Esoteric Quantization

The Esoteric Imagination in David Bohm's Interpretation of Quantum Mechanics

Thesis submitted to the University of Exeter by

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towards the degree of

Doctor of Philosophy in Western Esotericism

January 2016

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Abstract

This thesis aims to explore the relationship between the science, the philosophy and the esoteric imagination of the American physicist David Bohm (1917-1992).

Bohm is recognized as one of the most brilliant physicists of his generation. He is famous for his 'hidden variables' interpretation of quantum mechanics. Bohm wrote extensively on philosophical and psychological subjects. In his celebrated book *Wholeness and the Implicate Order* (1882) he introduced the influential ideas of the Explicate and the Implicate orders that are at the core of his process philosophy. Bohm was also a very close disciple of the Indian teacher Jiddu Krishnamurti (1895-1986), whom he recognized to have had an important influence on his thought.

Chapter 1 is a general explanation of what I intend to do, why my research is filling an important gap, introduce the field of Western esotericism as a scholarly subject and suggesting that it offers a fruitful way of approaching the thought of David Bohm. I also explain my research principles and a brief description of the philosophical standpoint from which I am approaching the material.

Chapter 2 gives a description of the textual sources I used in my research. This is followed by a comprehensive literature review.

Chapter 3 is a biographical essay where I give an account of Bohm's life, career, works, major ideas and their development, stressing their significance for the development of Bohm's holistic philosophy and his interactions with the esoteric. This chapter is an introduction to the main ideas of the dissertation.

Chapter 4 revisits the genesis of the Causal Interpretation, Bohm's first attempt to deal with the interpretation of quantum mechanics. I make emphasis on the philosophical developments that gave rise to it. I introduce all the relevant physics and give a detailed explanation of the problem of interpretation and Bohm's first proposal.

Chapter 5 is about the philosophical developments in Bohm's thought brought by the Causal Interpretation. In particular I examine the influence that G. W. F. Hegel (1770-1831) had on Bohm's thought and explain why I take the view that this is an esoteric influence.

Chapter 6 reviews the developments in Bohm's thought during the 1960's. I describe Bohm's search for radically new concepts in physics and his exchanges with several thinkers ending with his encounter with Jiddu Krishnamurti.

Chapters 7 and 8 are devoted to the study of Bohm's philosophy as he

elaborated it after 1960. Chapter 7 concentrates on the idea of the Implicate Order and it also studies the Ontological Interpretation of Quantum Mechanics, Bohm's last version of his interpretation effort, which is based on the Implicate Order. In chapter 8 I examine Bohm's theory of how the mind and the body are connected through a ladder of consciousness formed by a series of Explicate and Implicate Orders, and finishes with an exposition of Bohm's dialogue technique.

In the last chapter I summarize my conclusions.

An appendix is included with a brief overview of Bohm's legacy.

All the relevant details about the esoteric currents that Bohm encountered during his life and that are required to understand our argument are introduced as they are needed throughout the main body of the text.

Acknowledgements

I am deeply indebted to Nicholas Goodrick-Clark, the original supervisor of this thesis. His untimely death deprived us of an enthusiast, resourceful and visionary teacher.

Andrew Pickering accepted to supervise this thesis along with Nicholas. He accepted to become my main supervisor when most needed. I am thankful for his friendly support and his many suggestions, always helpful, insightful and to the point. It was a pleasure to work with Andrew.

Richard Noakes accepted to supervise the thesis along with Andrew. I am thankful for his many suggestions and support.

I am very grateful to Professor Basil Hiley. During the first years of my research I attended his weekly seminar at Birkbeck College. He provided me with very important insights and material. He also helped me to gain access to the David Bohm papers kept at Birkbeck College.

Many thanks to Sue Godsell, librarian at Birkbeck College Library, for all her assistance during my research at the Bohm's archive.

Many thanks to Dr. Garreth Burr and Arletta Ford whom read parts of the manuscript and made important suggestions.

Many thanks to Barbara Fernandez for reviewing the main parts of the manuscript and suggesting better ways to use the English language.

To all all the staff of the now closed Exeter Centre for the Study of Esotericism (EXECESO), and to the students who participated in the now closed MA in Western Esotericism at Exeter University a big thank you! It was a joy to be part of the discussions, seminars, knowledge, friendships, etc. I am very proud to be one of the first three graduates of the MA.

Many other important people that helped with suggestions, discussions, etc. will forgive me for not mentioning them explicitly. In an effort like this one, there are always many participants who deserve credit. Alas!, it is never possible to include explicitly all the people who deserve a big thank you.

