energy density. This effect was first observed in the late 1950s and has been tested on a number of occasions since then.

However, Rugh *et al.* have demonstrated that the Casimir effect can be derived from many different points of view, some of which are not based upon the notion of a fluctuating vacuum. In the view of these authors, the Casimir effect "does not give conclusive information about the vacuum," nor is it "an essential demonstration of the vacuum energy and fluctuations."[100] Other vacuum phenomena such as Lamb shift and spontaneous emission of electromagnetic radiations from an excited atom, have also been advanced to prove the physical reality of vacuum fluctuations and thus of vacuum. But these effects always relate to precise material systems (ex: atoms), and it is not clear whether what is observed is an inherent feature of the material systems or of the vacuum itself.[101] Nevertheless, if the physical existence of vacuum cannot be easily ensured on the basis of empirical observations, its heuristic role in explaining vacuum phenomena makes it relevant within the theoretical framework of QFT. Saunders, for instance, finds it appropriate to interpret the vacuum as a fluctuating system of fields insofar as it provides a reasonable explanation for the Casimir and Unruh effects.[102] According to Milonni, who is renowned for his studies on quantum vacuum, the consensus today is that:

> [...] most physicists would agree on the value of a single concept [the quantum vacuum] that provides intuitive explanations for the 'complicated and various facts of electromagnetism.'[103]

[100] Rugh *et al.*, "The Casimir Effect and the Interpretation of the Vacuum," 135.
[101] *ibid.*, 113-14.
[102] Saunders, S., "Is the Zero-Point Energy Real?" In: Kuhlmann, Lyre and Wayne (eds.), *Ontological Aspects of Quantum Field Theory*, 338.
[103] Milonni, *The Quantum Vacuum - An Introduction to Quantum Electrodynamics*, 295.

From a different perspective, philosophers of science have argued for the physicality of vacuum on the basis of their acceptance of a field ontology in QFT. In this picture, as discussed earlier, quantum fields are substances having a real and autonomous existence. Particles, or field quanta, are interpreted as the manifestation of excited states of the fields; they are dependent upon the fields for their existence. If we take fields as primary entities, then the vacuum is naturally interpreted as the state of a substratum and thus as something substantial itself. But the substantialist interpretation of vacuum raises questions, as Cao explains:

> On the one hand, according to special relativity, the vacuum must be a Lorentz invariant state of zero energy, zero momentum, zero angular momentum, zero charge, zero whatever, that is, a state of nothingness. Considering that energy and momentum have been thought to be the essential properties of substance in modern physics and modern metaphysics, the vacuum definitely cannot be regarded as a substance. On the other hand, the fluctuations existing in the vacuum strongly indicated that the vacuum must be something substantial, certainly not empty.[104]

What this remark suggests is that the traditional concept of substance cannot hold anymore even though we recognize a substantial character to vacuum. A possible solution brought out by Cao would be to redefine the concept of substance, and to "deprive energy and momentum of being the defining properties of a substance."[105] Another alternative, more appropriate in his sense, would be to interpret the vacuum as a kind of "pre-substance, an underlying substratum having a potential substantiality." By exciting this pre-substance with energy and other properties, substance in the form of particles acquires physical reality. In some sense, we return here to Dirac's insight that vacuum is an all-pervading and potential reservoir from which physical substance emerges. With this view in mind, many have depicted quantum vacuum to be a modern embodiment of the Western concept of ether and Eastern concept of *ākāśa*, both denoting all-pervading and subtle substances underlying physical

[104] Cao, *Conceptual Developments of 20th Century Field Theories*, 176.
[105] *ibid.*

phenomena.[106]

Another difficulty, closely connected to the problem of interpreting the formalism of quantum physics, concerns the ontological status of vacuum in the measurement process. As Saunders says, there is no reason "to suppose that the observed properties of the vacuum, when correlations are set up between fields in vacuo and macroscopic systems, are present in the *absence* of the establishment of such correlations."[107] As discussed earlier, quantum physics puts into question the idea that material objects exist with definite properties prior to measurement. The *state* of a system has a different meaning in this theory than in classical physics. In the classical picture, the state of an object is described by variables (position, velocity, etc.) conceived as inherent properties of the object. In contrast, the quantum state contains information about *probabilities* of obtaining specific values for these variables in a given experiment. Position, velocity, number of particles, etc., then have no definite value prior to measurement. We cannot construe "quantum objects" as entities endowed with fixed and objective properties, defined independently from the measurement process. Consequently, the conception that vacuum has objective reality is at stake here. For Mills, the vacuum state is not real in the classical sense for it has no meaning prior to measurement of its properties. Yet, it is not unreal insofar as its physical existence can be assessed through proper experiments.[108]

The philosopher of science Michel Bitbol would agree with this view. In some of his works, he points out how the concept of "state" in quantum physics can be

[106] In his later years, Dirac himself proposed to reintroduce the notion of a non-mechanical ether into quantum physics. As Cao notices, "Dirac's idea of the vacuum as a kind of substratum shared some of its characteristic features with the ether model, which explains why he returned to the idea of an ether in his later years..." See: Cao, *ibid.*, 174. For original papers by Dirac: Dirac, "Is there an aether?" (1951, 1952)

[107] Saunders, *op.cit.*, 339.

[108] Mills, R., "Qu'y a-t-il là quand il n'y a rien là?" In: Gunzig and Diner (eds.), *Le vide: univers du tout et du rien*, 301-02.

fairly misleading, if not inadequate. In consonance with the classical worldview, this concept involves a dichotomy between a given substratum and assumed inherent properties. The "state" is real and independent, a substratum in which inhere specific properties. According to Bitbol, the process of objectifying reality in terms of objects and properties, or object and subject, is a *détermination catégorique*.[109] In the context of QFT, the concept of quantum state might have led to the wrong view that there must be an entity "supporting" the qualities (supposedly) inhering in the state. Thus, the quantum field has generally been recognized as the *ontological support* of the quantum state, that is, as an entity endowed with objective reality and distinct from the measurement process. But it is impossible to attribute objectivity to the quantum field in this manner. The mathematical entity representing the field in quantum theory is not a function of local variables but an operator, more precisely an "observable" whose eigenvalues correspond to the *possible* outcomes of a measurement. As an example, the number operator has eigenvalues corresponding to the number of excited quanta that *could* be observed with a certain probability *if* a specific measurement was done. In no case, then, can the quantum field (or the vacuum, which is a state of the field) refer to a pre-existing entity defined independently of the experimental conditions of its measurement, or serve as an intrinsic support for definite states of excitation.[110]

Nevertheless, eminent personalities like Heisenberg and Popper have interpreted the quantum state to embody some form of potentiality.[111] The quantum state would express the *propension* of "something" — a substance, a pre-substance, or some form of vacuum or ether — to give rise to phenomena under specific experimental conditions. For Bitbol, the interpretation of quantum state as propension (or a *détermination propensive*, as he calls it) is in agreement with the empirical and predic-

[109]Bitbol, *L'aveuglante proximité du réel: anti-réalisme et quasi-réalisme en physique*, 246.
[110]*ibid.*, 254.
[111]Heisenberg, *Physics and Philosophy: The Revolution in Modern Science*; Popper, *Quantum Theory and the Schism in Physics*.

tive character of quantum physics: what quantum physics describes is the evolution of a pure predictive content in terms of the *potential* outcomes of an experiment.[112] But like the *détermination catégorique*, the *détermination propensive* preserves the idea of an external and independent substratum with which there is interaction during measurement. The ability for manifesting phenomena must belong to some etheric object opposing the measuring apparatus, a dichotomy that goes against the corroborated predictions of quantum physics.[113] In Popper's sense, however, the propension implies a *relational situation* rather than a relation between *entities* opposing each other. Here, there is no reference to the propension *of* a specific entity to manifest itself; the propension rather describes the ability of a certain situation to manifest itself in some way. Teller has a similar view in mind when he says that "we should understand the quantum state as specifying propensities for the manifestation of properties, but we can consistently deny that there has to be anything that exemplifies the state."[114]

In his *pragmatic-transcendental interpretation* of quantum physics, Bitbol brings this ontological deconstruction further. In his view, quantum physics does not deal with a pre-structured and independent reality, whether it be in the form of entities or propensions. Distancing himself from realism, Bitbol does not invoke an abstract metaphysics to assess the theoretical formalism of quantum physics. Nor does he concede, in consonance with instrumentalist views, that quantum theory is a mere recipe whose only purpose is to predict and manipulate quantum phenomena. The structure or formalism of the theory is for him highly significant. What makes quantum theory particularly significant, says Bitbol, is its ability to incorporate within its formalism the norms related to the experimental activities it accounts for and those related to the predictions of their results.[115] Within the framework of this interpretation, a

[112]Bitbol, *op.cit.*, 259.

[113]*ibid.*, 260.

[114]Teller, *An Interpretive Introduction to Quantum Field Theory*, 109.

[115]Bitbol, *L'aveuglante proximité du réel: anti-réalisme et quasi-réalisme en physique*, 269-70. Bitbol is inspired in its interpretation of quantum physics by Kant's transcendental philosophy. Like Kant, he believes that physical theories are neither mere predictive recipes nor true descriptions of

substantialist interpretation of vacuum is hardly possible. Quantum vacuum is not a state, or a set of propensions referring to a real and independent substrate. It is more akin, Bitbol notices, to the concept of "emptiness" (*śūnyatā*) defined by the Buddhist Madhyamaka philosopher Nāgārjuna (2nd century CE). Here emptiness refers to the "interdependent origination" of everything that exists: what emerges in dependence with other things is precisely empty of substance, empty of any individual nature or existence. Such vacuum, says Bitbol, has obviously "no pretention to an ontological status."[116]

Midway between naive realism and anti-realism lies Bernard d'Espagnat's interpretation of quantum physics. Like Bitbol, d'Espagnat contends that "quantum objects" have no reality of their own independently from the measurement process. Atoms, fields, etc., are only components of an *empirical reality*, that is, of a reality constructed through perception, reasoning and data processing. However, he differs from Bitbol in that for him quantum theory discloses the existence of an underlying reality, or fundamental Being "beyond" empirical phenomena. Since physico-mathematical laws of quantum physics do not arguably depend on human observation, there must be a reality-in-itself from which these laws originate and acquire their structure. In other words, there is something "real" that is not reducible to our concepts, theories and representations of reality. Such *ontological* or *veiled reality*, d'Espagnat argues, is not directly available to scientific enquiry for it "is not knowable as such and is extremely 'far' from our current set of concepts."[117] In d'Espagnat's view, then, the

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the thing-in-itself. Rather, they are justified by their aptitude to express, in Kantian terms, the "general conditions of possibility of experience." But to the Kantian synthetic *a priori* — against which many philosophers of science have rightly argued — Bitbol substitutes a "functional *a priori*," which consists in his view in "a set of basic presuppositions linked with practical activity." Such *a priori* may change with the redefinition of experimental activities in the course of time. See: *ibid.*, 146-154. For more details on the pragmatic-transcendental interpretation, see also: Bitbol, *Mécanique quantique, une introduction philosophique.*

[116] *L'aveuglante proximité du réel: anti-réalisme et quasi-réalisme en physique*, 272.

[117] d'Espagnat, *On Physics and Philosophy*, 400-01.

vacuum cannot reasonably be taken to be devoid of every ontological connotation. If the vacuum cannot be considered a substance, or an entity pre-existing measurement, it nonetheless mirrors (like all other "quantum objects") aspects of a "veiled reality" beyond the reach of perception and reasoning. We shall come back in more detail to d'Espagnat's views in Chapter 5.

3.3 Concluding Remarks

Throughout the history of Western thought the concept of vacuum has obtained a variety of meanings and connotations. In ancient Greek cosmology, the existence of empty space is closely related to speculations about the foundational principle of the world considered as a whole. Based on the view that the world is constituted by atoms, numbers or elements, empty space obtains a different ontological status. Primarily speculative and metaphysical, these arguments about vacuum shift to considerations of physical nature in the early modern period. On the basis of empirical and theoretical modes of investigation, modern science offers a new paradigm from which to reflect about vacuum. History of science presents us with two seemingly opposite sets of conceptions: some in which vacuum is envisaged as a passive entity equated with empty space, and others where vacuum is identified with an all-pervading substratum from which physical constituents emerge and return to. Hence vacuum denotes different things in different theories, and each theory embodies in some sense a specific and unique way of comprehending vacuum. For instance, the vacuum of general relativity is not identifiable whatsoever with that of quantum theory. In quantum physics, the vacuum has something to do with the quantum field, which differs radically from the gravitational field of Einstein's theory.

The interpretation of vacuum in a given theory, understood in a philosophical sense, is not straightforward and involves several complex conceptual and theoretical issues. In particular, the nature and function of vacuum in a definite theoretical framework depends upon the ontological status given to other theoretical entities featuring in the theory. In Einstein's general relativity, for instance, the notion of empty space obtains a different meaning whether we accept field or spacetime as the basic ontology of the theory. In QFT there is ambiguity as to the status of quantum vacuum, as noted by Cao who described this problem as the "most profound ontological dilemna in QFT."[118] As noted earlier, there exist several different ontological frameworks from which to understand the formalism of QFT. A good candidate for the basic ontology of QFT is the field ontology, according to which the quantum field is real and fundamental whereas particles are only subsidiary aspects of the substantial field. As a state of the quantum field, vacuum appears in this picture as a potential, substantial and all-pervading receptacle out of which particles are generated and to which they return at the end of their existence. A kind of subtle ether, quantum vacuum underlies every interaction in the material world and makes manifest the potentialities concealed in it. Several scientists and philosophers of science have taken vacuum phenomena, like Casimir and Unruh effects, as important evidence in this regard.

However, it is important to understand that a substantialist interpretation of vacuum is by no means essential. Other relevant ontologies have been proposed to explain QFT that do not take vacuum as a substance. Moreover, it has been shown that vacuum phenomenon like Casimir effect does not necessarily imply a substantialist stance. At a different level, the interpretation of quantum vacuum is intertwined with the interpretation of the formalism of quantum physics, and more specifically with the philosophical issue of realism. According to most recent interpretations, "quantum objects" like particles, fields, etc., cannot be taken as objective entities endowed with fixed and definite properties prior to measurement. The classically realistic conception of the physical world as a pre-structured reality independent of

[118]Cao, *Conceptual Developments of 20th Century Field Theories*, 176.

our measurement has no meaning in this theory. Accordingly, quantum vacuum can hardly be taken as a substance in the classical sense. Some philosophers, like Bitbol, have criticized the concept of "quantum state" and advanced an ontological deconstruction of entities in quantum physics; here vacuum has no intrinsic existence nor any particular substantiality. Others, like d'Espagnat, though agreeing that vacuum is not a substance in the classical sense, have argued for a non-classical form of realism in quantum physics. In this interpretation the vacuum, like every quantum entity, by revealing new laws of physics, contributes to unveil aspects of a "veiled reality" whose nature ultimately lies beyond scientific enquiry.

In contrast with other physical existents, vacuum lies at the "frontiers" of the manifest universe: it is not directly perceivable, it is fundamental in an ontological sense (at least in a field ontology), it is responsible for the generation and interaction of physical constituents and has arguably a crucial role in the origin of the structure of the universe as a whole. The vacuum also evokes the idea of unity in the current scientific representation of the world as opposed to the diversity of physical existents such as particles, fields, etc. If there exists a theory of quantum gravity reconciling quantum physics with general relativity, the vacuum could embody the fundamental state of all existing fields, gravitational and quantum. But looking at the history of science, it is most probable that such a theory will not put an end to enquiry in physics. It is perhaps more reasonable to believe that different and more refined conceptions of the vacuum will be proposed in the near future.

Chapter 4

Ākāśa in Hindu Schools of Thought

The concept of *ākāśa* is deeply embedded in the ancient philosophical and spiritual traditions of India. Initial references to the Sanskrit word *ākāśa* are found in early Vedic literature, especially in the *Upaniṣads*. Among the few English words used to translate *ākāśa*, those of "space" and "ether" are the most commonly accepted.[1] Multi-faceted, complex and sometimes ambiguous, the concept of *ākāśa* has been in-

[1] Chakrabarti notices that the several semantic changes this word has undergone in Indian literature all converge to mean "space." Indeed, this term is used in most English translations of *Upaniṣads* as well as several other Indian philosophical texts. However, if it is true that, at least in early Vedic literature, the distinction between space and *ākāśa* is almost non-existent, later schools of thought clearly distinguish both concepts. For instance, Vaiśeṣika makes a clear distinction between directional space (*diś*) and *ākāśa*. Sometimes, *ākāśa* is translated as "ether" because it is equated with the Greek cosmological element (*aither*), which connotes notions of space, heaven and celestial bodies. For the sake of simplicity, we shall use the Sanskrit word in most cases; otherwise, the word "space" will be used. See: Chakrabarti, S.C., "*Ākāśa*." In: Bäumer (ed.), *Kalātattvakośa*, 103.

vested with different layers of meaning throughout the history of Indian thought.[2] In Āyurvedic medicine, *ākāśa* is considered as one of the five *dhātus* or constitutive principles of the human body.[3] In ancient Indian mathematics, it is synonymous with the number zero[4] whereas in the *vāstu śāstra* (the traditional Indian art of architecture) it conveys the idea of an "all-filling space" endowed with an inner and spiritual meaning.[5] However, it is certainly in the *darśanas*, or classical Indian schools of thought, that this concept has been the object of the most intense reflection, discussion and debate among philosophers from the various schools of Hinduism, Buddhism and Jainism.[6] Since the concept of *ākāśa* was approached by philosophers in keeping with their own metaphysical outlook of the world, a variety of interpretations contributed to refine this concept through the ages.

[2]However, the concept of *ākāśa* has not always been restricted to the confines of Indian thought. In the Theosophical movement for instance, the notion of "akashic records" appears extensively to denote a non-physical "plane of existence" in which would be stored all human knowledge and the whole history of the universe (see, for instance: Ellwood, R.S., "Theosophy." In: Stein (ed.), *The Encyclopedia of the Paranormal*, 759-66). References to this concept by scientist Nikola Tesla and systems theorist Ervin László have been pointed out in section 2.1.3 of this dissertation.

[3]Subrarayappa, B.V., "Indian Perspectives on the Physical World." In: Chattopadhyaya (ed.), *History of Indian Science, Philosophy, Culture in Indian Civilization*, 81-86.

[4]Coomaraswamy, "*Kha* and Other Words Denoting "Zero" in Connection with the Metaphysics of Space."

[5]The historian of South asian art, Stella Kramrisch, describes in the following manner the symbolic role played by *ākāśa* in the architecture of Hindu temples: "Created once again, not cosmogonically, though, but artistically, this creation, the edifice of the temple in the density of images that emerge from and have their station on the bulwark of its walls - is a reiteration in its own terms, a re-construction of the all-filling *ākāśa* and of the waves of the flood prior to creation." See: Kramrisch, S., "Space in Indian Cosmogony and in Architecture." In: Vatsyayan (ed.), *Concepts of Space: Ancient and Modern*, 104. See also in the same volume: Bäumer, "From *guhā* to *ākāśa*: The Mystical Cave in the Vedic and Śaiva traditions," 105-19.

[6]In this study, the expression "classical Indian schools of thought" is used to denote both the classical "orthodox" schools of thought accepting the authority of Vedic sacred texts (i.e., Nyāya, Vaiśeṣika, Sāṃkhya, Yoga, Pūrva Mīmāṃsā and Vedānta) as well as the "heterodox" ones, denying this authority (i.e., Buddhism, Jainism and Cārvāka materialism). The expression "Hindu schools of thought" refers only to the orthodox schools of thought.

In classical Indian schools of thought, *ākāśa* is considered as one of the five elements (*bhūta*, *mahābhūta*, *pañcabhūta*) constitutive of the physical world. As suggested by Jhaveri,[7] we may broadly divide these schools into three classes depending on their understanding of the concept of *ākāśa*. In Nyāya-Vaiśeṣika, Pūrva Mīmāṃsā (especially the Prābhākara school), Jainism and early Buddhism, *ākāśa* is envisaged as an independent, all-pervading and eternal entity. In Nyāya-Vaiśeṣika in particular, it is considered as one of the five physical elements (the other being air, water, fire and earth), that which is the substratum of the quality of sound (*śabda*). In Jain philosophy, *ākāśa* constitutes one of the six fundamental substances (*dravya*) with soul (*jīva*), matter (*pudgala*), principle of motion (*dharma*), principle of rest (*adharma*) and time (*kāla*), and as such stands apart from the other four elements. It consists of two parts: the *lokākāśa*, containing the world where souls and other substances live, and the *alokākāśa*, the infinite and empty space beyond *lokākāśa*.[8] A second conception, shared by Sāṃkhya and the various schools of Vedānta, is that *ākāśa* is a physical evolute of *prakṛti* or *Brahman*, respectively. Here *ākāśa* is considered a created element that is devoid of eternality. Yet, since Sāṃkhya and Vedānta have a different outlook on the ultimate world-principle, they disagree about the place of this element in their scheme of cosmological evolution.

The third conception, peculiar to later Buddhist systems such as the Sautrāntika school, looks upon *ākāśa* as a concept that has no reality outside the mind. This element owns no positive existence and accounts only for the "mere absence of resistant matter." (*sapratighadravyābhāvamātra*)[9] Like the Jains, most Buddhist thinkers reject *ākāśa* from their list of elements because of its non-substantial nature, and prefer to include it in another list of six *dhātus*, together with consciousness (*vijñāna*). At the end of the spectrum, we find the materialistic school of Cārvāka that does not recognize the existence of *ākāśa*. Since *ākāśa* cannot be perceived through the

[7] Jhaveri, "The Concept of *ākāśa* in Indian Philosophy."
[8] *ibid.*, 301. See also: Jaini, *The Jaina Path of Purification*, 127-30.
[9] Karunadasa, *Buddhist Analysis of Matter*, 91.

sense-organs, and since perception is the only means of valid knowledge (*pramāṇa*) in this school,[10] the existence of this element is simply not recognized by Cārvāka philosophers.

Though listed as one of the five elements in most Indian schools of thought, *ākāśa* stands for more than a mere element in certain of them. The primary status granted to *ākāśa* in Sāṃkhya and Vedānta, as the first evolute to appear in the cosmogonical process, already manifests its ontological superiority. Schools like Nyāya and Vaiśeṣika distinguish *ākāśa* from other elements as being partless, not composed of atoms and thus not subject to change and becoming. Back in the *Upaniṣads*, there are passages where *ākāśa* refers to something with no definite relation to the empirical world. In the *Taittirīya Upaniṣad*, air, fire, water and earth emanate in succession from *ākāśa*, which itself derives from *ātman*. Thus, it is sometimes considered the most proximate symbol for the absolute reality (*Brahman*, *ātman*). In some passages, owing to its character of omnipresence and eternality, it is meditated upon as *Brahman*.[11] Elsewhere, it is referred to as the inner space of one's heart (*hṛdasyākāśa*) in which abides the "shining immortal spirit," (*puruṣa*) a conception similarly found in the *Yogavāsiṣṭha* and in the Śaivite tradition of Kashmir.[12] Such metaphysical connotations constitute a salient feature of *ākāśa* in contrast with the other elements.

[10] Sharma, *A Critical Survey of Indian Philosophy*, 42. It is to be noted, however, that in all probability, Cārvāka philosophers did not refute inference directly as a means of valid cognition. Such view would have been difficult to maintain as they themselves used inference to "infer" that inference is not a valid means of knowledge. See: Hiriyanna, *Outlines of Indian Philosophy*, 190-91.

[11] Dasgupta, *A History of Indian Philosophy* (Vol.1), 43.

[12] The *Yogavāsiṣṭha* and its compendium *Laghu-Yogavāsiṣṭha*, give great attention to the concept of *ākāśa*. In particular, it distinguishes between three kinds of *ākāśa*: *cittākāśa* (mental space), *cidākāśa* (consciousness-space) and *bhūtākāśa* (physical space). Bäumer notices that "*ākāśa* for the *Yoga-Vāsiṣṭha* serves as the most powerful symbol for the Advaita of pure consciousness..." In Kashmir Śaivism, the concept of inner *ākāśa* is also present. In Abhinavagupta's philosophy, the term *prakāśa* stands for the primeval and transcendent omnipresence of the "space" pertaining to consciousness. See: Bäumer, B. "From *guhā* to *ākāśa*: The Mystical Cave in the Vedic and Śaiva traditions." In: Vatsyayan (ed.), *Concepts of Space: Ancient and Modern*, 113; Halbfass, W., "Space or Matter? The Concept of *ākāśa* in Indian Thought." In: Nair (ed.), *Mind, Matter and Mystery:*

Overall, the fundamental nature of *ākāśa* in Indian philosophy remains unclear. Is it an empty space that passively contains bodies and objects or some subtle form of materiality? Is it some sort of transcendental entity involved in the origination and sustenance of the empirical world or an inner spiritual principle ? In this chapter, an attempt is being made to examine the concept of *ākāśa* as given in *Upaniṣads* and also study some of the different interpretations of *ākāśa* given in the three classical philosophical schools of Vaiśeṣika, Sāṃkhya and Advaita Vedānta. Among the Hindu classical schools of thought, these three discuss the concept of *ākāśa* in great detail. Prominence will especially be given to Advaita Vedānta as it is the school with which we are primarily concerned in our comparative study. The analysis shall remain as close as possible to the basic Sanskrit texts and will refer to the commentaries recognized by both scholars and traditional teachers as the most authoritative ones. Since *ākāśa* is classified as one of the five *bhūtas* (elements), it will be relevant to first discuss the concept of *bhūta* and its various meanings in Vedic literature and especially in the *Upaniṣads*. This will be followed by a study of *ākāśa* specifically in philosophical literature.

4.1 Textual Sources in Vedic Literature

Vedic literature constitutes the earliest source of information regarding Hindu thought. For the most part, the various philosophical ideas that were developed in the later philosophical systems go back to the *Vedas*.[13] These texts, as we know them, were originally transmitted for centuries through oral transmission. The exact period during which they were written is not known with certainty, but most scholars date this codification to somewhere around two thousand years BCE.[14] However, according to the tradition, the message of the *Vedas* is authorless (*apauruṣeya*) and without any

Questions in Science and Philosophy, 98.

[13] Flood, *An Introduction to Hinduism*, 225; Mohanty, *Classical Indian Philosophy*, 1.

[14] Mohanty, *Classical Indian Philosophy*, 1.

beginning (*anādi*). It ascribes the *Vedas* to the inspiration of primeval sages called *ṛṣis*, who received the stream of *Vedas*' perennial message intact and then passed it on to human beings. These sacred texts are called *śruti* (literally: "that which has been heard") and as such stand as an authoritative norm of belief and practice for most Hindus.

There are four *Vedas* (*Ṛgveda*, *Sāmaveda*, *Yajurveda*, *Atharvaveda*), each of them consisting of a collection of hymns, chants and liturgical formulas (*mantras*) and to which are attached prose texts describing in detail the meaning of the liturgy (*Brāhmaṇas*). In addition, each *Veda* has its own *Āraṇyaka* (literally: "forest treatise"), a group of texts dedicated to the inner meaning of the sacrificial rituals described in the *Vedas*. The philosophical essence of the *Vedas* is mostly reflected in their concluding portions called the *Upaniṣads*.[15] The composition of these celebrated works of intuitive philosophy possibly began at the end of the period aforementioned and continued until the last few centuries BCE.[16] Much of what is discussed in the *Upaniṣads* constitute a reflection on the inner meaning of sacrifical Vedic ritual, which amounts to a discussion on the nature of reality, the means for liberation from rebirth and sufferings and the importance of self-knowledge in this endeavour. The *Upaniṣads* are mainly constituted of dialogues between teachers and pupils, and cannot be taken as systematic philosophy in the modern sense. It is, however, among the earliest ef-

[15]According to Hiriyanna, the word *upaniṣad* itself means "sitting down near" (*upa ni sad*) the teacher to receive instruction, and later came to signify the secret instruction imparted at such private settings. In the view of traditional teachers or *ācāryas* such as Śaṅkara, *upa* and *ni* should be understood as prefixes to the root *sad*, which means "to loosen," "to reach" or "to destroy," suggesting that the knowledge conveyed in these texts is able to loosen or destroy ignorance about true reality. This is also the view of a contemporary and respected teacher of Advaita Vedānta, Swami Dayananda Saraswati, for whom the word *upaniṣad* refers to self-knowledge (*brahmavidyā*, *ātmavidyā*), that knowledge which destroys the real cause of sorrow. See: Hiriyanna, *Outlines of Indian Philosophy*, 49-50; Olivelle (trans.), *The Early Upaniṣads*, 24; Swami Dayananda Saraswati, *Exploring Vedanta*, 7-10.

[16]Olivelle (trans.), *op.cit.*, 12-13.

forts to give a philosophical explanation of the world we live in. The *Upaniṣads* have been at the basis of the subsequent development of philosophical reflection in India.

4.1.1 Early reflections about *bhūtas*

In Hindu philosophy, reflections about reality and truth are intermingled with the concept of "being." In Sanskrit, the language of Hindu sacred texts, reality and truth are denoted by the same word — *sat* — which can also mean "being" as opposed to "non-being" (*asat*) that is unreal.[17] History shows the importance that philosophers attached to the examination of "being" when enquiring into the true nature of the world and beyond. What is it to be, to exist? What does it mean? In what sense are "reality" and "being" related together in this world? Such reflections of a cosmological nature are obtained in the *Upaniṣads*. One attempt is to explain the nature of the physical world in terms of physical "elements" called *bhūtas*. The word *bhūta*, and its derivative *mahābhūta*,[18] are both derived from the verbal root *bhū*, which means "to be" or "to become."[19] This suggests that the element is not only constitutive of the physical world but also fully participates in its becoming.

The first references to the concept of *bhūta* in Vedic literature are found in the

[17] Fowler, *Perspectives of Reality: An Introduction to the Philosophy of Hinduism*, 5.

[18] In literature, the word *mahābhūta* is specifically used to denote the five "great elements," (*ākāśa* air, fire, water and earth) constituting the physical world. This usage should be distinguished from its compound form (*samāsa*), meaning the "great being." (ex: BrU II.4.12) The word *bhūta* is an older less specific concept that possesses different meanings: "element," "past," "creature," "living being," etc. See later references of P.-S. Filliozat and A.M. Ghatage.

[19] In Sanskrit literature, there is a rich and extensive vocabulary for the verb "to be." Strictly speaking, there exist two verbal roots having this meaning in Sanskrit: $\sqrt{bh\bar{u}}$ and $\sqrt{as}$. Whereas the root *bhū* refers to "becoming, growing, thriving" and thus to the dynamical aspect of "being," the root *as* involves a more static and essential notion of "being." The words *bhūta* and *sat* are respectively derived from these two roots. Together with their several nominal derivatives, $\sqrt{bh\bar{u}}$ and $\sqrt{as}$ account for most of the Indian ontological terminology. See: Halbfass, *On Being and What There Is: Classical Vaiśeṣika and the History of Indian Ontology*, 22.

Ṛgveda, clearly not understood there as a generic term for physical elements. In fact, as indicated by Filliozat, many layers of meaning exist for the word *bhūta* in literature. As the past participle of the verb *bhū*, it can mean "past," "produced," "happened"; it can also be used as a noun, masculine with the meaning of "living being, creature," neuter with the meaning of "well-being," "reality" and "element," and optionally masculine or neuter when referring to a supernatural being.[20] According to Filliozat, "past" and "creature" are the oldest meanings attested in the *Ṛgveda*. This claim is also supported by S.K. Lal in his short study on *pañcamahābhūtas*.[21] Denoting something "past," the word *bhūta* often appears together with the word *bhavya* in the *Vedas*, the latter gerundive conveying the idea of something occuring in the future, namely something that "has to be" or "has to become." For instance, this meaning is present in the following verse from the Ṛgvedic *Puruṣa-sūkta* (RV X.90.2ab): "*Puruṣa* [cosmic being] is this all, that has been and that will be." (*puruṣa evedaṃ sarvaṃ yadbhūtaṃ yacca bhavyam*) In another passage (RV X.55.2ab), we find a similar reference to the created world as something which became and will become in the future: "That is the great, much-desired Name with which you created everything, past and present." (*mahattannāma guhyaṃ puruspṛg yena bhūtaṃ janayo yena bhavyam*) We also find similar instances in the *Yajurveda* and the *Atharvaveda*.[22]

The idea that five basic elements constitute the physical world appears towards the end of the Vedic period. Filliozat maintains that the five elements were first introduced in the *Śāṅkhāyana Āraṇyaka* (VII.22) where, joined with other minor entities, they constitute the *sarvabhūtasaṃhitā*, that is, the "combination of all created things."[23] According to Ghatage, the earliest occurence of this concept is found in the

[20] Filliozat, P.-S., "*Bhūta-mahābhūta*." In: Bäumer (ed.), *Kalātattvakośa*, 50.

[21] "In the *Ṛgveda*, the term *bhūta* has been used mainly in the sense of "past," often in the juxtaposition of "future." Further, in almost all its occurences, the word means sentient or insentient beings." See: Lal, S.K., "*Pañcamahābhūtas*: Origin and Myths in Vedic Literature." In: Vatsyayan (ed.), *Prakṛti: The Integral Vision* (Vol.2), 7.

[22] Filliozat, *op.cit.*, 54.

[23] The passage goes like this: "Vāliśikhāyani says: "There are five vital elements [*mahābhūtāni*].

Aitareya Āraṇyaka (III.4).[24] Some of the *Upaniṣads* make references to five "great" (*mahat*) elements, namely earth (*pṛthivī*), water (*āpa*), fire (*jyoti, tejas*), wind or air (*vāyu*) and space (*ākāśa*), but do not provide a detailed account of the nature and function of these elements in the physical world. A more elaborate understanding will only come later with the emergence of the classical schools of philosophy. As is the case with most old doctrines and ideas, the evolution of the Upaniṣadic conception of elements is difficult to specify with certainty. Hiriyanna distinguishes three main stages of thought in the Upaniṣadic speculations on elements:[25]

1. The ancient Vedic conception of primeval waters, out of which everything in the world emerges;
2. The depiction of the world in terms of three elements, namely fire, water and earth. Here is an endeavour to order elements with respect to each other, and also to describe the mechanism by which they combine together to form the whole world;
3. The extension to five elements with the introduction of air and *ākāśa* in the list of elements. This classification was accepted and developed by practically all later schools of philosophy.

In the oldest *Upaniṣads*, a few passages recognize water as the original stuff of the world. For instance, in BrU V.5.1: "In the beginning only the waters were here."[26] Another passage from *Chāndogya Upaniṣad* claims that water dwells in all created things: "All these are simply specific forms of water — earth, intermediate region, sky, hills, gods, humans, domestic animals, birds, grasses, trees, and wild beasts down to the very worms, moths, and ants; they are simply specific forms of water." (ChU VII.10.1) There are good reasons to believe that this conception represents an

These are earth, wind, space [*ākāśa*], water and fire. These are the combinations jointly or together. And other minute elements, which are united with the vital elements are the combination of all created things." " See: Filliozat, *op.cit.*, 65.

[24] Ghatage, A.M., "The Five *Mahābhūtas*: A Semantic Analysis." In: Vatsyayan (ed.), *Prakṛti: The Integral Vision* (Vol.2), 89.

[25] Hiriyanna, *op.cit.*, 64.

[26] All quotations from *Upaniṣads* are taken from Olivelle (1998) except those from the *Maitrī Upaniṣad*, which are taken from Radhakrishnan (1995[1953]).

early stage in the reflection on elements as this doctrine is also part of the *Vedas*. In Hiriyanna's view, the next stage came with the recognition of fire and earth as other basic elements together with water. The acceptance of many elements led to the question of their formation: how to explain the creation of a diversity of elements and in particular their *order* in the cosmogonical process? In BrU I.2.2, it is said that from the churning of water by Prajāpati, earth arises, and that from the labour and heat, fire arises; here, the creation of elements goes from water to earth and then to fire. In ChU VI.2.2-4, Āruṇi teaches his son Śvetaketu about the creation of the world. In this passage, the order of manifestation is different, fire being envisaged as the first evolute from which came water and earth:

> How can what is existent be born from what is nonexistent? On the contrary, son, in the beginning this world was simply what is existent — one only, without a second. And it thought to itself: 'Let me become many. Let me propagate myself.' It emitted heat [fire]. The heat thought to itself: 'Let me become many. Let me propagate myself.' It emitted water…The water thought to itself: 'Let me become many. Let me propagate myself.' It emitted food [earth]. (ChU VI.2.2-4)

This passage is usually considered as the authority for the threefold conception of elements insofar as the order proposed here is maintained in later passages mentioning the five elements. The sixth section of this *Upaniṣad* features other important ideas regarding the nature of elements. It contains the first mention of a qualitative distinction between subtle (*sūkṣma*) and gross (*sthūla*) elements, a distinction accepted and developed in later schools such as Sāṃkhya and Vedānta. Beside the three gross elements (earth, water, fire), the existence of three corresponding "subtle" elements is assumed. Since gross elements are always found to co-exist in nature, it is suggested that there exists also a "pure" or "subtle" state — that is, a state not perceivable through sense-organs — in which the elements are unmixed and independent from each other. This section also includes the first mention of the dynamic process of "admixture," called *trivṛtkaraṇa*, by which subtle elements are combined together to produce gross elements. In ChU VI.3-4, we are told that gross elements are triply mixed from the three primeval essences of fire (*tejas*), water (*ap*) and earth (*anna*). Each gross element consists in the admixture of these three subtle elements.[27] This theory was quite influential in later systematic philosophy as Śaṅkara comments upon it in BSB II.4.20-22. Despite the speculative nature of these ideas, the emergence of the *trivṛtkaraṇa* process in Indian philosophy, together with the underlying distinction between subtle and gross elements, represent a major advance in the philosophical understanding of elements as entities partaking of a world infused with change and transformation.

The introduction of more abstract concepts such as space and air into the list of elements represents a further stage in the Upaniṣadic cosmological speculations. According to Halbfass, the oldest extant list of five elements is found in the *Aitareya Upaniṣad* (AU III.3): "It is *Brahman*; it is Indra; it is Prajāpati; it is all the gods. It is these five immense beings [*mahābhūtāni*] — earth, wind, space, the waters, and the lights; it is these beings, as well as those that are some sort of mixture of trivial beings [. . .]"[28] But the most significant passage in this regard is found in the *Taittirīya Upaniṣad*:

[27]The passage goes as follow: "Then that same deity thought to itself: 'Come now, why don't I establish the distinctions of name and appearance by entering these three deities [fire, water and earth] here with this living self (*ātman*), and make each of them threefold." We are then told that each gross element possesses three colours, the red corresponding to fire, the white to water and the black to earth. Therefore, each gross element consists in an admixture of the three subtle elements (the three deities in question). It is worth noting that these three colours are mentioned in the *Śvetāśvatara Upaniṣad* (IV.5): "One unborn male, burning with passion, covers one unborn female colored red, white, and black, and giving birth to numerous offspring with the same colors as hers, while another unborn male leaves her as soon as she has finished enjoying the pleasures." Several scholars have interpreted the female as the *prakṛti* of Sāṃkhya and the three colours as the three *guṇas*. The two unborn-males may be said to refer to the attached and the non-attached *puruṣas*. Thus it has been suggested that the Sāṃkhya doctrine of *guṇas* may originate from the threefold classification of elements in the *Upaniṣads*. See: Sen Gupta, *The Evolution of the Sāṁkhya School of Thought*, 57-58.

[28]Halbfass, "Space or Matter? The Concept of *ākāśa* in Indian Thought," 85.

> From this very self (*ātman*) did space come into being; from space, air; from air, fire; from fire, the waters; from the waters, the earth [...] (TU II.1.1)

In contrast with AU III.3, the elements in the TU are presented as successive emanations from each other, all ultimately emerging from the absolute reality (*Brahman*, *ātman*). Besides, in this passage the five elements are described in a dynamic perspective rather than as static elements. One should note that there is no trace, either in the *Taittirīya* or in other available *Upaniṣads*, of a model of admixture of the five elements. However, such a mechanism comes into being in later Vedānta schools of philosophy (see section 4.3.2). Called *pañcīkaraṇa*, this mechanism is the only model along with *trivṛtkaraṇa* explaining how gross elements are produced from subtle elements.[29] Though not prominent in the *Upaniṣads*, the list of five elements is prevalent in later Indian thought, corroborating Hiriyanna's claim that the fivefold classication of elements constitutes the latest stage of reflection on elements in the *Upaniṣads*.[30] Most scholars connect this doctrine to the all-pervasive idea that human beings have five sense-organs and that each sense-organ perceives one quality. For each quality perceived by a sense-organ, there is one and only one corresponding element in which that quality resides: sound (*śabda*) in *ākāśa*, touch (*sparśa*) in air, colour (*rūpa*) in fire, taste (*rasa*) in water and odour (*gandha*) in earth.[31] That is, each of the five elements has its own distinctive quality.

[29]Dasgupta, *A History of Indian Philosophy* (Vol.2), 74.

[30]For instance, the doctrine of five elements is clearly maintained in the *Mahābhārata* (c. 400 BCE-c. 400 CE). In a dialogue between Bhṛgu and Bharadvāja, the elements are correlated with the five sense-organs and their respective qualities. The Sāṃkhya, Vedānta, *Purāṇas*, *Āyurveda* and the Nyāya-Vaiśeṣika system, all recognize the existence of five elements. See: Halbfass, *op.cit.*, 86.

[31]As Hiriyanna says: "this [fivefold] classification [of elements], which has been accepted by nearly all the later Indian philosophers, it is obvious, corresponds to the fivefold scheme of the organs of sense — those of hearing, touch, sight, taste and smell, and should have been suggested by it." (Hiriyanna, *The Essentials of Indian Philosophy*, 24) According to Halbfass, it is most probable that this correlation between elements and sense-organs already played an implicit role before the introduction of *ākāśa* in the list of elements (Halbfass, *op.cit*, 86).

We find in TU II.1.1 the same order for the evolution of elements as ChU VI.2.2-4, except that two elements — *ākāśa* and air — are now added to the list. In the *Taittirīya*, *ākāśa* is considered to be the first created element and fire the third, while in the *Chāndogya* fire is envisaged as the first created element. Historically, this may not create a problem if we accept that the *Taittirīya* was composed after the *Chāndogya*, but scholars do not agree about which one comes first. This problem has important cosmological and metaphysical implications, and raises a few questions such as: 1. whether space and air can be considered elements or not; 2. which element was first created and 3. what is the accepted order of elements in the process of evolution. More importantly for us, it brings into question the ontological status given to *ākāśa*. If we accept the account given in the *Taittirīya*, *ākāśa* must be considered a created element insofar as it is produced from *Brahman*. On the other hand, if we accept the account given in the *Chāndogya*, one must accept that *ākāśa* is not created at all but is eternal like *Brahman*. These issues are discussed thoroughly by Śaṅkara in BSB II.3.1-7, and will be examined in detail in section 4.3.3 of this dissertation.

These two accounts of creation of the elements also raise questions of philosophical and theological import, i.e., what is the relationship between the empirical world and its cause? In the *Upaniṣads*, both *ātman* (TU II.1.1) and *sat* (ChU VI.2.2-4) are identical with *Brahman*, the underlying principle of existence, one, permanent and changeless.[32] If the empirical world emanates from *Brahman*, does it mean that the

[32] In the *Upaniṣads*, *Brahman* is the ultimate reality, one, unseen and all-pervasive, and its identification with *ātman*, the inmost essence of one's self, constitutes the essential teaching of the *Upaniṣads* according to the Advaita Vedānta perspective (with which we are concerned in this study). As regards the notion of *sat*, the existent, it is recognized as an essential aspect of the nature of *Brahman*. As Hiriyanna explains: "The spiritual and unitary character of this absolute reality [*Brahman, ātman*] is very well expressed by the classical phrase *saccidānanda*. As a single term defining its nature, it is met with only in the later Upaniṣads; but its three elements — *sat*, *cit* and *ānanda* — are used of Brahman, singly and in pairs, even in the earliest of them. *Sat*, which means "being" points to the positive character of Brahman distiguishing it from all non-being." See: Hiriyanna, *ibid.*, 22.

latter undergoes a change in the process? This would be contradictory to the concept of an unchangeable and permanent cause of the world mentioned in the *Upaniṣads*. On the other hand, if we consider that the finite world exists separately from *Brahman*, it entails that *Brahman* is limited in nature, which is also not acceptable. Then, does it follow that the world is none other than *Brahman* itself? If so, what ontological status should be given to the manifold nature of the world given that *Brahman* is said to be one? Are the various elements real or simply an apparent manifestation of *Brahman*? If the reality of the world is taken for granted, how does one explain the transition from *Brahman*, one without a second, to the manifold world? Of course, the assessment of *ākāśa* in a given philosophical system — especially if it admits *ākāśa* as the first created element — will depend largely upon the kinds of answers given to the above questions.

However, the *Upaniṣads* to these questions do not provide a clear and definite answer. In this context, one should recall the distinction made in these texts between the cosmic (*saguṇa*, *saprapañca*, *saviśeṣa*) *Brahman* and the acosmic (*nirguṇa*, *niṣprapañca*, *nirviśeṣa*) *Brahman*, i.e., *Brahman* with qualities and *Brahman* without qualities, respectively. Whereas the former *Brahman*, being all-comprehensive, gives rise to the world, maintains it and reabsorbs it, the latter *Brahman* is beyond the grasp of human experience, all-exclusive and can only be described through negation as *neti neti*, "not this, not this."[33] There are several passages in the *Upaniṣads* that teach that the world is but an appearance of *nirguṇa Brahman*, that empirical phenomena are not real in an absolute sense. There are other passages that grant reality to the world, while maintaining an intimate relationship between the latter and *saguṇa Brahman*. In fact, determination of the relative importance of these two conceptions of *Brahman* is one of the most difficult problems connected with the *Upaniṣads*.[34] The major problem for Vedānta philosophers interpreting the *Upaniṣads* has been precisely how to reconcile and harmonize statements that were apparently not com-

[33] Sharma, *A Critical Survey of Indian Philosophy*, 27-28.

[34] Hiriyanna, *Outlines of Indian Philosophy*, 61.

patible with each other. Accordingly, we find a rich variety of theories of creation and metaphysical descriptions of the nature of *Brahman* in Vedānta literature.

4.1.2 *Ākāśa* in the *Upaniṣads*

Ancient Vedic literature has an extensive vocabulary to describe the notion of unobstructed space. According to Halbfass, the word *loka*, usually translated as "world," has the meaning of a "room to exist freely and without hindrance and obstruction."[35] Vedic words for "atmosphere" and "sky," such as *kha*, *vyoman*, and *antarikṣa*, also convey the sense of "opening," "openness" and "free space."[36] Although the word *ākāśa* itself does not occur in the *Rgveda*, its meaning in post-Rgvedic literature closely resembles concepts like those mentioned above.[37] In the *Brāhmaṇas* and *Āraṇyakas*, *ākāśa* is associated with the notions of "free space" and "opening." For instance, in AitBr III.42, the Vasus come to Agni and request him: *ākāśaṃ naḥ kuru*, "make room for us," in order for them to pass through the "opening" to the world of heaven. The same sense is conveyed in the *Śatapatha Brāhmaṇa* (III.3.2.19): *madhye 'ṅgulijākāśaṃ karoti*, "he then makes a finger-hole in the middle." *Ākāśa* is also often used in the sense of "sky," "atmosphere," etc. Closely related to *antarikṣa*, the intermediate space between heaven and earth, *ākāśa* denotes the "free space" resulting from the separation of heaven and earth: *yo 'ntareṇākāśa āsīt tad antarikṣam abhavad*, "the space (*ākāśa*) which was betweeen them became *antarikṣa*." (ŚBr VII.12.23)[38] Lal also suggests that the concept of *dyaus* in the *Rgveda* — which des-

[35] Halbfass, *On Being and What There Is: Classical Vaiśeṣika and the History of Indian Ontology*, 30.

[36] Halbfass, "Space or Matter? The Concept of *ākāśa* in Indian Thought," 100.

[37] In this regard, it is worth noting the correlation established by Coomaraswamy between *ākāśa*, *kha*, *vyoman*, *antarikṣa*, *nabha*, *ananta* and *pūrṇa*, all used as synonyms of "zero" in mathematics. See: Coomaraswamy, *op.cit.*

[38] Chakrabarti, *op.cit.*, 115. According to Kramrisch, *ākāśa* is the name for *antarikṣa* itself in post-Ṛgvedic literature. See: Kramrisch, *op.cit.*, 102.

ignates "heaven" or the uppermost vault of the sky — presents important similarities with the Upaniṣadic *ākāśa*.[39] The word *ākāśa* is derived from the verbal root *kāś* — "to shine," "to be visible" — with the prefix *ā*, and as such it may be understood as the "space" that allows things to be visible and to manifest themselves.[40]

In this rich and manifold semantic framework, the concept of *ākāśa* appears in the *Upaniṣads* a few centuries before the common era. In these texts, *ākāśa* acquires the status of a physical element with air, fire, water and earth, as the first element from which the others come into existence and as responsible for the transmission of sound. Yet, *ākāśa* is also regarded as something transcending the very notion of elements in the *Upaniṣads*. As Halbfass remarks, *ākāśa* appears in some passages as "the closest approximation to *ātman/brahman*, as a form of its presence, as its most appropriate symbol, or even as a name for *brahman* itself."[41] Though created and endowed with phenomenal existence, *ākāśa* has close affinities with the uncreated *ātman* or *Brahman*. The paradoxical nature of *ākāśa* in the *Upaniṣads* and later Vedānta is a remarkable feature of this concept in Indian philosophy.

***Ākāśa* as a physical element**

When referring to *ākāśa* as a physical element two features must be noted: 1. its status as one of the five "great elements" (*mahābhūtas*) and 2. its correlation to the quality of sound (*śabda*). We find a few passages in the *Upaniṣads* where *ākāśa* is related to sound and the sense of hearing. A clear passage in this regard is ChU VII.12.1: "Across space (*ākāśa*) one calls out to someone, across space one hears that call, and across space one answers back." According to Lysenko, the status of *ākāśa* as a physical entity in the *Upaniṣads* arises from "its correlation with sound

[39] This is clearly attested in some passages such as ChU VII.12: "Space (*ākāśa*) verily is greater than fire, for in the space exist both sun and moon, lightning, stars, and fire." See: Lal, *op.cit.*, 14.

[40] Chakrabarti, *op.cit.*, 104.

[41] Halbfass, *op.cit.*, 94.

in the role of its milieu…Thus it becomes a primary element (*mahābhūta*) in the cosmology of the five elements."[42] This is in agreement with the assertion, made by most scholars, that the acceptance of five elements in the *Upaniṣads* corroborates the need for substances in which the qualities perceived by the five sense-organs can reside. However, it remains unclear whether the recognition of *ākāśa* as one of the five elements in these texts *only* results from its correlation with sound. After all, as already noticed, *ākāśa* was recognized as a *mahābhūta* in early Vedic literature, when the connection with sound was not yet clearly developed.

How is *ākāśa*, which conveys the meaning of space in post-Ṛgvedic literature, related to the quality of sound? Lysenko suggests that this correlation was probably inherited from the ancient Vedic concept of *diś*, usually associated with hearing and its sense-organ.[43] Appearing in early Vedic literature such as the *Ṛgveda*, the concept of *diś* is in fact older than *ākāśa*. In these texts, *diś* features as a kind of "directional" space, denoted by expressions such as "what is pointed at," "region," "quarter of space" and most often related with the four, five, six, eight or ten cardinal points.[44] The connection between *diś* and the sense of hearing is mentioned in the *Ṛgveda* and also in some *Brāhmaṇas* and *Āraṇyakas*.[45] Similar connection is also explicit in some *Upaniṣads*, such as the *Aitareya Upaniṣad*:

> A pair of ears was hatched; from the ears sprang hearing, and from hearing, the quarters (*diśaḥ*). (AU I.1.4)

[42]Lysenko, V., "The Vaiśeṣika Notions of *ākāśa* and *diś* from the Perspective of Indian Ideas of Space." In: Franco and Preisendanz (eds.), *Beyond Orientalism: The Work of Wilhelm Halbfass and Its Impact on Indian and Cross-Cultural Studies*, 426.

[43]*ibid.*, 423.

[44]*ibid.*, 421.

[45]In the *Ṛgveda* (RV X.90.14), the ears of the cosmic *puruṣa* give rise to *diśaḥ*, "the quarters of space." (*diśaḥ śrotrāt*) In the *Taittirīya Brāhmaṇa* (III.10.8.6), it is said: *diśo me śrotre śritaḥ*, "the quarters abide in my hearing," and so in the *Śatapatha Brāhmaṇa* (VII.5.2.20): *diśo vai śrotram*, "the quarters are indeed hearing." Similar instances are found in the *Aitareya Āraṇyaka* (II.4.1, II.4.2). See: Chakrabarti, *op.cit.*, 113.

> So, the fire became speech and entered the mouth; the wind became out-breath and entered the nostrils; the sun became sight and entered the eyes; the quarters (*diśaḥ*) became hearing and entered the ears. (AU I.2.4)

Conceptually, the connection between *diś* and the sense of hearing probably arose from the understanding that sound, in contrast with other qualities like colour, taste, etc., spreads itself in *all directions of space*. Sound is not understood here in the modern scientific sense of a vibratory movement of matter through a medium (gas, liquid or solid). It is perhaps more appropriate to define sound in this context as the "generic prototype of vibration in space," as suggested by René Guénon, and not as a specific kind of vibration in a definite milieu.[46] Such a view may underlie the kind of connection made between *diś* and sound in Upaniṣadic texts. Because of its "directional" character, *diś* emphasizes the ear's ability to apprehend sounds from all directions.[47]

As a spatial system of cardinal points, *diś* was especially indispensable in the organization of sacrificial space, for the construction of the altar and the ritual itself. However, in the *Upaniṣads* the understanding of ritual becomes more abstract and symbolic, the emphasis being laid on the knowledge of supreme reality. As suggested by Lysenko, a different kind of space was thus needed, "more universal and all-embracing than that of the cardinal points," which could account for the unitary and

[46] René Guénon offers an interesting interpretation of the connection between sound and space in Indian philosophy. According to him, sound should be understood as the generic prototype of any vibratory movement. As such, it has to originate in space as no precise particularization takes place in this undifferentiated milieu. In space, sound is subtle and not perceivable; it becomes "heard" when "amplified" by a particular milieu, like air for instance. The scientific understanding of sound as a vibratory movement in a certain milieu must then be envisaged as a "particularization" of this initial movement by the milieu in question. The essence of sound, i.e., its vibratory quality, does not arise in the milieu itself but in space. This is also why the sense of hearing is associated with space and not with other elements. See: Guénon, "Les Conditions de l'Existence Corporelle."

[47] Lysenko, *op.cit.*, 426.

all-pervasive nature of *Brahman*.[48] Indeed, the presence of directions in the absolute is explicitly rejected in some Upaniṣadic passages such as MtU VI.17: "For him [*Brahman*], indeed, east and the other directions exist not, nor across, nor below, nor above. Incomprehensible is that Supreme self, unlimited, unborn, not to be reasoned about, not to be thought of, he whose self is space." In accordance with its post-Ṛgvedic meaning of "open space," the concept of *ākāśa* was thus well designed for this function and certainly "more suitable for the image of the supreme reality than that of *diś*."[49] Halbfass notices that "there is no comparable structure of specific directions in *ākāśa*. Its openness is thus ontologically superior, less concrete and less defined than the structured realm of *diś*. It is closer to the infinite and undifferentiated origin of things."[50] It appears that the need for a more appropriate notion of space to depict the ultimate reality, has played an important role in the emergence of *ākāśa* as an important concept in the *Upaniṣads*.

It is plausible that the correlation of *ākāśa* with sound and the sense of hearing arose during this period of transition. But given that *ākāśa* and *diś* are two different kinds of space, their respective relation with sound differs in some degree. If *diś* accounts for the directional and isotropic nature of sound, *ākāśa* stands for the dynamic *transmission* of sound.[51] This is obvious in ChU VII.12.1 for instance, where it is stated that one calls and hears *across* space. As we shall see, this dimension of *ākāśa* becomes especially important in the later Nyāya and Vaiśeṣika systems which feature an intricate analysis of sound transmission. We may now ask: why was *ākāśa* added to the Upaniṣadic list of five elements (*mahābhūtas*) and not *diś*, if such addition was motivated solely by the need for a medium of sound, as Lysenko seems to suggest? First, in contrast with *ākāśa*, *diś* was never envisaged as a *mahābhūta* in Indian philosophical literature, even in the later Vaiśeṣika system where *ākāśa* and *diś* both

[48] *ibid.*, 422.
[49] *ibid.*
[50] Halbfass, *op.cit.*, 98.
[51] Lysenko, *op.cit.*, 426.

stand together as substances (*dravyas*). Second, as noted by Halbfass, the connection between *mahābhūtas* and sense-organs was already implicit before the introduction of air and *ākāśa* in the list of five elements.[52] By inheriting the association with sound and the sense of hearing from *diś* during the Upaniṣadic period, the concept of *ākāśa* became more suitable than *diś* to be one of the great elements in the *Upaniṣads*. This is reinforced by the fact that historically there was a shift in these texts from a directional notion of space to an abstract and all-pervasive space closer to the nature of *Brahman*.

It is important to understand that *ākāśa* does not share affinities with the notion of a passive empty space. In the *Upaniṣads*, it is envisaged as a *bhūta*, i.e., as a "being" participating in the manifestation and evolution of the world, a concrete existent that is subject to change and becoming. In several passages, it is put on a par with other elements and natural phenomena.[53] As one of the five *mahābhūtas*, it possesses qualities that place it on the same ontological level as other elements. Like earth, water, etc., it is correlated with a particular sense-organ (ear) and quality (sound), and also possesses its subtle counterpart (*ākāśa-mātrā*), as pointed out in PU IV.7-8. However, as shown in TU II.1.1, *ākāśa* is distinct from other elements insofar as it is the *first* element to appear in the cosmogonical process. Such a position in the list of elements may result from its most subtle nature and from its conceptual affinities

[52] "We may assume that this correlation and co-ordination [between elements, the five senses and their sensual qualities] already played an implicit role when *ākāśa* or ether was added to the list of elements." See: Halbfass, *op.cit.*, 86.

[53] For instance, we are told in ChU VII.11.1: "Heat, undoubtedly, is greater than water. So, when that holds back the wind and heats up the space [*ākāśa*], people say: 'It's sizzling! It's a scorcher! It's going to rain.' This passage shows that *ākāśa* is subject to change and is in close relation with other natural elements. In several other passages, *ākāśa* features alongside the other four elements either explicitly or implicitly as a *mahābhūta*: ChU VII.2.1, TU II.1., AU III.1.3, PU IV.7-8, MtU VI.4, PaU I.6, PaU III.3. We find also instances where it appears on the same level as natural objects and phenomena, such as moon, lightning, trees, etc. See for instance: BrU III.2.13, IV.4.5; ChU VII.2.1, VII.4.2, VII.11.1.

with *Brahman* itself, as we shall see later. Though the all-pervasive nature of *ākāśa* is accepted in later *darśanas*, the *Upaniṣads* are not clear whether *ākāśa* pervades or does not pervade what it contains. There are however some passages that seem to argue for the all-pervasiveness of *ākāśa*. In ChU VII.12.1, for instance, it is stated: "Within space (*ākāśa*) one is born, and into space one is born." Similarly, in BrU II.5.10: "This space (*ākāśa*) is the honey of all beings [*bhūtānām*], and all beings are the honey of this space." Thus, *ākāśa* would be connected to all beings, pervading everything and everything being contained in it.

Ākāśa as a trans-empirical element

Although on a par with fire, air, water and earth as one of the five *mahābhūtas*, *ākāśa* also transcends the very definition of element in the *Upaniṣads*. Not only is it the first phenomenal existent to be manifest, and thus the one from which the rest of creation derives, it is also all-pervasive and the most subtle of elements. As such, *ākāśa* seems to partake of the nature of the Upaniṣadic absolute, *Brahman*. In various passages of the *Upaniṣads*, *ākāśa* is found affiliated with *Brahman*, either as its close derivative or one of its most appropriate symbol. There are also passages where *ākāśa* is related to the innermost self of man, *ātman*, which is identified with *Brahman* in the *Upaniṣads*. Like *ātman*, *ākāśa* is said to be changeless, eternal, indivisible, invisible and omnipresent.[54] At other places, *ākāśa* disappears into the imperishable, in That which cannot be described in any way, *nirguṇa Brahman*. A certain semantic ambiguity is therefore attached to this word in the *Upaniṣads*, a feature that also remains present in later schools of philosophy.

The relationship between *ākāśa* and *Brahman* can be looked upon in various ways. In its fivefold classification of elements, TU II.1.1 states the primacy of *Brahman vis-à-vis ākāśa*, the former being recognized as the ultimate principle out of which all

[54]Lysenko, *op.cit.*, 422.

elements, including *ākāśa*, emanate successively. For instance, it is said in MtU VI.4: "The three-footed Brahman has its root above. Its branches are space (*ākāśa*), wind, fire, water, earth and the like." This seems to suggest that elements are not created *ex nihilo* from *Brahman* but verily emanate from it without any ontological discontinuity, *quasi* organically, like branches from a tree. Even though the different schools of thought differ as to whether the created elements are real or only apparent, it remains true that a deep connection exists between *ākāśa*, the first manifested element, and *Brahman*. For instance, in MtU VI.17, we are told that "from space He [*Brahman*], assuredly, awakes this world [...]" In another passage, *Brahman* establishes Himself as the self of every being with *ākāśa* as its source: "I was born from the womb of space as the semen for the wife, as the radiance of the year, as the self (*ātman*) of every being!" (KsU I.6) Of course, the Upaniṣadic philosophers face here the problem of explaining how the immutable *Brahman* can assume the form of *ākāśa*, and then of the whole world, without prejudice to its oneness and eternal nature. The *Upaniṣads*, as we already noticed, do not offer a definite and systematic answer to this question, leaving the door open for different kinds of interpretations.

There are several passages which apparently contradict each other as to the nature of *ākāśa*. For instance, in ChU I.9.1, it is stated: "Clearly, it is from space that all these beings arise, and into space that they are finally absorbed; for space indeed existed before them and in space they ultimately end." Since *all* beings (*bhūtāni*) arise from space, it seems that space itself is not considered as a *bhūta* here. In BrU III.8.4, space appears as an atemporal entity at the origin of time: "... all those things people here refer to as past, present, and future — on space, Gārgī, are all these woven back and forth." These statements, and others of the same kind, seem to contradict what is stated in TU II.1.1, namely that *ākāśa* is a created element like others, also subject to evolution and dissolution. According to Deussen, there would have been an older layer of Vedic-Upaniṣadic thought which identified *ākāśa* with the absolute, the highest *Brahman* itself. This association would have been abandoned later, *Brahman* being recognized having a higher ontological status than *ākāśa*.[55] Similar suggestions were also made by Erich Frauwallner.[56] For an Advaitin like Śaṅkara, the seemingly incompatible statements referring to *ākāśa* in the *Upaniṣads* are not contradicting each other. He provides detailed exegetical and logical arguments showing how, depending on the context and the purport of the section concerned, *ākāśa* can be understood either as physical space or as a symbol of *Brahman* (see section 4.3.3).

There are other Upaniṣadic passages where *ākāśa* denotes the inner realm of being. In many of them, the outer or ordinary space is identified with the inner or spiritual space residing inside one's self. The "openness" of space is not only found outside us but also within us, in the inner space of the heart (*hṛdayasyākāśaḥ*). Of course, the identification between "inner" and "outer" space is metaphorical and not literal in any sense. The underlying meaning here is not that the external and physical space permeates the human body from inside. According to Lysenko, these associations "should be primarily understood as referring to the series of macro-microcosmic identifications so characteristic of the classical ritual, rather than to some more or less independent cosmological speculation."[57] In the opinion of Halbfass, the macro-microcosmic identifications involving *ākāśa* have a profound ontological significance: "This is not simply a case of correlation between macrocosm and microcosm. The

[55]Deussen, *The Philosophy of the Upanishads*, 111-19.

[56]Frauwallner, *History of Indian Philosophy* (Vol.1), 48.

[57]Lysenko, *op.cit.*, 425. As a matter of fact, in the *Upaniṣads*, as well as in earlier Vedic literature, we do find several connections, or "homologies," made between inner states of being (the microcosm) and a feature of external reality (the macrocosm). As Hiriyanna points out: "Now there was from the time of the later Mantras and Brāhmaṇas the habit of seeking for a correspondence between the individual and the world and trying to discover for every important feature of the one, an appropriate counterpart in the other. It represented an effort to express the world in terms of the individual... The notion of parallelism between the individual and the world runs throughout the literature of the later Vedic period and is found in the Upaniṣads as well." See: Hiriyanna, *Outlines of Indian Philosophy*, 55.

'space in the heart' is not just microcosmic space, but...that openness of awareness, of the manifest and of pure consciousness, in which everything and anything can appear, and which can contain the whole wide world and all entities in itself."[58] That is to say that the space within the heart is not physical and ordinary space but the locus where *ātman* is identified with the whole universe and the "beyond." In his *Brahmasūtrabhāṣya* (BSB I.3.14-17), Śaṅkara asks whether the "space within the heart" must be considered as the familiar material space, or as the supreme self. As we shall see, he arrives at the conclusion that this space can only mean the supreme self in this context.

The concept of *ākāśa* has thus several layers of meaning in the *Upaniṣads*, meanings which can sometimes appear to be "extremely manifold, divergent, and even contradictory."[59] In some places, it is considered one of the five basic elements constituting the world; in others, it is conceived as a close derivative of *Brahman*, its most appropriate symbol, or identified with the self within the heart. In some passages also, its existence as a physical entity seems to vanish into the imperishable, *nirguṇa Brahman*, That which is beyond all names and forms. Such semantic ambivalence is also present in philosophical schools like Vaiśeṣika, Sāṃkhya and Advaita Vedānta. We have mentioned briefly how under the lead of Śaṅkara, the Advaita school of thought seeks to reconcile those different meanings through a proper interpretation of the *Upaniṣads*. Before examining in detail the different arguments brought forth by Śaṅkara in this regard, we first examine the views about *ākāśa* found in the Vaiśeṣika and Sāṃkhya schools of thought.

[58]Halbfass, *op.cit.*, 96-97.

[59]Lysenko, *op.cit.*, 426.

4.2 *Ākāśa* in the Hindu *darśanas*

Around the beginning of the Common Era there appeared in India elaborate and highly sophisticated systems of metaphysical speculations. The Sanskrit term generally used to describe these systems is *darśana*. Derived from the verbal root *dṛś*, "to see," the term implies a "view" or "perspective" of the world. The term "philosophy" has often been used to describe these systems though the term "theology" also conveys some of their aspects.[60] The *darśanas* refer to orthodox (*āstika*) systems that acknowledge the authority of the *Vedas*, but also to the heterodox (*nāstika*) systems of Buddhism, Jainism and Cārvāka materialism.[61] The orthodox, or Hindu

[60] Though there are clear differences between Indian *darśanas* and Western systems of philosophy, many scholars translate *darśana* as "system" or "school of philosophy." According to Halbfass, for instance, "the doctrines and systems which the Indian doxographies present under the title *darśana*, provide clear and specific parallels to what is commonly called "philosophy" in the West: they are theoretically oriented, systematized "world-views," and they exclude more or less matters of religious practice. However, we are dealing here with "philosophy" as something given by tradition, i.e., as a certain spectrum of firmly established, fully developed doctrinal structures; we are not dealing with "philosophy" as an open-ended process of asking questions and pursuing knowledge." (Halbfass, "*Darśana, Ānvīkṣikī*, Philosophy." In: Taliaferro and Griffiths (eds.), *Philosophy of Religion: An Anthology*, 304-05). Similarly, for Mohanty the Indian *darśanas*, "by virtue of their subject matter, their concerns, their methodologies, belong to the same genre of enquiry as philosophy." (Mohanty, *Essays on Indian Philosophy*, 213; 329-330)

[61] The division between orthodoxy and heterodoxy is a fluctuating one in Indian philosophy. Broadly speaking, there seems to be a "strict" orthodoxy, which considers the *Vedas* (from the *Mantras* up to the *Upaniṣads*) as a divine revelation of truth, and a "soft" orthodoxy, which accepts the *Vedas* as an inspired human creation. Hence, the kind of allegiance to the *Vedas* will differ from one school to another. The various schools of Buddhism, Jainism and the Cārvāka school are traditionally considered as *nāstika darśanas* because they do not recognize the authority of the *Vedas*. However, though different and sometimes opposed to the *Upaniṣads*, it is worth noting that the teachings of Buddhism for instance present several connections with them, such as the beliefs in the *karma* doctrine and in the concept of spiritual liberation. See: Hiriyanna, *Outlines of Indian Philosophy*, 135.

darśanas, are six in number: Nyāya, Vaiśeṣika, Sāṃkhya, Yoga, Pūrva-Mīmāṃsā and Uttara-Mīmāṃsā or Vedānta. Their teachings have been codified into sets of short aphorisms called *sūtras* ("threads"), which express in a condensed form the basic tenets of the school. Since most *sūtras* are difficult to comprehend without proper explanations, several commentaries (*bhāṣyas*), sub-commentaries (*vṛttis*, *vārttikas*) as well as independent works were composed to elucidate the meaning of *sūtras*. Some of them, such as Śaṅkara's *Brahmasūtrabhāṣya* for instance, eventually became more important than the *sūtra* itself.

The composition of the *sūtras*, primarily deriving from an oral tradition, probably came after the Vedic period, not earlier than 200 BCE.[62] The rise of Hindu *darśanas* can be seen as the result of a massive effort at systematization in order to uphold the Vedic tradition in face of those who rejected its authority. In response to the criticisms of Buddhist and Jaina philosophers, it became necessary for philosophers committed to the *Vedas* to re-examine the Vedic corpus of knowledge handed down to them in the course of time. In such an atmosphere, they were led to reflect upon their own way of obtaining valid knowledge of reality. The name *pramāṇa* was given to these means of valid knowledge, which include perception (*pratyakṣa*), inference (*anumāna*), analogy (*upamāna*), postulation (*arthāpatti*), verbal testimony (*śabda*) and non-apprehension (*anupalabdhi*).[63] The different systems accepted all or only some of these *pramāṇas*. In addition to theories of knowledge, the teachings of *darśanas* involved reflections of

[62]Potter (ed.), *Advaita Vedānta up to Śaṃkara and His Pupils*, xi.

[63]The Sanskrit word *pramāṇa* comes from the verbal root *mā*, "to measure," and signifies "that by which we measure" or "the means of measurement." The word *pramā* denotes a true cognition as distinct from a false one. Strictly speaking, *pramāṇa* is defined as the cause (*karaṇa*) of a *pramā*: *pramā karaṇam pramāṇam*. The word *karaṇa* must be understood in that context as a unique cause through the action of which a particular valid knowledge can be obtained. Hence, valid knowledge has an episodic character in Indian philosophy: it is a happening, an event that takes place when the right causal factors (*pramāṇas*) are present. See: Datta, *The Six Ways of Knowing: A Critical Study of the Advaita Theory of Knowledge*, 17-24; Matilal, *Perception: An Essay on Classical Indian Theories of Knowledge*, 35.

an ontological nature, particularly focusing on the nature of body, mind and matter and the relation between language, consciousness and being.[64]

The concept of *darśana* also involves important soteriological motivations. Each *darśana* ultimately aims at spiritual liberation (*mokṣa*, *kaivalya*, *apavarga*) through the pursuit of right knowledge. However, it would be wrong to consider that *darśanas* are solely concerned with the "mystical" or "spiritual" element. In fact, as mentioned earlier, the scope of *darśanas* includes philosophical reflection on topics having affinities with what is called logic, psychology, cosmology and theology in the West. In this sense, it seems appropriate to situate them at the intersection of what we call today science, philosophy and theology. It is also important to note that *darśanas* were traditionally followed as a way of life rather than solely as an intellectual pursuit. The followers were not only attracted by the teachings themselves but also by the committed lifestyle of their teachers. The teachings were carefully handed down from teacher to pupil, who most of the time lived close to each other. For this reason, we cannot ascribe a *darśana* to a single individual as is the case with the major philosophical systems in the West. Rather, each one of them has been the outcome of a long succession of thinkers. Moreover, since it was customary for the proponent of a school to consider and satisfy all possible outside objections before bringing forth his/her own view, *darśanas* have continuously been enriched by other schools of philosophy in the course of history, including modern Western philosophy.

Since historically Hindu *darśanas* have been integrating many elements from the *Upaniṣads*, it is but natural to find in them similar descriptions of *ākāśa*. In Advaita Vedānta, for instance, we find the Upaniṣadic conception of *ākāśa* as a "space" providing room for self-knowledge and the manifestation of the world. Though the Vaiśeṣika notion of physical elements as objectified, reified and clearly definable entities is not found as such in the *Upaniṣads*, the fivefold classification of elements is retained as well as the connection between *ākāśa* and sound, which is elaborated

[64]Flood, *An Introduction to Hinduism*, 225.

further. Together with Sāṃkhya, Vaiśeṣika probably offers the most significant philosophical explanation of the doctrine of five elements and, in particular, of the role of *ākāśa* as a physical element. Also, the schools of Vaiśeṣika and Sāṃkhya considerably interacted with Advaita Vedānta in the course of time. For instance, in Śaṅkara's *Brahmasūtrabhāṣya* (BSB II.3.1-7), we find an extensive discussion on the origin of *ākāśa* wherein Śaṅkara criticizes Vaiśeṣikas on their view that *ākāśa* is an eternal element. The integration by Sāṃkhya of the fivefold list of elements, together with its notion of *tanmātras*, also contributed much to Vedānta cosmology. In addition to providing detailed explanations of *ākāśa* as an element, an analysis of Vaiśeṣika and Sāṃkhya can thus serve as a good introduction to the study of *ākāśa* in Advaita Vedānta.

4.2.1 The Vaiśeṣika *darśana*

The Vaiśeṣika school of thought takes its name from the Sanskrit noun *viśeṣa*, which means "pertaining to individuality or particularity,"[65] because this school emphasizes "particularity" as a crucial feature of its metaphysics. The Vaiśeṣika is essentially a philosophy of distinctions, a pluralistic worldview where all objects of the world, including individual selves, are considered as reals independent from each other. In contrast to the *Upaniṣads*, Sāṃkhya and Vedānta, all of which seek to explain the world in terms of an underlying unity, this school accounts for what is observed in an analytic rather than a synthetic manner. In that sense, it has been characterized as the most "scientific" of all *darśanas*.[66] Vaiśeṣika was probably primarily formulated in

[65]Lipner, *Hindus: Their Religious Beliefs and Practices*, 157.

[66]The Vaiśeṣika *darśana* is often regarded as an exemplary expression of the secular, analytical and scientific dimension of Indian thought. Sarvepalli Radhakrishnan describes the standpoint of Vaiśeṣika as: "The Vaiśeṣika is not interested in constructing an all-embracing synthesis within whose bounds there is room for all that is, bringing all the variety of the worlds of sense and of thought under a single comprehensive formula. In the spirit of science, it endeavours to formulate the most general characters of the things observed." See: Radhakrishnan, *Indian Philosophy* (Vol.2), 176.

opposition to the *Vedas* and *Upaniṣads*, and only later did it recognize the authority of these sacred texts, especially regarding important matters like *dharma*.[67] By about the seventh century CE, this school was conflated with the logical school of Nyāya as both systems share a similar concern with analysis and logical reasoning. While Nyāya stresses epistemological issues and the importance of methodology, Vaiśeṣika is concerned with ontological distinctions about the nature of reality.

We have very little knowledge of the origin of Vaiśeṣika, since suggestions range from sixth century BCE to 400 BCE, to as late as 200-400 CE.[68] As with other *darśanas*, the Vaiśeṣika teachings were handed down orally until they were codified in the form of *sūtras*. The first systematic formulation of the Vaiśeṣika philosophy is found in the *Vaiśeṣikasūtras* of Kaṇāda, probably stemming from the first few centuries before the common era.[69] This collection of 370 *sūtras* aims to demonstrate how knowledge of the different world categories and of the true nature of the self ultimately leads to *mokṣa*. The second source of information is the independent work of Praśastapāda, called the *Padārthadharmasaṃgraha* (PDS), which is a commentary on the *Vaiśeṣikasūtras*. This is an important work that signifies the end of a long period of development in the Vaiśeṣika school. According to Halfbass, the PDS is a most significant work with regard to classical Vaiśeṣika ontology.[70] Probably composed around the fifth century CE,[71] this work extensively lists and classifies the fundamental categories of reality (*padārthas*), gives an account of the creation of the world and examines the nature of inference as a valid means of knowledge.

[67]Hiriyanna, *The Essentials of Indian Philosophy*, 84.

[68]Fowler, *Perspectives of Reality: An Introduction to the Philosophy of Hinduism*, 98.

[69]*ibid.*, 99.

[70]Halbfass, *On Being and What There Is: Classical Vaiśeṣika and the History of Indian Ontology*, 80.

[71]*ibid.*

Existence and function of *ākāśa*

Ākāśa is understood in Vaiśeṣika through the paradigm of substance (*dravya*) as the locus of particular qualities (*guṇas*).[72] Praśastapāda defines substance as that which is endowed with qualities (*guṇas*) and not located in anything else.[73] In order to relate the substance to its qualities, the relation of "inherence" (*samavāya*) is introduced by stating that each quality must inhere in a particular substance.[74] Thus, the *Vaiśeṣikasūtra* defines substance as possessing motion and qualities, and as the cause of inherence.[75] It is admitted that there are nine substances composing the physical world: earth, water, fire, air, space (*ākāśa*), direction (*diś*), time (*kāla*), self (*ātman*) and mind (*manas*). All these substances are essentially irreducible and indestructible constituents of the world, being either eternal or composed of eternal atoms (*aṇu*,

[72]The Vaiśeṣika school develops a pluralistic metaphysics based on the enumeration and classification of the different world constituents in terms of basic ontological units or "categories" called *padārthas*. The *padārthas* are not reducible to one common ground nor do they merge together: they always remain irreducibly distinct from each other. The classical classification of categories, found in Praśastapāda's *Padārthadharmasaṃgraha*, lists six fundamental *padārthas*: substance (*dravya*), quality (*guṇa*), action (*karma*), universal (*sāmānya*), particularity (*viśeṣa*) and inherence (*samavāya*). In later texts, the category of non-being (*abhāva*) was further added.

[73]*ato guṇavattvād anāśritatvāc ca dravyam* (PDS, p.58). See: Ganganatha (trans.), *Padārthadharmasaṃgraha of Praśastapāda with the Nyāyakandalī of Śrīdhara*, 130.

[74]By definition, *samavāya* is the constitutive or inherent relation that exists between the cause and its effect, the whole and its parts, the universal and its particulars. The effect is always related to a cause because they are naturally related through *samavāya*. The same relation holds between substance and qualities: qualities cannot exist without a substance and a substance cannot be known unless we apprehend it through its qualities. If a table is red, it is because the quality "red" inheres in the substance "table." However, the proponents of Vaiśeṣika attribute a special status to the substance for they believe that in essence, substances are devoid of qualities and are thus more fundamental than qualities. The substance, being the "possessor" of qualities, always remains an independent category underlying all other categories. See: Fowler, *Perspectives of Reality: An Introduction to the Philosophy of Hinduism*, 108.

[75]*kriyāvad guṇavat samavāyikāraṇam iti dravyalakṣaṇam* (VS I.1.14). Translation taken from: Halbfass, *On Being and What There Is: Classical Vaiśeṣika and the History of Indian Ontology*, 92.

paramāṇu).[76] The first four "elemental" substances (*mahābhūtas*), namely earth, water, fire and air, occur in two forms: eternal (*nitya*) in the form of atoms and non-eternal (*anitya*) in the form of objects made of atoms. Each *mahābhūta* is associated with a specific quality (*viśeṣaguṇa*) perceptible to one of the five sense-organs: earth with smell, water with taste, fire with colour, air with touch.[77] Of the five other "non-elemental" substances, *ākāśa*, direction, time and self are considered to be all-pervasive, eternal and partless or non-atomic. The mind (*manas*) is also eternal though of atomic dimension, and thus of finite extension. It is important to note that though *ākāśa* is non-atomic, it is also considered a *mahābhūta* for it serves as substratum for the quality of sound (see below).

As noticed by Bhaduri, the main function of *ākāśa* in Vaiśeṣika is to afford a substantial basis for the phenomena of sound and hearing.[78] It is through *ākāśa* that sound is transmitted from one point to another. The role of *ākāśa* as a bearer of sound (*śabda*) is inferred on the following basis: 1. A quality can only inhere in a substance; 2. Sound is a quality; 3. The quality of sound cannot belong to any other recognized substance, therefore it belongs to *ākāśa*. The first argument derives naturally from the definition given to substance in Vaiśeṣika and its introduction of inherence as relating

[76]According to Vaiśeṣika, things can be broken into smaller parts down to their primary constituents, that is, atoms. Atoms are imperceptible and their existence is inferred from the process of division, which cannot be carried on indefinitely without eliminating the differences of magnitude between bodies. Atom, the most fundamental constituent of matter, is considered to be indestructible and eternal. Objects experienced in daily life result from the aggregation and combination of atoms of earth, water, fire and air. Unlike atoms, objects are temporary and finite and ultimately disintegrate into their primary constituents.

[77]Like in the *Upaniṣads*, the correlation between the five elements and the five qualities perceived by sense-organs is accepted. Beside its specific quality, an element may partake the qualities of other elements: *ākāśa* is associated with sound only; air with touch only; fire with colour but also with touch; water with taste, colour and touch; earth with smell, taste, colour and touch. Since *ākāśa* is all-pervasive, it does not mix with other elements and thus, other elements cannot be attributed the quality of sound. See: Fowler, *op.cit.*, 101.

[78]Bhaduri, *Studies in Nyāya-Vaiśeṣika Metaphysics*, 165.

substance and quality. As to the nature of sound, i.e., whether it is a quality, a substance, etc., a number of arguments are advanced by Vaiśeṣikas to show that sound is a quality and not a substance or a form of motion.[79] According to Praśastapāda and his commentators, only *ākāśa* can be the bearer of sound. Sound cannot be a quality of earth, water, fire or air because the specific qualities (*viśeṣaguṇas*) related to these substances — smell, taste, form and touch, respectively — are not perceived by the ear, while sound is so perceived. In fact, the nature of sound largely differs from that of tangible qualities. As an example, if these qualities never exist apart from their substratum, sound is always found "outside" its originating substance and continues to exist once this substance disappears. For these reasons, sound must be the quality of an intangible substance. Since sound cannot be a quality of direction, time, soul or mind — for these substances either have no specific qualities or cannot be perceived by an external organ —, the only substance remaining is *ākāśa*. The claim that *ākāśa* is the bearer of the quality of sound is made on the sole basis that other substances cannot be endowed with this quality. No positive arguments are offered by Vaiśeṣikas to explain how *ākāśa* itself, as an all-pervasive substance akin to space, is connected to sound.[80] In that sense, it seems reasonable to agree with Halbfass

[79] First, sound cannot be identified with motion because the latter is only perceived visually, while perception of sound is never visual. Second, if sound were a substance, it would either be composed of parts or be incomposite. However, as experience reveals, nobody perceives sound to be composed of parts. Also, it cannot be an incomposite substance because such a substance (like atoms, direction, time or self) cannot be perceived by an external sense-organ, while sound can. Hence, if sound is neither a form of motion nor a substance, it can only be a quality inhering in a substance. It is to be noted that not all *darśanas* accept sound as a quality. For instance, the Mīmāṁsakas of the Bhaṭṭa school consider sound as a substance. It is stated by them that sound cannot be a quality for it is perceived independently of the substratum and that a quality cannot be perceived so. Another reason is that sound possesses qualities, such as number, velocity, etc., as does a substance. Finally, it is argued that sound is all-pervasive and eternal, two qualities that can only belong to a substance. Other schools, such as the school of Madhva and the Grammar school, maintain a similar view. The Vaiśeṣika philosophers reject this view. See: Bhaduri, *ibid.*, 166; Mishra, *Conception of Matter According to Nyāya-Vaiśeṣika*, 163-64.

[80] According to Halbfass, the arguments provided by Vaiśeṣikas to demonstrate that *ākāśa* is the

when he says that "the main function of *ākāśa* in Vaiśeṣika seems to be to complete the concordance and symmetry of sense qualities and elemental substances."[81]

Metaphysical status of *ākāśa*

Since it is devoid of colour, taste, touch and smell, *ākāśa* is imperceptible.[82] Apart from being imperceptible and the medium of sound, *ākāśa* possesses some other attributes like all-pervasiveness (*vibhu*, *sarvagata*), eternity (*nityatva*), unity (*ekatva*), non-activity (*niṣkriyātattva*), number (*saṃkhyā*), separateness (*pṛthaktva*), conjunction (*saṃyoga*) and disjunction (*vibhāga*).[83] In the PDS, most of these qualities are inferred on the basis that *ākāśa* is the bearer of sound, as it appears from the following verse:

> Because there is no difference as to the mark [of *ākāśa*], [namely] sound, it is established that [it] is one [by number]. From this follows its separateness as one. Because [the *Vaiśeṣikasūtra*] states [its] all-pervasiveness,

bearer of sound are very much *ad hoc* and "will hardly appeal to anybody who has not already accepted the basic premises and definitions of the Vaiśeṣika system." He adds: "No reference is made to the potentially deeper dimensions of the association between *ākāśa* and sound, as they may be found in ancient Vedic, as well as later, in Tantric texts. Here, sound (especially its prototype, the *om*) and ether [*ākāśa*] may appear as equally primeval cosmic occurences, the first exhalations of the absolute, as the very beginning of creation itself, closer to the roots of our world than anything else that may be found in it." Since Vaiśeṣika does not offer an evolutionary account of the world, the idea of a priority in evolution is not discussed and a potential association between *ākāśa* and sound is simply not envisaged. See: Halbfass, "Space or Matter? The Concept of *ākāśa* in Indian Thought," 91.

[81] Halbfass, *ibid.*

[82] Most philosophers agree that *ākāśa* cannot itself be perceived but some other thinkers, like the Bhāṭṭa Mīmāṃsākas and the Grammarian philosophers, maintain that *ākāśa* can be directly perceived on the basis of its being the locus of everything we perceive around us. See: Bhaduri, *op.cit.*, 163.

[83] Other minor qualities are also accepted, such as the "absence of lower genera" (*aparajātyabhāva*) and size (*parimāṇa*). See: Lysenko, *op.cit.*, 417.

> [its] extension is [established as] the greatest. As [it is] said to be the cause of sound, conjunction and disjunction [are established for it].[84]

Because sound may be perceived universally, *ākāśa*, being the bearer of this quality, is said to be one in number: there are not many *ākāśas* but only one, which is the same everywhere. The indefinite number and variety of sounds are not traced back to *ākāśa* but to the diversity of "auxiliaries," (*sahakāris*) such as stuff, size, configuration of the sounding bodies, etc.[85] Since sound is considered to be transmitted by a series of conjunctions and disjunctions in this school, *ākāśa* is also endowed with these two qualities.[86] It is also all-pervasive and extended throughout space, which means that it is in contact with all the movable substances of finite size (*sarva-mūrta-dravya-saṃyogitva*).[87] Being all-pervasive, *ākāśa* does not admit any movement or divisibility. Because it has no parts, *ākāśa* cannot essentially change and become many and so, it is non-active; not subject to any change, it is not subject to decay, and so it is eternal.

The fact that most attributes of *ākāśa* are inferred from its bearing the quality of sound clearly shows that *ākāśa* is viewed predominantly as a material element in this school. However, as noticed earlier, the peculiar position of this element among the Vaiśeṣika substances suggests an additional kind of understanding. Though it shares

[84] PDhS, p.58. Translation taken from: Lysenko, *ibid.*, 430.

[85] Bhaduri, *op.cit.*, 173.

[86] In addition to *samavāya*, Vaiśeṣika accepts another kind of relation, namely conjunction (*saṃyoga*). *Saṃyoga* consists in the conjunction of two terms that were previously unrelated or unconnected, such as a table and the floor on which it stands or the coming together of atoms to form a molecule. While *samavāya* is counted as one of the six *padārthas*, *saṃyoga* is considered to be a quality (*guṇa*) of the terms related. As to disjunction (*vibhāga*), it is the quality by virtue of which the connection or contact of things is destroyed. According to Vaiśeṣikas, the movement of sound in space is only apparent and consists in reality of a series of acoustic events in which each momentary sound produces its immediate successor. The sounding is either initiated by a conjunction (*saṃyoga*) or a disjunction (*vibhāga*), i.e., either by a contact or a rupture between things, and then it travels through a series of conjunctions and disjunctions until it reaches the hearer.

[87] Sastri, *A Primer of Indian Logic According to Annambhaṭṭa's Tarkasaṁgraha*, 69.

with other elements the coordination with a specific quality and sense-organ, *ākāśa* does not consist of any parts and so cannot form aggregates as other elements do, neither can it be mixed with them. Whereas elements can be broken into indivisible atoms, *ākāśa* cannot be disintegrated in any way. On the other hand, this element presents a few similarities with immaterial substances such as direction (*diś*), time (*kāla*) and self (*ātman*). Like direction and time, it is all-pervasive and eternal, and like the self it possesses specific qualities which last only for a single moment and exist only in certain parts of the substance (pleasure, pain, etc., in the case of the self and sound in the case of *ākāśa*).[88] Therefore, even though this school mostly dwells upon the material aspect of *ākāśa*, it is also concerned with its metaphysical status as an all-pervasive and eternal substance on par with immaterial substances.[89] But we must keep in mind that if *ākāśa* can be perceived via the quality of sound, other immaterial substances cannot be perceived through any specific quality. In that sense, we could reasonably say that the position of *ākāśa* in Vaiśesika metaphysics is intermediary between material and immaterial substances.

Ākāśa* and *diś

It is particularly important to notice the difference between *ākāśa* and *diś* in classical Vaiśeṣika because both refer, though in different ways, to the idea of space. In line

[88]PDS, p.25.

[89]The position of *ākāśa* with respect to immaterial substances has been subject to some revision in the course of time in Vaiśeṣika. It is worth noting the view formulated in the *Saptapadārthī* of Śivāditya, a Vaiśeṣika text composed in the twelfth century. In contrast with Praśastapāda, who clearly makes a distinction between direction, time and *ākāśa*, Śivāditya claims that they constitute in reality the same substance and appear to be different because of their different functions and properties. Centuries later, Raghunātha Śiromaṇi proposed a more radical view, stating that direction, time and *ākāśa* are not only the same substance but are not different from God himself. See: Gurumurti (trans.), *Saptapadārthī of Śivāditya*, section 18; Potter, *The Padārthatattavanirūpaṇa of Raghunātha Śiromaṇi*, 23; Halbfass, *op.cit.*, 104-05.

with the *Upaniṣads*, the Vaiśeṣika notion of *diś* is connected with the sense of direction. Praśastapāda defines it as "that from which there arise the ten notions of east, southeast, south, southwest, west, northwest, north, northeast, below and above, with regard to a corporeal substance after one has made another corporeal substance the point of reference."[90] Hence, *diś* serves primarily as a spatial framework in which things and phenomena are located with reference to each other, and whose structure is defined by the things and the observers who perceive them. In contrast, *ākāśa* is associated with the idea of a "mere undifferentiated reservoir" that contains all things and their relations as they are, without being affected by them.[91] Yet, as all conjunctions and disjunctions, and not only those related to sound transmission, take place in *ākāśa*, the latter has an important role in "connecting" things together. Not only is it the receptacle of things but it is also a "communicating space" providing room for all sorts of interconnections between finite things. Vaiśeṣikas do not associate *ākāśa* with the possibility of free movement or with the absence of bodies. In their view, *ākāśa* is not pure emptiness but a "fullness" filling all space and bodies.[92]

[90]PDS, p.66.

[91]Lysenko, *op.cit.*, 437.

[92]One may ask how the all-pervasive nature of *ākāśa* is reconciled with the notion of indivisible atoms distinct from each other. This issue is discussed in the *Nyāyasūtras* of Gautama. If *ākāśa* is all-pervasive, it must penetrate the atom and then the atom must have parts (then, it is no more an atom). On the other hand, if the atom has no parts and is indivisible, *ākāśa* cannot be all-pervasive. Gautama's reply to this objection is that there is no "interior" nor "exterior" with reference to atoms: the atom is a cause-substance and as such has no parts (NS IV.2.20). Ubiquity or all-pervasiveness is defined as the conjunction with all substances of limited magnitude and not with something which is non-existent, such as the "inside" of an atom. Still, the role of *ākāśa* with regard to atoms is quite obscure. As Lysenko notices: "The relationship between *ākāśa* and the atoms is a rather elusive subject [in Vaiśeṣika]. This is indicative of a somewhat weak point in Vaiśeṣika physics... There is no indication in the available sources that *ākāśa*, like the void [in Democritus' physics], assists the motion of the atoms and their combinations as their common milieu or free space." See: Lysenko, *op.cit.*, 433.

4.2.2 The Sāṃkhya *darśana*

Sāṃkhya is one of the oldest and most influential schools of systematic philosophy to have emerged in the Hindu tradition. Several doctrines and ideas developed by this school have had a remarkable influence on Indian culture in general, not only in the field of philosophy but also in medicine, arts, law, theology and mythology.[93] The term *sāṃkhya*, which means "enumeration" or "calculation," refers to the school's enumeration and categorization of the elements and principles of existence. It may also denote the activity of analysing and discriminating in a reflective manner.[94] As a matter of fact, the notion of discrimination (*viveka*) plays a crucial role in Sāṃkhya, insofar as its main purpose is to distinguish the realm of consciousness (*puruṣa*) from the various activities pertaining to nature (*prakṛti*) so that the real individual or *puruṣa* may be released from the cycle of rebirth (*saṃsāra*). The origin of Sāṃkhya is a matter of debate among scholars. Although there is no evidence in Vedic and Upaniṣadic literature as to the existence of a systematized school called Sāṃkhya, some scholars have argued that there are references to Sāṃkhya ideas and concepts in the *Upaniṣads*. There are those who believe that this school grew independently of the *Upaniṣads* but during the same period, thus explaining the similarity of ideas and concepts, while others are of the view that it grew directly from the *Upaniṣads*; there is no final agreement on this point.

The earliest book of authority on classical Sāṃkhya is the *Sāṃkhyakārikā* (SK), composed by Īśvarakṛṣṇa around the fifth century CE.[95] The text discusses the different kinds of sufferings in life and knowledge as a means of release from these sufferings; it also offers a detailed description of the several existents of the world, the nature of causality and the threefold nature of the world in terms of *guṇas*. Important commentaries were written on this *kārikā*, among which are Gauḍapāda's

[93]Larson and Bhattacharya (eds.), *Sāṃkhya: A Dualist Tradition in Indian Philosophy*, xi.
[94]Fowler, *op.cit.*, 160.
[95]Hiriyanna, *Outlines of Indian Philosophy*, 269.

Sāṃkhyakārikābhāṣya (c. 6th century CE), Vācaspati Miśra's *Tattvakaumudī* (c. 10th century CE) and Vijñānabhikṣu's *Sāṃkhyapravacanabhāṣya* and *Sāṃkhyasāra* (16th century CE). We may also mention the *Yuktidīpikā*, another important commentary on the *Sāṃkhyakārikā*, but its origin and author are unknown.