Gustavo Orlando Fernandez
Cambridge, England

December 2015

A Note on Style and References

The references and the general style of the thesis follows the recommendations of The Modern Humanities Research Association as described in *MHRA Style Guide*.[1]

NCUACS 66.4.97 stands for the David Bohm papers in the *National Cataloging Unit for the Archives of Contemporary Scientists 66.4.97*, deposed in the library of Birkbeck College of the University of London.[2] NCUACS 66.4.97 is organized in four broad sections: A, B, C, and D. Each section is subsequently organized in sequentially numbered folders. A reference of the form 'NCUACS 66.4.97 A.1' refers to the contents of folder 1 in section A.

JKO stands for L.Krishnamurti Online, an initiative of the Krishnamurti Foundations to make the teachings of J. Krishnamurti available and freely downloadable in text and audio formats.[3] The site guarantees the authenticity of a large text collection of all of Krishnamurti's works from 1933 to 1986. This repository includes a large collection of recorded dialogues between David Bohm and Jiddu Krishnamurti. Any dialogue can be identified by the date in which it took place and the text file in which the transcription is captured. A reference of the form 'JKO 750531 v1.2 Final.doc' refers to the document containing the transcription of the conversation that took place on 31 May 1975, and recorded in the file '750531 v1.2 Final.doc'. This file can be downloaded from the website.

[1] Glanville Priceand and Brian Richardson, eds., *MHRA Style Guide: A Handbook for Authors, Editors, and Writers of Theses* (London: Modern Humanities Research Association, 2008), <http://www.mhra.org.uk/Publications/Books/StyleGuide/> [accessed 1 September 2015].

[2] <http://www.bath.ac.uk/ncuacs/intro.htm> [accessed 1 September 2015]

[3] <http://www.jkrishnamurti.org/> [accessed 1 September 2015]

Contents

Chapter 1

Introduction

1.1 Research Motivations

This thesis aims to explore the relationship between the esoteric imagination and the science and philosophy of the American physicist David Bohm (1917–1992).

Bohm's esoteric inclinations showed very early in his career. He was already expressing his holistic tendencies in trying to find a broader philosophical meaning in his research on the behaviour of plasma. The introduction of the Causal Interpretation of quantum mechanics, a development for which he is most remembered, was an elaboration on the holistic aspects of quantum theory.

Bohm's thought was heavily influenced by the thought of the German Romantic philosopher G.W.F. Hegel (1770–1831) of whom Alexander Glenn Magee writes in *Hegel and the Hermetic Tradition* (2001) that:

> Hegel is a Hermetic thinker [...] I do not argue merely that we can understand Hegel as a Hermetic thinker, just as we can understand him as a German or a Swabian or an idealist

> thinker. Instead, I argue that we must understand Hegel as a Hermetic thinker, if we are to truly understand him at all.[1]

Many aspects of the Implicate Order, arguably the quintessential Bohmian idea, and its elaboration in the Causal Interpretation of quantum mechanics, that in a later rendition became the Ontological Interpretation, show an unmistakable influence of Hegel's metaphysics, and if we accept Magee's thesis, indirectly from the esoteric tradition.

Bohm was not only reading esoteric material. He was actively engaged in the esoteric field, encountering notable representatives of several esoteric schools. Bohm was well aware of the works of the Armenian esotericist George Ivanovich Gurdjieff (1866–1949) as well as Peter Demianovich Ouspensky (1878–1947), and had a sustained dialogue with John Godolphin Bennett (1897–1974), one of the main exponents of Gurdjieff's teachings in England.

Bohm's esoteric leanings are nowhere more evident than through his association with the Indian esoteric teacher Jiddu Krishnamurti (1895–1986). Bohm and Krishnamurti met in London in 1961 and immediately started an intense collaboration that lasted until Krishnamurti's death in 1986. At the time of their encounter Bohm had already made important contributions to physics and had developed the core of his philosophy. However many of Bohm's philosophical ideas found their mature form during the time when Krishnamurti's influence upon him was at its peak.