The Sāṃkhya worldview

Before explaining how Sāṃkhya philosophers look upon *ākāśa*, it is useful to briefly introduce the main metaphysical tenets of this school. This can also serve as an introduction to the philosophy of Advaita as Sāṃkhya and Advaita metaphysics share some common ideas. The metaphysical framework of this school can be divided into three main realms: the *tattvas* or ontological principles, the *bhāvas* or epistemological and ethical principles, and the *bhūtas* or constituents of the empirical world.[96] The *Sāṃkhyakārikā* lists twenty-five categories of existence in the *tattva* realm, with *puruṣa* (or spirit) and *prakṛti* (or the principle of energy and matter) as the two fundamental principles of being:

1. *puruṣa* - self, pure consciousness;
2. *prakṛti* - nature, energy, matter;
3. *buddhi* or *mahat* - non-individualized or cosmicized intellect;
4. *ahaṃkāra* - egoity, principle of individuality;
5. *manas* - mind;

6-10. *jñānendriyas* - five organs of perception (hearing, touching, seeing, tasting, smelling);

11-15. *karmendriyas* - five organs of action (speaking, grasping, movement, excreting, procreating);

16-20. five *tanmātras* or subtle elements - sound, touch, form, taste, smell;

21-25. five *mahābhūtas* or gross elements - *ākāśa*, wind, fire, water, earth.

[96] Mohanty, *Classical Indian Philosophy*, 51.

These categories comprise the whole universe of experience. Except for *puruṣa*, which stands apart from the empirical world, all *tattvas* (including mind and sense-organs) are considered phenomenal evolutes of *prakṛti*. According to Sāṃkhya, these evolutes are constituted by three qualities called *guṇas*: *sattva* (light), *rajas* (passion, energy) and *tamas* (inertia, darkness).[97] Everything in the world, ranging from natural objects to psychological states of mind, are constituted in different proportions by these three factors, which form the basis constitution of *prakṛti*.[98] *Prakṛti* evolves or transforms from an unmanifested state (*pralaya*) into a manifested state through a series of stages or levels in which the different categories appear. In the state of *pralaya*, the three *guṇas* are balancing each other. When *prakṛti* is disturbed, the equilibrium is broken and then starts the process of evolution. This process goes on until all existents become latent again and reintroduce the state of *pralaya*. Evolution, like dissolution, is cyclical, having neither a beginning nor an end. Thus, *prakṛti* is neither created nor destroyed; it is the fundamental and eternal matrix out of which all things — natural beings, objects, thoughts, emotions, volitions, and even space and time — emerge and into which they return. It reminds us of the Upaniṣadic concept of *Brahman*, the major difference here being that *prakṛti* is insentient and devoid of consciousness.

[97] The concept of *guṇa* in Vaiśeṣika is quite different from that found in Sāṃkhya. In Vaiśeṣika, the *guṇa* stands as a general quality inhering in a substance, both quality and substance being independent *padārthas* related to each other through inherence. In Sāṃkhya, the *guṇas* constitute the three principles of all material beings.

[98] The three *guṇas* are not qualities of *prakṛti* but "component factors" or intrinsic "constituents" of *prakṛti*. They are not parts of *prakṛti* for they depend on it as much as *prakṛti* depends on them. As Hiriyanna says: "These three constituents [*guṇas*] again, though essentially distinct in their nature, are conceived as interdependent, so that they can never be separated from one another. It means that they are not mechanically placed together, but reciprocally involve one another and form a unity in trinity. In other words, they not only coexist but also cohere. This intrinsic interdependence of the *guṇas* excludes the possibility of the breaking up of *prakṛti* by their separation." See: Hiriyanna, *The Essentials of Indian Philosophy*, 108.

The first evolute to emerge from *prakṛti* is the non-individualized intellect (called *mahat* in its cosmic aspect and *buddhi* in its psychological aspect), the capacity for awareness, from which then emerges the principle of individuality or the sense of ego (*ahaṃkāra*) (see Fig. 4.1). According to *Sāṃkhyakārikā*, two distinct groups of principles emerge from *ahaṃkāra*. The first, corresponding to the *sāttvika* aspect of *ahaṃkāra*, relates to our subjective apprehension of the world and is constituted by the mind (*manas*), the five organs of perception (hearing, touch, sight, taste, smell) and the five organs of action (speech, hands, feet, reproduction, excretory). The second group, corresponding to the *tāmasa* aspect of *ahaṃkāra*, corresponds to the objective world (i.e., seen from our viewpoint) and is constituted by the five gross elements and their subtle counterparts, called *tanmātras*.[99] As to the *rājasa* aspect of *ahaṃkāra*, it provides energy to the whole process by sharing in both *sāttvika* and *tāmasa* aspects.[100] The last step of evolution consists in the combination of the five elements together, giving rise to the common things we observe in the world. The whole process of evolution proceeds from subtle to gross evolutes, each of which has a finite existence. This conception being opposite to that of eternal substances (*dravya*) in Vaiśeṣika, it is not surprising that both schools have a very different understanding of *ākāśa*.

[99]Unlike elements in Vaiśeṣika, the Sāṃkhya elements are conceived to have two phases: a generic and simple phase in which elements are not yet concretized and specified, and a specific phase where those "subtle" elements combine together to form "gross" elements. The first phase refers to what are called *tanmātras*. The role of *tanmātras* is to bridge the gap between subjective and objective aspects of reality, in particular between the ego and the gross physical world. All sensations (hearing, seeing, etc.) first exist in a potential or generic form in the experiencer before being apprehended by sense-organs. For instance, for hearing to take place, there must be some sort of generic receptivity to sound in the individual for specific sounds to be perceived. The *tanmātras* are the material and imperceptible essences corresponding to those sensations in the experiencer, that allow for the perception of gross elements in the external world. Cosmologically, they exist prior to gross elements and "generate" them. See: Larson and Bhattacharya (eds.), *Sāṃkhya: A Dualist Tradition in Indian Philosophy*, 50.

[100]Larson, *Classical Sāṃkhya: An Interpretation of its History and Meaning*, 185.

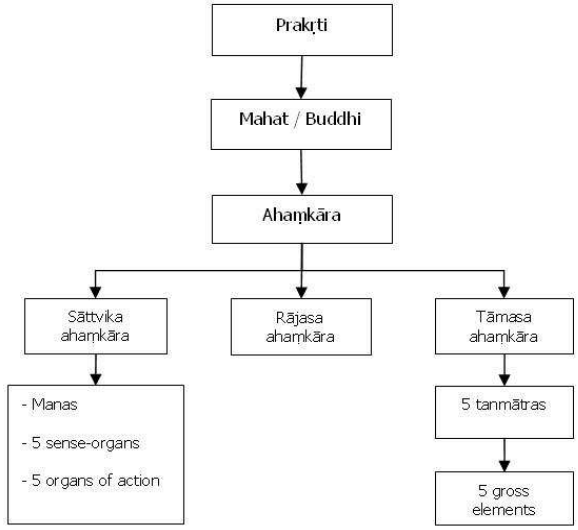

Figure 4.1: The evolution process in Sāṃkhya.

Puruṣa does not participate in the evolution of the world; it is described in the *Sāṃkhyakārikā* as a witness and spectator of the world, free, alone, indifferent, inactive (SK XIX). It is the conscious principle, the real enjoyer and knower of the world. In contrast, *prakṛti* and its emerging *tattvas* are unconscious and insentient.[101] Through right discrimination as to the nature of *prakṛti* and *puruṣa*, one attains true knowledge of one's own self (*puruṣa*) and becomes free from the entanglements of the world. However, the dualism of *prakṛti* and *puruṣa* raises an important problem. How are we to explain the manifestation of the world to consciousness if both *prakṛti* and *puruṣa* remain essentially independent principles? In fact, *prakṛti* cannot by it-

[101] One may point out that the emergence of psychical entities (*buddhi*, *manas*, etc.) in the course of evolution contradicts the fact that *prakrti* is unconscious. However, it must be understood that what appears to be psychical and conscious in the empirical world owes this character to the presence of *puruṣa*. As the properties of the moon, which is reflected in the water, should not be attributed to water itself, so are the attributes of *puruṣa*, which are only "reflected" in *prakṛti* and are not part of it. Thoughts and things, matter and intellectual processes are essentially the same as all are constituted by the same three *guṇas*, yet in different proportions. If certain evolutes can "reveal" objects in a "subjective" manner, it is purely because of their *sattvic* quality and not because of any connection with human subjectivity. See: Hiriyanna, *op.cit.*, 112.

self give impetus to the world, provide it with meaning and purpose. In order for things to be intelligible, the presence of *puruṣa* is essential. On the other hand, by providing a world and the possibility of objective knowledge, *prakṛti* enables *puruṣa* to eventually realize its true state as a free enjoyer and conscious knower. Therefore, the *Sāṃkhyakārikā* describes the relation between *puruṣa* and *prakṛti* as that between a blind man and a lame man who co-operate together to get out of a forest (SK XXI). But the analogy is not very appropriate. Unlike the two men, who are both conscious and thus able to make a plan in order to get out of the forest, *prakṛti* is unconscious and *puruṣa* is indifferent. The exact manner in which both principles interact constitutes a rather complex, if not ambiguous, aspect of the Sāṃkhya philosophy.[102]

In Sāṃkhya, the status of elements is quite different from that given in Vaiśeṣika. The five elements form the material world as we know it, but they are not the ultimate reals since all of them trace back to a common source, i.e., *prakṛti*. They are not eternal but finite for they emerge from the evolution process taking place in *prakṛti*. The five elements are associated with a specific quality (*viśeṣaguṇa*): *ākāśa* with sound (*śabda*), air with touch (*sparśa*), fire with colour (*rūpa*), water with taste (*rasa*) and earth with smell (*gandha*). Here also, elements share qualities with other elements: air has touch as a dominant quality but also sound; fire is related to colour but also to touch and sound; and so forth, ending with earth which possesses all the five qualities. In sharp contrast with Vaiśeṣika, sound is here a quality of *all* elements and not only of *ākāśa*. For each gross element there is a corresponding *tanmātra*, termed in accordance with the associated specific quality: *śabdatanmātra* for subtle *ākāśa*, *sparśatanmātra* for air, *rūpatanmātra* for fire, *rasatanmātra* for water and

[102] Fowler summarizes this problematic: "These are difficult aspects of Sāṃkhya philosophy, particularly the attempt to assign some kind of blind purpose to unconscious matter on the one hand, and to suggest that something that is already separate and pure consciousness can be trapped in such unconscious matter on the other. It seems futile for *prakṛti* to be purposefully (and yet unconsciously) operating for the freedom of that which is already free." See: Fowler, *op.cit.*, 189.

gandhatanmātra for earth. But the qualities possessed by *tanmātras* exist only in a potential or "rudimentary" form, so that *tanmātras* basically remain imperceptible. Unlike the gross elements they generate, subtle elements are inferred and not perceived.[103]

Metaphysical status of *ākāśa*

In Sāṃkhya, as in Vaiśeṣika and other orthodox *darśanas*, *ākāśa* is one of the five elements and is associated with the quality of sound. Unlike Vaiśeṣika, *ākāśa* is the *first* element (*mahābhūta*) to appear in the process of evolution in Sāṃkhya, a feature which it shares with Vedānta. It is possible that the mention of *ākāśa* as the first

[103]The views differ in Sāṃkhya literature as to the number of qualities per *tanmātra*. We find two different views expounded in the *Yuktidīpikā*. In the first view, each *tanmātra* has one and only one quality: *śabdatanmātra* is endowed with sound, *sparśatanmātra* with touch, etc. According to the second view, there is an accumulation of qualities in the process of evolution. For instance, *sparśatanmātra* not only has touch for quality but also retains that of the previous *tanmātra*, namely sound. This implies that the *tanmātras* evolve from each other, starting from *śabdatanmātra* with sound as its quality and ending with *gandhatanmātra*, which possesses the five qualities. This ambiguity is also reflected in the process by which gross elements are derived from subtle elements. According to Halbfass, "the most conspicuous and problematic aspect of the Sāṃkhya conception of elements is the distinction and dichotomy between the subtle elements and their gross counterparts," and seemingly, "neither traditional Indian commentators nor modern Western scholars have been able to come to a complete and definitive agreement concerning the precise nature of the relation between the two types of elements." The *Sāṃkhyakārikā* (SK XXII, XXXVIII) simply states that the five gross elements derive from the five subtle elements without providing any further explanation for the mechanism of derivation itself. The most common view is the so-called "accumulation theory," according to which each successive subtle element combines with the previous one in order to give rise to a gross element. For instance, the gross element of air, which is endowed with both touch and sound, would result from the combination of the subtle element of *ākāśa* (which has the quality of sound) and the subtle element of air (which has the quality of touch). This view, adopted by Vācaspati Miśra in his commentary, supposes that each *tanmātra* has one and only one quality. See: Chakravarti, *op.cit.*, 243; Halbfass, *op.cit.*, 88.

element to emerge from *Brahman* in TU II.1.1, played a role in the emergence of such a conception. However, there is no direct evidence in the *Sāṃkhyakārikā*, nor in the subsequent commentaries, as to why *ākāśa* obtains this status. It may be argued that this follows naturally from the principle that evolution proceeds from the subtle to the gross, *ākāśa* being more subtle in nature than earth for instance. Moreover, in contrast with Vaiśeṣika, there is no detailed analysis in this school as to the correlation made between *ākāśa* and sound. Its major contribution lies rather in the distinction made between subtle and gross elements, on the basis of which it offers its own specific understanding of *ākāśa*. As already mentioned, a gross element in Sāṃkhya is the substratum in which the subtle quality of the related *tanmātra* manifests itself. Thus, the role of the gross *ākāśa* is to manifest the subtle quality of sound (latent in the subtle *ākāśa*) to the individual's consciousness. The presence of the gross *ākāśa* in the world allows the various kinds of specific sounds to be experienced subjectively and manifested objectively in the empirical world.

In addition to being correlated with sound, *ākāśa* is said to possess three other physical properties: all-pervasiveness or ubiquity, penetrability and unobstructiveness.[104] Like in Vaiśeṣika, the property of ubiquity is accepted on the account that sound is heard from all directions. But while Vaiśeṣika insists on the distinction between *ākāśa* and space, the same cannot be said of Sāṃkhya. According to the *Yuktidīpikā*, the property of unobstructiveness is attributed to *ākāśa* because the latter provides space for all.[105] Bhaduri describes *ākāśa* as "the universal medium in

[104]The properties of elements are mentioned in the *Yuktidīpikā* but the source of information is not mentioned in this text. Earth is said to have form, weight, aridity, resistance, stability, position, divisibility, sustenance, dark shade and usefulness to all; water has liquidity, thinness, brilliance, whiteness, softness, weight, coldness, protectiveness, purification and cohesion; fire has upward movement, purification, burning, cooking, lightness, brilliance, destruction, power and lustre; air has horizontal motion, purification, pushing, impulsion, power, dryness, no shadow and coolness. See: Chakravarti, *op.cit.*, 246-47.

[105]*Kārikā* 38. See: Kumar and Bhargava (trans.), *Yuktidīpikā* (Vol.2), 287.

which all finite things exist as separate entities and move freely."[106] For these reasons, this element appears to be almost indistinguishable from empty space itself in Sāṃkhya. The view according to which *ākāśa* is identical with empty space is also adopted by some other schools of Indian philosophy. In Jainism, for instance, *ākāśa* is essentially empty space (*avakāśa*) because it offers no resistance to the passage of bodies. Similarly, the Vaibhāṣika Buddhists consider *ākāśa* as a positive entity (*dharma*) which neither obstructs objects nor is obstructed by them. Both schools seem to envisage *ākāśa* as a condition of free movement. This view is however refuted by Kaṇāda, the author of the *Vaiśeṣikasūtra*, on the basis that *ākāśa* is ubiquitous and thus incapable of movement. Consequently, it cannot be the cause or the substratum of movement of objects.[107]

Another important difference with Vaiśeṣika is that *ākāśa* is not an eternal element here. In Sāṃkhya metaphysics, there are only two eternal entities, *prakṛti* and *puruṣa*. All other *tattvas* are considered to have a finite existence. As an evolute of *prakṛti*, *ākāśa* has a cause and is subject to decay. At least in classical Sāṃkhya, there is no indication of *ākāśa* being endowed with a higher ontological status than other elements. In the *Sāṃkhyakārikā* and the subsequent commentaries, there is no trace of a transcendental type of *ākāśa* as described in the *Upaniṣads*. In other words, there is no ontological gap here between *ākāśa* and the other four elements: connected with the quality of sound and possessing certain physical attributes, *ākāśa* does not display any resemblance with either *prakṛti* or *puruṣa*. However, it must be noted that Vijñānabhikṣu, one of the most important exponents of later Sāṃkhya and Yoga philosophy, eventually introduced the notion of a "causal" *ākāśa*, a kind of *ākāśa* associated with *prakṛti*. In his view, there exist two kinds of *ākāśa*: 1. *kāryākāśa*: an elemental or gross *ākāśa*, which is derived from *śabdatanmātra* and thus an evolute; and 2. *kāraṇākāśa*: an original or causal *ākāśa*, associated with *prakṛti*. With this revision, we get a new type of *ākāśa*: causal, all-pervasive and associated with *prakṛti*.

[106]Bhaduri, *op.cit.*, 164.

[107]Bhaduri, *ibid.*

In that sense, we seem to return to the *Upaniṣads*, where *ākāśa* finds a place nearer the origin of things.[108]

4.3 The Advaita Vedānta *darśana*

The most influential school of theology and philosophy in India has certainly been the Vedānta. It has exerted an enormous influence on all Indian religious traditions throughout history and continues to attract a significant following to the present day. The term "Vedānta" refers to the *Upaniṣads* and their teachings as well as to the traditions inspired by them, and thus the Vedānta tradition is concerned with the exegetical interpretation of these texts.[109] The various schools of Vedānta accept Bādarāyaṇa's *Brahmasūtra* (c. 200 BCE), also called the *Vedāntasūtra*, as their foundational text. The latter summarizes the teachings of the *Upaniṣads* by investigating the nature of *Brahman*.[110] Besides this text and the *Upaniṣads*, the *Bhagavad-Gītā*

[108] However, the exact nature of this causal *ākāśa* as well as its relation with *prakṛti*, remains ambiguous. Vijñānabhikṣu's distinction between two *ākāśas* is alluded to in Jhaveri (1956), but the passage which he refers to, namely SPB II.12, is rather difficult to understand. Radhakrishnan makes the following translation: "Eternal space and time are of the form of *prakṛti*, or the root-cause of *ākāśa*, and are only the specific modifications of *prakṛti*. Hence the universality of space and time is established. . . But these, space and time, which are limited, are produced from *ākāśa* through the conjunction of this or that limiting object (*upādhi*)." (*Indian Philosophy*, Vol.2, 277) From this passage, which is the only reference we have, the nature of the causal *ākāśa* and its relation with *prakṛti* remain unclear.

[109] There is a general tendency to refer to the *Upaniṣads* collectively as the "Vedānta" (i.e., the "end of the Veda," *Veda* + *antaḥ* (end)). The word *Veda* itself means "knowledge" or "wisdom" whereas the word "end" has here a chronological and teleological sense. This suggests that the *Upaniṣads* form the concluding portions of the *Vedas* and also reveal the final and supreme goal of Vedic knowledge. However, this stance belongs to Vedānta schools and is by no means representative of all traditions of Hinduism.

[110] Flood, *An Introduction to Hinduism*, 239. It has been held in general in India that the author of the *Brahmasūtra* is Bādarāyaṇa. The celebrated Advaita teacher Śaṅkara also maintained this view.

was also the subject of exegetical interpretations, and together these texts form the "triple basis" (*prasthānatrayī*) of the Vedānta commentarial tradition. Under Vedānta there are a number of well-known schools, among which the most important are Advaita Vedānta ("non-dualism"), *Viśiṣṭādvaita* ("qualified non-dualism") and *Dvaita* ("dualism"), primarily associated with the names of Śaṅkara (8th century), Rāmānuja (11-12th century) and Madhva (13th century), respectively. Of the three, the non-dualistic school of Advaita Vedānta has arguably been the most influential.

Despite its clear exegetical nature, the school of Advaita Vedānta also addresses questions of philosophical interest in the fields of epistemology and ontology.[111] As appears from its numerous debates with schools like Sāṃkhya, Nyāya, Vaiśeṣika, Yoga, Buddhism, Jainism and Cārvāka, the Advaita school is deeply concerned with the nature of reality, knowledge and various other epistemological issues. In this regard, one cannot overlook the detailed theory of knowledge developed by the Advaitin Dharmarāja in his *Vedāntaparibhāṣā* (17th century). Like other *darśanas*, the purpose of Advaita Vedānta is to point the way to liberation (*mokṣa*) from one's bondage to the world (*saṃsāra*), the cause for sufferings and rebirth. Bondage is here conceived as the product of ignorance (*avidyā*) about the true nature of reality. The term *advaita* means "non-dual" and refers to the absolute monist stance of the school, which posits the unique reality of *Brahman* and its identity with one's inner self, *ātman*. Its purpose, both as a philosophy and a spiritual discipline, is to lead to the knowledge (*vidyā*) that *all* distinctions are ultimately false and that *Brahman-ātman* is the only Reality.[112]

The most famous Advaita philosopher, and probably one among the greatest

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But according to Nakamura, who wrote an extensive history of pre-Śaṅkara Vedānta, the author (or authors) of the *sūtra* would have lived *after* Bādarāyaṇa because the latter is mentioned as authority in the *sūtra* itself. See: Nakamura, *A History of Early Vedānta Philosophy* (Vol.1), 406.

[111] Flood, *op.cit.*, 238.

[112] For more details on the religious and philosophical facets of Advaita, see: Mohanty, "Advaita Vedānta as Philosophy and as Religion." In: Mohanty, *Explorations in Philosophy*.

philosophers of India, is Śaṅkara or Śaṅkarācārya (c. 788-820 CE). Yet, if Śaṅkara is indeed one of the most important exponents of Advaita, it would be wrong to identify early Advaita solely with his philosophy. There were at least a few other Advaitins before him, as he himself indicates by referring to his own "tradition," (*sampradāya*) though there is hardly any trace of an Advaita tradition before the time of the *Brahmasūtras*.[113] Gauḍapāda (c. 7th century), known to be the teacher of Śaṅkara's teacher, is one of the main figures of Advaita before Śaṅkara. His main work, the *Gauḍapādakārikā* (GK), a commentary on the *Māṇḍūkya Upaniṣad*, has probably been commented upon by Śaṅkara. It is worth noting that Gauḍapāda was probably influenced by Buddhist philosophy, especially Madhyamaka Buddhism. For instance, some scholars have pointed out that the GK quotes either fully or partially from Nāgārjuna's *Madhyamakakārikā*, and that there is a clear historical connection between the doctrine of *ākāśa* formulated in GK and a chapter from Bhāvaviveka's *Madhyamakahrdayakārikā*.[114] As for Śaṅkara, his most important work is the *Brahmasūtrabhāṣya* (BSB), an extensive commentary on the *Brahmasūtras* which is still recognized as a seminal work of the Advaita tradition. Three other theological works are positively accepted to be authored by Śaṅkara: the commentaries on the *Bṛhadāraṇyaka* and *Taittirīya Upaniṣads* and the independent work entitled "Thousand teachings." (*Upadeśasāhasrī*)[115]

According to the tradition, Śaṅkara had four disciples. One of them, Padmapāda (8th century), composed an important commentary on the *Brahmasūtrabhāṣya*, called *Pañcapādikā*. Later, Prakāśātman (c. 10th century) commented upon this text in what is called the *Pañcapādikā-Vivaraṇa*, or simply *Vivaraṇa*. Vācapasti Miśra (c. 10th century) also wrote a commentary on the *Brahmasūtrabhāṣya*, called *Bhāmatī*.

[113]Potter (ed.), *Advaita Vedānta up to Śaṃkara and his Pupils*, 9-10.

[114]For more details on this issue, see: Bhattacharya, *The Āgamaśāstra of Gauḍapāda*; King, *Early Advaita Vedānta and Buddhism: The Mahāyāna Context of the Gauḍapādīya-Kārikā*; Qvarnström, *Hindu Philosophy in Buddhist Perspective: The Vedāntatattvaviniścaya Chapter of Bhavya's Madhyamakahṛdayakārikā*.

[115]Flood, *op.cit.*, 240.

The schools of *Bhāmatī* and *Vivaraṇa* assumed so much importance in the course of time that they came to be known as independent schools of thought. Several other major works were composed in the next centuries, among which are numerous commentaries on the *Bhāmatī* and the *Vivaraṇa* and independent treatises such as the *Advaitasiddhi* of Madhusūdana Sarasvatī (16th century). The tradition of Advaita Vedānta continues to attract eminent thinkers right to the present day. The following section focuses on Śaṅkara's teachings as they are accepted as authoritative in the Advaita tradition.

4.3.1 Nature and Knowledge of *Brahman*

Before examining in detail the concept of *ākāśa* from the perspective of Advaita Vedānta, it is first essential to discuss some key features of this school. The main contribution of Śaṅkara has been to emphasize knowlege of *Brahman* as the only way to achieve liberation. Liberation is not achieved through ritual action (*karma*) but through *knowledge* of one's own identity with *Brahman*, which can only take place by dismissing the false notion of a distinction between the knower and the known, the subject and the object. The concept of *Brahman* is a central feature of the Advaita worldview. In BSB II.2.1-10, Śaṅkara argues against the view, maintained in Sāṃkhya, that the unconscious *prakṛti* is the ultimate cause of the universe. Though he contends that the design in the universe seems to presuppose a single cause, eternal and unlimited, he refutes the idea of a cause unconscious in nature. How can an unintelligent and insentient principle like *prakṛti* account for the beauty, symmetry, order and harmony at work in the universe? Moreover, the dualism erected between *prakṛti* and *puruṣa* raises problems. Without a third spiritual principle linking *prakṛti* to *puruṣa*, it is hardly possible to explain how this world comes into existence and continuously maintains its existence. The chasm between these two entities can only be bridged if a higher conscious principle is the cause of the world, namely *Brah-*

man, which transcends and yet preserves at the empirical level the subject-object (or *puruṣa-prakṛti*) duality.

It is often said that the entire system of Advaita Vedānta can be summed up in the following statement: *Brahman* is real, the world is unreal and the individual self is none other than *Brahman* (*brahma satyaṃ jagan mithyā jīvo brahmaiva nāparaḥ*). The first half of the statement gives the answer to one of the most basic questions taken up in the *Upaniṣads*, i.e., what is the relation between *Brahman* and the world? The *Upaniṣads* provide different answers to this question. In those passages describing the creation and evolution of the world, the *Upaniṣads* seem to affirm the reality of diversity; in other passages, the existence of multiplicity is taken to be subsidiary to that of *Brahman*, the ultimate reality, one without a second. According to Śaṅkara, the view emphasizing the manifold and changing character of the world must be considered only as a "concession" to empirical modes of thought. The only teaching of the *Upaniṣads*, in his view, is that of non-duality.[116] Though quite real at the empirical level, the world has no reality in the non-dual viewpoint. The world we experience, with all its distinctions and transformations, is unreal (*mithyā*) because it is ultimately obliterated by something more real: the non-dual *Brahman*.

In Advaita, *Brahman* is the one, all-pervasive, unchanging and underlying principle of all being and reality. It is the common essence or substratum that runs through all things but remains beyond them, not affected by them. Yet, it is not an objective principle of existence, neither a creation of the mind, nor a subjective state of being. As Deutsch says: "It is not a 'He', a personal being; nor is it an 'It', an impersonal concept. Brahman is that state which *is* when all subject/object distinctions are obliterated."[117] *Brahman* is beyond the subject-object duality and cannot be

[116]It is worth noting that Śaṅkara does not teach "unity" but "non-duality" for unity cannot exist apart from variety and diversity. In his *Bhāmatī* (II.1.14), Vācaspati Miśra describes Śaṅkara's teaching as only denying the many and not affirming the one: *na tu khalu ananyatvamiti abhedam brūmaḥ, kim tu bhedam vyāsedhāmaḥ*. See: Hiriyanna, *The Essentials of Indian Philosophy*, 154.

[117]Deutsch, *Advaita Vedānta: A Philosophical Reconstruction*, 9.

predicated with any quality. No positive language can describe adequately *Brahman* because it would limit or reduce its indescribable (*anirvacanīya*) reality to conceptual and linguistic categories, and make it an object of knowledge.[118] Still, Advaitins often describe *Brahman* to be *saccidānanda*, i.e., existence (*sat*), consciousness (*cit*) and bliss (*ānanda*).[119] As *sat*, *Brahman* refers to a state of pure being, undifferentiated, not subject to origination, change, destructions, or relations.[120] As *cit*, it refers to the principle of pure awareness that informs our real self (*ātman*), a state which is not an object of thought but which illumines every thought. *Brahman* is the conscious witness (*sākṣin*) behind the knower, the known and the knowledge. As to the word *ānanda*, it refers to *Brahman* as the source of all forms of bliss, whether born of sensory experience or from spiritual practices.[121] *Brahman* is thus described as the

[118]This *nirguṇa Brahman*, without qualities, must be distinguished in Advaita from the *saguṇa Brahman*, which is endowed with qualities. If nothing can ultimately be stated of the former, the latter can be affirmed from the empirical standpoint as that which creates, sustains and destroys everything that exists. According to Advaitins, it is the knowledge of *nirguṇa Brahman* alone that constitutes liberation.

[119]This triad can be related to a passage from the *Taittirīya Upaniṣad* (II.1.1): *satyam jñānam anantam brahma*, Brahman is truth, knowledge, infinite. Commenting on this passage, Śaṅkara explains that these three terms do not positively describe *Brahman* but only serve to "differentiate Brahman from other entities that possess opposite qualities." According to Padmapāda, these three words, or each of them singly, are not intended to be attributes superadded to *Brahman* (*taṭasthalakṣaṇa*) but only expressions of its essence (*svarūpalakṣaṇa*). See: Potter (ed.), *op.cit.*, 75; Deutsch, *op.cit.*, 9.

[120]See: BSB I.4.14-15 and Śaṅkara's commentary on ChU III.19. One can also find a short but valuable discussion on *sat* in Halbfass's *On Being and What There Is* (25-29).

[121]In Advaita, the use of the word *ānanda* to characterize *Brahman* has often been a source of confusion. Although the *Upaniṣads* frequently describe *Brahman* as such, Śaṅkara hesitates to use this word in his own works. Indeed, bliss seems to refer to a temporary pleasant state, having a beginning and an end. As such, it cannot characterize the unchangeable *Brahman*. Sureśvara points out, however, that the bliss referred to is not an object of consciousness that can be experienced in any empirical way. This bliss, of which our joys and pleasures are only feeble expressions, arises from *Brahman* being infinite and all-pervasive in nature. According to Swami Dayananda, the word *ānanda* cannot refer to the "experience" of bliss if it refers to the nature (*svarūpa*) of *Brahman*.

one reality persisting through both external and internal states of being, the pure existence behind and beyond this world.

It is important to understand that because it is neither an object of thought nor of perception, the existence of *Brahman* cannot be ascertained through reason nor by any means based upon perception. But this does not entail that we should either take its existence for granted or simply refute it on the basis of a lack of evidence. The existence of *Brahman* is not the outcome of belief for Advaitins, neither can it be proved through reasoning. Though different from any empirical knowledge (*aparāvidyā*), the knowledge of *Brahman* (*parāvidyā*) can be achieved through the proper understanding of sacred texts (*śruti*). But the sacred texts are only a means of knowledge, a tool for helping the seeker to understand that this truth about *Brahman* is not to be "attained" in any way because it already resides within us. What is needed is not a "new" knowledge but the removal of a false notion about the self and the world. Now, if the non-dual *Brahman* is the only real existent in the view of Advaita, what about the world we daily experience and feel to be quite real? The answer given by Advaitins is that the world we experience is fundamentally unreal (*mithyā*). Several Western, and Indian scholars as well, have interpreted this statement as meaning that the world has no reality at all, it is a mere illusion. However, Advaitins make a clear distinction between the real (*sat*), the unreal (*mithyā*) and the illusory or non-existent (*asat*).

The necessity for using the experiential word *ānanda* serves two purposes: 1. it shows that the knowledge of *Brahman* is desirable because it is *ānanda-svarūpa*; 2. it shows that the source of all forms of *ānanda* is nothing but the limitlessness (*anantam*) of *Brahman*. See: Potter (ed.), *op.cit.*, 76; Swami Dayananda Sarasvati, *The Teaching Tradition of Advaita Vedānta*, 8.

***Brahman* and the world**

By definition, what is real is that which *cannot* be sublated by any other experience, at any time (*trikālābādhyam*); what is unreal is that which *can* be sublated by another experience; what is non-existent is that which *neither can nor cannot* be sublated by another experience.[122] *Brahman* is the only existent which cannot be sublated because of its nature as pure awareness, and one cannot deny awareness without having recourse to awareness itself; it is thus the only "real," and so it is denoted as *sat*.[123] The horns of a hare, a square circle, etc., are non-existent or ontological impossibilities that neither can nor cannot be sublated by any other experience. The phenomenal world falls into the category of being neither real nor non-existent (*sadasadvilakṣaṇa*): it is not real because it is eventually sublated by the knowledge of *Brahman*, neither non-existent because it clearly presents itself to our sense-organs. What is unreal (*mithyā*) is not illusory but something that depends upon some higher reality, or substratum, for its own existence. As in the illusion of the rope as a snake, wherein the snake cannot appear without the rope being present, the world cannot be perceived unless it has the non-dual *Brahman* as its substratum. But, and this is crucial, *Brahman* does not depend upon the world for its own existence: it remains as it is, changeless and eternal, behind and beyond the manifold

[122] According to Deutsch, sublation (which he reconstructs as "subration") is the "mental process whereby one disvalues some previously appraised object or content of consciousness because of its being contradicted by a new experience." See: Deutsch, *op.cit.*, 15.

[123] By "awareness" or "pure consciousness," the Advaitin does not refer to an act of any sort because it is by definition beyond the distinction between act and doer. Also, consciousness is not adventitious, i.e., it is not imposed extrinsically on the one who is conscious. In contrast with Buddhism, Nyāya and Mīmāṃsā, which take consciousness as being dependent on some internal instruments (sense organs, mind, etc.), Advaitins consider that it persists eternally by itself, not being dependent upon anything. Since pure consciousness is not the object of any knowledge, it cannot be sublated.

activities of the world.[124]

The world is real as long as the process of sublation has not taken place, i.e., as long as *Brahman* remains unknown. Once it is known, all distinctions and multiplicities are obliterated, sublated, transcended. However, how is the projection of the unreal upon the real, of the world upon *Brahman*, taking place? Such mechanism of projection is referred to as "superimposition" (*adhyāsa*, *adhyāropa*) by Śaṅkara. At the very beginning of his commentary on the *Brahmasūtras*, he defines *adhyāsa* as *smṛtirūpaḥ paratra pūrvadṛṣṭāvabhāsaḥ*, i.e., as the "appearance elsewhere, with a nature like that of recollection, of what was seen before."[125] Superimposition occurs when the attributes of a thing seen elsewhere are projected upon another thing present to consciousness and then identified with it. Just as we project the attributes of the snake upon the rope and then take the rope to be a snake, we superimpose upon *Brahman* various names (*nāma*) and forms (*rūpa*), and then misidentify the world with *Brahman*. Since *Brahman* is identified with the self (*ātman*) in Advaita, we can also superimpose what does not belong to the self, say the size of the physical body, upon the self, and then say "I am small." In both cases, properties of the external world are falsely superimposed upon the non-dual *Brahman* or *ātman*. But why does this mechanism take place? Why are we taking the unreal for the real and the real for the unreal? Why is there a world at all?

[124]Likewise, if the snake depends upon the rope for its existence, the rope does not depend upon the snake for its own existence. Of course, this is only an analogy because the rope itself, as an object of the empirical world, is also sublated by the knowledge of *Brahman* while *Brahman* can never be.

[125]Translation taken from: Sastri and Raja (trans.), *Bhāmatī of Vācaspati on Śaṅkara's Brahmasūtrabhāṣya*.

Māya

The answer to this question finds its most common expression in the concept of *māyā*. The word *māya* accounts for each experience involving a distinction between subject and object, between the self and the non-self. *Māyā* is thus closely connected to *avidyā*, or ignorance, insofar as ignorance is responsible for our sense of duality.[126] According to Sharma, the concept of *māyā* in Śaṅkara's thought is endowed with the following characteristics:[127]

1. It has two aspects: negatively, it conceals (*āvaraṇa*) *Brahman* and positively, it projects (*vikṣepa*) the world of plurality upon *Brahman*;
2. It is without any beginning (*anādi*);
3. It is indescribable and indefinable (*anirvacanīya*) for it is neither real nor unreal. It is not real for it is dependent upon *Brahman* for its existence, neither unreal because it projects the world and lasts as long as we do not have the knowledge of *Brahman*.

As a power (*śakti*) of *Brahman*, power by which multiplicity comes into existence,

[126] In the writings of Śaṅkara, *māyā* and *avidyā* are used more or less synonymously. According to Hacker, *avidyā* is the same as "superimposition" (*adhyāsa*) in Śaṅkara's thought. It denotes the mutual superimposition of subject and object, of self and non-self, the confusion between the true and the false. With later Advaitins, however, *avidyā* acquires an ontological connotation as it refers to the "causal conditions of all error insofar as it is, so to speak, the stuff out of which every false idea is formed." Maṇḍana Miśra divides *avidyā* into a "covering" (*ācchādika*) and "projective" (*vikṣepika*) one, the former referring to nonapprehension and the latter to false apprehension. In line with this, Vācaspati Miśra introduces the distinction between a primeval or causal ignorance (*mūlāvidyā*) and a secondary or derivative ignorance (*tulāvidyā*). The followers of Miśra seem to explain the "apparent" existence of the empirical world in terms of *mūlāvidyā* and the individual world of temporary illusions in terms of *tulāvidyā*. See: Hacker, P., "Distinctive Features of the Doctrine and Terminology of Śaṅkara: *avidyā, nāmarūpa, māyā, Īśvara*." In: Halbfass (ed.), *Philology and Confrontation: Paul Hacker on Traditional and Modern Vedānta*, 58-59; Gupta, *Perceiving in Advaita Vedānta: Epistemological Analysis and Interpretation*, 97; Potter (ed.), *op.cit.*, 79.

[127] Sharma, *A Critical Survey of Indian Philosophy*, 274-75.

māyā is fully dependent upon and non-different from *Brahman*. It is the principle which at once conceals *Brahman* and projects upon it the manifold world we actually perceive. The empirical world is *māyā*, and is also created, or projected, by *māyā*. But this does not mean that the world is an illusion. Though it is not ultimately real, the world must be taken to be real from an empirical standpoint. Yet, the source of *māyā* cannot be known with certainty. It cannot be proved through reasoning, which is itself a product of *māyā*. Hence, the question — how did *māyā* appear? — cannot be logically raised since *māyā* has no beginning and is indescribable. *Māyā* is not created deliberately but simply exists where truth and knowledge are not. For many, the fact that *māyā* defies all logical treatment is a problem. There seems to be no way to explain how the world is related to *Brahman* because *māyā* cannot be interpreted as a cause of the world; it simply "is" where non-dual knowledge "is not."

In any case, Advaita does not aim to provide a definite solution to the problem of the relationship between *Brahman* and the world. What it claims is however significant: since the problem in itself assumes a duality between *Brahman* and the world, it cannot be given an ultimate and final solution. From a non-dual viewpoint, seeking to determine the relation between *Brahman* and the world is illegitimate. As Deutsch remarks: "The world cannot be explained in itself, for the mind that would explain it is part of, and is conditioned by, that which is to be explained; it cannot be explained with reference to *Brahman*, for no relations can be established between them... The ultimate "why" of the world cannot then be grasped."[128] *Māyā* is not a theory for the explanation of the world, its creation and manifestation, nor is it invoked to explain away the world as a feeble illusion; it is rather a statement of facts as they exist for humans trapped in duality and ignorance. In the framework of Advaita, it serves as a "provisional recovery of the world so that its ultimate non-being, along with *Brahman*'s being may be spoken... *Brahman* stands over against the world, and *māyā* is the ground of this provisional distinction between the world and *Brahman*, all distinctions being provisional."[129]

[128]Deutsch, *op.cit.*, 42-43.

[129]Arapura, J.G., "*Māyā* and the Discourse about *Brahman*." In: Sprung (ed.), *The Problem of*

Parāvidyā* and *aparāvidyā

As noticed earlier, Advaita Vedānta stresses the importance of knowledge in achieving liberation. What is to be sought for, however, is not knowledge of the totality of the empirical world but that of *Brahman*, the underlying ground of being. In the *Muṇḍaka Upaniṣad* (I.1.4), two kinds of knowledge are enunciated: "Two types of knowledge [*vidyā*] a man should learn — those who know *brahman* tell us — the higher (*parā*) and the lower (*aparā*)." While *parāvidyā* is solely concerned with the knowledge of the non-dual Reality, *aparāvidyā* has the empirical world — objects, events, means, ends, etc. — as its content. These two forms of knowledge are incommensurable with each other for the higher knowledge is *sui generis*, acquired without the mediation of any means of knowledge (*pramāṇas*), such as perception, inference, etc. In contrast, *aparāvidya* requires the mediation of certain means of knowledge and is always subject to negation.

Nonetheless, the supreme value given to knowledge of *Brahman* does not entail that *aparāvidyā* is without any truth value. Prior to the knowledge of *Brahman*, all transactions of the empirical world are real and true as far as they go and one cannot deny the reality of their content. As Deutsch notices:

> . . . there is no way open to the mind to deny logically the results of its own functioning; that is, to deny the reality of its own contents. Any attempt to demonstrate the falsity of all knowledge without reference to an eternal Absolute is doomed to failure, for the mind that would deny say, its own logic, without reference to Brahman, must be committed in advance to the use of that logic and any denial would thus be self-contradictory.[130]

Thus, empirical knowledge is justified as long as it does not claim ultimacy. Even though *pramāṇas* are themselves unreal (*mithyā*), as well as the objects they seek to reveal, they still remain essential in their own sphere. For instance, the teacher must

Two Truths in Vedānta and Buddhism, 119-20.

[130]Deutsch, *op.cit.*, 83.

use arguments in accordance with *pramāṇas* in the process of teaching the pupil. If *pramāṇas* do not tell truth, the teacher is unable to give the pupil proper and helpful instructions towards liberation. The lower forms of knowledge have thus a crucial role to play in the gradual unfolding of higher knowledge.

Knowledge of *Brahman*

It has been noticed earlier that knowledge of *Brahman* — also referred to as self-knowledge for the self is essentially identical with *Brahman* — can be achieved only through proper understanding of sacred texts (*śruti*), in particular the *Upaniṣads*. In Śaṅkara's view, only *śruti* can convey knowledge of "supersensuous" truths about reality, i.e., truths that lie beyond the reach of sense-organs and logical reasoning, like *Brahman* or the self (*ātman*). The *śruti* is infallible, not to be doubted and the right means of acquiring self-knowledge. Among the *pramāṇas* accepted by Śaṅkara, verbal testimony (*śabda*) thus stands apart or is unique because it is the only one that provides *śruti* with authority and meaning.[131] However, though *śabda* has a primary role in the attainment of *parāvidyā*, it does not provide a *direct* access to self-knowledge. As Śaṅkara notices, even sacred texts are unreal (*mithyā*) because they presuppose a duality in the same manner as other *pramāṇas* do.[132] In the *Taittirīya*

[131] In his writings, Śaṅkara refers to three means of knowledge, namely perception (*pratyakṣa*), inference (*anumāna*) and verbal testimony (*śabda*). *Śabda* refers to authoritative words (*śruti*), especially in sacred texts, or trustworthy speakers (*āpta*). Later, in the tenth century, Prakāśātman added postulation (*arthāpatti*). It is only in the seventeenth century, with Dharmarāja's *Vedāntaparibhāṣā*, that a list of six means of knowledge was established, including: perception (*pratyakṣa*), inference (*anumāna*), verbal testimony (*śabda*), postulation (*arthāpatti*), comparison (*upamāna*) and non-apprehension (*abhāva*). See: Mayeda, *A Thousand Teachings: The Upadeśasāhasrī of Śaṅkara*, 18.

[132] Since all *pramāṇas*, including *śabda-pramāṇa*, presuppose a knower and an object to be known, they only operate in the domain of *avidyā*, that is, where the sense of duality remains. In his *bhāṣya* on the *Bhagavad-Gītā* (XIII.2), Śaṅkara maintains that sacred texts are meaningful only in the state of bondage, and not in the liberated state (*bandhāvasthāyām eva śāstrādyarthavattvam, na*

Upaniṣad, *Brahman* is described as that "wherefrom words along with ideas turn back without reaching It." (TU II.4.1) Then, how does *śruti* convey knowledge of *Brahman*, which is beyond thought and speech?

Śaṅkara replies that the aim of *śruti* is not to describe *Brahman* as an object but solely to dispel our ignorance about it. In fact, most *Upaniṣads* refer to *Brahman* by stating what it is not (ex: "neither short, nor long," (BrU III.8.8) "other than cause and effect," (KaU I.2.14) "without an inner and an outer." (BrU II.5.19), etc.) In passages where *Brahman* is described positively, such as in "*Brahman* is truth, knowledge and infinite," (TU II.1.1) etc., we must understand that attributes do not qualify *Brahman* as such but express its intrinsic characteristics (*svarūpalakṣaṇa*). In short, *śruti* is not intended to define *Brahman*; it refers to its transcendental and indescribable reality by implication only. Murty explains:

> While no description is possible of *Brahman*, the task of the Vedānta is to teach about it, and so logically speaking it is an impropriety; but only in this way can the Vedānta emphasize the mystery of *Brahman*, which eludes all objective language; and yet it can be dealt with only in that way if *Brahman* has to be talked about intelligibly. While thus to talk of *Brahman* is a verbal impropriety, this impropriety is mitigated by means of qualifying epithets, which attempt to reduce or remove the spatio-temporal elements in experience, by either enlarging our conception or narrowing it down.[133]

The various Upaniṣadic statements stressing *Brahman*'s identity with the individual self are significant to the highest degree. The most famous passage in this regard is probably the instruction given by Uddālaka to his son Śvetaketu in the sixth chapter of the *Chāndogya Upaniṣad*. The passage starts with "In the beginning, son, this world was simply what is existent (*sat*) — one only, without a second," ending with this most important statement: "... that [i.e., the existent] constitutes the self of this whole world; that is the truth; that is the self (*ātman*). And that's how you are, Śvetaketu." Here, the identity between *Brahman*, the existent, and *ātman*, the self,

muktāvasthāyām).

[133] Murty, *Revelation and Reason in Advaita Vedānta*, 57.

is stated. According to Advaitins, there is no other direct nor better approach to *Brahman* than knowing Him as the very self of all. These statements are referred to as *mahāvākyas*, or "great sayings," in the later Advaita tradition.[134]

The path leading to knowledge of *Brahman* is not purely intellectual but requires that the aspirant has also certain mental and moral prerequisites for it.[135] After listening (*śravaṇa*) to the teachings, one is asked to reflect (*manana*) on their true meaning and to meditate (*nididhyāsana*) upon the truths accepted in the light of reflection. In this manner, one can gradually get rid of the delusion about one's own true nature and realize one's own self to be identical with the non-dual *Brahman*. In the process of interpreting *śruti*, the usage of reasoning is also most important, as explained by Satprakashananda:

> The truths declared by the *śruti* have to be known by reasoning on the texts and not by arguments independent of them. The function of reason is not to judge the truth of the Vedic statements, but to determine their true import, free from inconsistencies and in conformity with established facts. They are not to be accepted dogmatically, but through intelligent interpretation compatible with perceptual and inferential knowledge... Thus, the acceptance of scriptural authority in Advaita Vedānta is by no means denial of reason. Truth is not irrational. Reason is inherent in revelation... Reason is the key that unlocks the scriptural truths and paves the way to their intuitive perception.[136]

Thus, there is an intimate relationship between enquiry into sacred texts and reasoning in Advaita Vedānta. Provided both enterprises are given their right place, they are not mutually contradictory. On the one hand, reasoning is essential to understand

[134]The *mahāvākyas* are usually numbered four: 1. *Brahman* is consciousness (*prajñānam brahma*) (AU III.1.3); 2. I am *Brahman* (*aham brahmāsmi*) (BrU I.4.10); 3. Thou art That (*tat tvam asi*) (ChU VI.8.7); 4. This *ātman* is *Brahman* (*ayam ātmā brahma*) (BrU II.5.19).

[135]These four requisites (*sādhana-catuṣṭaya*) are: 1. discrimination between what is eternal and non-eternal; 2. giving up desires for enjoyment of fruits of actions both here on earth and post-mortem; 3. acquisition of self-control; 4. ardent desire for liberation. See: Datta, *The Six Ways of Knowing: A Critical Study of the Advaita Theory of Knowledge*, 295.

[136]Satprakashananda, *Methods of Knowledge According to Advaita Vedānta*, 215-16.

and assimilate the meaning of *śruti*, as well as to establish its validity. On the other hand, *śruti* has no authority in the empirical realm; here reasoning has a more important role.[137] But in no way can the transcendental truth of *Brahman* be equated with the phenomenal truth of the world.

4.3.2 Cosmological Insights into Advaita Vedānta

In Advaita Vedānta, *ākāśa* is, like in the other *darśanas*, one of the five elements constituting the physical world. We have seen how knowledge of *Brahman* (or self-knowledge) is approached by relying upon *śruti*. However, other lines of approach have been explored by Advaitins. One is the cosmological approach where there is an attempt to explain how the universe was created and how elements combined together to form the world.[138] In the Advaita perspective, cosmology deals with the creation and evolution of the world based on the acceptance that *Brahman* is the unique cause of the world, and with the provisional assumption that the world is an effect of *Brahman*. In line with the *Upaniṣads*, Advaitins look upon *ākāśa* as the first phenomenal existent to evolve from *Brahman*, the first effect in the chain of causation. It is thus important to examine the theory of causation accepted by Advaitins, as well as the formation of the different physical constituents in this philosophy.

[137] Commenting on BhG XVIII.66, Śaṅkara says: "Surely, even a hundred Vedic texts cannot become valid if they assert that fire is cold or non-luminous! Should a Vedic text say that fire is cold or non-luminous, even then one has to assume that the intended meaning of the text is different, for otherwise (its) validity cannot be maintained; but one should not assume its meaning in a way that might contradict some other valid means of knowledge or contradict its own statement." Translation taken from: Gambhīrānanda (trans.), *Bhagavadgīta*.

[138] Another approach, more psychological in nature, starts from an analysis of the different states of consciousness experienced by the individual to arrive at the knowledge that *ātman* is identical with *Brahman*.

Vivartavāda **and manifestation of the world**

From a cosmological standpoint, the question as to the relation between *Brahman* and the world is set forth in terms of two closely related theories of causation in Advaita: *satkāryavāda* (the theory of the pre-existent effect), and a specific application of it, called *vivartavāda* (the theory of apparent change). In line with Sāṃkhya philosophers, Śaṅkara contends that the effect must pre-exist in its material cause (*satkāryavāda*).[139] Otherwise, it is difficult to explain how a particular effect succeeds a unique and particular cause.[140] Still, there is a major difference in the way Advaita understands causation in comparison with Sāṃkhya. If the latter school assumes that the effect is a real transformation (*pariṇāmavāda*) of the cause, Advaita considers the effect as an *apparent* transformation (*vivartavāda*) of the cause. The one *Brahman* cannot *in reality* become many; it only *appears* to do so.[141] In BSB

[139] Sāṃkhya philosophers also believe in the "theory of the pre-existent effect" or *satkāryavāda*, which means that every effect (or product) exists in a latent state in the cause prior to its manifestation. When something is created, nothing new is produced. The process of causation only makes patent, through transformation and evolution, the effect that was latent in the cause. This theory of causation contrasts radically with that of Vaiśeṣikas (*asatkāryavāda*) who believe that the effect is something different and independent from the cause. For Śaṅkara, the *asatkāryavāda* faces an important problem: by positing that cause and effect are two distinct and independent realities, it is difficult to explain how they get linked to each other through inherence (*samavāya*). Assuming that such a third entity is needed to link them, we will need a fourth entity to relate this linking principle to the cause on the one hand and the effect on the other hand, and so forth. This is a clear case of infinite regress (*anavasthā*).

[140] "In the world it is seen that people wanting curds, pots, necklaces, etc., take up their well-established respective (material) causes - milk, clay, gold, etc. Not that a man wanting curds takes up earth, or a man wanting a pot takes up milk. This fact does not fit in with the theory of the non-existence of the effect before origination. If everything be equally non-existent everywhere before creation, why should curds be produced from milk alone and not from clay; and why should a pot come out of clay and not out of milk?" (BSB II.1.18) Unless otherwise indicated, translations from this text are taken from: Gambhīrānanda (trans.), *Brahma-sūtra-bhāṣya of Śrī Śaṅkarācārya*.

[141] It must be noted that though we find in Śaṅkara's literature a variety of analogies to illustrate the *vivarta* relationship between *Brahman* and the world, such as the rope and the snake, the crystal

II.3.1-7, for instance, *ākāśa* is mentioned as the first element to evolve from *Brahman*. If one accepts *pariṇāma* here, one faces the problem of how a material element like *ākāśa* can evolve from *Brahman*, which is pure consciousness. In order to solve this problem, Śaṅkara brings in an additional principle in his cosmological scheme, a principle called "unevolved name-and-form," (*avyākṛte nāmarūpe*) from which the material world emerges.[142] First evolving from *Brahman*, the "unevolved name-and-form" takes the name and form of *ākāśa*, air, etc. In other words, *ākāśa* and other elements — and by extension, the whole created world — are merely names and forms superimposed upon *Brahman*: they have no absolute reality by themselves for they are ultimately *Brahman* itself. By introducing this principle, Śaṅkara is able to explain how the manifold and material world emerges from the non-dual and spiritual *Brahman*: it is not directly from *Brahman* but from the material *avyākṛte nāmarūpe* that the transformations of the world proceed. Hence, this term embodies the idea found in *satkāryavāda* that everything already exists in a potential form prior to its manifestation.

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and the red object, the foam and the waves, etc., the word *vivarta* is not used in the "illusionistic" usage later given by Advaitins. For this reason, Hacker denotes Śaṅkara's cosmological view as a "kind of illusionistic *pariṇāmavāda*." Nonetheless, Śaṅkara is probably the first Advaitin who proposed a theory of causation in line with a *vivarta* theory. See: Hacker, *Vivarta*, 208-13.

[142]The term *nāmarūpa* can be traced back to two passages from the *Chāndogya Upaniṣad*: 1. ChU VI.3.2: *nāmarūpe vyākaravāṇi* (discussed in BSB II.4.20); 2. ChU VIII.14.1: *nāmarūpayor nirvahitā* (discussed in BSB I.3.41). *Nāma*, the name, can be taken as that which distinguishes a particular manifestation from another one in the linguistic usage. It denotes individuality in the human realm and individual things in the case of external entities. *Rūpa*, the form, may be understood as the shape or appearance associated with a particular manifestation that is known to senses and mind. The complex *nāma-rūpa*, by specifying the content of every individual manifestation, accounts for the variety and diversity found in the phenomenal world. See: Hacker, P., "Distinctive Features of the Doctrine and Terminology of Śaṅkara: *avidyā, nāmarūpa, māyā, Īśvara.* In: Halbfass (ed.), *Philology and Confrontation: Paul Hacker on Traditional and Modern Vedānta*; Wayman, A., "A Study of the Vedāntic and Buddhist Theory of Nāma-Rūpa." In: Hercus *et al.* (eds.), *Indological and Buddhist Studies.*

From an empirical standpoint, Śaṅkara conceives creation as a transition from *avyākṛte nāmarūpe* to *vyākṛte nāmarūpe*, from a state in which names and forms are not yet differentiated to a state in which they are fully manifest. This is clearly expressed in Śaṅkara's commentary on ChU VI.2.2, in which Uddālaka teaches his son Śvetaketu about creation: "In the beginning this world was simply what is existent (*sat*) — one only, without a second." Śaṅkara here interprets the expression "in the beginning" (*agre*) as a state where names and forms are not yet manifest.[143] In this primordial situation, there was only *sat* — which is another name for *Brahman* here — and nothing else. But *sat* is neither limited to this latent state, nor identical with it: if it underlies the emergence of names and forms, *sat* remains beyond the realm of names and forms. Essentially, then, there is no "real" creation for Śaṅkara: the whole world is nothing but the eternal and immutable *Brahman* itself. Names and forms are not absolutely real but appearances of *Brahman* that conceal its non-dual and eternal nature. Hence, the term *nāmarūpe* gets related to the concept of ignorance (*avidyā*) in many places in Śaṅkara's works. It is *avidyā* that is responsible for falsely taking names and forms to be real instead of *Brahman*.[144]

[143]In ChU III.19.1, a seemingly different cosmological account is given: "In the beginning this world was simply what is nonexisting (*asat*); and what is existing was that. It then developed. . . " We also find similar accounts in BrU I.2.1, TU II.7.1 and in earlier passages of the *Vedas* such as RV X.72, RV X.129.4, etc. While in ChU VI.2.2 the universe comes into being from the existent (*sat*), it is said to emerge from the non-existent (*asat*) in ChU III.19.1. This apparent contradiction is solved by Śaṅkara by taking the word *asat* not in the sense of pure non-existence, for the manifest universe cannot come out of nothing, but in the sense of something unevolved, undifferentiated or unmanifest. Thus, in both cosmological accounts, creation is not understood as a particular event in time, a *creatio ex nihilo*, but as the passage from an unmanifest to a manifest state of being.

[144]In BSB, for instance, Śaṅkara describes names and forms as "made of *avidyā*," "falsely imagined by *avidyā*," "superimposed through *avidyā*" and as "consisting of *avidyā*." But unlike his followers, Śaṅkara clearly distinguishes between *avyākṛte nāmarūpe* and *avidyā*. In his view, the primal state of the universe is not identical with *avidyā*, the latter's role being to act as a "kind of potency which. . . "posits" the illusion of the material seed of the cosmos that stands opposite the Creator." See: Mayeda, *A Thousand Teachings: The Upadeśasāhasrī of Śaṅkara*, 24-25.; Hacker, *op.cit.*, 75-76.

Nature and formation of elements

A second important feature of Advaita cosmology is its conception of elements (*bhūtas*). We have mentioned earlier that there are two different accounts for the creation of elements in the *Upaniṣads*. In ChU VI.2.3, *sat* is said to give rise to fire, water and earth, successively whereas in TU II.1.1, a fivefold conception is presented where *ākāśa*, air, fire, water and earth are said to successively originate from *ātman*. These two statements seemingly contradict each other with regard to the number of created elements as well as to their order of appearance in the process of creation. But for Śaṅkara there is no essential contradiction involved. In BSB II.3.1-7, he maintains that *ākāśa* and air are implicitly preceding fire in the account of creation given in ChU VI.2.3, so that ChU and TU both agree as to their conception of elements.[145] According to Śaṅkara and later Advaitins, the creation of the world begins with the formation of five elements (*ākāśa*, air, fire, water and earth, respectively) from which the whole material world is then produced. It is worth noting that Advaita and Sāṃkhya both adopt a fivefold classification of elements but only the former gives precedence to the five elements in the process of evolution whereas in Sāṃkhya, gross and subtle elements are preceded by *mahat*, *ahaṃkāra* and *manas*.

Śaṅkara introduced a new principle, called *avyākṛte nāmarūpe*, to protect *Brah-*

[145] The argumentation proceeds as follows. If TU II.1.1 is rejected on the basis that *ākāśa* and air are not mentioned in ChU VI.2.3, these two elements cannot be considered as elements at all, which goes against experience. On the other hand, if TU II.1.1 is accepted, the creation of fire is not affected because it is also mentioned there. The only difference consists in the attribution of the first place to *ākāśa* instead of fire. However, it is more important to include *ākāśa* and air and dismiss fire from its first place, than to reject the existence of these two elements while keeping fire in the first place. Moreover, if *ākāśa* and air are not accepted as created elements, two problems come up: 1. not being effects of *Brahman*, these elements cannot be known when *Brahman* is known, thus contradicting the *śruti* claiming that when *Brahman* is known *everything* else becomes known; 2. if not created, these elements could be considered as eternal, which is not acceptable as *Brahman* alone has an eternal nature in Advaita.

man from the changes occuring in the world. In later Advaita, this function is mainly assumed by *māyā*. It is the indescribable *māyā* that is responsible for the manifestation of the objective world, i.e., the elements and the different physical objects we perceive in the world. In his *Siddhāntabindhu* (SB 138), for instance, Madhusūdana Sarasvatī (16-17th century CE) says that nescience in the form of *māyā* first took the form of *ākāśa*, and *ākāśa* then took the form of air, etc., so that the five elements are the direct products of *māyā*. In *Pañcadaśī* (PD), a major Advaita treatise of the 14th century, a similar model is presented except that *māyā* here emerges from *prakṛti*, and not directly from *Brahman*.[146] We are told that *prakṛti* is endowed with three *guṇas* — *sattva*, *rajas* and *tamas* — and is called *māyā* when the *sattva* aspect predominates and *avidyā* when *rajas* and *tamas* predominate (PD I.16). The process of evolution unfolds according to these three tendencies. From this account, it is clear that the cosmological framework proposed in Advaita has affinities with that of Sāṃkhya as notions like *prakṛti* and *guṇas* primarily belong to the latter system. However, these notions are not found in early Śaṅkara's Advaita so that it can be assumed that if Sāṃkhya played a decisive role in the development of Advaita cosmology, it occured only later in the history of Advaita.

Another feature peculiar to later Advaita cosmology, probably also inherited from Sāṃkhya, is the notion of *tanmātra*. In *Pañcadaśī*, we are told that the *tamas* aspect of *prakṛti* first gives rise to the five *tanmātras*, out of which then emerge the five gross elements. Like other existents, *tanmātras* are endowed with three *guṇas*. From the *sattva* aspect of *tanmātras* taken separately arise the five organs of perception (*jñānendriyas*): ear from subtle *ākāśa*, skin from subtle air, eyes from subtle fire, tongue from subtle water and nose from subtle earth (PD I.19). Like in Sāṃkhya, each *tanmātra* is associated with a specific quality and qualities of preceding elements: subtle *ākāśa* is associated with sound only, subtle air with touch and sound, subtle fire

[146]It is to be noted that this *prakṛti* is dependent upon *Brahman* for its own existence whereas in Sāṃkhya *prakṛti* is an independent entity.

with form, sound and touch, etc.[147] The *sattva* aspect of *tanmātras*, taken collectively, gives rise to the organ of inner perception, called *antaḥkaraṇa*, which is constituted by intellect (*buddhi*) and mind (*manas*) (PD I.20).[148] From the *rajas* aspect of *tanmātras* are created the five organs of action (*karmendriyas*), i.e., speech, hands, legs, anus and organs of procreation, respectively, and also the five *prāṇas*, which supply energy to all functions of the body (PD I.21-22). From the *tamas* aspect of subtle elements, finally, the five gross elements are created. Through the latter process, referred to as *pañcīkaraṇa*, the unperceived *tanmātras* are brought to the cognition of the individual as objects of perceptual knowledge (PD I.18).

The oldest reference to the *pañcīkaraṇa* cosmological theory perhaps is in the *Mahābhārata*.[149] But among the orthodox *darśanas*, only Advaita takes recourse to this mechanism to explain the formation of gross elements. It is mentioned in several independent works (*prakaraṇa*), such as the *Pañcīkaraṇavārttika* (7-10), *Pañcadaśī* (I.27), *Vedāntaparibhāṣā* (VIII.30), *Vedāntasāra* (XV.123-128) and *Siddhāntabindhu* (144). The mechanism is simple and is described in Fig. 4.2. In the first stage (i),

[147] It must be noted that unlike Vaiśeṣika, which considers that sound inheres only in *ākāśa* because the latter does not mix with other elements, in Advaita sound is a quality of each and every element. One should also notice that the relation between substance and quality in Advaita is not one of inherence (*samavāya*) like in Vaiśeṣika but one of identity-in-difference (*tādātmya*), i.e., of a non-difference that "tolerates" difference (*bhedasahiṣṇuḥ abhedaḥ*). An example that may be given is that of a pot made of clay. The pot and the clay are essentially non-different because the pot is nothing but clay with a particular shape, but they are also different because they are denoted by different names and have different functions. The pot is thus in *tādātmya* relation with the clay. Similarly, qualities like sound, touch, etc., are in *tādātmya* relation with their related subtle elements: *ākāśa*, air, etc.

[148] It is the *antaḥkaraṇa* which coordinates the information coming from organs of perception, and commands the organs of perception to respond. The mind (*manas*) is defined to be of the nature of indecision (*manaḥ vimarśa rūpam syāt*), and the intellect (*buddhi*) to be of the nature of decision (*buddhiḥ syāt niścayātmikā*). The *Tattvabodha*, *Pañcīkaraṇam* and *Vedāntaparibhāṣā* all include ego (*ahaṃkāra*) and memory (*citta*) also in the *antaḥkaraṇa*.

[149] Mayeda, *op.cit.*, 60 (note 26).

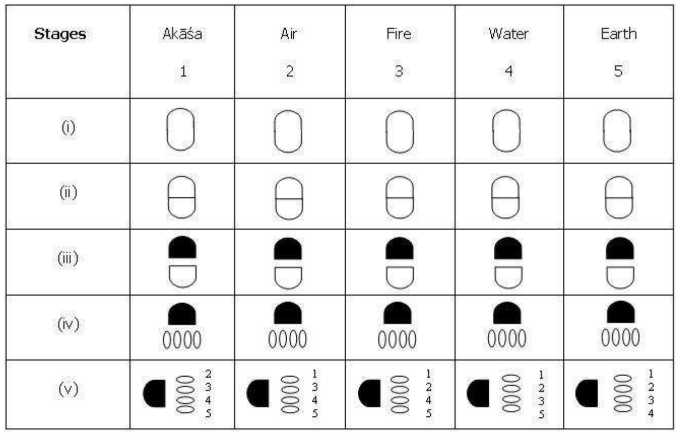

Figure 4.2: The *pañcīkaraṇa* model.

each subtle element stands alone. In the second stage (ii and iii), each is divided into two equal parts. In the next stage (iv), one half remains intact while the other half is divided into four equal parts (each of these parts is thus equal to one-eight of the initial element). The last stage (v) consists in the combination of the unchanged half with one-eight of each other element. Each resulting element, a "gross" element, consists in the admixture of the five subtle elements, and gets its name from the element that is predominant in it. This mechanism of quintuplication constitutes an extension of the *trivṛtkaraṇa* process described in ChU VI.2-4, in which fire, water and earth are first divided into three parts and reconstituted by a process of intermixing. But though a fivefold classification of elements is clearly recognized by later Advaitins, we find no mention of the *pañcīkaraṇa* model in the *Upaniṣads* or in other early Vedāntic texts. In *Brahmasūtras*, only the *trivṛtkaraṇa* mechanism is explicitly discussed (BS II.4.20).

A question that can be raised in this context is whether Śaṅkara held a theory of *trivṛtkaraṇa* or *pañcīkaraṇa* because in some works, such as *Pañcīkaraṇam* and *Tattvabodha* for instance, Śaṅkara maintains the *pañcīkaraṇa* model whereas he only comments upon *trivṛtkaraṇa* in his most important work, the *Brahmasūtrabhāṣya*

(BSB II.4.20).[150] Mayeda argues that Śaṅkara implicitly held a theory of *pañcīkaraṇa* and disregarded the *trivṛtkaraṇa* model. He bases his argumentation on the fact that *trivṛtkaraṇa* is mentioned in only two of Śaṅkara's works regarded as authentic (in his view), namely his commentaries on BS (BS II.4.20) and ChU (ChU VI.2-4). The *trivṛtkaraṇa* model was mentioned in these works only because the context demanded it according to Mayeda. The fact that Śaṅkara clearly recognizes the existence of five elements in BS II.3.1-7, and seems to hold a theory similar to *pañcīkaraṇa* in the *Upadeśasāhasrī*, another work considered to be authentic by Mayeda, make him conclude that Śaṅkara "paved the way for the later establishment of the theory of *pañcīkaraṇa*."[151] Unlike Mayeda, for whom the two theories of intermixing are in opposition to each other, Sundaresan does not see any contradiction in the fact that Śaṅkara commented upon *trivṛtkaraṇa* while accepting five elements. He points out that the absence of an explicit reference to *pañcīkaraṇa* in BSB should be read along with Śaṅkara's commentary on ChU VI.4.4, where he mentions *pañcīkaraṇa* besides *trivṛtkaraṇa*.[152] What is fundamental for Śaṅkara, Sundaresan argues, is not the

[150] One can question Śaṅkara's authorship of independent works such as *Pañcīkaraṇam* and *Tattvabodha* as some have done, but one can also assume these to be his works as well. For our purposes we can accept these as being the works of Śaṅkara until conclusive evidence becomes available to question that.

[151] Mayeda refers here to Upad II.1.19-20: "This name-and-form...[originally unevolved], took the name-and-form of "ether" [*ākāśa*] in the course of its evolution. Becoming grosser in the course of evolution, the name-and-form from ether becomes air; from air, fire; from fire, water; from water, earth. In this order each preceding [element] has entered each succeeding one and the five gross elements, [ether, air, fire, water, and earth], have come into existence. Consequently earth is characterized by the qualities of the five gross elements. . . " See: Mayeda, *op.cit.*, 26-27.

[152] In ChU VI.4.4, after commenting upon *trivṛtkaraṇa*, Śaṅkara says that a similar argument (*samāna nyāya*) applies to *pañcīkaraṇa* as well: "But as in the process of making three-fold, what are real are the three colours alone, the same logic (*samāna nyāya*) applies in the case of becoming five-fold also. Therefore, all things being modifications of Existence, when Existence becomes known all this becomes known. Hence it becomes surely established that Existence alone, which is one without a second, is Real." Here the translation is taken from: Gambhīrānanda (trans.), *Chāndogya Upaniṣad.*

difference between both models of intermixing but their essential equivalence as far as their purpose is concerned:

> This equivalence lies not in the details of the two accounts of intermixing, but in what both theories imply, in an Advaita Vedāntic sense. Śaṅkara holds that in either case, one knows everything there is to be known, simply by knowing Being (*sat*), which is One without a second. Thus, Śaṅkara's purpose in mentioning *pañcīkaraṇa* along with *trivṛtkaraṇa* is not to uphold one or the other theory as the only process by means of which the universe of duality comes into existence. Rather, both accounts are treated equally, and the emphasis is shifted back to non-dual Being.[153]

One can agree with Sundaresan's position for different reasons. First, it takes into account the general purpose of Advaita cosmology, which is to help obtain knowledge of *Brahman*. According to *Vedāntaparibhāṣā*, the purport of creational texts is not to provide details on creation *per se* but to point towards the non-dual *Brahman* (VP VIII.53). Certainly, Śaṅkara was much more concerned with the teaching of non-duality than with the establishment of a particular creation theory. Hacker is also clear on this point:

> We know further that for Śaṅkara cosmogony was only of very minor importance. For him it was not much a matter of concern exactly how the events of creation are presented or conceived nor, certainly, which terms are used. The account of creation in his system has only the propaedeutic function of drawing attention to the unity of being.[154]

Since the world and its creation have no absolute reality, there is no harm in accepting different accounts of creation as far as they help attain knowledge of *Brahman*. The *pañcīkaraṇa* mechanism must then be understood as a model, a theoretical tool and not a final explanation, since the purpose of the cosmological model in Advaita is

[153]Sundaresan, "What Determines Śaṅkara's Authorship: The Case of the Pañcīkaraṇa," 4.

[154]Hacker, "Distinctive Features of the Doctrine and Terminology of Śaṅkara: *avidyā, nāmarūpa, māyā, Īśvara*," 84-85.

simply to further and deepen the understanding of *Brahman*.[155] Another argument in favour of Sundaresan's interpretation is that Śaṅkara never refutes a creation theory in preference to another. In fact, unlike some of his followers, Śaṅkara remains quite neutral on the issue. As to the "conflicting" BS statements about the creation of the universe, the main purpose of the *sūtras* is to pinpoint and resolve some unclear issues in the *Upaniṣads*. Thus, each section (*adhikaraṇa*) has a different subject matter (*viṣaya*) and serves a particular purpose (*prayojanam*) of its own. That a particular section discusses *trivṛtkaraṇa* without the mention of *pañcīkaraṇa* does not necessarily entail contradiction, as long as the purpose of this section may be to establish non-duality and not a particular creation theory.

The theory of *pañcīkaraṇa* is not accepted by all followers of Śaṅkara. In fact, the two main sub-schools of Advaita, *Bhāmatī* and *Vivaraṇa*, diverge in this regard. Followers of *Vivaraṇa* accept *pañcīkaraṇa*, but Vācaspati Miśra, the author of *Bhāmatī*, a commentary on Śaṅkara's *Brahmasūtrabhāṣya*, does not. Vācaspati refutes this model on the basis that only *trivṛtkaraṇa* is mentioned in *śruti*.[156] The same position is held by Amalānanda, the author of *Kalpataru*, a commentary on *Bhāmatī*. The fact that Vācaspati says that *śruti* does not mention *pañcīkaraṇa* despite Śaṅkara's commentary on ChU VI.4.4, perhaps implies that he was not aware of this commentary or that he differed from Śaṅkara on this issue. Sundaresan tends to believe that Śaṅkara's commentary should have been known to Vācaspati Miśra, if not at least to

[155]For instance, an analysis of the five elements as a means to better understand *Brahman* is done in the second chapter of the *Pañcadaśī*, called *pañcabhūta viveka prakaraṇa*. The purpose of this chapter is precisely to discriminate (*viveka*) between the external universe composed of the five elements and pure Existence (*sat*), as stated in PD II.1: "That existent secondless entity which is heard (from the *Veda*) is possible of being known by separation of the five elements. The five elements are therefore clearly separated (here)." Translation taken from: Svaminah (trans.), *Pañcadaśī*.

[156]Another argument advanced by Vācaspati is that only fire, water and earth are actually perceived combined together in nature. *Ākāśa* and air have no form and cannot be perceived at all. See: Sastri (trans.), *Siddhāntabindu of Madhusūdana Sarasvatī*, 120-21.

Amalānanda.[157] In his opinion, it is more reasonable to assume that Vācaspati simply disagreed with the *pañcīkaraṇa* model, even though he was in agreement with the existence of five elements. In all cases, Vācaspati's viewpoint did not receive much support within the Advaita tradition, since the *pañcīkaraṇa* is recognized in most major works of Advaita such as *Vedāntaparibhāṣā*, *Pañcīkaraṇam*, *Vedāntasāra* and *Pañcadaśī*. Madhusūdana Sarasvatī himself raises the issue in the *Siddhāntabindu* and argues in favour of the *pañcīkaraṇa* model.

4.3.3 *Ākāśa* in Advaita Vedānta

The previous discussion has provided us with some insights into the concept of *ākāśa*. Like Sāṃkhya, with which it shares many cosmological features, the school of Advaita Vedānta accepts five elements, five *tanmātras* as well as their respective qualities (sound, touch, etc.). Here also, *ākāśa* is connected to the quality of sound and is the first among the elements to emerge in the evolution process. An important difference, however, is that while elements evolve directly from the originating principle (*Brahman*) in Advaita, so that *ākāśa* becomes the first phenomenal existent to be created, they follow *mahat* and *ahaṃkāra* in Sāṃkhya. In addition to its *pañcīkaraṇa* model, the *vivarta* theory of causation is another contribution of Advaita. According to this theory, the various worldly objects and phenomena are only names (*nāma*) and forms (*rūpa*) superimposed upon *Brahman*. Therefore, *ākāśa* and other elements have a finite (i.e., non-eternal) existence as well as a relative (i.e., not absolutely real) ontological status in Advaita. Furthermore, given its close relationship with the "unevolved name-and-form," the indescribable and potential state preceding physical manifestation, *ākāśa* is surrounded by a certain ontological ambiguity in this school. As we shall see, in certain instances it simply denotes a kind of physical space associated with the quality of sound while in others it seems to play the same role as the

[157] Sundaresan, *op.cit.*, 4-5.

the non-dual and transcendental *Brahman*.

In its effort to reconcile the seemingly incompatible statements made in the *Upaniṣads*, the school of Advaita also engages with the various meanings these texts attach to the word *ākāśa*. Detailed discussions on this element are found in Śaṅkara's commentary on the *Brahmasūtras*, the *Brahmasūtrabhāṣya* (BSB), and his commentaries on the *Upaniṣads*, namely the *Chāndogya*, *Taittirīya* and *Bṛhadāraṇyaka*, and his commentary on Gauḍapāda's *Māṇḍūkyakārikā*. The first topic under discussion in this section is that of the origin of *ākāśa*: is *ākāśa* an eternal entity on par with *Brahman* or one of the created elements? The Advaitins have their own reasons to consider *ākāśa* as a created element. A detailed analysis of these reasons based on Śaṅkara's BSB and his other important commentaries will provide us with an understanding of the position of *ākāśa* in the metaphysics of Advaita Vedānta. In the following part, we will investigate the relationship between this element and *Brahman* and shortly address its epistemological status. Then, we will analyse different passages where *ākāśa* appears in relation with the self (*ātman*).

***Ākāśa*: a created element (BSB II.3.1-7)**

The *Brahmasūtra adhikaraṇa* discussed here, called *viyadadhikaraṇa*, is the one where *ākāśa* is discussed extensively by Śaṅkara in his *Brahmasūtrabhāṣya* (BSB).[158] Its main purport is to clarify and resolve the issue of the origin of *ākāśa* in the *Upaniṣads*. Indeed, as noted earlier, we find different accounts of creation in these texts. In the *Taittirīya* (TU), *ākāśa* is considered to be the first created element and fire the third, while in the *Chāndogya* (ChU) fire is envisaged as the first created element. ChU

[158]The *Brahmasūtra* is divided into four main chapters (*adhyāyas*): 1. *samanvaya* ("Reconciliation through proper interpretation"); 2. *avirodha* ("Non-contradiction"); 3. *sādhana* ("Spiritual practice"); 4. *phala* ("Result"). Each chapter consists of four parts (*pādas*); each part has a certain number of sections (*adhikaraṇas*) and each section has many aphorisms (*sūtras*).

makes no mention of *ākāśa* so that we may conclude that *ākāśa* does not originate and is therefore eternal. But if we follow TU, *ākāśa* must be considered a created element. Thus, the *śruti* itself seems to differ as to the origin of *ākāśa*. Śaṅkara analyses this question in the *adhikaraṇa* BSB II.3.1-7 and tries to provide a solution that is both in agreement with logical reasoning and *śruti*.

To start with, in BSB II.3.1-2, these two different accounts of creation and their implication as to the origin of *ākāśa* are stated. The position taken by the *pūrvapakṣin* (opponent)[159] is that it is impossible to arrive at a definite conclusion regarding the creation of elements because the two theories of creation in the two *Upaniṣads*s are fundamentally irreconcilable with each other. We therefore cannot reasonably claim that both fire and *ākāśa* have the primary position in the scheme of creation. Neither can we conceive that they are created simultaneously, since in TU fire is said to be created only *after* *ākāśa* and air are created. Moreover, in ChU, fire is said to be created from *sat* while it is created from air in TU. For all these reasons, both *śrutis* must be considered as invalid (*apramāṇam*) as regards the creation of elements.

In BSB II.3.3-5, a different stand is taken. The validity of both *śrutis* is maintained by giving a figurative meaning (*gauṇārtha*) to TU and a primary meaning (*mukhyārtha*) to ChU, thereby taking that *ākāśa* has no origin (i.e., eternal). The proponent here — the opponent of the *siddhāntin*, referred to as *siddhāntaikadeśin* — mainly resorts to the Vaiśeṣika theory of causation to defend his point, and also mentions some Upaniṣadic statements and other sacred texts. The arguments are as follows:

1. According to Vaiśeṣika, the cause of an effect is of three types: inherent (*samavāyi*), non-inherent (*asamavāyi*) and efficient (*nimitta*).[160] In no case can such causes account for the creation of *ākāśa* since, as Śaṅkara says, "an inherent

[159]Each section (*adhikaraṇa*) contains five main elements: a subject-matter (*viṣaya*), a doubt (*saṃśaya*), the initial thesis (*pūrvapakṣa*) raised by the opponent, the conclusion (*siddhānta*) established by the Advaitin, and the transition (*saṃgatiḥ*) to the following section.

[160]In the example of the production of a cloth, the inherent cause (*samavāyi*) consists in the

cause of an object is constituted by an abundance of substance of the same class. But for space [*ākāśa*] there can be no such abundance of any substance of the same class, which can constitute its inherent cause; nor is there any conjunction of such substances which can be accepted as the non-inherent causes from which space can emerge. And since these two causes are absent, any efficient cause for space, which functions when these are favourable, becomes a far cry."[161]

2. Normally, there is a clear distinction between the state preceding creation of an entity, and the state following. But there is no such distinction in the case of *ākāśa*, which cannot be conceived "as existing without space, interstices, or cavities."

3. Since created elements are not all-pervasive, and *ākāśa* is all-pervasive (*vibhu*), the latter cannot be created.

4. The *śruti* itself declares the eternal nature of *ākāśa* in passages such as "Now the subtle - it is air and space. It is immortal," (BrU II.3.3) "It is all-pervasive and eternal like space," (no reference available) "Brahman has space as Its body," (TU I.6.2) "Space is the self," (TU I.7.1) etc.

In the commentary on the fifth *sūtra* (BSB II.3.5), an objection is advanced against the eternal nature of *ākāśa*: if *ākāśa* is on par with the eternal *Brahman* (or *ātman*) before creation, how do we account for the *śruti*: "In the beginning. . . this world was simply what is existent — one only, without a second." (ChU VI.2.1) Responding to this objection, the *siddhāntaikadeśin* tries to show how this *śruti* remains meaningful even if *ākāśa* is accepted to exist with *Brahman* before creation. He remarks that "one only" should be understood as the absence of *effects* of *Brahman*, and not with reference to *ākāśa*, which is eternal and not an effect.[162] As for the phrase "without a second," it means that there is no other efficient cause than *Brahman* for creation. He goes on to explain that this is not a problem since there is no essential difference

threads, the non-inherent cause (*asamavāyi*) is the union (*saṃyoga*) of the threads, and the efficient cause (*nimitta*) is the weaver, etc.

[161]This quotation and the following are taken from: Gambhīrānanda (trans.), *Brahma-sūtra-bhāṣya of Śrī Śaṅkarācārya.*

[162]The example cited in this context is that of someone going to a potter's house on a specific day, and sees that there is clay, potter's wheel, etc. The next day, he notices many vessels made of clay and says: "There was clay only the other day." By saying that, he means that the products of clay alone were not present the previous day, and not the potter's wheel, etc. Similarly, the expression "one only" refers only to the products or effects of *Brahman*, and not to the uncreated *ākāśa*.

between *ākāśa* and *Brahman*: both possess the same characteristics, such as all-pervasiveness, partlessness, formlessness, etc., so that it is impossible to perceive them separately. Like milk and water in a mixture, there is no way to distinguish them as two different entities: just as milk alone is perceived to exist in this mixture, though water is also present, only *Brahman* is perceived to exist though *ākāśa* is also present.

Another question that comes up is: if *ākāśa* is not created, how can we justify the statement in the *śruti* that describes *Brahman* as "[That] through which the unknown becomes known." (ChU VI.1.3) In this statement, "the unknown" denotes the various things belonging to the phenomenal world. If *Brahman* is known, how can we know the eternal *ākāśa*, which does not belong to the phenomenal world? The *siddhāntaikadeśin* again uses the milk-water analogy to prove his point. He argues that by knowing *Brahman*, which is non-separate from *ākāśa* as water in milk, one knows everything including *ākāśa* itself. Just as a few drops of water in milk are taken up when the milk is taken up, so also when *Brahman* is known, *ākāśa* is known. These are the broad arguments advanced by the *siddhāntaikadeśin*.

In the commentaries on the last two *sūtras* of the *adhikaraṇa* (BSB II.3.6-7), these arguments are successively refuted by the *siddhāntin*, Śaṅkara, who concludes that *ākāśa* must be considered a created element. In BSB II.3.6, Śaṅkara defends his position with *śruti* and maintains that the real import of: "[That] through which the unknown becomes known," is that all things to be known must originate from *Brahman*. For example, only those things made of clay become known when clay is known and not the potter, neither the different tools in the production of vessels, etc. The "all-knowingness" resulting from the knowledge of *Brahman* must be understood in conformity with the import of the *śruti*, which speaks of the non-difference between *Brahman* and the entities originating from *Brahman*. Thus, if *ākāśa* is not considered a product of *Brahman*, it will remain unknown even when *Brahman* is known. The metaphor of the milk and water is also not tenable. The knowledge of water acquired through the knowledge of milk is not complete knowledge, for water is known only indirectly. The water may be there, but there is no way to be sure. The all-knowingness referred to in *śruti* entails that *all* existents are creations of *Brahman*, and so *ākāśa* must be taken to be created.

In BSB II.3.7, Śaṅkara takes recourse to logical arguments to show that *ākāśa* is a creation of *Brahman*. The *sūtra* — *yāvadvikāraṃ tu vibhāgo lokavat* — states that wherever there is distinction there is modification, implying that since all products in this world (pot, pitcher, jar, etc.) are seen distinct from each other, they must be created. Śaṅkara simply extends this statement to *ākāśa*. Since *ākāśa* can be separate (at least conceptually) from earth and other elements, it must be taken as a modification (*vikāra*) of *Brahman*. This argument brings much clarity about the way *ākāśa*, as a physical element, is understood by Śaṅkara. Since it is contrasted with other elements (being separate from them), *ākāśa* is somehow considered on a par with other physical entities. Hence, like in Vaiśeṣika and Sāṃkhya, *ākāśa* has a tangible and physical reality in Advaita Vedānta.

In the last part of the *sūtra*, Śaṅkara refutes the arguments raised earlier by the *siddhāntaikadeśin*. He first disputes the Vaiśeṣika claim that the nature of *ākāśa* is by definition incompatible with any causal dependence. According to Vaiśeṣikas, any inherent cause (*samavāyi*) leading to the production of an effect consists in a variety of materials of the same class (ex: many cotton threads produce a cotton fabric). Such an inherent cause does not exist for *ākāśa*. Again the rule is not universally true since, in certain instances, an effect can be produced from materials belonging to *different* classes (ex: a rope made of cotton yarn and cow's hair). Moreover, it is possible that an effect can be produced from a cause consisting of a *single* material, such as curd produced from milk alone. Hence, there is nothing which prevents the emergence of *ākāśa* from *Brahman* alone, which is at once the efficient and material cause of the world.

Śaṅkara also refutes the claim that since there can be no distinction between the nature of *ākāśa* before and after its creation, *ākāśa* cannot be created. He points out that in the Vaiśeṣika philosophy itself, sound is considered to be the specific quality (*viśeṣaguṇa*) of *ākāśa*. Since sound did not exist before creation, the nature of *ākāśa* after its creation necessarily differs from its previous nature. This is also reinforced by the *śruti* which declares *Brahman* to be *anākāśam* (BrU III.8.8), i.e., free from the characteristic of space. Śaṅkara then dismisses the view that *ākāśa* has no origin because it is all-pervasive while other created elements are not. For Advaitins, *Brahman* is the only all-pervasive entity, not because it is in physical contact with all entities — which is impossible for it is relationless — but because it is the cause and essential nature of every existent entity. In this specific sense, *ākāśa* cannot be all-pervasive although it is so in a purely spatial sense.[163] Finally, *ākāśa* is impermanent because it possesses impermanent qualities, such as sound. Let's recall that for Advaitins the relation between substance and quality is that of "identity-in-difference." (*tādātmya*) Sound is essentially non-different from its substratum, *ākāśa*, and therefore one must accept that *ākāśa* is impermanent as sound is.

Relationship between *ākāśa*, *Brahman* and the world

In the last *sūtra* of the *viyadadhikaraṇa* II.3, *ākāśa* is treated as an entity separate from other physical entities, which implies that in some sense *ākāśa* is ontologically akin to other physical entities. In addition, *ākāśa* may be interpreted in this *sūtra* as the spatial locus of material objects. But to speak of *ākāśa* as pure "empty space" has no real meaning here. In fact, the idea of empty space does not appeal to Advaitins for they take pure existence (*sat*) as the ultimate substratum of the world. In the *Pañcadaśī* (PD II.28-29), Vidyāraṇya explicitly rejects the notion of void (*śūnya*)

[163] In his commentary on TU II.1.1, Śaṅkara explains that *ākāśa* is infinite in space but not with reference to time and things for, being an effect (*kārya*), it has a finite existence and is separate from other things. Unlike *ākāśa*, *Brahman* is unlimited with respect to space, time and things.

advanced by Mādhyamika Buddhists. The existence of the void presupposes the existent, *sat*, a positive entity. *Sat* pervades the whole world and cannot be denied because its very denial would imply the *existence* of some ground for negation. In BSB II.2.24, Advaitins refute the Sautrāntika Buddhist theory that *ākāśa* consists only in the "absence of resistant matter [or obstruction]," (*sapratighadravyābhāvamātra*) thus without objective reality. For Advaitins, *ākāśa* is a positive entity, cognizable through proper *pramāṇas* like other elements, and not a mere mental construction. Thus, *ākāśa* has no similarity at all with empty space in Advaita. Rather, it is a substance pervading all bodies, subtle in nature, and in some sense dependent upon the objects it "contains."

BSB II.3.1-7 also gives us another understanding of *ākāśa*. We are told that *ākāśa* is one of the five great elements (*mahābhūtas*), together with earth, water, fire and air. Like them, it possesses a specific quality (sound) and is correlated to a particular sense-organ (organ of hearing), and as such definitely acquires a special place among the various physical entities of the world. It is no more regarded as some portion of space associated with bodies but as an extended and subtle form of materiality, on a par with other great elements. Moreover, TU II.1.1 gives prominence to *ākāśa* by ranking it first in the scheme of creation as mentioned earlier. As such, it plays an active role in the world by giving rise to elements and the rest of creation. Here, *ākāśa* seems to present itself as a reality ontologically superior to the material world, closer to the Absolute, sometimes identified with it.[164]

[164] Unlike other elements, *ākāśa* cannot be touched, tasted, etc. It is considered to be the finest among all elements, subtler than air, fire, water and earth. Since, in the development of things, the gross (*sthūla*) always proceeds from the subtle (*sūkṣma*), Advaitins take *ākāśa* to be the first created element in their cosmological model. Such an idea seems logically tenable given that our perception of air, fire, etc., always presupposes the existence of a space in which they are located. Also, nothing material can be conceived to precede *ākāśa*, for a peculiar feature of space is that it exceeds what it contains without itself being exceeded. In this sense, *ākāśa*'s reality is ontologically superior to that of the material world. Among all *darśanas*, Advaita is the only one that gives such a prominent place to *ākāśa* in its cosmology.

The purport of BSB II.3.1-7 was to demonstrate that *ākāśa* is a created element, and not an eternal entity as it is in Vaiśeṣika. For this reason, the intimate relation between this element and *Brahman*, in terms of their common characteristics, is not thoroughly discussed. We must look at other commentaries and *adhikaraṇas* to better understand this aspect of *ākāśa*. Gauḍapāda's *kārikā* on *Māṇḍūkya Upaniṣad* (III.3-12) uses the analogy of space located in a jar (*ghatākāśa*) and the space outside it (*mahākāśa*) to illustrate the non-dual nature of *ātman* in relation with individual selves (*jīvas*). It is explained that both spaces are essentially the same but appear to be distinct due to the limitations (*upādhis*) imposed by the body of the jar on *mahākāśa*. When the jar is broken, the primary unity of *ākāśa* is restored. Hence, the multiplicity of names, forms, functions, etc., given to *ākāśa* are not real for it is essentially non-dual and undifferentiated. Likewise, *jīvas* are essentially non-different from *ātman*; they appear to be different on account of the apparent limitations imposed by the body-mind complex.[165] *Ākāśa* is described here as a space perfectly homogeneous, non-dual, free from inner differences and thus independent of the things it contains. Rather than being defined in *relation* to other bodies, it appears here as a *condition* for the manifestation of these bodies. Though the common container of all things, *ākāśa* remains free from them and unaffected by the various changes occuring in the physical world. Clearly, such a conception is analogous to that of *Brahman*, which is also defined as non-dual and unaffected by what takes place in the world.

In several places, *ākāśa* is brought closer to *Brahman* because of its capacity for creating or manifesting the various existents of the world. In TU II.1.1, for instance,

[165] "Though forms, actions, and names differ in respect of the difference (in the spaces created by jars, etc.), yet there is no multiplicity in space. So also is the definite conclusion with regard to the individual beings." (MaU III.6) Śaṅkara comments: "... but all these differences are not surely real that are implied in conventional dealings involving dimensions, etc., created in space; in reality, space has no difference (*ākāśasya na bhedaḥ asti*), nor can there be any empirical dealing based on the multiplicity of space unless there be the instrumentality of the limiting adjuncts." Translation taken from: Gambhīrānanda (trans.), *Eight Upaniṣads*.

we are told that "from space, air [came into being]; from air, fire; from fire, the waters; etc.," indicating that *ākāśa* has the potential to give rise to other elements. The creative character of *ākāśa* also appears clearly from its natural capacity to "give room" for objects to exist. In his commentary on TU II.1.1, Śaṅkara defines *ākāśa* as "that which is possessed of the attribute of sound and provides space for all things that have forms." (*ākāśo nāma śabdaguṇaḥ avakāśakaraḥ mūrtadravyāṇām*)[166] Affording space for things to exist, *ākāśa* contributes positively to their creation and manifestation. Sureśvara, a disciple of Śaṅkara, describes *ākāśa* as "the *prakṛti* or material cause of all that exists in space."[167] We also find several passages in Vedānta literature where *ākāśa* is used as a synonym for *avyakta*, *avyākṛta*, *māyā*, *prakṛti*, etc., all words suggesting the idea of potentiality for creation and manifestation. For instance, in BrU III.8.11, the "unmanifest" (*avyakta*) is referred to by the word *ākāśa*. According to Hacker, *ākāśa* is one of the preferred expressions used by Śaṅkara to denote the primal state of creation itself, *avyākṛte nāmarūpe*.[168] Given that *ākāśa* is the first evolute arising from this state, such an equation is not surprising.

In the *Chāndogya Upaniṣad*, two statements also bring to light the potential nature of this element. In ChU VIII.14.1, we are told "Now, what is called space is that which brings forth name and visible appearance." (*ākāśo vai nāma nāmarūpayornirvahitā*). In ChU I.9.1, in answer to the question — "Where does this world lead to?" — it is replied: "Clearly, it is from space that all these beings arise, and into space that they are finally absorbed; for space indeed existed before them and in space they ultimately end." In the opinion of some scholars, these statements bring to the fore the potential nature of *ākāśa*. Referring to ChU VIII.14.1, Kramrisch describes *ākāśa* as "the name of the possibility of coming into existence of the perceptible world."[169] According to

[166]Translation taken from: Gambhīrānanda (trans.), *Taittirīya Upaniṣad*.