In contrast with many other thinkers, Bohm was not simply responding to the influence of his encounters. He was a very original thinker, a true maverick, furiously independent, and profoundly inspiring, with a message

[1] Glenn Alexander Magee, *Hegel and the Hermetic Tradition* (New York: Cornell University Press, 2001), pp. 1–2.

that has only been partially heard. Although he was certainly influenced by his encounters, some of them frankly esoteric, what may be called his esotericism was not dependent on exterior influences. Since early childhood he had developed a vivid inner world that included a quasi-mystical vision in which reality was not made of objects and things, but was rather an undefinable whole of pure movement. As he remarks, his research was aiming at:

> ...understanding the nature of reality in general and of consciousness in particular as a coherent whole, which is never static or complete, but which is in an unending process of movement and unfoldment.[2]

Bohm sublated these two aspects of his thought into a single unit for which he introduced a neologism, the Holomovement, an idea with many esoteric undertones. Bohm endeavoured to create a realist process ontology, an epistemology, a philosophy of science, a physical theory and a psychology, all founded on the Holomovement, and his work can be interpreted as an effort to make sense of this mystical holistic vision.

There are striking correspondences between Bohm's philosophy and some esoteric forms of thought. I claim that these correspondences are not accidental and my aim is to show that many aspects of Bohm's thought are indeed of an esoteric nature, that Bohm's mature notions of the Holomovement, the Implicate Order, the Super-Implicate Order, and the thought process were influenced by Bohm's encounter with esoteric philosophy, and that the elaboration of these into his physics constitutes an example

[2]David Bohm, *Wholeness and the Implicate Order* (New York: Routledge, 2002), First published in 1980 by Routledge and Kegan Paul, p. x.

of a direct influence of the esoteric tradition upon contemporary scientific practice.

To achieve this aim, my point of departure is as comprehensible as possible a review of Bohm's works, approaching them in a critical but sympathetic way, and under the assumption that an esoteric world-view can be fully integrated with a scientific world-view.[3]

This is a novel approach to Bohm's work, and in definite contrast with other studies that tend to be partial and biased. The physicist interest in Bohm tends to be concentrated in developing the ideas of Bohm's 1952 papers about the Causal Interpretation, disregarding the later developments of his physics, the more challenging aspects of his process philosophy, and his relationship with several esoteric thinkers. For Bohm the Causal Interpretation was not an end in itself, but a step in a much more ambitious agenda. What Bohm wanted was to find new ways to think about physics, a philosophy of science integrated with an integral philosophy centred on the idea of the Implicate Order. These philosophical developments reached new heights years after the publication of the Causal Interpretation and in collaboration with other thinkers, many of them decidedly within the esoteric tradition. On the other hand, the more philosophical studies tend to ignore Bohm's relationship with Krishnamurti, his allegiance to Hegel's Logic, and are severely limited by the technical aspects of Bohm's physics, making them only partial assessments of Bohm's thought. Accordingly, one of my research objectives has been to review the Bohmian corpus as a single unit and including published and unpublished material, technical work along with his more subtle philosophical argumentation, his psychological, artistic and social works, and of course his esotericism.

[3]See section 1.4 below for an elaboration of what I mean by critical and sympathetic.

Although in my extensive review of the Bohmian corpus I didn't find explicit evidence in the form of references or quotations showing Bohm's allegiance to the esoteric tradition, I am maintaining that Bohm's relationship with Krishnamurti and other esoteric thinkers, his lifelong interests in the aspects of Hegel philosophy that show an influence of the esoteric tradition, and his pursuit of a holistic world-view in the practice of his physics and the elaboration of is philosophy, elicit a definite inclination for the world-view of the esoteric tradition. Moreover, making use of the methodological tools developed by the academic study of Western esotericism, an original approach towards the study of the thought of a Twentieth century scientist, it has been possible to reorganize Bohm's philosophy achieving a clarification of many aspects of Bohm's thought that may seem unconnected, but that when seen through this lens find a natural place.[4] The natural fit of Bohm's thought into the standard model of Western esotericism supports my argument that Bohm's philosophy resembles a traditional form, albeit with contemporary scientific and philosophical content, of Western esotericism.

I think that the subject of this thesis is important because:

- The whole of Bohm's work deserves more academic attention. Bohm's ideas are very relevant for today, but as mentioned above, he remains only partially known and partially studied. I consider that the examination of Bohm's work in a more holistic way, taking into consideration all areas of his thought can bring up new ideas for the further development of philosophy and physics.

- It is important to acknowledge the significant role that the esoteric tradition has had upon the thought of a major contemporary scient-

[4]These methodological tools will be reviewed in section 1.3.4 below.

ist, as this opens new research opportunities in the history and the philosophy of contemporary science.

- Last but not least, Bohm's ideas have the power to inspire and to broaden the imagination.

1.2 Plan of the Thesis

In what remains of this introductory chapter I will introduce the field of Western esotericism as a scholarly subject, describe the main methodological framework for the study of Western esotericism, and will finish with the description of what I mean by a critical and sympathetic approach, which clarifies the philosophical standpoint from which I am approaching the work of David Bohm.