[167]Translation taken from: Sastry (trans.), *Taittirīya Upaniṣad with the commentaries of Śri Śaṅkarācārya, Śri Sureśvarācārya and Śri Vidyāraṇya*, 294.

[168]Hacker, "Distinctive Features of the Doctrine and Terminology of Śaṅkara: *avidyā, nāmarūpa, māyā, Īśvara*," 84. For more details, refer to section 5.1.2 of this dissertation.

[169]Kramrisch, "Space in Indian Cosmogony and in Architecture." In: Vatsyayan (ed.), *Concepts*

Coomaraswamy, a passage such as ChU I.9.1 seems to indicate that *ākāśa* "represents primarily a concept not of physical space, but of a purely principial space without dimension, though the matrix of dimension."[170] The passage "...and into space that they are finally absorbed" indicates that *ākāśa* is also the locus towards which all elements return at the end of their existence. In all of these passages, *ākāśa* appears almost identical with *Brahman*, the principle at the origin of the world and to which the world ultimately returns.

Yet, it is not clear whether the potentiality for creation must be ascribed to *ākāśa* only or to *Brahman*, which is ontologically prior to *ākāśa*. When we say that *ākāśa* creates, do we mean that it creates from its own inner power or due to some other cause or influence? Does *ākāśa* have the capacity to create at all or is it only a passive intermediary in the process of creation by *Brahman*? In BSB I.3.41, the doubt is raised as to whether the word *ākāśa*, denoting that "which brings forth name and visible appearance" in ChU VIII.14.1, corresponds to the material space with which we are familiar or to *Brahman*. Śaṅkara argues that since *Brahman* is by definition the only entity that has no name and form (*neti neti*), only *Brahman* can manifest *every* name and form. *Ākāśa* being created from *Brahman*, it has name and form, and it would be illogical to believe that it manifests its own name and form. It is only on account of its similarities with *Brahman*, such as its great extension, formlessness, subtle nature, etc., that the word *ākāśa* is used in this context.[171] Similarly, in BSB I.1.22, Śaṅkara contends that since there is a mark (*liṅga*) pointing to *Brahman* in ChU I.9.1, the word *ākāśa* must be understood in that context as a synonym of *Brahman*. The mark is that *ākāśa* is said to be the cause of *all* things, which can be true of *Brahman* only.

of Space: Ancient and Modern, 103.

[170] Coomaraswamy, "*Kha* and Other Words Denoting "Zero" in Connection with the Metaphysics of Space," 493.

[171] In his commentary on ChU VIII.14.1, Śaṅkara says that this *śruti* is "meant to set forth the characteristics of *Brahman* for the sake of meditation...That which is indeed called space, is the self [i.e., *Brahman*] well-known in the *Upaniṣads*. [It is called space] because It is bodiless and subtle like space." Translation taken from: Gambhīrānanda (trans.), *Chāndogya Upaniṣad*.

Śaṅkara corroborates this statement with passages from *śruti* that describe *Brahman* (or *ātman*) as the primordial cause.[172] Such a symbolic usage of *ākāśa* is noticed by Deussen also, who considers this concept to be, besides *prāṇa*, *manas* and *āditya*, a "most important symbol under which the worship of *Brahman* is enjoined."[173]

However, if *ākāśa* is sometimes used as an appropriate symbol for *Brahman*, under no circumstances can it be identified with it. In fact, despite their similarities, *ākāśa* and *Brahman* differ considerably as to their essential nature. Unlike *Brahman*, whose nature is *saccidānanda* — pure existence, consciousness and bliss — *ākāśa* has only a relative existence, is insentient and devoid of bliss. Like every other existent, *ākāśa* is *mithyā*, or *sadasadvilakṣaṇa*: it is neither *sat* because it is ultimately sublated by the knowledge of *Brahman*, neither *asat* because it is actually perceived to be real. It depends upon *Brahman* for its own existence. From an Advaita perspective, in those instances where *ākāśa* is identified with the prime matter of the universe (*avyakta*, *māyā*, etc.), it is verily *Brahman* which is referred to, but *Brahman* envisaged as the unevolved potential of the world.[174] *Brahman* is the only creator of the universe. In any case, we must recall that creation for Advaitins — whether mediated through *māyā*, *ākāśa* or any other primary principle — stands as a valid explanation of the universe from a transactional or conventional standpoint only. From a non-dual standpoint, neither the universe nor the elements do really exist: *Brahman* alone exists.

[172]For instance, we are told in TU III.1.1: "That from which these beings are born; on which, once born, they live; and into which they pass upon death — seek to perceive that! That is *Brahman*!" Similarly, in ChU III.14.1: "All this is *Brahman*. (This) is born from, dissolves in, and exists in That."

[173]Deussen, *The Philosophy of the Upanishads*, 115. According to Divanji, the etymology of the word *ākāśa* justifies that it has often been equated with *Brahman* in Vedic literature. He derives the word as *āsamantāt kāśata iti*, which denotes an "entity shining all-round by its own effulgence." Such an entity can be "none other than *Brahman* which is self-resplendent and the source of light of the celestial luminaries. . . " See: Divanji, "Brahman-Ākāśa Equation: Its Origin and Development," 158-59.

[174]Though *māyā* is invoked in Advaita to explain the creation of the manifold world, yet *Brahman* alone is the creator because *māyā*, being a power (*śakti*) of *Brahman*, is non-different from *Brahman*.

But if *ākāśa* cannot be looked upon as the creator of the universe, is it the creator of other elements such as air, fire, etc.? At first sight, this is what TU II.1.1 seems to convey. But in his commentary, Vidyāraṇya clearly states that *ākāśa* is not itself the creator of elements but only an agent in the process: "From *Brahman* associated with *māyā* and having put on the form (*upādhi*) of *ākāśa* which was first evolved, the air was born…and therefore it is on account of the special relation of the air to *Brahman*'s *upādhi* of *ākāśa* as its proximate invariable antecedent, that the air is declared to be born of *ākāśa*."[175] In the process of creation, *ākāśa* is only an *upādhi* to *Brahman*, which alone has the potential to create. In BSB II.3.10, in order to reconcile the creation of fire from air (TU) with its creation from *sat* (ChU), it is said that *Brahman* assumed the form of air in order to produce fire. Thus, not air but *Brahman* is the creator of fire. In BSB II.3.13, Śaṅkara says that it is *Īśvara* himself, abiding in the elements as their self, that creates every element in succession.[176] Strictly speaking, then, *ākāśa* is neither the creator of the universe — this role being attributed to *Brahman* as *Īśvara* only — nor the real creator of air, fire, etc — for it is only an *upādhi* to *Brahman*. We can only talk of a creation "as if it were" by *ākāśa*. The same is true with respect to the dissolution of the universe, which ends into *Brahman* and not into *ākāśa*.

Nevertheless, it is significant that the word *ākāśa*, and not any other word, is used to denote *Brahman* in many instances. Notwithstanding its different ontological status, *ākāśa* possesses enough similarities with *Brahman* to be equated with it. Like *Brahman*, it is of great extension, omnipresent, formless, changeless, etc. As the first created element, space or *ākāśa* enables every physical thing to be and to become. Without space, it is hardly possible to imagine that physical bodies could exist, evolve

[175]Sastry (trans.), *op.cit.*, 308.

[176]The concept of *Īśvara*, the Lord and Creator of the world, is identified with *saguṇa Brahman* in Advaita, that is, *Brahman* with qualities. Such *Brahman* "is interpreted and affirmed by the mind from its necessarily limited standpoint; it is that about which something can be said." See: Deutsch, *Advaita Vedānta: A Philosophical Reconstruction*, 12.

and interact with other things. Already in the *Upaniṣads*, space appears as a bridge between the unmanifest *Brahman* and the manifest world. In the *Bṛhadāraṇyaka Upaniṣad* (III.8.7), Gārgi asks on what entity is space "woven back and forth." The great teacher Yājñavalkya replies:

> That, Gārgi, is the imperishable (*akṣara*), and Brahmins refer to it like this — it is neither coarse nor fine; it is neither short nor long; it is neither blood nor fat; it is without shadow or darkness; it is without air or space; it is without contact; it has no taste or smell; it is without sight or hearing; it is without speech or mind; it is without energy, breath, or mouth; it is beyond measure; it has nothing within it or outside of it; it does not eat anything; and no one eats it.

The transcendental dimension of *ākāśa* is clearly evident in this passage. The entity on which space is "woven back and forth" is the imperishable that lies beyond any phenomenal category. From an empirical viewpoint, space appears to be the most appropriate symbol of the unmanifest (*Brahman*) in the material world. Or, to express it differently, space is the very appearance of the unmanifest as an externalized phenomenon in a sense-perceived world.

Epistemological status of *ākāśa*

Before examining the inner meaning given to this element in Advaita, we must address its epistemological status. For Advaitins, *ākāśa* is an object of knowledge in the strict sense, i.e., something that can be apprehended through proper means of knowledge (*pramāṇas*). However, in sharp contrast with other elements, *ākāśa* lies beyond the range of direct perception. It is colourless, odourless, tasteless, etc., and therefore cannot be grasped or understood through sense-organs. Cārvāka philosophers did not accept this element in their own classification of elements precisely for this reason. Since perception is an essential *pramāṇa* in the Cārvāka school, the existence of *ākāśa* cannot be ascertained in any way. As noted earlier, a similar view is maintained in the various schools of Buddhism. For the great Buddhist thinker Nagārjuna, "space is mere name (*nāmamātraka*), because it is nothing but the absence of form (*rūpa*)."[177] We also recall the Sautrāntika definition of *ākāśa* as mere "absence of resistant matter [or obstruction]," (*sapratighadravyābhavamātra*) which amounts to say that *ākāśa* has no objectified reality. Similarly, in a Theravāda text such as *Milindapañha*, *ākāśa* is said to be incomprehensible, boundless and immeasurable, and thus beyond the range of direct perception.[178] In this context, one wonders how the existence of this element is ascertained by Advaitins.

For Śaṅkara also, *ākāśa* lies beyond the range of direct perception, as it appears in his introduction to the *Brahmasūtrabhāṣya*: "Nor is there any rule that something has to be superimposed on something else that is directly perceived through the senses; for boys superimpose the ideas of surface and dirt on space [*ākāśa*] *that is not an object of sense-perception*." Colours, forms, etc., do not belong to *ākāśa* but are falsely superimposed upon it. However, according to the author of the *Paribhāṣā Prakāśikā*, a commentary on Dharmarāja's *Vedāntaparibhāṣā*, this very superimposition can serve as a means of knowing *ākāśa*. In his view, when Śaṅkara states that *ākāśa* cannot be known through sense-organs, it is meant that *ākāśa as such* cannot be perceived. Yet nothing prevents from inferring its existence through false association with certain qualities.[179] When I perceive sky as blue, for instance, I can infer the presence of the colourless space in the same way as the rope can be inferred from the illusory snake that is superimposed upon it. The existence of *ākāśa* can also be inferred from its quality of sound. In BSB II.2.24, Śaṅkara says that *ākāśa* can be inferred from sound, in the same way as qualities such as smell and the rest enable to infer the existence of substances like earth, etc.

For a later Advaitin like Madhusūdana Sarasvatī, *ākāśa* can neither be known through perception nor inference. It is perceived through what is called "witness-

[177] Quotation taken from: Halbfass, "Space or Matter? The Concept of *ākāśa* in Indian Thought," 103.

[178] Trenckner (trans.), *The Milindapañha*, 388. See: Halbfass, *op.cit.*, 102-03.

[179] Gupta, *Perceiving in Advaita Vedānta: Epistemological Analysis and Interpretation*, 124.

consciousness" (*sākṣin*): "Similarly, since space has no form, etc., it is not perceived by any of the sense organs such as the eye; nor is it known by inference. So the knowledge of space is not due to a mental modification, because a mental modification arises only when a sense organ functions. So space is also directly perceived by the witness-consciousness."[180] The existence of *ākāśa* can only be revealed through consciousness *qua* consciousness, i.e., through the entity standing behind what is known and unknown, as well as behind the knower.[181] This provides *ākāśa* with a peculiar status in Advaita as far as epistemology is concerned. While some philosophers deny its existence because it is devoid of qualities and relations, Advaitins evoke the possibility of knowing *ākāśa* though it is free from names and forms. Something without any name and form is not necessarily non-existent since beyond names and forms, there is existence, *sat*, which is self-revealing and sustains every other existence. In the *Pañcadaśī* (PD II.42), we are told: "Just as *ākāśa* absolutely free from the universe (of names and forms) is comprehended by your intellect, in the same manner why is it not the Existent free of *ākāśa* also comprehended by you?"

However, if *ākāśa* is devoid of name and form, are we not simply referring to *Brahman* itself? Again, the gap between *ākāśa* and *Brahman* appears quite narrow. There is a close relationship — conceptual as well as logical — between *ākāśa* and the unmanifest (*Brahman*) that lies beyond the reach of any means of knowledge. As the first phenomenal existent to evolve from *Brahman*, *ākāśa* somehow expresses in the categories of the phenomenal world the *Brahman* which would be inexpressible and unthinkable (*anirvacanīya*) otherwise. It is the "ultimate knowable" beyond which epistemology halts and gives place to the *ontos*, to the Absolute as it is. It has the ability to reveal the modalities of the unmanifest in this world but to do so, one

[180] Sastri (trans.), *Siddhāntabindu of Madhusūdana Sarasvatī*, 128.

[181] Like internal mental states and illusory existents, and other entities like time, *ākāśa* is known through the ever-present *sākṣin*, the witness of all knowledge. Witness-consciousness is not pure consciousness but consciousness identified with the cognizing subject. For an informative discussion on this concept, see: Gupta, *op.cit.*, 54-72.

should neither try to grasp nor understand it as an object of knowledge. The way in which *ākāśa* is conceived to lead to the apprehension of the unmanifest, without itself becoming an object of knowledge, can be better appreciated through an esoteric interpretation in the *Upaniṣads*.

A portal into the unmanifest : *ākāśa* in the heart

We have seen above how *ākāśa*, despite being a physical element, is also considered as a proper vehicle to achieve an understanding of *Brahman* in Advaita. In fact, in several instances, the *Upaniṣads* enjoin students to meditate upon *ākāśa* as *Brahman*. In ChU III.18.1, for example, *ākāśa*, besides the mind (*manas*), is said to be especially fit for meditating upon *Brahman*. In his commentary, Śaṅkara says: "Since space and mind are subtle, and since *Brahman* is realised by the mind, and also since space is all-pervasive, subtle and without any limiting adjunct, therefore, mind and space are fit for being meditated upon as *Brahman*." Later in the same *Upaniṣad*, we are told: "If someone venerates *Brahman* as space — well, a man wins worlds that are spacious, worlds that are wide open, unconfined, and far-flung..." (ChU VII.12.2) In those passages, we find the idea that *ākāśa* is an appropriate symbol for meditating upon *Brahman*, because it is infinite, subtle, all-pervasive, changeless, formless, etc., like *Brahman*. The *Upaniṣad* in this context points to the totality of external space, which encompasses everything that exists.

But there are also a number of passages where the *ākāśa* to be meditated upon is internal to the individual, located in the "space within the heart," (*antaḥ hṛdaya ākāśaḥ*) wherein abides the supreme reality, *Brahman* or *ātman*.[182] One of those passages from the *Chāndogya Upaniṣad* is significant:

[182] We find mention of *ākāśa* being located in the heart at several places in *Upaniṣads*: BrU II.1.17, II.5.10, IV.2.3, IV.4.22; TU I.6.1; ChU VIII.1. In other passages, the heart is depicted as the abode of the self or *Brahman*: KaU I.2.20, I.3.1, II.1.6-7, II.1.12.

> Now, here in this fort of *Brahman* there is a small lotus, a dwelling place, and within it, a small space. In that space there is something — and that's what you should try to discover, that's what you should seek to perceive... As vast as this space here all around us, is that space within the heart; and in it are contained both earth and sky, both fire and wind, both the sun and the moon (both lightning and the stars); both what belongs to it and what does not, in it is contained all that. (ChU VIII.1.1-3)

According to Śaṅkara, the expression "fort of *Brahman*" (*brahmapura*) in the above passage refers to the complex of human subtle and gross bodies together. The analogy is that of a fort with a king and many officers fulfilling the orders of the king. Similarly, in the body, the different organs, mind and intellect fulfill the needs of *Brahman*, which is said to abide in a lotus-like dwelling (*puṇḍarīkam veśma*). Later in the passage, this dwelling is identified with the heart. According to Bäumer, both the "fort of *Brahman*" (*brahmapura*) and the lotus (*puṇḍarīka*) are commonly used in the *Upaniṣads* as symbols for the inner space of being.[183] Another symbol that is often invoked similar to the heart is the "cave" or "cavity," (*guhā*) in which *Brahman* is said to be "lodged," "placed," "hidden." (*nihitam*) The "cave of the heart" does not refer to the physical heart according to Śaṅkara but to the intellect (*buddhi*), the higher discriminative faculty through which knowledge of ultimate reality can be achieved.[184] The withdrawal within the "cave of the heart" thus corresponds to a process of interiorization, in which one progressively becomes detached from external things and meditates, with the help of the intellect, upon a more subtle reality.

In the passage above, a small space (*daharaḥ ākāśaḥ*) is said to pervade the lotus-

[183]Bäumer, "From *guhā* to *ākāśa*: The Mystical Cave in the Vedic and Śaiva traditions," 107.

[184]For instance, in TU II.1.1: "*Brahman* is truth, knowledge, and infinite. He who knows that *Brahman* as existing in the intellect which is lodged in the supreme space in the heart (*nihitaṃ guhāyāṃ parame vyoman*), enjoys, in identification with the all-knowing *Brahman*, all desirable things simultaneously." According to Śaṅkara, the word *guhā*, which is derived from the root *guh* meaning "hiding" or "covering," here means "intellect," (*buddhi*) because in the intellect are hidden the categories of knowledge, knowable and knower, or the two main human objectives, i.e., worldly experience and liberation.

like dwelling, or heart. Since the *Upaniṣads* refer to *ākāśa* in various ways, it is important for Advaitins to determine what the word *ākāśa* exactly refers to in these different contexts. Should we understand that what lies within the heart is the familiar material space, or the supreme self (*ātman*)? This question is examined by Śaṅkara in BSB I.3.14, which in brief is as follows.[185] Firstly, the opponent *pūrvapakṣin* takes *ākāśa* to mean material space, and provides three main reasons in this regard: 1. It is the conventional meaning of the word *ākāśa*. Such meaning is also suggested by the adjective "small" (*dahara*) attached to the word *ākāśa*, for the place where it subsists is small; 2. In ChU VIII.1.3, we are told that the space within the heart is as vast as the space outside. Such statements can only be valid with reference to the material space, which is known to be one; 3. The word *ākāśa* cannot denote the supreme self since we are not told that the knowledge of *ākāśa* should be sought for. Rather, what must be known exists *within* that space ("In that space there is something — and that's what you should try to discover…"). The material space is therefore the abode of the supreme self, which dwells inside *ākāśa*.

Against this position of the opponent, Śaṅkara maintains that *ākāśa* denotes the supreme reality, *ātman* itself. It cannot refer to the material space because in this passage the teacher denies *ākāśa* any physical sense. In his commentary on ChU VIII.1.2-3, he explains:

> When I [the teacher] said: 'Within that is a small space', I did not say so with the idea that the space which exists in the lotus-like dwelling is smaller than the lotus… The lotus is small, and the internal organ corresponding to that and contained in it is limited by the space within the lotus […] Since there is the internal organ acting as the limiting adjunct, I said 'Within that is a small space'. By itself however, *antaḥ-hṛdaya-ākāśaḥ*, the space within the heart… is as vast as this physical space.

One could however argue, against the position that what lies in the heart refers to

[185] For the sake of simplicity, we do not present here the arguments as to why *ākāśa* cannot mean the individual soul in this context.

the self, that the self cannot be "as vast as this space here all around us." Indeed, the *śruti* (*Śatapatha Brāhmaṇa* X.6.3.2) declares the self to be "greater than space." But according to Śaṅkara (BSB I.3.14), the expression "as vast" does not imply that the self has the same expanse as *ākāśa* (in the sense of external space). Rather, it serves to illustrate its infinity. Śaṅkara also holds that the space within the heart is precisely "what should be sought for." Otherwise the claim that the "space within the heart is as vast as the space outside," meant to bring in some contemplative state, would have no purpose. Following BSB I.3.14, Śaṅkara resorts to *śruti* and also invokes those passages where *ākāśa* refers to *Brahman*, namely ChU I.9.1 and ChU VIII.14.1, to defend his position.

Just as the external *ākāśa* is used sometimes as a symbol for the infinite nature of *Brahman*, the *ākāśa* within the heart is used to denote the ineffable supreme reality dwelling inside us. It is clear that locating the supreme reality within the heart, in the form of space, serves to facilitate meditation upon the self, or *Brahman*. The symbolic role of the lotus-like heart in this regard is clearly mentioned by Śaṅkara at the beginning of ChU VIII:

> Although. . . it has been known that *Brahman* is free from direction, location, time, etc., still, since the intellect of dull people, which conceives that all things are possessed of the differences of direction, location, etc., cannot be suddenly turned towards the supreme Reality, and since the supreme Goal of life cannot be attained without realization of *Brahman*, hence the location of the lotus of the heart has to be here instructed for Its realization. Although the reality of the self which is Existence, is the only object of fullest knowledge and is devoid of any quality, still, it is necessary to speak of It as possessed of such qualities. . . since people of dull intellect seek an entity with qualification.

BSB I.2.11 raises the question of how the supreme self, which is omnipresent, can be cognized in the small cavity of the heart. Śaṅkara replies that it is so *precisely* because the cavity is its dwelling.[186] For him, the internal *ākāśa* dwelling in the heart is an appropriate means for the realization of *Brahman*, the supreme self. As Bäumer

[186] "The supreme self is to be cognized from the very fact of remaining in the cavity; for the fact of

notices, it is significant that though he most often insists on *śruti* as the only means for knowing *Brahman*, he still recognizes the possibility of its realization through a certain kind of mystical experience.[187]

Progressive interiorization and detachment from the external world make the internal *ākāśa* an effective means in helping the seeker to obtain knowledge of the supreme reality. By withdrawing its attention from the mind objects (thoughts, emotions, and objects of the senses), the seeker enters into contact with pure consciousness itself. In ChU VIII.1.1-3, we are told to first concentrate on the "fort of *Brahman*," then on the heart and finally on the small space within the heart. In this inner space, there is a silence that enables one to perceive his real self, free from desires and attachments to the world. In his commentary on TU II.1.1, Śaṅkara states that *Brahman* is "perceived clearly through the function of that intellect (*buddhi*)," which dwells within the space in the heart. The unmanifest *Brahman* dwells there as a witness and can be directly perceived as such. In BrU IV.4.22, he describes *ākāśa* as the seat of the intellect, and maintains that *ātman* "lives in that ether containing the intellect." Similarly, in ChU VIII.2-3, he maintains that it is through a purified internal organ, namely the intellect, that *Brahman* can be realized, "like an image appearing in clear water or in a mirror."

Hence, *ākāśa* not only accounts for the openness, infinity and homogeneity of the external space but also for the experience of infinity and openness characterizing inner awareness. The space-as-consciousness experienced within oneself is the inner equivalent of external space: just as external space allows all physical objects to be, the inner space enables mind objects to be. By becoming aware of what lies beyond space — that is, beyond physical or mind objects — without trying to grasp it as an

remaining within the cavity is very often declared in the *Vedas* and the *Smṛtis* with regard to the supreme self Itself [...] And we stated earlier that it involves no contradiction to teach about any place as suitable for the realization of *Brahman*, omnipresent though It is." (BSB I.2.11)

[187] Bäumer, *op.cit.*, 109.

object of knowledge, one enters into contact with the unmanifest in the form of pure consciousness. By bridging the inner and outer space, the Vedāntic concept of *ākāśa* thus serves as a means for realization of the identity between *Brahman* and *ātman*. As one *Upaniṣad* says:

> That indeed which is *Brahman*, is surely this which is the space outside a person. That space indeed which is outside a person, is surely this which is the space within the person. That indeed which is the space within a person, is surely the space that is within the heart. That which is this (space within the heart) is all-pervading and without movement. He who knows thus, attains a glory which is full and indestructible. (ChU III.12.7-9)

But, like any symbol, *ākāśa* simply points towards the Absolute, and should ultimately be transcended. In the end, *ākāśa* is only a portal into the unmanifest, a means to the path of self-discovery, a realization that is also part of what Advaita teaches. In sharp contrast with other *darśanas*, it is significant that this physical element has soteriological implications in Advaita.

4.4 Concluding Remarks

In our study, we have seen that Upaniṣadic literature endows the word *ākāśa* with various meanings. In some passages, *ākāśa* is stated to be one of the five elements (*mahābhūtas*), connected with hearing and sound. Elsewhere, it acquires a metaphysical meaning while being closely equated to the eternal *Brahman* and the innermost *ātman*. We also saw that later *darśanas* like Vaiśeṣika and Sāṃkhya more or less retained these different meanings, even though each of them emphasized a particular aspect of *ākāśa* in consonance with its metaphysical view of the world. In Vaiśeṣika, *ākāśa* is mainly envisaged as a physical element responsible for the transmission of sound, but also as an all-pervasive and eternal substance on par with immaterial substances. In classical Sāṃkhya, *ākāśa* is looked upon as a mere product of *prakṛti*.

With Vijñānabhikṣu, however, another kind of *ākāśa* is introduced, causal and thus closer to the origin of things. In both schools, the physical or cosmological aspect of *ākāśa* is emphasized, the metaphysical aspect being present but mostly hidden in the cosmological. In Advaita, however, there is an emphasis on *ākāśa* as an entity with affinities to *Brahman-ātman*, as opposed to its familiar meaning of physical space.

Halbfass traces the variety of meanings of *ākāśa* to the interaction between two different ontologies in Indian philosophy, which he refers to as a "substantialist ontology" and as an "ontology of openness" respectively.[188] According to the "substantialist ontology," of which the sixth chapter of the *Chāndogya Upaniṣad* is a good example, *sat* is the irreducible substance underlying every entity that exists. In this view, the whole world and its multiplicity is nothing but Being, which seemingly unfolds in different names and forms at the moment of creation. The phenomenal world is not *really* created but is only a manifestation of the same eternal Being that exists "before" creation. According to Halbfass, this ontology was preceded by an "ontology of openness" in old Vedic texts. Here, the primary concern "is not the substance or material out of which entities are made, but the open space — the void — in which they appear and which is the very condition of their appearance."[189] Things and events appear in an extended and primordial openness: they become visible, measurable, projected. As such, they cannot be described as mere modifications of an underlying substance. While there is no room for creation in a substantialist ontology, the ontology of openness implies a "beginning," or a primeval event of separation and opening.[190]

[188] Halbfass, "Space or Matter? The Concept of *ākāśa* in Indian Thought," 93; 98ff.; Halbfass, *On Being and What There Is: Classical Vaiśeṣika and the History of Indian Ontology*, 25ff.

[189] Halbfass, "Space or Matter? The Concept of *ākāśa* in Indian Thought," 100.

[190] Halbfass explains: "The distinct entities that appear in the Vedic openness cannot be described as mere modifications of a primeval substance or substrate. Rather, their appearance implies the negation of such substantiality. It implies novelty and contingency. The Vedic "creation," the primeval opening may not be a "creation from nothing." Yet, it implies a first beginning, an event that remains unique in spite of all the ritual repetitions by which it is followed. See: *On Being and*

Halbfass argues that the semantic richness associated with the concept of *ākāśa* derives from the historical tension between these two ontologies. The description of *ākāśa* as a reified substance on par with other elements — found in Vaiśeṣika, Sāṃkhya and at some places in Advaita — seem indicative of an ontology of substance. Yet, when *ākāśa*, especially in Advaita, is looked upon as an entity connected to the creation and the visible manifestation of the world, the Vedic ontology of openness seems more prominent. Of course, this hermeneutic issue is not very relevant as far as Śaṅkara and other Advaitins are concerned. In their view, the various meanings of *ākāśa* in *Upaniṣads* simply correspond to different levels of discourse within the revealed text. Since *śruti* is assumed to be coherent as a whole, no meaning can essentially come into contradiction with others. Whether *ākāśa* is addressed in its cosmological or metaphysical aspect, the purpose remains the same for Advaitins, i.e., the attainment of ultimate knowledge (*parāvidyā*, *brahmavidyā*). In the end, each meaning must be interpreted along this line. We have seen how Śaṅkara constantly tries to fulfill this objective in his interpretation of Vedānta texts in general, and *ākāśa* in particular.

Unlike other *darśanas*, the school of Advaita Vedānta offers a reflection on *ākāśa* that takes into consideration both external and internal aspects of space. A close relationship is established between inner space and pure inner awareness (*ātman*), and between external space and the unmanifest *Brahman*. Because of its many affinities with *Brahman*, *ākāśa* is interpreted as its most appropriate symbol, a form of its presence in the material world. Similarly, it is used as a symbol of the ineffable and spiritual self (*ātman*) dwelling inside us. Furthermore, given the homology between *Brahman* and *ātman* in Upaniṣadic literature, a homology is also traced between the inner and outer space. In the form of *ākāśa*, the unmanifest pervades the entire universe — from within and without. Though it can neither be perceived nor inferred, *ākāśa* can be meditated upon to grasp the Beyond, the Unknowable, the Infinite. It

What There Is: Classical Vaiśeṣika and the History of Indian Ontology, 31.

expresses, in the modalities of rational thinking, That, which by definition resists any kind of description, or any conceptualization in terms of this or that (*anirvacanīya*).

Chapter 5

Analysis and Proposal for Dialogue

In Chapter 2, we discussed extensively the issue of "parallelism" as applied to two major systems of thought and practices, namely quantum physics and the age-old Indian tradition of Advaita Vedānta. The purpose of this discussion was to introduce and critically examine the kinds of parallels made in literature between these systems. Special attention has been paid to the parallels and analogies involving concepts of quantum field theory, namely the quantum field and its correlate the quantum vacuum. A number of authors, ranging from Capra and László in the West to Panda and Chandrasekharayya in India, have recently traced relationships between these concepts and others found in the Advaita Vedānta tradition such as *Brahman*, *ākāśa* and *avyakta*. Such suggestions are not new since similar claims relating *ākāśa* to the luminiferous ether of classical physics were made by the Hindu reformer Swami Vivekananda more than a century ago. In order to understand the relevance of such parallels and also to see how far they are pertinent for the current dialogue between modern physics and Vedānta, a thorough examination of the concepts of quantum vacuum and Hindu *ākāśa* was attempted in Chapters 3 and 4.

In this chapter, we bring together the lessons learnt in Chapters 3 and 4 and explore further the question as to how Advaita Vedānta could relate to modern physics. In the first part of the chapter, a detailed comparative analysis of the concepts of quantum vacuum and *ākāśa* is provided. We start with a discussion as to what extent the parallels made in literature are exact and relevant, and then an attempt is made to identify those aspects that deserve more attention than others. The conclusion we arrive at is that: 1. most parallels are in fact inappropriate and represent in general just conceptual analogies with no direct bearing on the systems compared; and 2. a stronger correspondence may be established at the epistemological level by recognizing that both concepts disclose the existence of an unmanifest state of being that is unavailable to sense-perception and reasoning. On this basis, we will be in a better position to work towards the reconstruction of a consistent model integrating modern physics and Advaita Vedānta. This model will be formulated in the second part of the chapter.

5.1 Comparative Analysis: Quantum vacuum and *ākāśa*

As noted earlier, the practice of parallelism — that is, of drawing parallels between claims of different disciplines — may exhibit different kinds of problems: lack of contextuality, translation problem, language fallacy, over-simplification, ideological bias, etc. Needless to say, any comparative study must take care of these methodological difficulties. In *Interpreting Across Boundaries*, Larson mentions some general presuppositions or biases that are common in comparative philosophy, among others the tendency to favor similarities between concepts and ideas while ignoring or glossing over their differences.[1] This bias is indeed found in works comparing modern

[1] Larson, G.J., "Introduction." In: Larson and Deutsch (eds.), *Interpreting Across Boundaries: New Essays in Comparative Philosophy*, 16.

physics with Eastern spiritual traditions. However, from a comparative perspective, emphasizing differences is also conducive to rich and fertile exchanges. It is useful when, Krishna mentions, these differences "are articulated not in terms of the doctrines held, but in terms of the problems perceived and the solutions attempted."[2] What often matters in comparative philosophy is to identify the philosophical problems that various cultures and systems of thought have perceived as valuable, and to search for distinctiveness in the solutions offered to similar problems. Following this trend of thought, we will analyze how *ākāśa* and quantum vacuum reveal, though in distinctive ways, a similar epistemological problem — that of specifying the content of reality as a whole by the means of sense-perception and reasoning alone.

A second methodological problem commonly found in comparative philosophy is the tendency to ground comparisons in terms of Western concepts and categories. The themes for comparative philosophizing are most often centered on the Western tradition and anchored in Western academic disciplines such as ethics, metaphysics, epistemology, philosophy of language, etc.[3] However, the Western perspective is not universal and there exist alternative conceptual structures and worldviews in other traditions as well. Thus, it is important to question the use of Western style categories of epistemology and ontology in our comparative analysis, and to inquire whether there are comparable categories in the Indian philosophical tradition. As far as epistemology is concerned, Matilal contends that the doctrine of means of knowledge (*pramāṇa-śāstra*) in Indian philosophy coincides to a great extent with epistemology in the West.[4] Both are concerned with the nature of knowledge, and with methods of reasoning and criteria upon which knowledge-claims are based. As to ontology, Halbfass notices that though the Indian tradition contains no "science of being *qua* being" in the Aristotelian sense nor does it have any systematic monographs on ontology *per*

[2]Krishna, D., "Comparative Philosophy: What It Is and What It Ought to Be." In: Larson and Deutsch (eds.), *ibid.*, 82.

[3]Larson, *op.cit.*, 11-12.

[4]Matilal, *Perception: An Essay on Classical Indian Theories of Knowledge*, 22.

se, "being is one of the central and pervasive themes of Indian thought."[5] In light of these remarks, it is reasonable to assume that Indian philosophy also developed its own distinctive forms of epistemology and ontology.

5.1.1 Analogies and Parallels: A Critical Analysis

The objects under comparison are, on the one hand, the concept of *ākāśa* as assessed in the classical Hindu *darśanas* and particularly in Śaṅkara's Advaita Vedānta; and, on the other hand, the concept of quantum vacuum as interpreted by physicists and philosophers of physics. A first and obvious feature pertaining to both concepts is their richness in terms of meanings and interpretations. As we have seen, both vacuum and *ākāśa* have a long history reaching back to Antiquity. In the *Upaniṣads*, *ākāśa* is already endowed with various meanings, from one of the five great elements (*mahābhūtas*) constituting the universe to a symbol of the absolute reality (*Brahman, ātman*). In the classical period, the *darśanas* appropriated and adapted these meanings to various degrees in accordance with their own metaphysical views. While Vaiśeṣika and Sāṃkhya mostly regard *ākāśa* as a physical element, the school of Vedānta correlates it with the all-comprehensive *Brahman* and the innermost self of beings, *ātman*. Such semantic variations are also available for the concept of vacuum in physics. As empty space, vacuum has been refuted by Aristotle and others as an ontological impossibility, and affirmed in the systems of atomists and Newton. As an all-filling substance, it has been interpreted by Young and Fresnel as an etheric medium connected with light transmission. In Einstein's general relativity, it is regarded as a structural quality of the gravitational field, and in quantum field theory (QFT) as the fundamental or ground state of quantum fields. In most of the parallel studies, however, the various meanings of *ākāśa* and vacuum are not taken into account. Some meanings are emphasized while others are simply overlooked, and most

[5] Halbfass, *On Being and What There Is: Classical Vaiśeṣika and the History of Indian Ontology*, 21.

often no clear justification is provided for the conclusions arrived at. Needless to say that if we are to compare carefully the Vedāntic *ākāśa* and quantum vacuum, these various aspects must be taken into consideration.

As discussed in Chapter 4, *ākāśa* receives a number of meanings in Śaṅkara's thought. When envisaged as a *mahābhūta*, Śaṅkara's *ākāśa* presents affinities with Aristotle's *aither*. It has been noted that like *aither*, *ākāśa* is the fifth element of an extant list of four elements (earth, water, fire and air), is changeless, subtle or rarefied, and connected to higher regions of the cosmos.[6] We recall that Aristotle was strongly against the existence of empty space, and thus his *aither* is an all-filling substance similar to *ākāśa*, which is envisaged as an extended and subtle form of materiality in the Vedānta tradition. However, one also notices several dissimilarities between both these concepts. Firstly, the nature of *ākāśa* as a created and creative element in the Upaniṣadic-Vedāntic tradition is not shared by Aristotle's *aither*. In BSB II.3.1-7, *ākāśa* ranks first in Śaṅkara's scheme of creation and is responsible for the emergence of all other created entities. Furthermore, in line with TU II.1.1, *ākāśa* is itself considered a created element, that is, an emanation of the absolute *Brahman*. Such a view is inimical to Aristotle's conception because for him the world is not created but has always existed as it is. Thus, his *aither* is eternal, neither creative nor created. In fact, as far as the Greek tradition is concerned, the Vedāntic *ākāśa* conceived as the first emanation of the one Being and Consciousness *Brahman*, seems

[6]McEvilley, *The Shape of Ancient Thought: Comparative Studies in Greek and Indian Philosophies*, 308. It is remarkable that the fivefold list of elements advanced by Aristotle (and others) is identical with that of the Indian tradition, and even more significant that in both traditions a fifth element is added to the extant list of four elements, which are already adequate to account for all phenomena. On this basis, McEvilley refutes the claim of Deussen (and others) according to which both lists of five elements were probably construed independently based on the "simple observation of nature." In the view of McEvilley, the early doctrine of four elements arose in India — "where the developmental sequence is clearer than in Greece" — and then found its way to Greece in different versions. The concept of a fifth element was probably imported later during the Upaniṣadic period. See: Deussen, *The Philosophy of the Upanishads*, 189; McEvilley, *op.cit.*, 300-09.

embedded in a worldview more akin to neo-Platonism. Like Vedāntins, neo-Platonists such as Plotinus (c. 205-270 CE) and Proclus (c. 412-485 CE) primarily conceive the world in terms of a graduated series of emanations deriving from the One Being, or World-Soul. But they do not recognize the existence of a subtle element like *aither* and they affirm like Plato that only four elements exist whose origin and arrangement is explained through Being.[7]

In Aristotle's system *aither* is set in a category apart from other elements. In Aristotle's view, *aither* is the substance of which the heavenly bodies (inhabiting the superlunar realm) are made; it is eternal and unchangeable unlike other elements which are temporary and inhabit the sublunar realm. In Śaṅkara's thought, although

[7] See: Cantor and Hodge (eds.), *Conceptions of Ether: Studies in the History of Ether Theories (1740-1900)*, 7. There have been serious academic works exploring the relationship between neo-Platonic and Upaniṣadic-Vedāntic traditions. Many scholars have argued that Plotinus' philosophy is so close to that of the *Upaniṣads* and Vedānta that it must have been influenced by those sources, or that both traditions share a common origin. According to McEvilley, Plotinus was "philosophizing in an Indianized tradition" and may "have received the Indian influence from Gymnosophists [the "naked philosophers," i.e., Jaina monks, Indian yogis, etc.] in Alexandria, or from the works of Plato, or both..." There is no doubt that many passages in Plotinus' and later neo-Platonists' works, present deep affinities with Vedāntic monistic thought. Both traditions have questioned the relationship of Being with non-Being, or the One with the Many, and come up with similar answers and metaphors. The thesis that only the One is real and the Many (or the world) is unreal has been maintained on the Indian side by Śaṅkara, and on the Greek side by Plotinus (in some passages) and his student Porphyry. According to Bhatt, "both Plotinus and Vedānta philosophers regard the One negatively as unknown and undefined and positively as unity of Being, Thought and Bliss. Both ascribe freedom and volition to the One. Both insist that the One is immanent and transcendent in many." Others, like Nayak, have compared the concept of "sage" in Plotinus's thought and that of "liberated while alive" (*jīvanmukta*) in Śaṅkara's philosophy. However, despite doctrinal similarities, one should not overlook their distinctions as to the setting and conceptual framework in which these philosophies have operated throughout history. See: McEvilley, *op.cit.*, 549-64; Bhatt, S.R., "Plotinus and Vedānta." In: Gregorios (ed.), *Neoplatonism and Indian Philosophy*, 211; Nayak, G.C., "Plotinus and Sankara: Some Significant Affinities and Divergences." In: Gregorios (ed.), *ibid.*, 219.

ākāśa is emphatically presented as an entity akin to *Brahman* and *ātman*, it is at the same time envisaged on a par with other elements. Like water, fire, air and earth, *ākāśa* possesses a specific quality (i.e., sound) and is correlated to a specific sense-organ (i.e., hearing). Also, Śaṅkara argues at length in BSB II.3.1-7 that *ākāśa* is not eternal but a created element like all other physical existents. It is worth noting that this argument is directed against Vaiśeṣikas who believe in the eternal nature of *ākāśa*. Thus, if certain parallels are to be made with Aristotle's conception on this point it should be with the Vaiśeṣika system and not with Vedānta. Such parallels are indeed drawn by McEvilley, who writes:

> In both systems the fifth element is kept carefully separate from the others, in the Vaiśeṣika view by the doctrine that it does not combine with the other elements, in Aristotle's by secluding it in the superlunary realm where the four elements and the process of change they are involved in do not exist.[8]

The meaning of *ākāśa* in Vaiśeṣika is mostly associated with physical connotations. Vaiśeṣikas explicitly stress the correlation of *ākāśa* with the sense of hearing by making it the substratum of sound. But even if it shares a similarity with other elements by having a specific quality and sense-organ, *ākāśa* is different for some other reasons: 1. it has no parts or atoms and thus it cannot form aggregates like other elements and mix with them; and 2. it is all-pervasive and eternal like immaterial substances such as direction (*diś*) and time (*kāla*). Since *ākāśa* involves extended continuity, the things that reside in it "are therefore not absolutely distinct essences... but part and parcel of one continuum."[9] In this sense, the Vaiśeṣika conception of space contrasts with that of atomists for whom space is an empty and infinite receptacle in which individual and distinct atoms reside. It is interesting to note that the all-pervasive nature of *ākāśa* in Vaiśeṣika has been criticized for displaying a lack of consistency

[8] McEvilley, *op.cit.*, 525.

[9] Lysenko, V., "The Vaiśeṣika Notions of *ākāśa* and *diś* from the Perspective of Indian Ideas of Space." In: Franco and Preisendanz (eds.), *Beyond Orientalism: The Work of Wilhelm Halbfass and Its Impact on Indian and Cross-Cultural Studies*, 432.

with its claim that atoms are indivisible. A similar problem arises in the Greek context with the debates between the atomists and Aristotle, since Aristotle firmly believes in the continuity of the world at all times and rejects the existence of atoms.[10] This shows how two distinct traditions embedded in different historical settings and conceptual structures can encounter similar philosophical problems.

Now coming to modern science, several parallels have been drawn between *ākāśa* and the luminiferous ether of classical physics. Perhaps the first to establish such a correlation was the Hindu monk and reformer Swami Vivekananda. Vivekananda probably became familiar with ether as a physical concept during his stay in the West (1893-96) where he met well-known scientists like Lord Kelvin, Hermann von Helmholtz, Sir William Thompson and Nikola Tesla, and perhaps even earlier during his college education when he studied Western philosophy, science and history. In 1895, he published in the *New York Medical Times* a short anonymous article entitled "The Ether," in which he clearly equates the "*ākāśa* of the Hindus" with the "ether of the Greeks" and the luminiferous ether of physics. In his *Jnana-Yoga*, he claims that "[*ākāśa*] is somewhat similar to the modern notion of ether though the similarity is not complete."[11] Around the same period, the inventor and engineer Nikola Tesla

[10] In Greece, the doctrine of atomism was formulated by Leucippus around the 5th century BCE and then systematized by his student Democritus, and later Epicurus and Lucretius. Beside Vaiśeṣika, several Indian schools of thought (Nyāya, Buddhist, Cārvāka, Jaina and Ājīvika) have also developed their own versions of atomic theory. Despite important affinities between Indian and Greek atomic systems, scholars like Bailey and Keith have argued that no relationship ever existed between them and that they developed independently. McEvilley, however, believes that if the Buddhist and Nyāya-Vaiśeṣika conceptions were probably formulated after the Greek conquest of northwest India, Cārvāka, Jaina and Ājīvika — which were already in existence by the 6th century BCE — may well have influenced the thought of Leucippus and Democritus. See: Bailey, *The Greek Atomists and Epicurus*, 65; Keith, *Indian Logic and Atomism*; McEvilley, *The Shape of Ancient Thought: Comparative Studies in Greek and Indian Philosophies*, 311.

[11] Vivekananda, *Jnana-Yoga*, 233. Though this work was initially published in English, I have used the French translation by Jean Herbert. The passage here is my own translation from French to English.

also drew clear parallels between Hindu *ākāśa* and luminiferous ether. As early as 1891, he started to use Sanskrit words such as *ākāśa* and *prāṇa* in his attempts to describe the nature and functioning of matter. One biographer cites the following excerpt from an unpublished article of Tesla called *Man's Greatest Achievement*:

> Long ago he [Man] recognized that all perceptible matter comes from a primary substance, or tenuity beyond conception, filling all space, *the Akasha or luminiferous ether*, which is acted upon by the life giving Prana or creative force, calling into existence, in never ending cycles all things and phenomena. The primary substance, thrown into infinitesimal whirls of prodigious velocity, becomes gross matter; the force subsiding, the motion ceases and matter disappears, reverting to the primary substance.[12]

It is quite probable that Tesla came into contact with Sanskrit terminology and philosophy through his association with Vivekananda. Both of them would have met during the first visit of Vivekananda to America when he delivered his famous lecture at the Chicago's Parliament of Religions in 1893. The parallel with Vivekananda's conception of *ākāśa* is clear as shown by this passage from Vivekananda's *Raja-Yoga*:

> According to the philosophers of India, the whole universe is composed of two materials, one of which they call Akasha. It is the omnipresent, all-penetrating existence. Everything that has form, everything that is the result of combination, is evolved out of this Akasha... It cannot be perceived; it is so subtle that it is beyond all ordinary perception; it can only be seen when it has become gross, has taken form. At the beginning of creation there is only this Akasha. At the end of the cycle the solids, the liquids, and the gases all melt into the Akasha again, and the next creation similarly proceeds out of this Akasha... The sum total of all forces in the universe, mental or physical, when resolved back to their original state, is called Prana... At the end of a cycle the energies now displayed in the universe quiet down and become potential. At the beginning of the next cycle they start up, strike upon the Akasha, and out of the Akasha evolve these various forms, and as the Akasha changes, this Prana changes also into all these manifestations of energy.[13]

In both passages, *ākāśa* is brought into close relationship with *prāṇa*, which are said to interact mutually in a self-renewing fashion to create the material universe.

[12] O'Neill, *Prodigal Genius: The Life of Nikola Tesla*, 251.

[13] Translation found on Wikisource: Vivekananda, *The Complete Works of Swami Vivekananda.* In: *Raja-Yoga*, Vol.1, Chap.3.

At this point, it is interesting to examine to what extent Vivekananda's *ākāśa* is representative of the so-called "Hindu" conception of *ākāśa*. No doubt, Vivekananda was one of the key figures in introducing Advaita Vedānta to Europe and America, but it remains unclear whether his appraisal of *ākāśa* is interpreted along the lines of the Vedānta tradition or not. Some scholars have argued that Vivekananda's teachings deviate in important ways from the Advaita tradition. For Hacker, for instance, it is questionable whether there is "a straight prolongation of the lines traced out by the ancient masters of the monistic Vedānta, or whether there is a break between the ideas of the old school and Vivekananda's presentation of the Vedānta."[14] In his opinion — as participant in the Hindu reform movement of which he was an important leader — Vivekananda would have adapted traditional teachings of Vedānta to make them accessible to each and everyone. But in doing so, Hacker says, "he did not notice that his adaptation altered the nature of the tradition to the extent of almost turning it into its opposite."[15]

From the passage above, there is no doubt that Vivekananda's description of *ākāśa* is embedded, at least partly, in Vedānta cosmology. His characterization of *ākāśa* as a subtle, omnipresent and all-penetrating element from which all existents evolve in a self-renewing fashion is indeed in agreement with basic Vedānta texts. However, the notion that *ākāśa* and *prāṇa* are the two main components of the universe is not found as such in traditional Advaita texts. Furthermore, in his article "The Ether," Vivekananda mentions that "*ākāśa* was, after the mind, the first material manifestation... and out of this *ākāśa* all this has been evolved."[16] This conception is more typical of Sāṃkhya — in which the formation of elements (*bhūtas*) follows the emergence of cosmic mind (*mahat*) — than of Vedānta cosmology, according to

[14] Hacker, "Aspects of Neo-Hinduism." In: Halbfass (ed.), *Philology and Confrontation: Paul Hacker on Traditional and Modern Vedānta*, 240.

[15] *ibid.*, 241.

[16] Translation found on Wikisource: Vivekananda, *The Complete Works of Swami Vivekananda*. In: *Prose and Poems*, Vol.9.

which *ākāśa* and other elements emerge first from *Brahman* to be then followed by intellect (*buddhi*), mind (*manas*), etc. Therefore, we cannot refer to Vivekananda's *ākāśa* as Advaitic in the traditional sense nor representative of the Hindu tradition as a whole.

In the decades after Vivekananda's travels to the West, many authors continued to associate *ākāśa* with the luminiferous ether in physics. For instance, the Bengali scholar of Sanskrit and Indian philosophy Surendranath Dasgupta (1887-1952), in his celebrated five-volume *A History of Indian Philosophy*, writes that "*ākāśa* corresponds in some respects to the ether of the physicists..."[17] More recently, in *The Shambala Encyclopedia of Yoga*, Georg Feuerstein claims that *ākāśa* "regarded as the finest of the five material elements of the manifest cosmos... is similar to... the luminiferous ether of nineteenth-century physics."[18] We could quote several other parallels of that sort from popular science and "mysticism" books. In almost all cases, however, the parallels drawn are superficial if not simply inaccurate. In many respects, the luminiferous ether of physics diverges from the Vedāntic *ākāśa*. First, the ether possesses mechanical properties such as the ability to vibrate, viscosity, incompressibility, etc., whereas no such properties are ascribed to *ākāśa*. Second, it is a medium for the step-by-step transmission of light, which was believed before Einstein to be impossible in empty space. The idea of a transmitting medium is essential here. Though *Upaniṣads* relate *ākāśa* to sound and the sense of hearing in some passages (cf. ChU VII.12.1), the concept of *ākāśa* as a medium for *sound transmission* is put forward only in Nyāya-Vaiśeṣika. Thus, if we have to make a parallel it should be with the Vaiśeṣika *ākāśa* and not with the Upaniṣadic *ākāśa* — as Feuerstein and others seem to do. Lysenko seems to agree in this sense when she says that "in its role as the sound-substratum [in Nyāya-Vaiśeṣika], *ākāśa* may well be translated as "ether," for the same reason that the light-substratum was thus called in nineteenth century physics."[19]

[17]Dasgupta, *A History of Indian Philosophy* (Vol.1), 253.
[18]Feuerstein, *The Shambala Encyclopedia of Yoga*, under the word *ākāśa*.
[19]Lysenko, *op.cit.*, 423.

This brings us to the parallels drawn between *ākāśa* and quantum vacuum. It is worth noting that conceptually the concept of quantum vacuum is somewhat in continuity with that of ether. The notion of vacuum in quantum physics appears with Dirac for whom the vacuum is not empty but filled with a "sea" of negative energy electrons. Though it may not be productive to use the old notion of ether in this context, it seems fair to say that his vacuum — as an all-pervading, material and subtle substratum — played a similar role in quantum physics as ether in classical physics. As one knows, in his later years, Dirac even ventured to posit the existence of a "non-mechanical ether" in quantum physics. In a paper submitted to *Nature* in 1951, he says:

> Physical knowledge has advanced very much since 1905 [the year when Einstein published his paper on special relativity], notably by the arrival of quantum mechanics, and the situation has again changed. If one examines the question in the light of present-day knowledge, one finds that the aether is no longer ruled out by relativity, and good reasons can now be advanced for postulating an aether.[20]

In line with Dirac, Cantor and Hodge notice that "quantum theory has led to new conceptions of ether, and not a few physicists have urged the *necessity* of some form of ether theory."[21] Therefore, it must be borne in mind that even though Einstein's relativity put an end to the concept of ether *in its pre-relativistic sense*, ether has continued to be invoked by scientists in various contexts till today. Given this relationship between vacuum and ether, it is no surprise that several conceptual parallels have also been drawn between quantum vacuum and *ākāśa*.

Among the many claims comparing notions of Eastern spiritual traditions with

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[20]Dirac, "Is there an aether?" *Nature*, 168 (1951): 906-07. According to Einstein, the existence of ether is incompatible with the principle of relativity. There cannot exist an absolute frame of reference like ether and one must accept that in principle a "perfect vacuum" exists. But in quantum mechanics, says Dirac, the various properties of an hypothetical ether are subject to uncertainty relations. It means, for instance, that the velocity of ether for a particular state at a certain point of spacetime can be distributed over possible values according to probability laws. According to Dirac, it is not impossible to "set up a wave function which makes all values for the velocity of the aether equally probable. Such a wave function may well represent the perfect vacuum state in accordance with the principle of relativity." See: *ibid.*, 906.

[21]Cantor and Hodge (eds.), *op.cit.*, 53.

concepts of quantum physics, some highlight the affinities between quantum vacuum and *ākāśa* in Hinduism. In *Science and the Reenchantment of the Cosmos*, published in 2006, the Hungarian systems theorist Ervin László makes the following remark:

> The latest cosmologies re-discover the cyclically self-renewing universe, a cosmos that takes off from, and returns to, an enduring fundamental medium. The ancient Hindu cosmology can be restated in contemporary scientific terms simply by substituting "quantum vacuum" for *ākāśa*.[22]

In László's opinion, the emerging idea in cosmology of a self-renewing universe out of which matter and forces arise and return to cyclically is not new. It was foreseen a long time ago in the Hindu concept of *ākāśa*. According to ancient Hindu cosmology, indeed, there is something that remains when all matter and forces in the world have returned to their source: *ākāśa* without any motion, or *prāṇa*. When *prāṇa* becomes active again, the whole mental and physical universe evolves once more in various forms. In the light of latest cosmologies, says László, the quantum vacuum plays exactly the same role as *ākāśa* in Hindu cosmology: it is the substratum that remains "alive" when the whole universe enters into a latent state, and it is the medium through which this universe eventually takes existence again. This correlation is explicitly established in the following excerpt of another paper:

> [The quantum vacuum] is both the beginning and the end, the cradle and the deathbed of universes. But, although they die, universes do not *stay* dead: they come back to life as the vacuum re-energizes itself. The vacuum is *ākāśa* and *prāṇa* rolled into one: the dynamic virtual-energy substratum that endures through all of time and fills all of space.[23]

Clearly, what is at stake here is vacuum as a "cosmic substratum" that is dynamic in nature and all-pervading in space. László stresses the fact that vacuum endures through all of time, and survives multiple births and deaths of universes. However,

[22] László, *Science and the Reenchantment of the Cosmos: The Rise of the Integral Vision of Reality*, 89-90.

[23] László, "The Old and the New Concept of a Self-Renewing Universe," 3. This article was found on Internet and does not seem to be part of any book (Source: http://www.adebate.com/descargas/Saber/Selfrenewinguniverse.pdf).

this is far from a commonly accepted view in the field. In fact, László grounds his idea of the existence of many universes in some recent cosmological observations still unexplained by the standard Big Bang model.[24] To mention only two of them: 1. the *flatness problem*: it is difficult to explain the (spatial) quasi-flatness of the present universe without assuming there was an extreme "fine-tuning" of the conditions prevailing in the early universe; and 2. the *horizon problem*: though in all probability different regions of the universe have never "contacted" each other due to the great distances between them, they still show similar physical properties.[25] In order to explain why the universe appears so fine-tuned cosmologically, László suggests that the present universe might have emerged from a more fundamental "meta-universe" existing beyond the observable universe.[26]

It is true that the abovementioned problems represent important shortcomings of the standard Big Bang model. However, solutions have been proposed that should reasonably be put to test before invoking the existence of "multiverses" — that is of an ensemble of universes or universe domains — as an explanation of fine-tuning. As of now, "cosmological inflation" provides an attractive and coherent framework to account for the structure of the present universe. Though many inflationary models exist that can satisfy the present observational data, there is hope that future observations will allow scientists to discriminate between these various models.[27] Also, the hypothesis of many universes is observationally and experimentally untestable. If science is taken to involve testability, such a claim becomes problematic as a scientific explanation.[28] Further, the multiverse hypothesis represents "a regress of causation"

[24]As of now, the Big Bang model is the most accurate and comprehensive cosmological model stating the initial conditions and subsequent development of the universe. It asserts that the universe had its origin in a primordial dense and hot state around 13 billion years ago. Gradually, the universe expanded and became colder giving birth to the various forces and forms of matter currently known.

[25]László, *Science et champ akashique: Une théorie intégrale du Tout*, 34-35.

[26]*ibid.*, 36.

[27]Langlois, D., "Lectures on Inflation and Cosmological Perturbations" (2010), 52-53 (Physics Archives: http://arxiv1.library.cornell.edu/abs/1001.5259).

[28]Ellis, G.F.R., "Issues in the Philosophy of Cosmology" (2006) (Physics Archives:

because the question remains as to how the multiverse originally came by the right properties at the beginning to create that of our universe, and so forth.[29] This does not mean that the hypothesis is unreasonable philosophically speaking but only that its scientific status is difficult to assess.

In László's view, quantum vacuum is *substantial* insofar as it carries light, energy, pressure, sound and arguably information itself.[30] In *Science and the Akashic Field*, he takes resort to recent discoveries in quantum physics, post-darwinian biology and consciousness studies to posit the existence of an all-pervading "field of information": the akashic field. This field, which he eventually locates in quantum vacuum, correlates beyond space and time all the entities in the universe from atoms and galaxies to cells and minds. In his view, quantum vacuum acts as a kind of "hologram" carrying information on everything that exists and evolves in space and time. This is a feature also shared, he says, by the so-called "akashic chronicle" that "conserves the trace of all there is in the world, and all that ever was."[31] The point here is that even though several facts seem to suggest a substantialist interpretation of vacuum, other viewpoints can also be taken into consideration. For instance, the Casimir effect, usually invoked to support the view that vacuum is filled with energy and fluctuations, can be explained without relying on the notion of a fluctuating vacuum. As we have seen, there is also ambiguity as to the ontological status of vacuum in virtue of the various ontologies that can fit the QFT formalism. Moreover, from the general standpoint of quantum physics, ascribing an objective status to a quantum entity has no significance independently of the act of measurement. Recalling arguments by Bitbol and d'Espagnat, is it even meaningful to talk of vacuum as an objective substratum filled with energy and matter?

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http://arxiv.org/abs/astro-ph/0602280).

[29]Stoeger, W.R. *et al.*, "Multiverses and Cosmology: Philosophical Issues" (2008), 34 (Physics Archives: http://arxiv.org/abs/astro-ph/0407329).

[30]László, *Science et champ akashique: Une théorie intégrale du Tout*, 61.

[31]László, "The Old and the New Concept of a Self-Renewing Universe," 5.

Furthermore, what László really means in the first quotation above when he refers to *ākāśa* in "ancient Hindu cosmology" is unclear. Hinduism does not possess a uniform and commonly accepted cosmology. Reflections of a cosmological nature are found in a multitude of texts and genres, from mythical and metaphysical speculations in the *Vedas* and *Purāṇas* to more elaborate and systematic reflections of the classical *darśanas*. Given that László seems familiar with Vivekananda's writings (he quotes him in some of his books) and also that he often mentions *ākāśa* in conjunction with *prāṇa*, he probably has Vivekananda's interpretation in mind when discussing *ākāśa*.[32] When correlating vacuum with the "akashic chronicle," László deviates in important ways from the meanings given to *ākāśa* in the Indian tradition. Neither in the *Upaniṣads* nor in *darśana* literature do we find the idea that *ākāśa* contains and carries information about physical and mental facts of existence. The notion of "akashic chronicle" (or "akashic records") which he refers to originates in the Western Theosophical movement during the late 19th century, and designates a non-physical place wherein all knowledge and history — past and future, individual and collective — would be stored since the beginning of time. Since its inception this notion has remained in circulation in a number of forms in New Age literature, and László may possibly be referring to some such prevalent idea.

In László's writings, we find an honest effort to build a synthetic view of the world on the basis of insights coming from all fields of science. In line with "integral thinkers" like Jean Gebser and Ken Wilber, he believes in an "authentic theory of everything" that would integrate not only the physical world but also life, spirit and culture on a scientific basis.[33] However, as we have seen, a major problem with László's approach is that some of the "scientific" facts invoked in support of his views are either not unanimously accepted by the scientific community or simply beyond the

[32]As an example, László quotes the description of *ākāśa* given by Vivekananda in his *Raja-Yoga* (quoted above) in the introduction of his paper "The Old and the New Concept of a Self-Renewing Universe."

[33]László, *Science et champ akashique: Une théorie intégrale du Tout*, 2.

scope of scientific investigation. His comparison between *ākāśa* (or "akashic field") and quantum vacuum is subject to the same fallacies. His notion of "akashic field" as an all-pervading and interconnecting field of information is as hypothetical as his description of quantum vacuum as a substantial medium at the origin and end of multiple universes. Methodologically, he overlooks the multi-faceted nature of these concepts and the fact that they also pertain to traditions of knowledge that are diverse in terms of aims and methods. While reading László, we also sometimes get the impression that he uses the ancient Hindu *ākāśa* to justify his own views about quantum vacuum and more generally science itself.

A similar though less ambitious attempt has been made by Dr. Nrusingh Charan Panda in his book *Māyā in Physics*, first published in 1991. Panda seems to share with László the idea that *ākāśa* and quantum vacuum both connote potentiality of some kind. In several passages, he describes *ākāśa* as the locus out of which particles (and antiparticles) emerge and to which they return at the end of their existence. Here are some examples:

> ... particles and antiparticles appear from *ākāśa* (space)... They originate from space; they are dissolved into space (p.160).
>
> The particle-pairs were formed out of *ākāśa* and were again re-united to be merged into *ākāśa* (p.275).
>
> Particles and antiparticles are produced from it [*ākāśa*] and again they are merged into it (p.277).

It is to be noted that Panda never explicitly identifies *ākāśa* with quantum vacuum *per se*. But there is good reason to believe that this is what he means since the function of generating and taking back particles is generally ascribed to vacuum in QFT. Strictly speaking, however, this can also be a property of the quantum field (of which the vacuum is a specific state) and thus Panda identifies *ākāśa* with field in some passages:

> With the "field" concept in modern physics, *ākāśa* is being considered as field. The so-called void of *ākāśa* is really full; from it micro-particles jump out to appear and they dip into to disappear (p.5).
>
> What we call "field" in quantum physics is described by three words in the Vedic literature, viz., *apāṁ-napāt* or *āpaḥ*, *prāṇa* and *ākāśa*. All these three words represent three sub-states of a single state known as "field"... *Ākāśa* or space is less subtle than *prāṇa*, but subtler than energy and matter particles (pp.275-76).

In Panda's view, then, *ākāśa* is a latent or potential state "subtler than energy and matter." Though it looks like void or emptiness (*śūnya*), it is not "nothing": it is a positive entity, a plenum full of potentiality but too subtle to be perceptible to our senses. And yet, Panda considers *ākāśa* on par with other physical existents insofar as it is a created element. In line with Śaṅkara and other Advaitins, he believes that *ākāśa* "has no existence after the dissolution and before the creation and hence is not ever present. It has been created in the process of cosmogony and it will be dissolved in the process of dissolution."[34] In support of his claim, he takes his cue from Vedāntic literature such as the *Brahmasūtra* (BS I.1.22; II.2.24) and *Upaniṣads* (ChU I.9.1, TU II.1.1). On this point, he thus stands closer to the Indian tradition (in particular, Advaita Vedānta) than László who considers *ākāśa* to "endure through all of time," that is, beyond the dissolution or "death" of the universe. For that matter, this is another aspect on which László deviates from traditional Vedānta teachings.

As far as his conception of vacuum is concerned, Panda seemingly follows László in taking vacuum as something substantial. As noted earlier, such an interpretation is subject to criticism. Though there have been interesting developments in recent years in favour of a field ontology (in which field/vacuum is substantial), the ontological status of vacuum in QFT is still a much debated issue among physicists and philosophers of physics. Furthermore, since the introduction of fermionic fields by Jordan and Wigner in 1928, the definition and role of "substance" as a philosophical category in physics has been deeply questioned. Overall, there is a lack of nuance in

[34]Panda, *Māyā in Physics*, 277.

this regard in Panda's study. In spite of this, one special feature draws our attention: the rapprochement he makes with the concept of "unmanifest." (*avyakta*) Panda considers *ākāśa* (and implicitly vacuum, which he also refers to as "space") as a subtle form of matter out of which particles are "created" and to which they inevitably return when "destroyed." But what is the meaning of "creation" and "destruction" here? Here is Panda's explanation:

> ... particles and antiparticles appear from *ākāśa* (space)... suddenly they appear, transiently they live, for a billionth or a trillionth part of a second they dance, and then they disappear. When they disappear, they apparently vanish but they don't become nothing. They originate from space; they are dissolved into space. In the beginning they were unmanifested (*avyakta*); in the middle they became manifested (*vyakta*); and in the end they became again unmanifested (*avyakta*). There is no gain and no loss in this whole process. Really there is neither generation nor annihilation.[35]

What is called "creation" consists in fact in a transformation from an unmanifest (*avyakta*) to a manifest (*vyakta*) state of being. Conversely, "destruction" consists in a transition from a manifest to an unmanifest state of being. In Panda's view, *ākāśa* is the locus where the unmanifest becomes manifest by evolving from subtler to grosser states, and vice-versa. In the process of evolution, gross and perceptible matter in the form of particles and antiparticles emerges from *ākāśa*, which is subtle and non-perceptible; in the process of involution, what is gross returns to a subtle and unmanifest state. There is no reason to believe, says Panda, that space, matter and energy are created *ex nihilo*. The appearance of particles and antiparticles in vacuum is not a phenomenon of nothing becoming something but one of transformation of something into something else.[36] Eventually, being subject to dissolution, *ākāśa* will also return to a subtler state of being, namely *māyā*. In turn, *māyā* itself, the source and final recipient of the whole universe, must also return to its unmanifested source: *Brahman*, the "unbroken whole" that is also "pure consciousness." *Brahman* is the

[35] Panda, *op.cit.*, 160.
[36] *ibid.*, 397-98.

only Reality, the substratum underlying and supporting the apparent and ephemeral phenomenal world.

No doubt, Panda's explanations agree in detail with Advaita Vedānta teachings. For instance, the correlation between *ākāśa*, *avyakta* and *Brahman* is a recurrent theme in Śaṅkara's writings. The significant point here, however, is Panda's use of the concept of "unmanifest" (*avyakta*) as a way to link Advaita Vedānta conception of *ākāśa* with quantum vacuum in physics. A similar attempt has been made by Dr. U. Chandrasekharayya in his book *Vedānta and Modern Physics*, published in 2006. Here, the author equates quantum field with Śaṅkara's unmanifested *avyakta*: both field and *avyakta* have the potential to manifest something — particles and antiparticles on the one hand, and names and forms (*nāma-rūpa*) on the other hand — and may be said to be in a state of readiness to do so.[37] Unlike Chandrasekharayya, however, it is not clear whether Panda identifies *avyakta* with vacuum (or field) itself or with some other state of existence beyond vacuum. In any case, it seems pertinent to ask whether physicists and philosophers of physics have really come to similar conclusions in their approach to vacuum. Does quantum physics look upon vacuum (or quantum field) as an "unmanifest" state of being, that is, a positive though non-perceptible entity out of which the phenomenal world manifests itself? We shall examine this question in more detail in the next section.

From our comparative analysis, it appears that Vedāntic *ākāśa* and quantum vacuum indeed share some conceptual affinities. Before proceeding further, it is useful to summarize and comment upon them:

1. *Substantiality*: Quantum vacuum and *ākāśa* can hardly be equated with void or pure nothingness; both seem to be endowed with a certain form of substantiality. *Ākāśa* is one of the five *mahābhūtas* (from *bhū*, "to exist"), and is the medium for the quality of sound; it pervades all bodies and is subtle (*sūkṣma*) in nature. As to vacuum, it is widely recognized that pure empty space does not exist in quantum physics: the fluctuations in the vacuum state strongly suggest that the vacuum must be something substantial (though not in the classical

[37] Chandrasekharayya, *Vedānta and Modern Physics*, 408-09.

sense of some "stuff" endowed with objective properties). The field ontology in QFT, which is accepted by a large number of scientists and philosophers, supports such an interpretation. However, there exist other possible ontologies for QFT like particle, event, tropes, etc., in which vacuum does not obtain such a status. In any case, we cannot equate *ākāśa* and vacuum on the basis of their "substantiality" given that the concept of substance obtains different meanings in Advaita Vedānta and QFT;

2. *Potentiality*: Quantum vacuum and *ākāśa* denote the media from which the manifest world comes into existence. *Ākāśa* gives rise to other elements — air, fire, water and earth — and incidentally to all created things; in texts, it is identified or correlated with concepts like *avyakta*, *prakṛti*, *māyā*, i.e., all terms suggesting ideas of potentiality for creation and manifestation. Yet, for Śaṅkara *ākāśa* is only a passive intermediary in the process of creation initiated by *Brahman*. From Dirac onwards, quantum vacuum has been described as a reservoir containing particles and antiparticles that continuously pop into and out of existence. Some philosophers (viz., Cao) have recently interpreted vacuum as a "pre-substance, an underlying substratum having a potential substantiality." Despite the fact that QFT can be understood without the notion of a fluctuating and potential vacuum, the latter remains a consistent means to explain/understand phenomena like Casimir and Unruh effects;

3. *Cosmogonic primacy*: Both Advaita Vedānta and modern physics admit that the present universe is the outcome of an evolution process. *Ākāśa* is the *first* material element to appear in Śaṅkara's view and in most Advaita texts. Yet, it has its ultimate source in the non-dual *Brahman*, with *avyākṛte nāmarūpe* (or *māyā* in later Advaita) as an intermediary principle of creation. Quantum vacuum stands as the "entity" (if entity there is) from which cosmogenesis takes place insofar as it is at the origin of all elementary particles and carriers of field interactions in QFT. This is also supported by cosmological inflation models which argue that vacuum fluctuations played a crucial role in the early development of the universe. However, inflation remains hypothetical, and given that we have no consistent theory of quantum gravity, we are still unable to understand spacetime and quantum dynamics of the vacuum state at the beginning of the universe. Thus, the real implications of vacuum in cosmogenesis remain currently unknown;

4. *Non-perceptibility*: Quantum vacuum and *ākāśa* are both non-perceptible as such though their existence can be inferred in other ways. *Ākāśa* lies outside the range of direct perception: it has no taste, no colour, no smell, etc. Yet, if it cannot be perceived *as it is*, its existence can be inferred from its association with certain qualities (sky colour, sound, etc.). Some later Advaitins, however, argued that *ākāśa* can only be known through "witness-consciousness" and not through perception or inference. Strictly speaking, quantum vacuum equally lies outside the range of direct perception: it has zero energy, zero momentum, zero charge, etc., and as such cannot be detected with instruments. Nevertheless, its existence can be inferred through vacuum fluctuations in the form of virtual particles (predicted by Heisenberg's principle). These virtual particles may not be directly observable, yet they arguably have measurable effects on the "real" world (ex: Casimir and Unruh effects). However, we must again bear in mind: 1. these effects do not *necessarily* entail the *physical existence* of vacuum

fluctuations; 2. because it is a quantum entity, it cannot be claimed that the observed properties of vacuum are "objective," i.e., present in the absence of measurement;

5. *All-pervasiveness*: Quantum vacuum and *ākāśa* are both all-pervasive. Many texts assert the all-pervasiveness (*vibhutvam*) of *ākāśa*. But Śaṅkara explains that it is all-pervasive only in a spatial sense, not with reference to things and time: it is separate from other things and has a finite existence. Only *Brahman* is all-pervasive with respect to space, time and things. Quantum field (of which quantum vacuum is a state) can be said to be all-pervasive with respect to space (it is embedded in the whole spacetime) and things (insofar as particles and forces are a manifestation of quantum fields). Yet, it remains true that without a proper theory of quantum gravity, the relation between quantum vacuum and gravitational field remains unknown: the all-pervasiveness of vacuum is not complete. Moreover, we must be aware that since quantum vacuum is a quantum object, its properties are defined in the microscopic realm; no such distinction exists in the cosmology in which *ākāśa* is defined.

Given these affinities, it seems at first sight understandable that parallels would be drawn between these concepts. However, a closer scrutiny reveals that mere conceptual affinities do not entail any kind of genuine correspondence between *ākāśa* and quantum vacuum. It is in no way possible to equate or identify these concepts as referring to the same reality — an enduring, subtle and all-pervading physical substratum out of which the constituents of the world come into existence and to which they ultimately return. Deep down, the attributes mentioned differ both in content and in form. Thus, conceptual parallels of that sort cannot lead to a productive exchange between modern physics and Advaita Vedānta. Each system has its own conceptual and epistemological framework, its own aims and methods as well as its own hermeneutical and historical issues. In almost all cases, however, this complexity is either not taken into account or not properly addressed. Sometimes affinities noted between *ākāśa* and quantum vacuum seem to have an apologetic bias. The intention is not to critically examine how both concepts relate to each other in terms of their similarities *and* differences, but to associate them in a way to promote certain views (such as the superiority of Vedānta over science, the "scientific" character of Vedānta or the "mystical" nature of science). For these reasons, we believe that conceptual affinities generally fall short of establishing a productive dialogue between modern physics and Vedānta.[38] A more significant line of approach might be to compare how these systems respond differently to similar philosophical problems. Such an approach necessarily involves considering the various differences between the systems, therefore leading to a deeper and more authentic exchange.

In the present context, we note that the conceptual affinities mentioned above point to a remarkable epistemological fact arguably common to both Advaita Vedānta and quantum physics: both Vedāntic *ākāśa* and quantum vacuum would disclose the existence of an *unmanifest* state preceding worldly manifestation. By "unmanifest" we understand here a positive yet non-perceptible state of existence that is beyond the scope of reasoning as well. It can be understood in a cosmological sense as that latent state of existence preceding manifestation, and yet which constantly "supports" manifestation. It can also be understood more generally in terms of the limits of empirical knowledge, i.e., as "that" which remains inaccessible to sense-perception and reasoning when enquiring into the nature of the world. Such considerations invite deeper reflection as to how the broader concept of "reality" is assessed in modern physics and Advaita Vedānta. As we shall see, in their attempt to define the nature of reality both systems face a similar epistemological problem, namely the impossibility to specify the whole content of reality by the means of sense-perception and reasoning alone. Thus it is possible to argue that *ākāśa* and quantum vacuum function as such "epistemic boundaries" within their respective framework. Shifting the comparative outlook from the conceptual to the epistemological level, we can try to provide a more consistent basis for reconstructing the dialogue between modern

[38]That is not to say that conceptual rapprochements have no epistemological value whatsoever. For instance, it might be worth noting that the idea of an oscillating universe emerging in modern cosmology finds more resonance with the Hindu cosmological cyclical doctrine of creation than with Western religious cosmologies. This shows how non-Western paradigms can also have relevance in discourses at the intersection of science, philosophy and religion. What should be avoided is the tendency to see in conceptual affinities "meaningful identities," or the indication of a significant *relationship* between the disciplines compared. Analogies might be tempting but upon closer scrutiny they reveal nothing substantial, and do not seem to entail any constructive dialogue either.

physics and Advaita Vedānta.

5.1.2 Epistemological Boundary

In Chapter 4, we looked into the diverse interpretations of *ākāśa* in the main Hindu *darśanas* or schools of thought. Our analysis revealed the ambiguous character of *ākāśa* as both an element on par with other elements and an entity transcending the very notion of element. In his short study on *ākāśa* in Indian thought, Halbfass depicts this ambiguity as follows:

> ... [*ākāśa*] is not simply one element among others. It is something far more elusive and ambiguous, something floating and oscillating between being and nonbeing, something appearing as an entity in space, sometimes as the openness and emptiness of space itself.[39]

In his view, the ambiguity characterizing *ākāśa* reflects the disparity between two interacting ontologies in Indian philosophy: a substantialist ontology and an ontology of openness. In Advaita Vedānta more than in the other schools, the second ontology obtains a prominent status. This ontology does not focus on the substance which gives birth to entities, but on the "open space" in which they appear. Here allowance is made for *creation* understood as a primeval event of separation and opening.[40] Hence, *ākāśa* in Advaita Vedānta is often emphasized not as a substance on par with others but as an entity akin to (and sometimes synonymous with) the creator and support of the world, *Brahman*. Further, *ākāśa* is associated with the inner self, *ātman*, and stands as its symbol in the "inner space of the heart." (*antaḥ hṛdaya ākāśaḥ*) No other element comes closer to the Absolute than *ākāśa*, and so it has been

[39]Halbfass, "Space or Matter? The Concept of *ākāśa* in Indian Thought." In: Nair (ed.), *Mind, Matter and Mystery: Questions in Science and Philosophy*, 85.

[40]Halbfass, *On Being and What There Is: Classical Vaiśeṣika and the History of Indian Ontology*, 31.

described as "the first exhalation of the absolute. . . closer to the roots of our world than anything else that may be found in it."[41]

In Advaita Vedānta, the Absolute is the non-dual *Brahman*, which is beyond all kinds of distinctions and non-different from pure awareness (*ātman*). As discussed earlier, a most pressing question for Advaitins is: if *Brahman* is non-dual and beyond distinctions, what can explain our experience of a plural world? How can *Brahman*, which stands for pure awareness, give rise to this material world? Why should the One become many, the self other-than-the-self? On the authority of TU II.1.1, the *Brahmasūtra* (II.3.1-7) considers *ākāśa* as the first evolute to emerge from *Brahman* and as noted already, Śaṅkara agrees with it. But in order to solve the questions above, Śaṅkara introduces a principle in between *Brahman* and *ākāśa* so to say, namely the "unevolved name-and-form." (*avyākṛte nāmarūpe*) We already explained the central role played by this principle within Śaṅkara's cosmological scheme of creation. Here we would like to emphasize in what sense it stands as an "unmanifest" state of being in his Advaita philosophy. In the Vedāntic texts, unevolved name-and-form is a state *prior* to the manifestation of the world, in which state names and forms (*nāmarūpe*) — which specify the content of every individual manifestation — are still unfolded (*avyākṛta*) and not manifested (*abhivyakta*). BSB I.2.22 denotes this state as *bījaśakti*, which means "seed potency" or "seed power," indicating its inherent power or capacity for manifestation. In Śaṅkara's *Upadeśasāhasrī* (II.1.18), it is described as the "seed of the world." (*jagadbījabhūta*) Similarly, in BSB II.1.14 it is called the "seed of *saṃsāra* and the phenomenal world." (*saṃsāra-prapañca-bīja*)[42]

In all these passages, unevolved name-and-form is clearly understood as a latent state from which the world comes into being. Insofar as it is potential and preceding

[41]Halbfass, "Space or Matter? The Concept of *ākāśa* in Indian Thought," 91.

[42]Hacker, "Distinctive Features of the Doctrine and Terminology of Śaṅkara: *avidyā, nāmarūpa, māyā, Īśvara*." In: Halbfass (ed.), *Philology and Confrontation: Paul Hacker on Traditional and Modern Vedānta*, 68.

world manifestation, it denotes an unmanifest (*avyakta*) state of being. But it is an unmanifest *ready* to be manifest and transformed into something else. In Śaṅkara's view, the primal state of the universe is thus characterized by instability and indeterminacy. In several instances, Śaṅkara uses the expression *tattvānyatvābhyām anirvacanīya* as an adjective qualifying the principle of "unevolved name-and-form." The term *anirvacanīya* itself conveys the sense of something indescribable, indefinable, indeterminable, unspeakable; and thus, the whole expression means that *avyākṛte nāmarūpe* is "indescribable as this or something else."[43] In the words of Hacker, the expression denotes:

> ...the instability of the primal state, which is not yet something but desires to be made into something (*vyācikīrṣita*). In a broad sense the expression describes the unsteadiness of that about which one can never say, "It is that" or "It is something else," for just as it wanted to unfold itself in the primal state, so now it always want to transform itself and is never anything constant [*sic*].[44]

According to Hacker, the expression *tattvānyatvābhyām anirvacanīya*, when juxtaposed to unevolved name-and-form, carries important epistemological implications for Śaṅkara. Because the primal state of the world is unstable — for it always wants to be transformed into something else — it is indeterminate and unknowable as a category of thought. Thus, in his *Upadeśasāhasrī* (II.1.18), Śaṅkara states that unevolved name-and-form is "known only to *Brahman* itself." (*svayaṃvedya*) In other words, what is unmanifest cannot be known using the categories of the phenomenal world, that is, what is manifest. In later Advaita, however, the term *anirvacanīya* is used in conjunction with *sadasadbhyām* instead of *tattvānyatvābhyām*, the former implying an ontological judgement. For Advaitins following Śaṅkara, the expression *sadasadbhyām anirvacanīya* suggests the impossibility to prove that *avidyā* or *māyā* (or its product, the world) *is* or *is not*.[45]

[43]Mayeda, *A Thousand Teachings: The Upadeśasāhasrī of Śaṅkara*, 22.
[44]Hacker, *op.cit.*, 73.
[45]Hacker, *op.cit.*, 73.

In post-Śaṅkara Advaita, *māyā* mainly assumes the role played by *avyākṛte–nāmarūpe* in Śaṅkara's cosmology. Like unevolved name-and-form, *māyā* explains why the One becomes the many, the real the unreal, the self the other-than-the self. It is the power (*śakti*) of *Brahman* that at once conceals the non-dual and spiritual *Brahman* and projects upon it the manifold material world. Preceding *ākāśa* in the evolution process, *māyā* obtains the same status as *avyākṛte nāmarūpe* in the hierarchical scheme of creation. As an example, in Upad II.1.19 it is said that "originally unevolved, this name-and-form (*nāmarūpe*) took the name-and-form of *ākāśa* in the course of its evolution..." Similarly, the much later text *Siddhāntabindhu* (138) says that ignorance in the form of *māyā* first took the form of *ākāśa*, which took the form of air, etc. Already in Śaṅkara's BSB, *māyā* is identified with *avyākṛte nāmarūpe* or given a similar meaning. In BSB I.4.3, for instance, we are told: "That *māyā* is surely unmanifest (*avyakta*), for it can neither be ascertained as real nor as unreal." (*avyaktā hi sā māyā tattvānyatva nirūpaṇasyāśakyatvāt*) Though the term *anirvacanīya* is not used here, the same meaning is conveyed. Like unevolved name-and-form, *māyā* is unmanifest as well as indeterminate. Perception and logical reasoning cannot disclose the nature of *māyā*, which is neither real nor unreal: "not real" because it is eventually sublated by the knowledge of *Brahman*, and "not unreal" because it manifests, or projects, the world as something real until *Brahman* is known.

There is a correlation between *avyākṛte nāmarūpe* and *māyā* as it is by the power of *māyā* that the world of names and forms comes into being. There is also a correlation between *avidyā* (ignorance) and both *nāmarūpe* and *māyā* in several instances. It is because of *avidyā* that the complex *nāmarūpe*, which is manifested through the power of *māyā*, appears to be real. The three concepts differently explain or account for the transition from the real *Brahman* to the "unreal" material world. Thus, in BSB I.4.3 *avyakta* is equated with *māyā* but also with *avyākṛte nāmarūpe*, *avidyā*, *akṣara* ("imperishable") and *ākāśa*. The series of identification suggests that these terms are all interchangeable for Śaṅkara, at least in reference to the prime matter of the universe.[46] But in contrast with Śaṅkara's *avyākṛte nāmarūpe*, which has cosmological connotations, *māyā* is a purely epistemological entity. Functionally, it is "that which measures" (*mīyate anena iti māyā*) our own *unknowability of Brahman*. In the realm of *māyā*, individuals and the world have a seemingly separate and objective existence of their own. In this perspective, *Brahman* can only be approached as an "object" of thought, different from the world and individuals. But *Brahman* is by definition pure subject *sui generis*, and beyond the scope of perception and reasoning. In a certain sense, then, *māyā* has the ability to awaken us to the understanding that through perception and reasoning (which pertain to *māyā*), *Brahman* cannot be known.[47]

In literature, *ākāśa* is closely related to *avyākṛte nāmarūpe*. According to Hacker, both *ākāśa* and *avyākṛte nāmarūpe* are among the preferred expressions used by Śaṅkara to denote the primal state of creation itself.[48] In several places, *ākāśa* is described as the first material element to emerge from *avyākṛte nāmarūpe* or *māyā*. As a consequence, it can be said that the immediate cause of *ākāśa* in Advaita Vedānta is: ontologically, a potential and unmanifest state of being; and epistemologically, an indeterminate state unknowable through perception and reasoning. In other words, *ākāśa* represents a boundary delimiting two domains: on the one hand, the unmanifest and the unknowable (in a rational-empirical sense), and on the other, the manifest and the knowable. However, it is crucial to understand that what is ultimately unknown, indescribable, unmanifest and potential can only be *Brahman* according to Advaita. In fact, neither *māyā* nor *avyākṛte nāmarūpe* have a reality independent of *Brahman*. In Upad II.1.19, the relation between unevolved name-and-form and *ātman*, which is identical with *Brahman*, is explained as follows:

> [Originally] unevolved, this name-and-form took the name-and-form of

[46]Hacker makes the following remark: "But one should note that the equation of *avidyā* and *māyā* with *nāmarūpa* and *avyakta* occurs only in series of identifications. When they stand alone they have their specific function..." See: Hacker, *ibid.*, 84-85.

[47]Ramakrishna Rao, *Ontology of Advaita with Special Reference to Māyā*, 12-13.

[48]Hacker, *op.cit.*, 84.

> ether [*ākāśa*] in the course of its evolution from this very *ātman* [= *Brahman*]. And in this manner this element named "ether" arose from the highest *ātman*, as dirty foam from clear water. Neither is foam [identical with] water, nor absolutely different from water, since it is not seen without water. But water is clear and different from foam, which is of the nature of dirt. Likewise, the highest *ātman* is different from name-and-form which corresponds to foam. . .[49]

The simile of dirty foam and clear water indicates that unevolved name-and-form is neither identical with nor absolutely different from *Brahman*. Moreover, Śaṅkara's characterization seems to ascribe a lower reality to the unevolved name-and-form as foam — which is of "the nature of dirt" (*malarūpa*) — comparing to *Brahman* which is "clear," (*prasanna svaccha*) and "pure." (*śuddha*) "Dirt" is unreal and characterized by *avidyā*, and thus *nāmarūpe* has been variously denoted as "made of *avidyā*," (*avidyākṛta*) "falsely constructed by *avidyā*," (*avidyopasthāpita*) "consisting of *avidyā*," (*avidyātmaka*) etc.[50] Ultimately, *avyākṛte nāmarūpe* has no reality independently of *Brahman* and insofar as it has reality, it is a lower or transactional kind of reality. Similarly, *māyā* has its foundation in *Brahman* as its inherent power (*śakti*). Though it has its own existence in appearance — the world appearing as independent and self-contained — it is fundamentally dependent upon, coeval with and non-different from *Brahman*. The relation of *māyā* and *Brahman* is said to be one of *tādātmya*: it is neither identity nor difference nor both.[51] In BSB I.4.3, the "unmanifest" (*avyakta*) itself — equated with *māyā* and *avyākṛte nāmarūpe* — is said to be "subject to the supreme Lord, but not as an independent thing" (*parameśvarādhīnā tv iyam asmābhiḥ prāg-avasthā jagato 'bhyupagamyate, na svatantrā*).

We might want to recall the controversy in BSB (I.1.22, I.3.41) as to whether the word *ākāśa* — featuring in passages like ChU I.9.1 and ChU VIII.14.1 — corresponds to ordinary space or to the absolute *Brahman*. As we have seen, Śaṅkara concludes in such instances that *ākāśa* can only mean *Brahman* and not the usual space. The same

[49] Mayeda, *op.cit.*, 23.
[50] *ibid.*, 23-25.
[51] Sharma, *A Critical Survey of Indian Philosophy*, 274.

idea applies here. As far as the prime matter of the universe is concerned, terms like *avyakta*, *avyākṛte nāmarūpe*, *māyā*, *ākāśa*, etc., all point towards *Brahman*. From the standpoint of the *Brahman*-experience, which is the viewpoint *par excellence* in Advaita, there is no such thing as creation or creator. In this system, it must be emphasized that the purpose of cosmological inquiry is only to draw one's attention to the unity of being, i.e., *Brahman*. *Brahman* itself is non-relational, neither an object of thought nor a knower nor a witness. Because it is pure *ontos*, it is unknowable through means of knowledge like perception and reasoning. And yet, Advaita Vedānta teaches that *Brahman can* be known through a direct and non-epistemic kind of knowledge. Through contemplation and a process of internalization, it is possible to intuitively realize our deep identity and that of the world, with the Absolute *Brahman*.

It is significant that *ākāśa* has been invoked in the *Upaniṣads* and later Vedānta texts as an appropriate means for this realization. We have already shown how *ākāśa* — understood as the totality of external space — is an appropriate symbol for the Absolute, with whom it shares several affinities: it is infinite, subtle, all-pervasive, changeless, formless, etc. In the same manner, the *ākāśa* within the heart (*hṛdayākāśaḥ*) is a symbol of the ineffable self (*ātman*) dwelling inside us. In our inner "space," the self — which is identical with *Brahman* — dwells as an unmanifest and unknown witness. It cannot be perceived through sense-perception or inferred logically; it can only be revealed through insight when freed of attachment to sense and mind objects. Therefore, if *ākāśa* arguably embodies a *boundary* between *Brahman* and the manifest world, it can also be a *portal*, by means of inner contemplation, to the nature of the unmanifest and unknown Absolute. However, it is important to understand that notions like "boundary" and "portal" are meaningful only from the standpoint of rational-empirical consciousness; they lose their significance once the Absolute is self-revealed.

Quantum Vacuum as an Epistemological Boundary

In Chapter 3, our analysis made it clear that vacuum is also subject to ambiguity in quantum physics. Whether vacuum is endowed with substantiality or not is a hotly debated issue among scientists and philosophers of physics as we have seen. Particle ontology, for instance, gives prominence to particles and makes quantum field (and vacuum) a mere mathematical device for generating particles and their interactions. In contrast, field ontology features particles as epiphenomena of the primitive quantum field; here, field and vacuum are real and autonomous substantial states of being of which particles are manifestations. Conceptually, field ontology has the advantage of being able to solve the wave-particle problem in quantum physics. Wave and corpuscular aspects of matter are no more exclusive to each other but different aspects of the same reality — the quantum field. In this picture, the substantial vacuum appears as a truly unifying concept accounting for the creation and annihilation of particles and physical effects like Casimir and Unruh effects. The dilemma here is that, according to Einstein's special relativity — which has proved right since its formulation in 1905 — vacuum must be a state of nothingness. We recall here Cao's statement of the problem:

> On the one hand, according to special relativity, the vacuum must be a Lorentz invariant state of zero energy, zero momentum, zero angular momentum, zero charge, zero whatever, that is, a state of nothingness. Considering that energy and momentum have been thought to be the essential properties of substance in modern physics and modern metaphysics, the vacuum definitely cannot be regarded as a substance. On the other hand, the fluctuations existing in the vacuum strongly indicated that the vacuum must be something substantial, certainly not empty.[52]

There is some ambiguity as to whether vacuum has substantiality or not. According to relativity, it cannot be a substance whereas quantum physics depicts it as something far from empty. The parallel with Halbfass' description of the ambiguous nature of

[52]Cao, *Conceptual Developments of 20th Century Field Theories*, 176.

ākāśa in Indian thought is remarkable. Insofar as it is looked upon as a substance as well as a state of pure nothingness, vacuum also is "floating and oscillating between being and nonbeing, sometimes appearing as an entity in space, sometimes as the openness and emptiness of space itself." The parallel with *ākāśa* is not so much conceptual as epistemological: both concepts are elusive and ambiguous in ontological terms, an indication that their object is also difficult to assess epistemologically.

Earlier, we raised the question whether vacuum can be reasonably interpreted as an unmanifest state of being in quantum physics. As noted, Panda relates both *ākāśa* and quantum vacuum in terms of the locus where the unmanifest (*avyakta*) becomes manifest (*vyakta*) in the process of creation of particles. Similarly, Chandrasekharayya equates quantum field with the *avyakta* of Śaṅkara's philosophy, and draws an analogy between the "manifest" in both cases — that is, the virtual particles and the "names and forms" respectively — which are both characterized by indeterminacy. In the West, cosmologist Brian Swimme also raised similar ideas. In a 2001 interview, he was asked whether modern science also accepts the existence of an "unmanifest" realm besides the manifest realm characterized by space, time and and change. In Swimme's opinion, the unmanifest realm may well be represented by quantum vacuum in physics. In contrast with Newtonian vacuum, which is broadly understood as a place empty of things, quantum vacuum is *full* of things and events; it is dynamic and pure generativity. However, he says, vacuum *itself* is not manifest and cannot be an object of study:

> You can't *go* anywhere with this [quantum vacuum] in science because you can't study it. There's nothing to study. But it's there. It's real. So what we do is study its effects or manifestations, which we began to do in the '40s. There's no question now for a physicist about the reality of the quantum vacuum. Right now in this room, there are all kinds of particles that are foaming into existence and foaming back out of existence. That's what *we* mean by the unmanifest. So you could say that at the root of reality is space, time, and foam. It breaks with the Newtonian tradition of thinking of the universe as a *place* in which things are happening. It's actually this fountain of generativity; every moment of our existence is

> another flaring forth from the quantum vacuum.[53]

Coming from a renowned scientist, this statement has far-reaching implications. Insofar as vacuum is "pure generativity," we can only observe its effects or manifestations in the physical world. As discussed earlier, quantum fluctuations in vacuum are responsible for the sudden appearance of virtual particle-antiparticle pairs that usually last for a very short period of time. These "virtual" particles are not directly observable, and their existence can only be inferred from their effects on the "real" world. There exist a whole range of observable physical phenomena resulting from the interactions of virtual particles: the Coulomb force is caused by the exchange of virtual photons; the strong nuclear force between quarks is the result of interactions between virtual gluons; the spontaneous emission of a photon results from the decay of an excited atom; the Casimir effect and Lamb shift; etc. Though unobservable, virtual particles are omnipresent. According to QFT, there is a "cloud" of virtual particles surrounding each elementary particle in the universe. For instance, the electric field surrounding an electron has the ability to generate virtual photons of different energies. Close to the electron, photons have a high energy; apart and extending to infinity, photons have a low or null energy. If enough energy is available, virtual photons can themselves create other virtual photons, and so forth. The same picture is applicable to all particles in the universe.[54]

The vacuum is constantly subject to the frenetic activity associated with these unobservable virtual particles. Therefore, it is fair to say that at a fundamental level the vacuum is itself *unmanifest*: it remains beyond the scope of any kind of perception, however precise it may be. Incidentally, no inference or logical reasoning

[53] This excerpt was taken from an interview conducted in Issue 19 of *EnlightenNext* (Spring/Summer 2001). It can be found on: http://blog.enlightennext.org/2009/07/21/brian-swimme-on-emptiness-and-the-quantum-vacuum/

[54] It must be noted, however, that the view of vacuum as "pure generativity" does not imply a substantialist interpretation of vacuum as something "filled" with energy and matter. As "quantum objects," virtual particles cannot be envisaged as objective entities independently of the act of measurement. Moreover, though their effects on the "real" world are measurable, it does not mean that virtual particles themselves have a physical existence. What generates these effects — whether we call it "virtual particles" or something else — is simply beyond the scope of perception.

can really elucidate the nature of vacuum due to the lack of perceptual knowledge. As Swimme says, there is "nothing to study. But it's there." This is exactly the paradox Cao is referring to. On the one hand, because it is by definition devoid of any particle, vacuum cannot be regarded as a substance; it is pure nothingness and thus "not there" to be studied. On the other hand, vacuum fluctuations seem to point to something substantial, certainly not empty. In this context, Cao has proposed that perhaps it would be best to describe vacuum as a "pre-substance with a potential substantiality." Such pre-substance, says Cao, "can be excited to become substance by energy and momentum, and become physical reality if some other properties are also injected into it."[55] In other words, vacuum is an unmanifest and unobservable state that can become manifest if rightly excited. It is revealing that human beings have a central role to play in uncovering the deep nature of vacuum. In furnishing energy to quantum vacuum, *we* can help materialize its unmanifest and infinite potentialities. As physicist Basarab Nicolescu observes:

> The full quantum vacuum contains in itself potentially all particles, whether they have already been observed or not. It is we who have drawn most existing particles from nothingness in building our accelerators and other experimental apparatuses, whereas the "natural" world is much more "economical": the proton, the neutron, and the electron are sufficient for constructing almost the whole of our "visible" universe. We are, in this sense also, participants in a reality which embraces us, our particles, and our universe.[56]

We noted earlier that the quantum vacuum also serves an important purpose in the current understanding of the origin and evolution of the universe. Firstly, vacuum has deep implications in the cosmological constant problem. Vacuum fluctuations give rise to an enormous vacuum energy density that is believed to contribute significantly to the cosmological constant. In turn, the cosmological constant plays an important role in the physics underlying the acceleration of cosmic expansion. Secondly, in inflationary models vacuum fluctuations account for the formation of larger structures

[55]Cao, *Conceptual Developments of 20th Century Field Theories*, 176.

[56]Nicolescu, B., "Gurdjieff's Philosophy of Nature." (Source: http://www.gurdjieff-bibliography.com/Current/index.html).

in the universe such as galaxies. It has also been suggested that a vacuum fluctuation could be responsible for the creation of the whole universe. Should we then understand the vacuum to be the "medium" in which the Big Bang took place nearly 13 billion years ago? In fact, current theories are quite inadequate for the period preceding 10^{-43} seconds after the Big Bang. At that time, called *Planck time*, the universe was the size of an atom and had an extremely high temperature. At such temperature, it is believed that the four fundamental forces of nature (weak, strong, electromagnetic and gravity) were united together. At present, physicists are still struggling to bring together these forces into a single theory. But at such a small scale Heisenberg uncertainties become very significant, implying a very complicated spacetime dynamics, and the energies involved are extremely high, which makes investigation in laboratories very difficult.

Despite theoretical difficulties and lack of experimental evidence, the best speculation currently remains that the Big Bang occurred in the quantum vacuum. Current cosmological theories regard vacuum as the primary material reality generating all physical existents and interactions during cosmogenesis. The vacuum thus plays a crucial role in the creation and early evolution of the universe, at least from a theoretical point of view. But the physics governing cosmogenesis is not understood well enough to predict the exact implications of vacuum in the process. Beyond Planck time, notions of space, time, matter and energy lose their common meaning. Conceptual and even mathematical language prove insufficient to properly describe physical reality. The situation at the time $t = 0$ is even more complex. The Big Bang model predicts a *spacetime singularity* at that time, which means that all matter and energy of the universe is compressed in a single point of space. Since all the known laws of physics fall apart at the singularity point, the conditions at that time are inherently unpredictable from the standpoint of physics. Given our inability to assess the first moments of the universe, the profound nature of the cosmological vacuum thus remains a mystery. Once again, though in another sense, the vacuum embodies an epistemic boundary beyond which we have no access conceptually, theoretically and empirically.

It is worth noting that this conceptual failure is not only peculiar to modern cosmology but is a feature of most theories in modern physics. In special relativity, the classical notions of absolute space and time are abandoned and replaced by the more complex concept of a four-dimensional spacetime continuum. Conceptually speaking, the latter cannot be visualized as such but only represented in highly abstract mathematical terms. In quantum physics, physical reality becomes totally non-visualizable as we enter the realm of the infinitely small. Several features of this theory — from wave-particle dualism and indeterminacy to nonseparability — are simply not comprehensible within the logical framework of classical physics. In QFT, an extension of quantum physics, particles and fields are no more independent entities but different manifestations of a rather complex mathematical entity — the quantum field. Further, as previously noted, quantum theories, in sharp contrast with classical physics, do not ascribe the atomic world and its objects with objectivity in the classical sense. In no case can we suppose that a physical system exists with definite properties prior to measurement. This is a radical epistemological shift compared to classical physics. As far as the vacuum is concerned, it means that its various properties are intrinsically related to the measurement process. In a different manner, we revert to Swimme's claim that the vacuum itself cannot be a pure "object" of scientific investigation.

Having said this, the most appropriate ground to compare quantum vacuum and *ākāśa* appears to be epistemological rather than conceptual. In their respective framework, both concepts disclose an unmanifest state of existence beyond the reach of sense-perception and reasoning. In physics, the relation (or adequation) between vacuum and the "unmanifest" shows itself in various ways: 1. the unmanifest nature of vacuum as "pure generator" of particles that are not directly observable; 2. its unobservable character as a primary material reality in cosmology; 3. the impossibility of ascribing vacuum an objective and independent existence in quantum physics.

In the current state of physics, taking QFT as the standard worldview, no other deeper reality has been posited to underlie the vacuum or to explain its unmanifest nature. However, in Advaita Vedānta Śaṅkara traces the origins of *ākāśa* to the unmanifest "unevolved name-and-form" (*avyākṛte nāmarūpe*) which in turn depends upon *Brahman* for its existence. In Advaita Vedānta, *Brahman* ultimately stands alone as unmanifest and unknowable: unevolved name-and-form, *ākāśa* and the rest of creation all derive from it. Not surprising then that several authors have equated quantum vacuum with *Brahman* and other versions of the Absolute such as Spirit, Consciousness, the Tao, the Void of Buddhism, and so on. But as Ken Wilber observes, the result of such an equation "has been calamitous" and "perhaps the single biggest theoretical confusion in the entire field."[57]

The problem here is clearly one of ontological categories: we cannot equate a material reality with the non-dual Absolute. Firstly, insofar as it has properties and qualities (ex: energy) and is theoretically embedded in space and time, the vacuum cannot be identified with the qualityless (*nirguṇa*) *Brahman* of Advaita Vedānta; it is part of the manifest realm like other physical entities. This is a point that has also been noticed by Wilber:

> ...once you (mis)identify spirit with the quantum potential, there is no other way to go. Precisely because the quantum potential is not actually a radically formless or non-dual domain, it cannot serve as anything resembling a genuine spiritual reality, but rather is simply one aspect of a manifest realm that itself has qualities and quantities, and hence is not the radically Unqualifiable.[58]

Secondly, vacuum has no spiritual or esoteric connotation in contrast with *Brahman*, which is identified with *ātman*, pure awareness. Thirdly, to identify *Brahman* with whatever concept is to bring the non-dual into the domain of duality. The non-dual *Brahman* is not an "object" of perception and cannot be categorized as an object

[57]Quoted from: "Toward a Comprehensive Theory of Subtle Energies." (Source: http://wilber.shambhala.com/html/books/kosmos/excerptG/part2.cfm)

[58]*ibid.*

of thinking either. It can only be known with direct insight and not through means of knowledge pertaining to the manifest realm of *māyā*. Expressed differently, we cannot confuse absolute or non-dual truth (*parāvidyā*) with conventional or relative truth (*aparāvidyā*). Both truths belong to distinct ontological realms. Relative truth is concerned with the mundane world and its manifestations; it can be described in logical and conceptual terms. Absolute truth cannot be categorized in any way; any statement, by nature finite and relative, would reduce non-dual reality to something it is not. Insofar as it has a precise role and definition in physical theories, the vacuum is part of the relative, finite and manifest realm of *māyā*; it belongs to the domain of relative truth and as such can be studied through scientific means.

Nonetheless, vacuum has been described as "pure generativity" and something that cannot be studied (Swimme), as a "pre-substance" (Cao) and as something with no "pretention to an ontological status." (Bitbol) As such, the vacuum is envisaged as an unmanifest state of being which is *not* subject to scientific inquiry. Hence, what vacuum might share with *Brahman* is not so much its creative or potential nature — after all, from a non-dual standpoint there is nothing like "creation" — as the fact that it embodies, like *Brahman*, the restriction of our investigation of reality through rational-empirical means. Could we go further and take the unmanifest vacuum as a "pointer" to a more fundamental reality? In the same way that *ākāśa* is a means to know *Brahman*, could we envisage vacuum in physics as an invitation to contemplate a higher and transcendental reality? Since physics is not particularly concerned with esoterical or transcendental matters, this hypothesis seems hardly convincing. However, a physicist could consider vacuum as a theme for personal contemplation. The relationship established by Bitbol between vacuum and Nāgārjuna's emptiness (*śūnyatā*) points in that direction.[59]

[59]Bitbol notes that insofar as vacuum eludes any ontological characterization, it has a "therapeutic" function in that it contributes to overthrow mere "essentialist claims" about reality. We could go further and say that following Nāgārjuna's philosophy, such understanding could lead to the direct realization that all phenomena — including our own body, senses and mind — are devoid

5.2 Modern Physics and Advaita Vedānta

Our previous discussion has shown that conceptual affinities between *ākāśa* and quantum vacuum are not really productive. More relevant for us is that both concepts disclose a similar epistemological situation within their respective system: the existence of an unmanifest state of being inaccessible to perception and reasoning. The Advaita Vedānta tradition refers to this state as *Brahman* — described in the sacred texts as non-dual, and of the nature of being (*sat*) and consciousness (*cit*). Though *Brahman* gives rise and sustains the physical and mental realms of existence, it also transcends them and is said to be qualityless (*nirguṇa*). It is unknowable through perception and reasoning but it can be approached in a non-epistemic manner, i.e., through direct self-knowledge (*ātmavidyā*). From a different perspective, modern physics arguably envisages quantum vacuum as an unmanifest state of being out of which the physical world (particles, radiation, forces, etc.) originates and on the basis of which it maintains its existence. Though partly knowable through its effects on the "real" world, vacuum is not directly accessible through sense-perception (and its extension in measuring devices) and reasoning. Hence, despite their obvious differences — in terms of historical context, metaphysical framework and epistemological premises — *both systems recognize the limits of perception and reasoning when enquiring into the nature of reality.*

In order to elaborate this point, two specific issues have to be tackled: 1. we must first enquire further into the epistemology of quantum physics and compare it with that of Advaita Vedānta. It is usually taken for granted that the scientific worldview is strongly realistic in the sense that the world and its objects are independent "reals" that we can study objectively. This stance would contrast radically with the absolute idealism of Advaita Vedānta that takes *Brahman*, which is pure consciousness

of "self-nature" and "own-being." See: Bitbol, *L'aveuglante proximité du réel: anti-réalisme et quasi-réalisme en physique*, 272.

(*ātman*), as the foundation of reality.[60] However, the question of realism in physics has been debated by physicists and philosophers of physics on the basis of recent insights into quantum physics. Realism has either been completely rejected or has taken weaker forms to make room for some form of transcendence; 2. we must explore the philosophical implications of an astonishing phenomenon predicted by quantum physics, namely nonseparability. According to some scientists and philosophers, nonseparability might imply the existence of a "whole" underlying physical reality which is not embedded in space and time. The relationship of consciousness with this whole has also raised the attention of some philosophers of physics. These two philosophical issues of contemporary physics deserve attention and will be discussed in the next two sections. In the last section, we will provide what we consider useful guidelines for a constructive dialogue between modern physics and Advaita Vedānta.

5.2.1 Scientific Realism and Limits of Knowledge

In Chapter 2, we noted that one of the main implications of quantum physics was that it is inherently impossible to know reality "as it is." First, because the observer and more specifically the measuring device, inevitably interacts with the observed system. An atomic system is so tiny that no observation can be made without considerably

[60] As far as the external physical world is concerned, Advaita Vedānta adopts a naive realism. The physical objects are concrete entities existing independently of the individual mind and the senses, which apprehend them directly as they are. On its own level, the world is taken as real and thus Advaita refutes the thesis of subjective idealism, which denies any reality to the external world by reducing objects to collections of sense data in the perceiver. However, Advaita does not give ultimate reality to the physical world and upholds the primacy of the spiritual reality, *Brahman*. According to Satprakashananda, "Vedānta may be characterized as metaphysical or absolute idealism, inasmuch as it maintains the ultimate reality of one undifferentiated supreme Consciousness and views everything as identical with It in essence... Mental ideas and physical objects are both appearances from the standpoint of fundamental reality." Thus, the Advaita worldview should not be confused with objective realism. See: Satprakashananda, *Methods of Knowledge According to Advaita Vedānta*, 66.

affecting the system's behavior. In quantum physics nothing can be said about the properties of a system *prior* to measurement. The theory only provides probabilities for measuring specific values corresponding to physical properties in an experiment. Thus, we cannot construe "quantum objects" as entities endowed with fixed and objective properties independently of measurement. Second, and more generally, what the physicist is looking at is never "reality-in-itself" or "things-in-themselves," but a mediated reality in the form of concepts, models and abstract mathematical symbols. As British physicist Sir James Jeans explains, discussing the study of modern physics:

> ... we can never understand what events are, but must limit ourselves to describing the patterns of events in mathematical terms; no other aim is possible... Physicists who are trying to understand nature may work in many different fields and by many different methods; one may dig, one may sow, one may reap. But the final harvest will always be a sheaf of mathematical formulae. These will *never* describe nature itself, but only our observations on nature. Our studies can never put us into contact with reality; we can never penetrate beyond the impressions that reality implants in our minds.[61]

Virtually all the great physicists in the last century, from Planck and Bohr to Heisenberg and Schrödinger, did agree with this. They also believed that to equate insights from physics with mystical truths amounted to a profound confusion. If physics deals with symbols and constructions of reality, mysticism is rather concerned with a direct and nonmediated approach to reality. It is worth asking then, why these same physicists (and not those of the previous era) took interest in Eastern thought, as noted in Chapter 2. What features of the "new physics" (i.e., quantum and relativistic) were conducive to appreciate Eastern mysticism and philosophy? In *Quantum Questions: Mystical Writings of the World's Great Physicists*, Ken Wilber examines this question in the light of the writings of several important physicists. In their view, Wilber notices, there is a crucial difference between the "new" and the "old" physics: if both "physics" deal with symbols of reality, the "new physics *was forced to be aware of that fact* — forced to be aware that it was dealing with shadows and illusions, not re-

[61] Jeans, *Physics and Philosophy*, 15.

ality."[62] In the 1920s, when quantum physics was being created, the British physicist Arthur Eddington said that "the frank realization that physical science is concerned with a world of shadows is one of the most significant of recent advances."[63] The father of wave mechanics, Erwin Schrödinger, commented on this important result:

> Please note that the very recent advance [of quantum and relativistic physics] does not lie in the world of physics itself having acquired this shadowy character; it had ever since Democritus and Abdera and even before, but we were not aware of it; we thought we were dealing with the world itself.[64]

In other words, this "shadowy character" is not peculiar to quantum physics; it is characterizing every scientific enterprise yet it shows itself more clearly in the light of the epistemological changes entailed by quantum theory. In the same line of thinking, Sir James Jeans said:

> Many would hold that, from the broad philosophical standpoint, the outstanding achievement of twentieth-century physics is not the theory of relativity with its welding together of space and time, or the theory of quanta with its present apparent negation of the laws of causation, or the dissection of the atom with the resultant discovery that things are not what they seem; it is the general recognition that we are not yet in contact with ultimate reality. We are still imprisoned in our cave, with our backs to the light, and can only watch the shadows on the wall.[65]

The deep understanding that we have no access to ultimate reality in the "new physics" but only to "shadows on the wall," had a significant impact on the great physicists of the last century: it led the most sensitive among them to look "outside the cave," i.e., beyond physics, to know more about this reality. Their interest for the doctrines, ideas and concepts of Eastern philosophies corroborates this. It is not, as many authors believe, that there are particular affinities between the worldviews

[62] Wilber (ed.), *Quantum Questions: Mystical Writings of the World's Great Physicists*, 9.
[63] Eddington, *The Nature of the Physical World*, 282.
[64] Schrödinger, *Mind and Matter*, 42.
[65] Jeans, *The Mysterious Universe*, 111.

of physics and mysticism. As Wilber rightly points out, it was the "radical failure of physics, and not its supposed similarities to mysticism, that paradoxically led so many physicists to a mystical view of the world."[66]

In the decades to come, physicists and philosophers of physics would question more deeply the pertinence of realism in physics. In the philosophical sense of the word, realism involves the notion of reality-per-se, i.e., a reality conceived of as totally independent of our possible means of knowing it. Every realist conception also involves the belief that we can build a representation of independent reality on the basis of our experience. This representation is of a varied nature, and thus we find different versions of realism in science.[67] In his important book *On Physics and Philosophy* (2006), theoretical physicist Bernard d'Espagnat discusses whether or not physical realism still has relevance in contemporary physics. As we shall see later, on the basis of nonseparability d'Espagnat is led to distinguish between two concepts of reality: *empirical* and *ontological* reality. Empirical reality refers to the set of phenomena that the totality of human experience has access to; ontological reality is the notion referred to when "what exists independently of our existence" is thought of or alluded to.[68] D'Espagnat defines the statements made by quantum physics as *weakly objective*, as opposed to *strongly objective* statements made in classical physics. If the latter statements refer to things-in-themselves without reference to human agency

[66] Wilber (ed.), *op.cit.*, 10.

[67] Several forms of scientific realism are described by Bernard d'Espagnat in his book *On Physics and Philosophy* (pp.24-31), among which: 1. *objectivist realism*: reality consists of a familiar group of impressions such as properties of objects, quantities, values of quantities, forms, and more specifically objects themselves; 2. *Einsteinian or mathematical realism*: reality consists of notions borrowed from mathematical physics (ex: four-dimensional spacetime, curvature of spacetime, etc.); 3. *ontological realism*: reality is Being, that is, ultimate reality and it can be reached by means of science; 4. *open realism*: it says that there is "something" real the existence of which does not hinge on thought; 5. *near realism*: reality consists of clear and distinct notions like figures, sizes and motions, and thus this form of realism is a restricted version of objectivist realism; 6. *structural realism*: only "structures" present in the mathematical or conceptual content of theories are real.

[68] d'Espagnat, *On Physics and Philosophy*, 4.

(i.e., to ontological reality), the former involve the notion of an observer but in such a form that they implicitly claim to be true for any observer whatsoever.[69] Because it involves human interaction in a fundamental way, quantum physics is not concerned with reality-per-se but only with empirical reality. As d'Espagnat says about the implications of quantum physics:

> I think that our scientific knowledge finally bears, not on reality-in-itself — alias "the Real," alias "the ground of everything" – but just on empirical reality, that is, on the picture that, in virtue of its structure and finite intellectual capacities, the human mind is induced to form of reality-in-itself.[70]

What this means is that quantum physics is not concerned with "objects-per-se" but only with our representation of these objects. Electrons, quarks and their composite objects cannot be thought of as self-existent.[71] That is not to say that reality is

[69]The central focus of quantum physics is to provide rules that yield the probabilities that if such or such measurement is made on a system prepared in such and such a way, such and such a result is obtained. Insofar as they yield results valid for everybody, the statements of quantum physics are objective; but insofar as these statements necessarily require human agency, they are weakly objective and not strongly objective. See: d'Espagnat, *op.cit.*, 93-94.

[70]Quoted from an article by Mathew Iredale in TPM (The Philosopher's Magazine) in June 2009 (Source: http://www.philosophypress.co.uk/?p=283).

[71]The question might arise here whether quantum physics is a *universal* theory or not, i.e., whether its results also apply at the macroscopic level or not. If not, then quantum physics is only a theory of the atomic world and has no bearing on the broader problem of reality as experienced by human beings in their daily life. But the fact is that quantum physics seems to be such a universal theory. First, the laws of quantum physics apply in practically all fields of physics, from solid-state physics to elementary particle physics. Second, it is quite a precise theory insofar as its observational predictions have most of the time agreed with observed facts. Third, there is evidence that we can express the laws of classical (macroscopic) physics in terms of a set of predictive rules, and that these rules follow from those of quantum physics. Moreover, with the recent insights into the phenomenon of "decoherence," a great step forward towards understanding the "classical appearance" of a quantum world has been achieved. In particular, decoherence might explain why macroscopic objects are always seen to be localized in space while at the microscopic level objects are "entangled" together. For more details, see: d'Espagnat, *On Physics and Philosophy*, Chapter 8; 459.

a purely mind-made construct as radical idealism would believe, and that there is no place in d'Espagnat's thought for reality-in-itself. In *On Physics and Philosophy*, he puts aside arguments of antirealists and idealists and argues in favour of "open realism." Firstly, in his view the fact that some laws of physics persist to be valid in spite of the changes in the theoretical framework of physics suggests "something of which the existence does not proceed from human mind." Physics relies on descriptive and predictive laws that were arguably not invented, but discovered. Though it is true, as d'Espagnat says, that human beings impart to laws a certain form, they cannot be arbitrarily different. In other words, the physical laws do not totally depend on us, which means that they depend on "something else."[72] Secondly, intersubjective agreement between different observers about specific experimental results is hardly explainable without reference to some human-independent reality. In view of Bell's theorem and experiments on nonseparability, d'Espagnat is led to admit the existence of an independent reality ("Real" or "reality-in-itself") that is neither multitudinist (i.e., composed of parts) nor embedded in spacetime. As such, its nature remains beyond the scope of perception and reasoning, that is, beyond the scope of scientific inquiry. D'Espagnat still concedes that we can get glimpses of the general structure of reality-in-itself through the great laws of mathematics and physics, and thus he refers to the latter as *veiled reality.*

D'Espagnat's thesis has been criticized by two other French philosophers of science, Michel Bitbol and Hervé Zwirn. In Chapter 3, we briefly discussed Bitbol's *pragmatic-transcendental interpretation* of quantum physics. In contrast with the kind of realism advocated by d'Espagnat, Bitbol believes that quantum physics does not deal with a pre-structured and independent reality. In his view, one of the main problems with d'Espagnat's realism is the epistemological accessibility of reality-in-itself. If it is possible, like d'Espagnat says, to get glimpses of reality-in-itself, it means that the latter is describable and knowable in some way. All knowledge being *a priori*

[72] *ibid.*, 117-18.

relative *to* something, it must be admitted that scientific inquiry is in some *relation* with reality-in-itself, which amounts to say that the latter is identical with empirical reality.[73] In response to this criticism, d'Espagnat explains that if we cannot indeed have a discursive and precise knowledge of reality-in-itself (which would make it a mere object of knowledge), a vague "grasping" of its general features is possible. But this implies that ultimate reality should be *structured* in some way, and this is indeed d'Espagnat's conception:

> The Veiled Reality conception. . . involves the conjecture that our great mathematical laws are highly distorted reflections — or traces impossible to decipher with certainty — of the great structures of "the Real."[74]

Such structural characterization of reality-in-itself, however vague it is, remains a *descriptive* statement for Bitbol. Since the very concept of description is always relative to some perceptual, instrumental and intellectual context, reality-in-itself must be empirical and not transcendental.[75] On this point, d'Espagnat contends that if observational predictive rules and empirical laws of physics are indeed relative to some context, they arguably do not depend *exclusively* on it.[76] This is why specific experiments can reveal if a theory is adequate or not: reality-in-itself "resists" in a certain way our attempts to understand it. Nevertheless, d'Espagnat is clear about the fact that nothing *positive* can be said about the "Real" or its properties: it is by understanding what *it is not* that we can have a glimpse of reality-in-itself.

Notwithstanding these arguments, Bitbol has strong reservations regarding the idea that scientific facts can provide us with information about the "Real" or its structure. In a paper entitled *Le réel-en-soi, l'inconnaissable et l'ineffable*, Bitbol gives five reasons against the possibility of knowing reality-in-itself on a scientific basis: 1. its infinite complexity; 2. the "blinding proximity" of the knowing subject

[73] Bitbol, *L'aveuglante proximité du réel: anti-réalisme et quasi-réalisme en physique*, 101.
[74] d'Espagnat, *op.cit.*, 455.
[75] Bitbol, *op.cit.*, 123.
[76] d'Espagnat, *op.cit.*, 387.

(which makes impossible to treat reality-in-itself as a proper object of knowledge); 3. the limited nature of scientific methods; 4. the irrelevance of applying epistemological notions of knowledge to something of a radically different ontological order; 5. the inevitable limits of the *concept* of reality-in-itself.[77] He conludes his paper with the following remark:

> ...the question of a relation between our scientific knowledge and reality-in-itself is not decidable, and by construction doomed to be so. No scientific result...offers an irrefutable guarantee of its isomorphism with any aspect of reality-in-itself.

In *Les Limites de la Connaissance*, philosopher of science Hervé Zwirn also criticizes d'Espagnat's conception but on a different ground. Against d'Espagnat's argument that "something says no" and that this "something" *cannot be us* but *only* an independent reality, Zwirn argues that it implicitly assumes that a mind construction cannot generate contradiction; but this is not logically necessary. In a conception in which everything is assumed to be mind created, chances are that what we call "reality" could well be an unconscious "perceptual construction." Given that even in formal and explicit constructions consistency is sometimes difficult to ascertain, it could be possible that "from time to time, we should discover contradictions revealed by discrepancies between our theoretical constructs and the particular construct that we call the Real."[78] But, d'Espagnat argues, if theoretical and perceptual constructs are exclusively constructions, how is it that when testing our theories we always choose to believe the information yielded by the corresponding perceptual constructs rather than the one yielded by the theory? Why not proceed the other way around? Since this procedure seems absurd, Zwirn's hypothesis cannot reasonably be maintained.[79]

[77]Bitbol, M., "Le réel-en-soi, l'inconnaissable, et l'ineffable." *Annales d'Histoire et de Philosophie du Vivant* (Vol.1) (1998): 143-152. (Source: http://pagesperso-orange.fr/michel.bitbol/Reelensoi.html)

[78]Zwirn, *Les limites de la connaissance*, 336.

[79]d'Espagnat, *op.cit.*, 391.

In fact, both Bitbol and Zwirn seem reluctant to forsake the notion of reality-in-itself. As noted by d'Espagnat, in Bitbol's thesis the concept of reality remains as a kind of "limiting concept." For instance, Bitbol writes: "What remains screened from criticism. . . is the abstract concept of a reality conceived of as setting limits to the determining power and factual and symbolic activity of the experimentalist."[80] As for Zwirn, he recognizes the need for "something" along the lines of open realism but refuses to give it explicit "existence." Like d'Espagnat, he also distinguishes different levels of reality — amounting to three — in his conception:[81]

1. *Phenomenal reality*: This level of reality corresponds more or less to d'Espagnat's concept of empirical reality. It is the form taken by *empirical reality* (in Zwirn's sense; see below) for each individual. As such, it is plural. It is what is *known* through the conceptual filters of language, culture, education and through the filters of our sense organs. It is *représentable*, which means that we can form a clear mental image of it (ex: a table, records of data on computer screens);
2. *Empirical reality*: In contrast with phenomenal reality, empirical reality is not *représentable* but only *conceptualizable*, which means that we can talk about it and describe its effects but cannot have a mental representation of it (ex: entangled states in quantum physics, spacetime continuum). Empirical reality is one and yet it can be actualized in different ways by individual consciousness. In other words, phenomenal realities are the different viewpoints from which we can represent to ourselves empirical reality. It is the *unknown that can be known* and in this sense, it does not exist independently of human beings;
3. *"Something"*: Zwirn considers naive to assume that what is conceptualizable "exhausts the world." On the other hand, we cannot say that something non-conceptualizable *exists* because to say so is to associate it with the concept of "existence." This "something" is neither *représentable* nor *conceptualizable*: it is the *unknowable*. At most, it can only be characterized negatively or described indirectly through analogy.

In line with early quantum physicists, contemporary philosophers of physics also contend that there are inherent limits to scientific knowledge. The three philosophers studied here — who are considered important philosophers in today's scientific community — unanimously reject the idea that physics deals with a mind-independent

[80] Quoted from: d'Espagnat, *op.cit.*, 452.

[81] Zwirn, *op.cit.*, 357-65.

reality (or things-in-themselves). They depart from each other on whether reality-in-itself still has relevance or not, and whether it can be known in some way or not. If Bitbol tends to dismiss the very notion of reality-in-itself, d'Espagnat and Zwirn both accept the idea of "something" lying beyond empirical reality. But there are differences between d'Espagnat's and Zwirn's conceptions. Whereas d'Espagnat concedes "reality" and "existence" to this "something" (which he terms "reality-in-itself," "Real," "veiled reality" or "Being"), Zwirn denies any such characterization except that it is unknown. For Zwirn, this "something" is *totally* inaccessible while d'Espagnat holds that the "Real" is structured and that some of its structure passes into the laws of physics. Unlike d'Espagnat, Zwirn does not believe that there is "something" beyond empirical reality based on "resistance" to our theories. In his view, "something" is inferred from the fact that we cannot reasonably accept that conceptualization exhausts the world.

5.2.2 Nonseparability and d'Espagnat's Ontological Reality

In the last decades, an astonishing discovery in the field of quantum physics has shed new light on the problem of realism in physics: nonseparability. Perhaps no previous discovery in the history of science has posed more challenges to our understanding of physical reality than this phenomenon. Nonseparability was revealed in a series of rigorous experiments testing predictions based on a theorem formulated by John Bell in 1964. This theorem was a response to questions raised by the so-called EPR thought experiment proposed by Einstein, Podolsky and Rosen in 1935 (see section 2.1.2). This experiment aimed to challenge the view, central to Bohr's Copenhagen interpretation, that we can never report the state of an atomic system *before* measurement. In the view of Einstein and his colleagues, every element in a physical theory should have a counterpart in physical reality, a view often referred to as *classical realism.* As a consequence, it should be possible to define with certainty the value of all physical properties of a system (position, momentum, etc.) prior to measurement and if quantum physics does not allow this, it is because it is an "incomplete" theory.[82] Bell's theorem was predicting that certain kinds of measurement involving correlations between pairs of particles could prove whether quantum theory is complete or not. The theorem was tested for the first time in Alain Aspect's experiments (1980-82) in France and has been tested a number of times since then.

In Chapter 2, we discussed one version of the EPR experiment in which the information about one particle (ex: a spin component) is used to deduce complementary properties (ex: another spin component) of another particle. Most experiments testing Bell's theorem involve pairs of particles that originate in a single quantum state like that featured in the EPR experiment. In most cases, experiments are conducted with pairs of photons and the property measured is their polarization state.[83] Given Heisenberg's indeterminacy, we cannot predict with certainty what will be the polarization state of a single photon in any given measurement. What we have is only a random series of measurements of polarization. But since the polarizations of paired photons are equal and opposite (like spin components in EPR experiment), the random series corresponding to one photon should correlate precisely with that of the other photon if the experiment is conducted a sufficient number of times. We will not describe in detail here the nature of experiments testing Bell's theorem. What is important to understand is that those experiments have undoubtedly shown that photons are correlated instantaneously over any distance. Moreover, this phenomenon

[82]Incompleteness in quantum physics is the claim that the quantum state of a physical system does not give a complete description of the system. For a minority of physicists, the statistical nature of quantum physics indicates the incompleteness of this theory; for a theory to be complete, it must be deterministic. A "complete" or "right" theory must account for all observable behaviour and not leave anything to chance. This belief gave rise to "hidden-variable theories," in which variables not currently known are posited that would make the theory understandable in deterministic terms. The currently best-known hidden-variable theory has been formulated by David Bohm in the 1950s.

[83]The polarization of a wave is described by specifying the direction of its electric field at a point in space.

holds for every pair of quanta having interacted together and grows exponentially with the number of particles involved in the original quantum state.[84] Since virtually all particles in the history of the cosmos have interacted with other particles from the Big Bang to the present, nonseparability may be said to be a *general property of nature*.[85]

The scientific and philosophical implications of nonseparability are far-reaching. According to Einstein and other supporters of classical realism, to explain correlation we must accept that properties of both particles are already well-defined before measurement. Otherwise, the properties of one particle would depend upon the process of measurement carried out on the other particle. Given that both particles are located far away from each other, this would imply that they can instantaneously influence each other without direct mediation, thus violating the sacrosanct principle of locality. But experiments on Bell's theorem prove precisely what the quantum formalism predicts: that correlations exist regardless of the distance between the two particles. Two explanations are possible here. If we hold the view that physical reality has an independent existence (classical realism), we must accept that this reality supports direct influences at a distance between objects (nonlocality); this is the view held in Bohm's hidden-variable theory (1952).[86] The second explanation, in line with Bohr's

[84] Mermin, "Extreme Quantum Entanglement in a Superposition of Macroscopically Distinct States."

[85] d'Espagnat, *In Search of Reality*, 43-48. It is also important to understand that Bell's theorem is valid independently of any theory. The theorem is based on the violation of locality, which is a direct consequence of experimental data. Even if quantum physics is replaced by some other theory based on different concepts in the future, the consequences of Bell's theorem will remain valid.

[86] In this approach, nonseparability is envisaged as a *real attribute* of the physical system constituted of the two particles. This means that the measurement on a particle has an immediate long-distance effect on the other distant particle. Technically, the distant particle gets a wavefunction — here understood as an element of reality — that it did not previously have. However, the principle of locality formulated in special relativity, according to which no influence can travel faster than light, is not violated here. In Bohm's theory, no superluminal transfer of information is involved since no event actually interacts with another event in the "explicate realm": all events are

Copenhagen interpretation, upholds locality and gives up the views of classical realism. Most physicists today tend to favour this view. It maintains that we cannot define the properties of a particle independently of the measurement process. Prior to measurement, the "two" particles constitute in fact a single correlated whole: they are nonseparable from each other and remain so until measurement "separates" them. With measurement each particle "acquires" individuality but this is not separate from the act of measurement itself. In other words, individuality is not an objective feature of reality but only a manifestation of the observer's knowledge of reality.[87]

What is the impact of nonseparability on the problem of realism in physics? According to the standard view, nonseparability implies that prior to measurement it is impossible to ascribe individual properties and independent existence to systems that have interacted together. Ontologically speaking, this means that we can no more consider the universe as constituted of separate entities endowed with definite objective properties and interacting only locally with each other. What d'Espagnat calls the *multitudinist* view, i.e., that the whole universe is a composition of parts, no more holds in quantum physics. One consequence of this is that we must come up with the concept of *empirical reality.* If we hold only to the view of classical realism, according to which what we apprehend is reality-in-itself, we can hardly explain why at the level of observable phenomena everything occurs as if the universe was constituted of parts isolated from each other. For this reason, we must accept the existence of an empirical reality, that is, of a reality envisaged as a set of phenomena

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deeply interconnected within what he calls the "implicate order." The term "nonlocal" applies to this theory because it admits a direct influence of one object on another distant object, but not because it violates the principle of locality defined in relativity.

[87]In a more technical form, it means that before measurement we cannot treat each particle as describable by a wavefunction of its own. In cases where particles originate in the same quantum state, such individual wavefunctions simply do not exist. Only the wavefunction characterizing the pair of particles can be introduced. Thus, one speaks of *nonseparable* wavefunctions or, alternatively, of the *entanglement* of particle wavefunctions. It must be noted that in this conception no faster-than-light influence explicitly appears. See: d'Espagnat, *On Physics and Philosophy*, 53.

perceived and acted upon by human beings. In contrast with classical physics, quantum physics thus implies a turning away from any version of naive realism. However, most of the phenomena that compose empirical reality exhibit no features that could be called "nonseparable." According to d'Espagnat, this forces us to accept also the notion of a human-independent reality — an ontological reality — that is not constituted of distinct parts. As he says, nonseparability "confirms the necessity of at least distinguishing between the two *notions* of mind-independent and empirical reality."[88]

As noted above, d'Espagnat is nonetheless reluctant to ascribe properties to human-independent or ontological reality. As he explains, the implications of Bell's theorem about ontological reality are basically *negative*:

> . . . Bell's theorem does not infer from the phenomena the existence of some property that, transcending the said phenomena, would be ascribable to mind-independent reality. It merely shows that if we build up too naive a representation of the latter (the one corresponding to locality) we get results that experiment falsifies. Aiming at changing this essentially negative statement into a positive one might well result in a description of some alleged property of mind-independent reality. For the above stated reasons, such a move would not be justifiable.[89]

Fundamentally, science cannot describe positively reality-in-itself because its domain of inquiry is strictly restricted to empirical reality. Like Kant, d'Espagnat admits that the aim of science is not knowledge of reality-in-itself but that of phenomena. But he does not believe, like Kant, that reality-in-itself is totally unknowable. In his view, reality is "veiled," not hidden, and science *can* get glimpses of its structure through the great physical laws it discovers to be valid.[90] When reality-in-itself

[88]d'Espagnat, *On Physics and Philosophy*, 4.

[89]*ibid.*, 78-79.

[90]Kant thought that science was concerned only with phenomena and not noumenon (thing-in-itself). Because science makes use of descriptive concepts — like Euclidean space, absolute time, determinism, etc. — that are close to common sense, Kant argued that scientific concepts were in fact *a priori* elements of human knowledge, and thus not referring to reality-in-itself. However, with the advent of notions like non-Euclidean geometries, curved spacetime, indeterminism, etc.,

"resists" by falsifying certain of our theories, we acquire some knowledge about this reality in a negative manner. For d'Espagnat, nonseparability refers to this kind of knowledge. Relying on Bell's theorem and experiments on nonseparability, he argues that reality-in-itself *can neither* be multitudinist *nor* embedded in space and time. We have already seen why nonseparability implies that reality cannot be multitudinist. Now, if reality-in-itself were embedded in space and time it would amount to accept classical realism, which in turn implies nonlocality according to Bell's theorem. Like most physicists, d'Espagnat is inclined to think that physical reality is local and thus he concludes, in the manner of Kant, that the nature of space and time is not "noumenal" but phenomenal, i.e., a "reality-for-us."[91] Therefore, what *really* exists for d'Espagnat is some sort of indivisible Whole that is not embedded in spacetime, and whose "parts" are only empirically perceived, that is, "molded" through human understanding.[92]

In section 5.1.2, we argued that quantum vacuum shares affinities with *Brahman*

which contradict common sense, this argument cannot hold anymore. As d'Espagnat notices, it is indeed difficult to believe that pure *a priori* concepts can evolve in time with the development of scientific knowledge. It seems more meaningful to assume that these concepts have their source (at least partly) in reality-in-itself. In order to allow an "influence" from reality-in-itself on phenomena, d'Espagnat introduces the concept of "extended causality" beside the Kantian notion of causality. If the latter takes place solely between phenomena alone, the former consists of influences that are exerted *by* reality-in-itself *on* phenomena. See: d'Espagnat, *op.cit.*, 239-41; 454.

[91] d'Espagnat, *op.cit.*, 239.

[92] According to d'Espagnat, "the, perceived, locality of the macroscopic objects [experienced in daily life] is a feature that not only is not obvious but even cannot be imparted to them as elements of human-independent reality. Presumably it must be considered a universal appearance." As to *why* macroscopic objects appear localized in space rather than entangled together, decoherence might be a good explanation. It tells how the wavefunction of atomic systems *apparently* collapses during measurement. The idea here is that the superposed nature of a quantum state is "leaked" into the macroscopic environment so that the superposition exists but is no more measurable. This results from the fact that macroscopic systems always appreciably interact with their environment. In other words, decoherence would explain how empirical reality arises and why we apprehend the world of objects to be different from the quantum world. See: d'Espagnat, *op.cit.*, 183.

insofar as both concepts refer to unmanifest as well as unknowable states of being. However, vacuum is a theoretical entity endowed with different physical meanings and as such, it can also be considered as an object of scientific investigation. In contrast, *Brahman* is of the nature of pure consciousness, partless, changeless, devoid of any quality and beyond any form of conceptualization; it is not an object but the subject *sui generis*. In this regard, d'Espagnat's notion of ontological reality comes closer to the *Brahman* of Advaita than vacuum. The transcendental nature of *Brahman* seems to find an echo in d'Espagnat's claim that "underlying empirical reality is a mysterious, non-conceptualisable 'ultimate reality,' not embedded in space and presumably not in time either."[93] The fact that ontological reality is not endowed with parts, which are only empirically perceived, also agrees with the partless nature of *Brahman*. Nevertheless, it remains that *Brahman* is basically a spiritual principle, the foundational basis of self-awareness. It is then interesting to examine what place consciousness has in d'Espagnat's philosophical considerations. How does it relate to his concept of ontological reality?

D'Espagnat develops in several books the idea of a "coemergence" of consciousness and empirical reality from reality-in-itself.[94] As far as the origin of consciousness is concerned, he rejects the "identity theory," which identifies consciousness with some material structure internal to or involving neurons. He also rejects the "efflorescence theory" according to which consciousness is a derived product of neuronal activity. His argument is based on implications of quantum physics: all parts of our bodies, including neurons, are essentially elements of the *empirical reality*. Since empirical reality, as a *representation* of reality-in-itself, is *a priori relative* to consciousness, it is difficult to imagine how it might possibly generate the latter or be identified with

[93] Quoted from an article by d'Espagnat in *Guardian* in March 2009, entitled "'Quantum weirdness: What we call 'reality' is just a state of mind." (Source: http://www.guardian.co.uk/science/blog/2009/mar/17/templeton-quantum-entanglement)

[94] D'Espagnat uses interchangeably the terms "thought," "mind" and "consciousness" to denote the mere fact of "being or becoming aware."

it.[95] Does it mean that consciousness constitutes some sort of an absolute, as stated in radical versions of idealism? According to d'Espagnat, the answer is no. States of consciousness involved in quantum measurements are also relative in the sense that they refer to "points of view" adopted by different observers in different contexts.[96] Neither the things or phenomena observed nor the states of consciousness involved in measurement are absolute. Both seem to exist in relation to each other, or to generate reciprocally one another, and this is why d'Espagnat brings in the notion of a coemergence of consciousness and empirical reality. This coemergence arises — atemporally, because time is part of empirical reality — out of the mind-independent reality that is conceptually prior to both consciousness and empirical reality. What is really "veiled" in d'Espagnat's conception is not empirical reality but ontological reality, which is identified with Being itself (Fig. 5.1).[97]

The conception of d'Espagnat — that individual consciousness has only access to *representations* of reality, and is somehow co-equal with things and phenomena — comes close to the views of Advaita Vedānta. His concept of reality-in-itself or Being, out of which both thought and phenomena emerge, has clear affinities with

[95] d'Espagnat, *op.cit.*, 418.

[96] The potential implications of consciousness in quantum physics are complicated and still widely discussed today. For the sake of brevity, we shall only summarize d'Espagnat's argument here. He asks us to imagine two observers participating in a quantum measurement: Peter who is conducting the measurement, and Paul who is looking at an instrument pointer and registering what information he reads on the dial. When Paul observes the dial, this induces a specific and seemingly "absolute" state of consciousness in him: either the pointer is at place A or not. But for Peter, Paul's state of consciousness is unknown and undefined. For him, the system is in a state of quantum superposition because it is not yet measured: it is both in the state "at place A" and in the state "not at place A." Not being measured, the system is in a potentially predictive state. Consequently, Paul's state of consciousness is also in such a superposed state for Peter, and it will become definite for Peter only after interaction of some kind with Paul. If Paul's observation creates in his own mind a definite state of consciousness, this is not the case from Peter's angle so that states of consciousness involved in quantum measurements cannot be considered absolute. See: d'Espagnat, *op.cit.*, 420-21.

[97] d'Espagnat, *op.cit.*, 388.

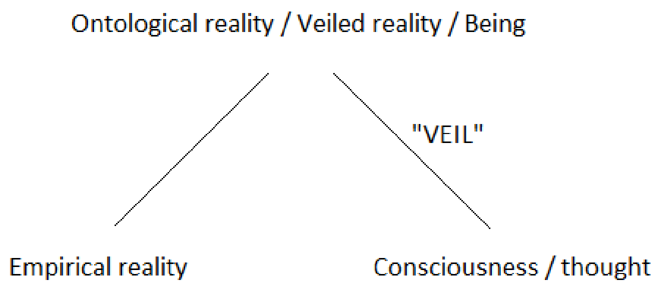

Figure 5.1: D'Espagnat's scheme of (atemporal) coemergence of thought and empirical reality out of ontological reality.

Brahman, the pure Being and fundamental reality underlying both physical and psychical realms in Advaita. The whole world of phenomena is grounded in *Brahman* and what is regarded as a conscious state is but an expression of *Brahman* through a certain modification of the mind. However, although both certainly have a lot in common, d'Espagnat's Being is not as explicitly of the nature of consciousness as *Brahman*. When d'Espagnat discusses consciousness, he means the individual consciousness facing empirical reality and not the pure and undifferentiated consciousness characterizing *Brahman*.[98] It is worth noting that d'Espagnat himself notices that the similarities between his conception of veiled reality and "the great eastern philosophical systems should be considered..." But because modern science is mostly embedded in the Western tradition, he prefers to confine himself to comparisons with

[98]However, d'Espagnat seems to believe in the unicity of individual consciousnesses. In *Mind and Matter* and in *My View of the World*, Schrödinger had raised the problem of the existence of a plurality of conscious minds, which he refers to as the *arithmetical paradox*: how to explain the existence of a plurality of conscious minds while the world described by science is only one? In Schrödinger's view, a consistent solution was to adopt the thesis of the unicity of minds: there is only one mind shining differently in each of us which makes it *appear* to be many. D'Espagnat faces the same problem as many minds seem to take part in the emergence of the one empirical reality. In many respects, he seems to agree with Schrödinger's thesis. Needless to say, this conception comes close to Vedāntic-Upaniṣadic monistic idealism as Schrödinger himself noticed. Despite this tendency towards a form of spiritual monism, we might recall that consciousness is in no way transcendental for d'Espagnat but remains co-equal with empirical reality. This is a major difference with the absolute idealism of Advaita Vedānta. See: d'Espagnat, *op.cit.*, 426-27.

Western philosophical systems like Platonism and Aristotelism.[99]

Though, like Kant, d'Espagnat believes that there are inherent limits to scientific knowledge, he still leaves room for some form of spirituality in science.[100] Science might not be in a position to comprehend ultimate reality, but it can reveal the profound mystery at the core of our existence. This mystery is what d'Espagnat calls the "veiled reality": the "ground of things," or Being, existent yet not accessible to discursive knowledge. By means of science, man gravitates with wonder and expectation towards the knowledge of the hidden structures of reality. And yet, he knows this knowledge exceeds his understanding. In this sense, the Real, like a distant horizon, partakes of transcendence. D'Espagnat believes we can get rare and precious glimpses of this Real, or get a "little closer" to it, not only through the great physical and mathematical laws but also through intuitions like the art, music and spirituality.[101] In some respect, the views of d'Espagnat are quite akin to those of Einstein who also considered that the Real can be approached through the channel of the great laws of physics. That there is an orderly harmony in the universe that science can reveal was the source for Einstein of an unbounded, quasi-divine, admiration for the world. In his view, every profound scientific mind was endowed with a kind of "cosmic religious feeling" that takes the form "of a rapturous amazement at the harmony of natural law, which reveals an intelligence of such superiority that, compared with it, all the systematic thinking and acting of human beings is an utterly insignificant reflection."[102]

[99] d'Espagnat, *op.cit.*, 458 (footnote 25).

[100] See this article about d'Espagnat's views: "The scientist who leaves room for spirituality," published in *Reuters* on March 17, 2009. (Source: http://blogs.reuters.com/faithworld/2009/03/17/the-scientist-who-leaves-room-for-spirituality)

[101] d'Espagnat, *op.cit.*, 455.

[102] Einstein, *Ideas and Opinions*, 40.

5.2.3 An Integral Perspective to Dialogue

With these insights from contemporary philosophy of science, there seems to be a basis for a more consistent dialogue between modern physics and Advaita Vedānta.[103] Our comparative analysis of quantum vacuum and *ākāśa* provided us with two key ideas in this regard: 1. that there are inherent problems with conceptual comparisons involving systems with different aims, methods and theoretical frameworks; 2. that physics and Advaita Vedānta share a common epistemological truth, which is that sense-perception and reasoning provide only a limited knowledge of *what is*. On the side of science, this amounts to a denial of scientific knowledge as an ultimate explanation of reality-in-itself. In the process, some philosophers and scientists — along the lines of instrumentalism — have rejected the very concept of reality-in-itself while others — along the lines of open realism — have located reality-in-itself beyond the scope of scientific inquiry. We tend to lean towards this second stand for two reasons. Firstly, as d'Espagnat and Zwirn argue, "something" that does not hinge on thought and perception is deducible from a rigorous philosophical analysis of quantum physics. Secondly, open realism allows an exchange between science and other traditions of knowledge in terms of how "reality" as a whole can be alternatively approached and understood. In a philosophical sense, this exchange of views seems meaningful. In this context, the views of Zwirn and especially those of d'Espagnat are relevant.

Both modern physics and Advaita Vedānta are cognizant of the inherent limits of empirical knowledge. As noted earlier, that empirical knowledge cannot convey knowledge of ultimate reality is also a central claim of Advaita Vedānta epistemology. Empirical knowledge, or "lower knowledge," (*aparāvidyā*) is concerned with the

[103] As noted earlier, the reconstruction proposed focuses on philosophical aspects of both systems. We leave aside mathematical/experimental and religious features of physics and Advaita Vedānta, respectively. In the following, we take for granted with d'Espagnat the "universal" character of quantum physics and thus extend our considerations to modern physics in general.

empirical world — objects, events, causes, means, ends, etc., — and is mediated through means of knowledge (*pramāṇas*) such as perception and inference. In contrast, "higher knowledge" (*parāvidyā*) has the non-dual *Brahman* as its content and is "acquired" (or more precisely, realized) without any mediation of such means of knowledge. Empirical world has lower reality than the timeless and all-comprehensive reality referred to as *Brahman*. In his various works, Śaṅkara describes three *levels of reality* or *being*: 1. *pāramārthika*: the "real," absolute or non-dual Reality, *Brahman*; 2. *vyāvahārika*: the "empirically real," transactional reality, including all existents except *Brahman* and "illusory existents"; 3. *prātibhāsika*: the "unreal," including illusory existents like hare's horns, son of a barren woman, etc. The empirical world belongs to the *vyāvahārika* level of reality, which is also the level of *māyā*. It has no absolute reality because it is neither permanent, eternal nor infinite and because it is ultimately sublated by the knowledge of *Brahman*; it is not unreal because it appears as an objective datum of experience until it is sublated. The world has an apparent or practical reality (*mithyā*) and as such its nature is indeterminable and indefinable (*anirvacanīya*).

This categorization in terms of levels of reality reminds us of how d'Espagnat and Zwirn describe ontological reality, and distinguish it from empirical reality.[104] This ontological reality presents affinities with the Advaita *pāramārthika* level of reality insofar as both refer to that aspect of "reality" that is independent of human conceptions, unknowable and non-conceptualizable. As to empirical reality, it can be roughly identified with the *vyāvahārika* level as both refer to the empirical world

[104] D'Espagnat and Zwirn both use the concept of "orders" or "levels of reality" ("niveaux de réalité" in French) to differentiate aspects of reality that are incommensurable with each other and that cannot be equated in any ontological sense. D'Espagnat refers variously to ontological reality as the "Real," "Being," etc., while Zwirn denotes it as "something." For the sake of simplicity, we use the term "ontological reality" to denote both d'Espagnat and Zwirn's notions of what lies beyond empirical reality. However, Zwirn would probably disagree with this term as it involves the characterization of the non-conceptualizable as something "real."

composed of objects, events, etc., i.e., the world *as it appears*. In this regard, it is interesting to note that d'Espagnat takes care to differentiate empirical reality from "mere appearance" as well. It is true, he says, that empirical reality is "built up" but it cannot be considered as a pure appearance without reality. Empirical phenomena, though not absolutely real in the sense of being mind-independent, are still subject to intersubjective agreement between those who apprehend them. Because it is endowed with some degree of reality "the proper domain of scientific knowledge, empirical reality, is far from being a mere mirage."[105] Similarly, though *Brahman* alone is real, the empirical world is not devoid of truth value in Advaita Vedānta. Prior to *Brahman*-knowledge, transactions of the empirical world are real and not illusory. But when considered independently of *Brahman*, the world lacks *absolute reality*.[106] D'Espagnat in a similar way considers empirical reality dependent or subordinate to ontological reality, out of which it coemerges atemporally with consciousness. There is no strict separation between ontological reality and phenomena: the empirical world is but a reflection of the "veiled reality."

According to d'Espagnat, empirical knowledge has no direct access to reality-in-itself. He mentions that reality-in-itself cannot be described positively as endowed with any property. At most, he has recourse to negative expressions like "not multitudinist," "not embedded in space and time," etc.[107] Zwirn holds that there is "something" beyond empirical reality which is neither *représentable* nor *conceptualizable* and therefore, which cannot be disclosed through empirical knowledge. He also contends that the nature of this "something" can only be characterized negatively or described indirectly through analogy. According to Advaita Vedānta, empirical knowledge cannot reveal the nature of *Brahman*. In its *nirguṇa* or unqualified as-

[105] d'Espagnat, *On Physics and Philosophy*, 5.

[106] Śaṅkara says: "*Brahman*, the Cause, does not lack existence at any of the three periods of time, neither does the world, its effect. Since there is only one Existence pure and simple, the effect is non-different from the cause." (BS II.1.16)

[107] Though d'Espagnat denotes reality-in-itself as "Being," "Real," etc., these terms remain for him labels to describe a reality that otherwise would be inexpressible.

pect, *Brahman* defies all description of characterization and can at best be described through negative statements like "not this, not this." (*neti neti*) Non-dual reality is necessarily without any internal difference, and is thus unrelated to the content of any form of experience — it is unthinkable, indeterminate and indeterminable. Hence, physics and Advaita Vedānta both recognize that empirical reality does not exhaust the whole of Reality and that there is "something more real" that does not hinge on thought, perception or any other phenomenal experience. It is also remarkable that *via negativa* is promoted in both cases as the only valid way to describe ultimate reality.[108] This is a crucial point on which both systems meet and agree in their inquiry about the nature of reality.[109]

Towards Another Model

Based on what has been said so far, it is relevant to ask in what way physics (i.e. philosophy of physics) could interact meaningfully with Advaita Vedānta. In section 2.2.2, we discussed four different ways of relating science and religion: conflict,

[108]The *via negativa* is often associated with Christianity and in particular with the apophatic or negative theology. In this theology, there is an attempt to achieve unity with God by gaining knowledge of what *it is not* rather than what *it is.* Though God is not an issue in philosophy of physics, the term *via negativa* suits well the attempts of some philosophers of physics to describe reality-in-itself by having recourse to negative statements.

[109]Most of the time, the *Upaniṣads* only describe *Brahman* with negative expressions but in some places, *Brahman* is referred to as pure being (*sat*), pure consciousness (*cit*) and pure bliss (*ānanda*). We could interpret such statements as positive descriptions of indescribable *Brahman* and make it a major point of contention with the scientific approach that avoids characterizing ontological reality (at least in d'Espagnat's and Zwirn's conceptions). But this would be to misunderstand the import of Upaniṣadic passages. Śaṅkara and other Advaitins emphatically assert that the above attributes are not intended to describe *Brahman* positively; they only *refer* to it by implication. Positive expressions like *sat*, *cit* and *ānanda* are used to exclude ideas of non-being, materiality and imperfection with regard to *Brahman.* See: Satprakashananda, *Methods of Knowledge According to Advaita Vedānta*, 199.

independence, complementarity and convergence. Considering that physics and Advaita both share the realization that there are limits to empirical knowledge and that "something" might exist which is beyond the reach of perception and reasoning, we can neither affirm that these systems conflict with each other, nor that they are completely independent. On the contrary, they meet and agree in their recognition of some kind of unmanifest and unknowable state of being. Another possibility is to consider, like Fritjof Capra and others, physics and Advaita Vedānta as two complementary approaches to the *same reality*. One argument against complementarity, however, is that physics has the physical world as its object whereas the purpose of Advaita's teachings is to draw attention to the unity of being in providing correct knowledge about the self. Advaita's emphasis on the knowing subject presupposes and implies a worldview that contrasts sharply with that advocated in physics. It is therefore difficult, and in a sense simplistic, to hold that both systems approach the same reality. Another point worth mentioning is that complementarity implies mutually exclusive approaches of the real and thus, by implication, the idea that each system has access to one — and only one — aspect of reality. As we shall see, this seems too constraining as well. For these reasons, both systems can hardly be considered complementary to each other. As for convergence, it mainly relies on the observation that science and religion exhibit concepts that are identical, similar or that function in a similar manner. But we have shown how conceptual parallels are generally superficial and fail to establish a deep correspondence between systems with different aims, methods and metaphysical premises.

It is also important to understand that both systems depart from each other when it comes to defining the nature and epistemic accessibility of reality-in-itself. Thus, *Brahman* is essentially a spiritual principle: it is the principle of awareness (*cit*) underlying all beings, the unchanging witness (*sākṣin*) underlying phenomenal existence. Though ontological reality in d'Espagnat's conception, for instance, shares affinities with the *Brahman* of Advaita — both referring to something partless, beyond space and time and not conceptualizable — nothing is said of its spiritual nature. Ontological reality is responsible for the atemporal emergence of consciousness but is not identified with consciousness. Moreover, consciousness in d'Espagnat's thought is essentially individual and not extended to the whole of reality like in Advaita. Another difference is that by definition, what "really is" strictly remains beyond the scope of scientific inquiry. In contrast, Advaita Vedānta avers that ultimate reality is something "reachable" through a proper spiritual practice. Though not conceptualizable, *Brahman* can be realized through the immediate, intuitive and non-conceptual experience of the innermost self.[110] Hence, Advaita Vedānta has been considered a more "encompassing" system than physics insofar as it provides the means through which one can realize the nature of ultimate reality. If we are to take this view seriously, we cannot place Advaita Vedānta and physics on the same epistemological level.

This is the position taken by Richard H. Jones and others against the complementary model upheld by Capra and others: complementary viewpoints are assumed to have an equal epistemological value (each viewpoint requires the other for complementarity to emerge) but this is obviously not the case here. For the most part, Vedāntins consider that *Brahman*-knowledge has more cognitive value than the empirical knowledge disclosed by science. As the *Śvetāśvatara Upaniṣad* (I.12) put it: "Higher than that [*Brahman*-knowledge] there is nothing to be known." In *Science and Mysticism*, Jones holds that from the viewpoint of mystical systems like Advaita Vedānta for instance,

> the most important problem is that science takes seriously the realm of *māyā*: nescience (*avidyā*) precisely is taking diversity as real: its relation to a reality beyond what is revealed by dualistic awareness is ignored.[111]

[110]If the study of sacred texts (*śravaṇa*) and individual reflection (*manana*) are certainly part of the spiritual path, the last stage consists in meditation (*nididhyāsana*) on one's own real nature. Ultimately, sacred texts (*śruti*) and all kinds of reasoning are only subsidiary means to *Brahman*-realization.

[111]Jones, *Science and Mysticism: A Comparative Study of Western Natural Science, Theravāda*

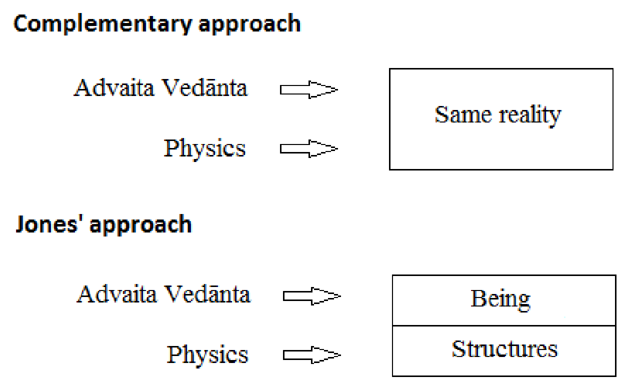

Figure 5.2: Two ways of relating physics and Advaita Vedānta. The complementary approach, advocated by Fritjof Capra and others, and the approach advocated by Richard H. Jones in *Science and Mysticism*.

Scientific inquiry is fundamentally limited: it starts from and is akin to the realm of change, and as such it cannot realize the changeless, the eternal. This is an epistemological fact that has been overlooked by Capra and others who have been almost exclusively concerned with conceptual similarities between mystical and scientific worldviews. In response to that, Jones has come up with a model in which neither science nor mysticism provides an exclusive way of knowing reality and where no complementarity is involved. In his model, science and mysticism are not conceived as two different ways of experiencing *one reality*, like in the complementary approach, but as ways of apprehending two equally fundamental components of reality. While mysticism deals with the unstructured and non-objectifiable "being" beneath multiplicity, science has authority concerning the structures and regularities within the realm of becoming and change.[112] Both world structures and being are given equal importance and yet are considered as different and separate realms of existence. Thus, each system is concerned exclusively with its own domain: the scientific approach reveals nothing of beingness and mysticism nothing of structures. In this scheme, then, the empirical knowledge disclosed by science and the knowledge of being disclosed by mysticism are both necessary though incommensurable with each other (Fig. 5.2).

Buddhism and Advaita Vedānta, 178.

[112] *ibid.*, 214.

The distinction between being and structures in Jones' model avoids the problems of complementarity. Jones defends the cognitive value of each system on its own level so that each type of claim has its own context. There can be conflict over the nature of being or structures only if the context of the claims is ignored.[113] In such a model, Advaita Vedānta cannot be said to "encompass" physics insofar as structures are given as much cognitive value as being. The fact that Advaita clearly deals with a different realm of reality than physics is not overlooked like in the complementary approach. The strength of this model is to avoid two extremes: the devaluation of the realm of becoming in favour of being, that is prevalent in some mystical traditions, and the devaluation of being in favour of becoming, characteristic of natural sciences. Nevertheless, Jones' model has been criticized for drawing "too sharp a line" between science and mysticism.[114] Jones clearly subscribes to the independence thesis, according to which science and mysticism are totally independent and autonomous enterprises. However, as noted earlier, the independence stance fails to account for the commonalities between physics and Advaita Vedānta. That both systems agree on the limits of rational-empirical knowledge in disclosing the nature of reality is a meeting point that deserves attention in the context of understanding how physics and Advaita Vedānta relate to each other. A consistent dialogical model should take this fact into account.

Indeed, since Jones' publication of *Science and Mysticism* in 1986 there has been considerable progress in the fields of physics and philosophy of physics. In the above-mentioned quotation, Jones observes that science's most crucial problem from a mystical standpoint is that it takes diversity (i.e., the realm of *māyā*, or the empirical realm) as *fundamentally* real. But we have seen that this view is no more held by contemporary physicists and philosophers of physics. The analysis of quantum physics, in particular nonseparability (first tested in 1981), has revealed that scientific inquiry is only concerned with empirical reality, which is a representation of reality-in-itself

[113] *ibid.*, 215.
[114] Barbour, *When Science Meets Religion*, 86.

and not the real itself. In other words, *māyā* has been recognized for what it is — a conditioned representation and nothing more. A second important fact to be noted is that most philosophers of physics contend that *there is* something "beyond" *māyā*. From Zwirn's non-conceptualizable "something" to d'Espagnat's atemporal and "veiled reality," most agree that empirical reality does not exhaust the whole content of reality. In a broad sense, there is room for reflection about the unstructured and the non-objectifiable in contemporary philosophy of physics. It is therefore hard to believe that physics has nothing to do whatsoever with what Jones has described as "being." The facts rather suggest that the boundaries between Advaita Vedānta and physics are more porous than supposed in Jones' model. Therefore, another approach is required that could integrate the differences and similarities between these two systems.

An Integral Model

The *integral* stance holds that science and religion (or mysticism) are both part of a "big picture" that fully integrates their respective contributions.[115] It is distinct from *complementarity* because the disciplines compared deal with *different realms*, like in Jones' model; it is also distinct from *independence*, for these realms are not incommensurable with each other but rather interpenetrate each other. In his book *Religion and Science*, Ian Barbour convincingly argues that integration is a more

[115] An important representative of this stance is Ken Wilber. Since the late 1990s, Wilber has been using the term "integral" to refer to his own philosophy, called *integral theory*. This theory claims to be an all-inclusive framework that draws on the key insights of the world's greatest knowledge traditions. It aims to synthesize in a comprehensive worldview the imports from various disciplines, ranging from natural and human sciences to humanities and mysticism. However, the use of the term would go back to the writings of the Indian Sri Aurobindo (1872-1950), who used it to describe his own conception of a more comprehensive form of *yoga* called "integral yoga." In the following decades, Aurobindo's writings have influenced others who have used the term "integral" (or referred to this kind of view) in more philosophical or psychological contexts.

promising way to bring scientific and religious insights together than the independence or complementary thesis. But given that Barbour's argumentation relies mainly on the Christian tradition, we shall consider Ken Wilber's integrative approach which puts more emphasis on non-Western spiritual traditions. At the basis of Wilber's approach is what he calls *epistemological pluralism* — the idea that reality consists in several interwoven realms shading into each other, each of which is associated with a specific mode of knowing. Reality is not dichotomized in terms of being and world structures like in Jones' model but organized as a series of nests within nests reaching from gross to subtle levels — from matter to organic life to mind to soul to Absolute. Each higher realm at once transcends and includes its lower realm, so that every thing in the world is interwoven with every other. The lowest realm is that of matter and the highest is the non-dual Absolute, which is also considered the ground of all other realms. Here Wilber largely takes inspiration from what he calls the traditional "Great Chain of Being." (Fig. 5.3)[116]

As Wilber explains, according to the traditional view, science (physics, biology and psychology) deals mostly with the lower realms of the Great Chain while religion (theology, mysticism) deals with the higher realms. At first sight, then, this model looks like a more complex version of Jones' model where instead of having two single realms relating to science and religion, we have two *groups* of realms — the lower and higher realms. But it must be noted that the realms in Wilber's model shade into each other (i.e., are not incommensurable) and more important, that each realm

[116]A number of important thinkers — Huston Smith, Arthur Lovejoy, Ananda Coomaraswamy, René Guénon, Fritjof Schuon, *et al.* — have affirmed that virtually all of the world's great wisdom traditions have subscribed to the Great Chain of Being. According to Lovejoy, the Great Chain would have "been the dominant official philosophy of the larger part of civilized humankind through most of its history." Quoted in: Wilber, *The Marriage of Sense and Soul: Integrating Science and Religion*, 6-9. The names and number of realms may have differed from tradition to another one but the basic idea remains: reality consists in a series of nests within nests reaching from matter to the Absolute (Spirit, God, Goddess, Tao, Brahman, etc.), each higher level transcending and integrating the lower one.

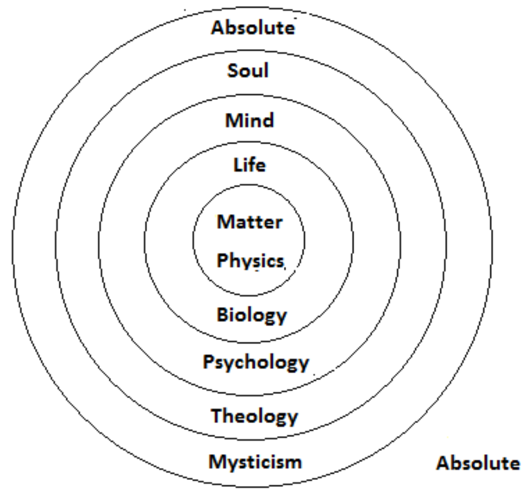

Figure 5.3: The traditional Great Chain of Being. In this picture, life transcends and includes matter: it includes matter in its makeup but adds qualities to it like sensations, feelings, etc. Similarly, mind transcends life because it is endowed with qualities that life does not have such as reason and logic; but it also includes life because for rationality to develop there is need of an organic body. It is to be noted that the highest level is the Absolute, which transcends all realms but is also their common ground. The present diagram is a simplified version of Wilber's own version in: Wilber, *A Theory of Everything: An Integral Vision for Business, Politics, Science and Spirituality*, 69.

contributes to the broader understanding of reality and not only to a specific domain of reality. For instance, mystical experiences are not the sole object of mysticism or theology; neurosciences also contribute to understanding this phenomenon in describing how the brain behaves in these conditions. In an integrative approach, an event or thing is never reduced to a single realm or another; rather, it is addressed from a plurality of perspectives or dimensions of experience that include subjective as well as objective modes of experience.[117]

One important feature of Wilber's model is to bring in the concept of "experimentation" as a meeting point of science and religion. In Wilber's view, the one characteristic feature of any kind of science — whether it is a "hard science" such as physics, chemistry or biology, or a "human science" such as psychology, linguistics or semiotics — is its correlation with a form of experimentation. Science, he says,

[117] Wilber, *A Theory of Everything: An Integral Vision for Business, Politics, Science and Spirituality*, 65-66.

broadly consists in "a certain attitude of experimentation, honesty, and collaborative inquiry, and it grounds its knowledge, wherever it can, in evidence."[118] In a broad sense, science is not only concerned with the exterior and physical world: it also has something to do with *interior* states as in psychology for instance. His views find some resonance in several works on Indian religion and philosophy. For leading spokesmen of modern Hinduism like Radhakrishnan, Vivekananda and Aurobindo, Indian philosophy and religion (particularly the Advaita Vedānta tradition) starts from and returns to an experiential basis. It emphasizes "inner experimentation" with modes of awareness in the same way Western science experiments with the external world, yet it has its own rules and standards. The notion of experimentation understood in this broad sense might have a role to play in the encounter between physics and Advaita Vedānta. Knowledge of *Brahman* has an experiential component insofar as ultimate reality is not known in a discursive manner but reached directly, without any mediation. D'Espagnat holds similar views when he says that artistic and mystical intuitions might provide "glimpses" at the structures of reality-in-itself, or what he calls "veiled reality."

Wilber's model presents some key features for an integral perspective to the dialogue between physics and Advaita Vedānta. Some of those relevant for our purposes are mentioned below. One can consider the application of these features to both physics and Advaita Vedānta as follows:

1. *The Absolute*: Perhaps the most interesting and fruitful meeting ground between physics and Advaita Vedānta lies in the recognition that empirical reality does not exhaust the whole content of reality, and that there exists something "beyond" empirical reality which does not hinge on thought and perception. In Wilber's model, this comes under the broad category of "Absolute." The Absolute stands as the highest realm in the Great Chain; it is non-conceptualizable and as such transcends all other realms. In our model, we leave open the question whether the Absolute is the ground of everything or not, or whether it is the culminating stage of an evolutive process like in Wilber's model. The mere consensus that "something" is not reachable through rational-empirical knowledge is taken as a sufficient starting point for dialogue;

[118] *ibid.*, 74-75.

2. *A broader understanding of "experimentation"*: In line with Wilber, it seems important to widen the meaning of "experimentation" to include under the domain of scientific inquiry not only objective but subjective "facts of existence" as well. In the present context, it is particularly relevant to afford the possibility of "experiencing" Being ("Real", *Brahman*, etc.) in an immediate, intuitive manner as advocated in Advaita Vedānta. On the side of philosophy of physics, d'Espagnat has conjectured that our "affective percepts" (which amount to a form of pure emotional experience) might sometimes provide us with genuine elements of information concerning Being.[119] Beside the universal laws of physics, he mentions mysticism, poetry and other arts as domains where such elements can be found. Of course, not all philosophers and physicists agree with the views of d'Espagnat. If some simply deny the existence of "something" else than empirical reality, others, in line with Kant, accept its existence but deny that its nature can be known. However, leaving the possibility open for a genuine experience of Being is a step towards a better understanding of the Advaita position. Thus, a dialogue can be pursued and pertinent questions can be asked;

3. *Several interwoven realms*: Unlike Jones' model, which admits of only *two* realms — being and world structures — Wilber's model posits *several* realms: matter, life, mind, soul and Absolute. However, this categorization is not particularly relevant here. For instance, neither Advaita nor physics is really concerned with the realm of life or soul. Moreover, the "transcend/include" evolutive scheme presented by Wilber hardly applies here. For instance, d'Espagnat refers to an *atemporal* emergence of empirical reality from ontological reality and not to a temporal or progressive evolution. As for Advaita, if it accepts that *Brahman* is responsible for some form of cosmic evolution, still it does not really present *Brahman* as the last stage of a "spiritual evolution."[120] We believe Jones's division in terms of being and world structures is closer to the more static categorization in terms of "levels of reality" featuring in both systems. Nevertheless, Wilber's idea that realms are not incommensurable but in fact interpenetrate each other is worth considering. As noted earlier, drawing a too sharp line between realms does not seem appropriate;

4. *Multi-level epistemic accessibility*: The most pertinent feature of Wilber's model is perhaps the *multi-level epistemic accessibility* ascribed to both science and religion. In the present context, it is true to say that each system has its "dominant" realm: physics deals mostly with empirical reality (strictly speaking, it cannot go beyond it) while Advaita Vedānta is mainly concerned with self-knowledge and the realization of the unity of being. However, it is also true that both systems have something to say on other realms. Based on an analysis of quantum physics (in particular nonseparability), philosophy of physics has come to the realization that there might be something "beyond" empirical reality. In turn, Advaita Vedānta also admits empirical reality as a stepping stone to its own cosmology and makes claims about the structural features of the world.

[119] d'Espagnat, *On Physics and Philosophy*, 433-33.

[120] We refer here to Śaṅkara's Advaita Vedānta and not to more recent reinterpretations of Advaita like that offered by Sri Aurobindo for whom the central aim of life is to evolve towards a form of "life divine" characterized by a spiritualized, truth-consciousness humanity.

On the basis of the above discussion it is possible to propose another model that could relate modern physics and Advaita Vedānta. The proposal takes the form of a simple map, which, we believe, both systems can agree to and can use as a basis for dialogue (Fig. 5.4). The starting point of the dialogue consists in the following *epistemological consensus*: both systems recognize the limits of perception and reasoning when it comes to define the content of ultimate reality. Empirical reality, i.e., the set of phenomena we perceive, analyze and reflect upon, is not the totality of *what is*: there is "something," mind-independent, of which the existence does not hinge on thought and perception. This has been labelled differently in the course of our analysis: ontological reality, Being, veiled reality, "something," *nirguṇa Brahman*, *pāramārthika*, etc. In line with our comparative study of vacuum and *ākāśa*, we ourselves used the term "unmanifest." As discussed earlier, there are clear differences as to how each system conceives the nature of the unmanifest. But what is significant from a dialogical perspective is that no system can possibly have the "final word" on this issue to the extent that the unmanifest is by definition beyond any kind of description. Nothing can be positively *affirmed* about it, which is consistent with the fact that each system has recourse to negative statements (*via negativa*) to describe the unmanifest: *neti neti*, not multitudinist, not embedded in space and time, not conceptualizable, etc. In our view, therefore, the unmanifest embodies a *horizon of knowledge* based on which both systems can meet and talk to each other respectfully. It is in this sense that the unmanifest is looked upon as a point of convergence between physics and Advaita Vedānta.[121]

[121] It is to be noted that this point of convergence differs from the conceptual rapprochements criticized earlier in that the "concept" of unmanifest primarily points to "something" beyond conceptual constructs. Using the terms of Ulrich Libbrecht in his *Introduction to Comparative Philosophy*, the unmanifest might be identified as a *deep structure* having no particular relation with a specific philosophical or cultural framework. That there is an unmanifest state of existence neither describable nor perceivable has been posited not only in Vedānta but in several other religious and mystical traditions of the world, ranging from neo-Platonism and negative theology to Taoism and Buddhism.

The categorization in terms of "levels of reality" in Advaita has close affinities with that proposed in d'Espagnat and Zwirn's models. In our map, we simply superimpose the levels upon each other, though we remain aware of their basic differences. Similar to Jones' model, we posit *two fundamental realms*: 1. the "unmanifest" realm just mentioned, which is identified with Advaita's *pāramārthika* level as that aspect of reality which is independent of human conceptions, unknowable and non-conceptualizable; and 2. empirical reality, which is more or less identical with Advaita's *vyāvahārika* level. As defined by d'Espagnat, empirical reality includes the whole phenomenal world under the scrutiny of science, and is set in opposition to individual consciousness (see Fig. 5.1). Empirical reality is *relative* to consciousness and vice-versa because both presuppose one another and none "emerges" from the other.[122] It must be recalled that for d'Espagnat consciousness is identical with mind or thought (thus, the term "individual consciousness") whereas according to Advaita consciousness (*caitanya, cit*) *precedes* all mental operations and is identified with pure Being (*Brahman*). In Advaita, consciousness has a wider meaning as it underlies objective and subjective phenomena. Empirical world and individual mind are only different manifestations of the same non-dual consciousness. But if like d'Espagnat we equate consciousness with mind, the Advaita position roughly amounts to that of d'Espagnat from the *vyāvahārika* point of view.[123]

In an integral perspective, the unmanifest realm is distinct but not incommensurable with the realm of empirical reality. In d'Espagnat's conception, reality-in-itself is "veiled" and not totally unknowable: what we apprehend by rational-empirical means, i.e., what constitutes empirical reality, is a *reflection* or *trace* of the Real. Empirical reality is linked to its ontological ground, the Real or what we have called the "unmanifest," out of which it *coemerges* along with individual consciousness. The unmanifest is endowed with *general structures* that constitute the ground not only of our great literary, artistic and mystical inspirations but also of our great scien-

[122] d'Espagnat, *On Physics and Philosophy*, 424.

[123] Satprakashananda, *Methods of Knowledge According to Advaita Vedānta*, 64.

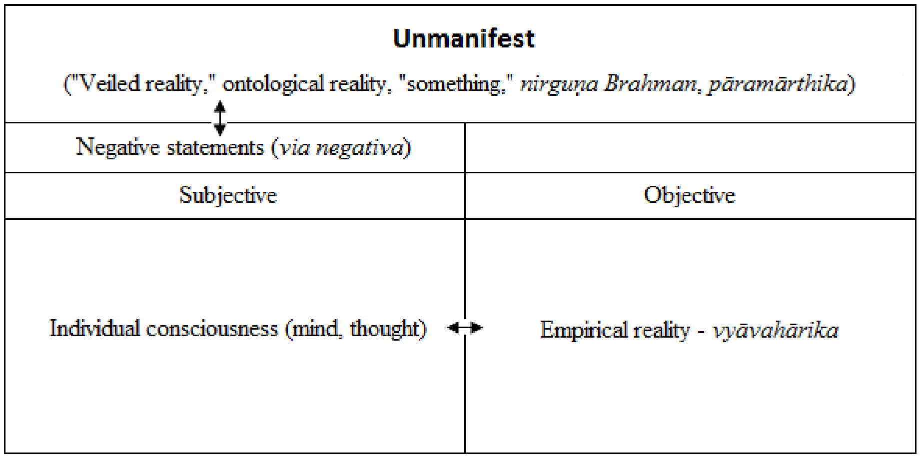

Figure 5.4: A simple map serving as a dialogical basis for relating modern physics and Advaita Vedānta.

tific laws.[124] In Zwirn's thesis, however, the unmanifest has a much more distant relation with empirical reality. His notion of "something" includes everything that is not possibly conceptualizable. Though we have to admit its "existence," it is strictly unknowable and is not "reflected" in the categories of empirical reality. Zwirn simply remains silent as to the possible relation between his concept of "something" and empirical reality. It is significant that in their description of the nature of *nirguṇa Brahman*, Advaitins have come to similar considerations. From a non-dual standpoint (*aparāvidyā*), ultimate reality has no relation whatsoever with empirical reality and is incommensurable with it; only *Brahman* is real and there is no such thing as world, creation, etc. If the world exists as an empirical necessity it has no transcendental validity. Nevertheless, Advaitins must and do admit that *there is* a world that we perceive, experience and act upon at a transactional level. In Advaita cosmology, for instance, there is an attempt to relate *Brahman*, the ultimate cause of the world, to the world and its different components (elements, senses, mind, etc.).

The conception proposed here, which we find consistent with both systems, takes for granted that both empirical reality and the unmanifest, are fundamental components of the total Reality. The unmanifest is the ontological ground of the multifarious

[124] d'Espagnat, *op.cit.*, 455.

world, the "power" that supplies or underlies its laws, structures and phenomena. In turn, empirical reality refers to the set of laws, structures and phenomena that human experience has access to.[125] The important point is that no realm has more cognitive value than the other. If the unmanifest indeed constitutes the ground underlying empirical reality, the latter has an equally important role in *disclosing the mystery of the unmanifest*. By its very limited nature, empirical reality suggests the existence of something "beyond" itself and makes one wonder about the true nature of reality. Or in Advaita terms, *māyā* itself — to the extent that it "measures" our own unknowability of the real — opens the path to the realization of the very ground of things, *Brahman*. As we have seen, the recognition that we have access only to "shadows on the wall" has led some of the founders of quantum physics as well as contemporary philosophers of physics, to develop a strong interest and even to speculate about what lies "outside the cave." It is not true anymore to say that physics is *only* concerned with empirical reality now that some philosophers of physics, on the basis of quantum physics, have been invoking the existence of a non-conceptualizable realm of reality.

It is equally inadequate to envisage Advaita Vedānta as being *only* concerned with self-knowledge and the realization of *Brahman*. This system also deals to some extent with the unfolding of the empirical world from *Brahman* and makes specific claims about the structural features of the world. Too often we get the wrong impression that the world has no cognitive value for Advaitins. However, in their view, the world is not at all "illusory" (*prātibhāsika*) but has an empirical or transactional kind of reality (*vyāvahārika*). Knowledge of the empirical world is justified as long as it does not claim ultimacy. It is understood that though, for instance, means of

[125]There is some similarity here with Jones' conception of Reality as being composed of two different components: being and structures. However, our approach differs in that we do not consider these two realms as totally independent from each other. Moreover, the realm of "structures" in Jones' model is purely objective in character whereas empirical reality is by definition related to our apprehension of the world. See: Jones, *Science and Mysticism: A Comparative Study of Western Natural Science, Theravāda Buddhism and Advaita Vedānta*, 214.

knowledge (*pramāṇas*) are ultimately unreal (*mithyā*), they are still essential for the teacher in order to lead the pupil to the realization of *Brahman*. Lower knowledge (*aparāvidyā*), including cosmology, has an important role in the gradual unfolding of higher knowledge (*parāvidyā*).[126] As we have seen, Advaita Vedānta proposes its own detailed conception of the constitution and evolution of the world in terms of subtle elements (*tanmātras*) evolving into gross elements (*bhūtas*) and other physical and psychological evolutes.

The dialogue following the above lines results in Advaita Vedānta being given authority within the realm of the "unmanifest" (top part of the map) and physics being given authority in the empirical realm (bottom right side of the map).[127] But authority does not mean supremacy. It would be wrong to assume that the scientific approach reveals nothing of the unmanifest, and that Advaita Vedānta is not concerned at all with world structures. The point is that each approach is concerned to some extent with both realms, and this is what justifies, in our view, the necessity of a dialogue between these systems. It means that neither physics nor Advaita Vedānta is confined to a single specific region of the map. In contrast with Jones' model, each system has access to the whole map, though in different ways and degrees.

[126]This is well exemplified, for instance, in the second chapter of Vidyāraṇya's *Pañcadaśī* where non-dual reality is approached by differentiating it from the five elements. Here cosmology is explicitly used as a path to self-realization.

[127]For reasons mentioned above, the empirical realm has been divided into two sections: subjective and objective. Though consciousness is dealt with to some extent in quantum physics, physics is mostly concerned with the objective part of the map, i.e., with the external world as perceived and built by us, and more precisely with its material aspects. The proposed dialogue does not suggest anything substantial regarding other empirical domains such as organic life, functioning of consciousness, mind and body, etc., which fall into the domains of other sciences like biology, psychology and neurosciences. Similarly, I do not deal with the subjective part of the map which relates to consciousness in all its details, even though such insights are generally found in Eastern spiritual traditions and other mystical traditions of the world.

Conclusion

The object of this comparative study dealing with philosophical aspects of modern physics and Advaita Vedānta was twofold: 1. based on an analysis of general parallels and more specifically that between quantum vacuum and *ākāśa*, to show the inadequacies of a comparison relying on mere conceptual similarities; and 2. to reconstruct the dialogue between modern/quantum physics and Advaita Vedānta on an epistemological level by demonstrating that the most significant point of convergence between these systems is the recognition that reality as a whole *cannot* be investigated using rational-empirical means of knowledge. It is worth noting that great physicists of the last century — from Heisenberg and Schrödinger to Jeans and Eddington — recognized this fact as the most important philosophical implication of quantum physics. Perhaps more important for us is the fact that this very recognition led some of them to explore other traditions of knowledge, such as those coming from the East. Today, the situation remains pretty much the same. A brief survey of the views of Michel Bitbol, Bernard d'Espagnat and Hervé Zwirn — three philosophers of science renowned for their rigorous analysis of quantum physics — has shown that they agree on the inherent limitations of a purely empirical approach to reality. It is significant that two of them (Bitbol and d'Espagnat) have invoked other traditions of knowledge — Platonism, Aristotelism, Nāgārjuna's Buddhist philosophy and Vedānta — for comparison with some aspects of quantum physics. Coming from serious academics, this is indeed a remarkable opening.

In this dissertation, we have been mostly concerned with the views of the theoretical physicist and philosopher of science Bernard d'Espagnat. This is because his interpretation of quantum physics today stands as one of the most lucid, worthy of attention from both scientific and philosophical standpoints. It also presents strong affinities with the thought of Advaita Vedānta. In his "veiled reality" thesis, d'Espagnat asserts that the Real must be some sort of indivisible Whole that is neither constituted by parts nor embedded in space and time. What is endowed with parts and subject to change is empirically perceived and "molded" through human understanding. This conception reminds the affirmation in Advaita that *Brahman* is a non-dual, spaceless and timeless Being, the one all-comprehensive reality underlying the variety of empirically perceived phenomena. The non-conceptualizable nature of *Brahman*, repeatedly emphasized in the Vedāntic tradition, finds also an echo in d'Espagnat's negative description of reality-in-itself. That there might exist such an "unmanifest" state of being beyond the reach of thought and perception was also suggested by our comparative analysis of quantum vacuum and *ākāśa*. For these reasons, in our model the assumption of an "unmanifest" realm was considered an important condition for the encounter between physics and Advaita Vedānta. Another feature of d'Espagnat's thesis is the distinction between two "levels of reality": a mind-independent or ontological reality, and a transactional or empirical reality. These levels have been brought into correspondence with the levels of reality in Advaita Vedānta (*vyāvahārika*, *pāramārthika*).

Even though there are clear differences to be taken into consideration in Advaita Vedānta and modern physics, it is still possible for both to have a dialogue and reflect deeply on these divergences. How does each system conceive the nature and epistemic accessibility of ultimate reality? How is the "unknowable" and "unmanifest" aspect of Reality conceived and approached in both systems? Can we compare the role of devotion and meditation in Advaita Vedānta with that of concentration, imagination and intuition in theoretical science? What about the notion of "grace" and the process of "discovery" in science? As far as d'Espagnat's thesis is concerned, it is interesting to note the relationship established between consciousness, empirical reality and the Real. According to him, some of the structures of the Real passes into the universal laws of physics. These laws are reflected in empirical reality and apprehended through consciousness, and thus the structures of the Real can be "glimpsed" at through the laws of physics. It is significant that Advaitins emphasize self-knowledge (*ātmavidyā*) as a way to realize the nature of the Real, which is described as pure existence (*sat*) and pure consciousness (*cit*): the Real, *Brahman*, is essentially identical with our innermost self, *ātman*. For d'Espagnat, however, the Real is neither located in the things of the empirical world nor in "us," and can only be grasped partially through scientific inquiry. Now, could there be a yet unknown, and more direct, relationship between the *consciousness* that gleans a few glimpses of the Real through physical laws, and the *Real* underlying those laws? This is a question that might not be subject to direct scientific inquiry but one of the directions in which contemporary philosophy of physics and cognitive studies of religion could well be leading to.

The fact that modern physics and Advaita Vedānta face similar epistemological issues even while attempting to define the content of reality as a whole is significant from a comparative philosophical perspective. It is revealing that both systems look upon the nature and epistemic accessibility of ultimate reality as valuable philosophical problems, and offer distinct solutions to them. To understand that a similar problem can be approached differently in distinct traditions of knowledge is enriching and conducive to a dialogue free from conceptual constraints. As Krishna says, to search for

> distinctiveness in the solutions offered to similar problems is not only to see the alien tradition in a new way but to enrich oneself with the awareness of an alternative possibility in thought, a possibility that has already been actualized. The awareness of this alternative actualized possibility may, one hopes, free one's conceptual imagination from the unconscious constraints of one's own conceptual tradition.[128]

[128] Krishna, D., *Comparative Philosophy: What It Is and What It Ought to Be.* In: Larson and Deutsch (eds.), *ibid.*, 83.

It can also stimulate philosophical and scientific reflections in unexpected ways. For instance, the fact that Advaita Vedānta contends that knowledge of *Brahman* can be gained by means of different spiritual practices might offer an additional perspective from which to approach the problem of ultimate reality in philosophy of physics. Indirectly, it suggests that an increasing collaboration between philosophers of physics, teachers of Advaita Vedānta, neuroscientists and scientists of cognitive religion could be beneficial. Conversely, the fact that a physicist like d'Espagnat maintains that the laws of physics reflect in some way the structure of reality-in-itself can lead Advaitins to reconsider their own understanding of the nature of empirical reality and its relationship with *Brahman*. By reconstructing the dialogue along such epistemological issues, there might be more room for an authentic encounter between modern physics and Advaita Vedānta.

The age-old Indian tradition of Advaita Vedānta is a philosophical system as well as a practical guide to spiritual experience. It is an attempt to synthesize into a comprehensive and integrated worldview both external and internal aspects of reality. In the vision it brings forth, the world and human beings' innermost self are both envisaged as manifestations of a deeper Reality, unconceivable, unknowable, non-dual and spiritual: *Brahman*. The fact that the very advances made in quantum physics entail a rapprochement with some key ideas of this system is quite significant and worthy of reflection. We do not talk here of a mere set of conceptual similarities but of a consistent meeting at the epistemological level. What does it suggest and where does it point to? Obviously, it does not mean that science is returning, or must return to the tenets of this ancient spiritual philosophy. It appears inappropriate, as we have seen, to conclude that Advaita Vedānta can *legitimate* modern science in any way. But the very possibility of a rapprochement at the epistemological level reminds us of the deeply philosophical character of the scientific enterprise. What is Reality, what is consciousness, and what is our relationship with the world? Is there something like an "ultimate reality" and if so, is it possible to gain knowledge of it? These are questions that occupy the minds of some philosophers of science today and to which no definite answer has yet been offered. Naturally, this opens the door to profound exchanges with other traditions of knowledge. The physicist Wolfgang Pauli, who was deeply interested in the dialogue between science and religion, said:

> ... Contrary to the strict division of the activity of the human spirit into separate departments... I consider the ambition of overcoming the opposites, including also a synthesis embracing both rational understanding and the mystical experience of unity, to be the mythos, spoken and unspoken, of our present day and age.[129]

What humans really need today is a profound sense of unity. To feel part of the whole universe, to be one with it, is the unspoken mythos Pauli is referring to. The spoken mythos might refer to human's explicit attempts to achieve a unified and all-embracing conception of nature, an attempt that features in virtually every field of contemporary science from quantum physics and cosmology to neurosciences and genetics. In its quest for unity of the world, science looks outside and tries to arrange the physical facts of existence into a comprehensive worldview. However, it leaves aside the *interior* facts of consciousness which also demand a place in a unified and integral conception of reality. Though insightful, an understanding of the physical correlates of consciousness, like that provided by neurosciences, can only constitute a partial understanding of the fact of awareness itself.[130] In this context, we might profit from a deeper understanding of spiritual insights about reality and consciousness

[129]Quoted from: Wilber, *Quantum Questions: Mystical Writings of the World's Great Physicists*, 163.

[130]Our research has indicated that it is inadequate to try to explain consciousness as a pure epiphenomenon of matter. To envisage consciousness as a derived product of neuronal activity is to assume the objective reality of neurons, brain, etc. However, according to d'Espagnat's views, these are essentially elements of empirical reality, which itself depends on the co-existence of consciousness. A couple of decades ago, this difficulty was noted by the physicist Robert Oppenheimer: "... despite our increasing knowledge of these intricate marvels both as to their structure and their functioning, it seems rather unlikely that we shall be able to describe in physico-chemical terms the physiological phenomena which accompany a conscious thought, or sentiment, or will. Today the outcome is uncertain. Whatever the outcome, we know that, should an understanding of the physical correlate

pertaining to other traditions of knowledge. As physicist Eddington said, we might need to

> return to our starting point in *human consciousness* — the one centre where more might become known. There [in immediate inward consciousness] we find other stirrings, other revelations than those conditioned by the world of symbols... Physics most strongly insists that its methods do not penetrate behind the symbolism. Surely then that mental and spiritual nature of ourselves, known in our minds by an intimate contact transcending the methods of physics, supplies just that... which science is admittedly unable to give.[131]

Recognizing the limits of empirical knowledge inevitably involves a deeper consideration of the inner world — thoughts, emotions, imagination, intuition and ultimately, as Eddington conveys, the fact of awareness itself. Yet, a divorce with physical science is not desirable. A right synthesis cannot be achieved by means of an idealistic spiritual philosophy that would reduce *exterior* facts of physical existence to some form of inner subjectivity. An integral approach to reality should strive to discover the laws that govern the external world as well as those that govern one's inner world, and perhaps culminate in the formulation of a higher truth reconciling these facets of reality. We believe an honest and rigorous dialogue between physics and Advaita Vedānta could lead the way in this endeavour. It could open a space where intellectual rigour and spiritual awareness work together to evolve a more embracing conception of Reality.

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of elements of consciousness indeed be available, it will not itself be the appropriate description for the thinking man himself, for the clarification of his thoughts, the resolution of his will, or the delight of his eye and mind at works of beauty. Indeed, an understanding of the complementary nature of conscious life and its physical interpretation appears to me a lasting element in human understanding..." See: Oppenheimer, *Science and the Common Understanding*, 80-81.

[131] Quoted from: Wilber, *Quantum Questions: Mystical Writings of the World's Great Physicists*, 10.

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