Chapter 2 is a literature review starting with the works authored by David Bohm and continuing with a comprehensive examination of what has been written about David Bohm.

The thesis continues presenting Bohm's intellectual development up to the beginning of the 1960s, at the point in which his thought reached a certain stability that enabled him to articulate more clearly his philosophical views. One important element to keep in mind is that Bohm never considered his thought as a finalized product, not even as something that could be finalized. For Bohm every idea was a tentative and provisional explanation, and therefore has to be considered as an on going research, or as Bohm used to say, 'as it is so far'.

Chapter 3 is a biographical essay where I give an account of Bohm's life, career, major works, his principal ideas and their development, stressing their significance for the development of Bohm's holistic philosophy

and his interactions with the esoteric. This chapter can be read as an introduction to the main ideas of the dissertation.

Chapter 4 revisits the genesis of the Causal Interpretation, Bohm's first attempt to deal with the interpretation of quantum mechanics. I make emphasis on the philosophical developments that gave rise to it. I introduce all the relevant physics, carefully explain the problem and how Bohm though he had achieved an important breakthrough.

Chapter 5 is about the philosophical developments in Bohm's thought brought by the Causal Interpretation during the beginnings of the 1960's, when he assumed the Chair of Theoretical Physics at Birkbeck College, a position in which he remained for the rest of his career. I introduce the main two concepts in Bohm's philosophy: wholeness and process, which Bohm synthesized in a neologism: the 'Holomovement'. This chapter is about how Bohm ideas started to change from a Marxist-materialist position towards a more idealist and frankly esoteric view. A large part of the chapter is about the influence that G. W. F. Hegel (1770-1831) had on Bohm's thought. I do not focus on Hegel's philosophy directly, but on how Bohm received this philosophy, which is a foundation of the ideas that he developed later. The chapter ends on Bohm being ready to embrace explicitly ideas coming from the esoteric tradition.

Chapter 6 is about Bohm during the 1960s when he finally settled down and found stability in his intellectual, academic and economical life. He took a new direction, searching for radically new concepts in physics and a new vision of science, against the background of his search for a more definite articulation of his holistic philosophy of movement. I review the influence that several important thinkers had on Bohm's ideas. The chapter finishes studying the mutual influence of Krishnamurti and Bohm on each

other. The mature articulation of Bohm's philosophy was done at the peak of Krishnamurti's influence on his thought. I begin with an overview of Krishnamurti's work and his relationship with Theosophy. Here I find a completely committed Bohm to the esoteric world–view of Krishnamurti.

Chapters 7 and 8, change the emphasis of the thesis from an intellectual biography to a synchronic presentation of Bohm's philosophy, reorganized in a form that I believe clarifies its contents and its message, making it look very similar to an esoteric philosophy as it is studied today in the academic world. In chapter 7 I explain the ontology of the Implicate Order, how Bohm used it in the interpretation of quantum mechanics. In chapter 8 I show how he extended the Implicate Order into psychology, society, art and religion, and I also examine Bohm's panpsychism articulated in his theory of the mind body connection through a ladder of consciousness planes organized as a series of Orders: Explicate, Implicate, Super-Implicate, Super-Super-Implicate, and so on. This presentation includes the epistemological issues of the limitations of language, perception and communication in science and thought and the applications of Bohm's philosophy, in particular the practical means to achieve awareness of awareness and the development of his dialogue technique.

In the last chapter I will summarize what I think this dissertation has accomplished, summarizing the overall form of the argument, the historical support and it's conclusions.

The appendix gives a brief review of what I consider to be the important aspects of Bohm's legacy.

1.3 Modern Western Esotericism

1.3.1 Esotericism

The noun 'esotericism' has its origins in the much older adjective 'esoteric' found for the first time in Lucian de Samosata's (125–180) satire *Vitarum Rustio* to mean 'seen from within'. The term was used by Clement of Alexandria (150–215) in his *Stromata* to contrast public or 'exoteric' doctrine with secret or 'esoteric' teachings. The much more recent noun is the English translation of the French *l'esotérisme* first used in 1828 by the French scholar Jacques Matter (1791–1864) to refer loosely to secret knowledge. This obscure academic word was later popularized by the French magician Eliphas Lévi (1810–1875) who used it in his influential books on magic. Subsequently, the theosophist Alfred Percy Sinnett (1840–1921) introduced the term into English in his *Esoteric Buddhism* (1883).[5]

The contemporary popular use of these words has not changed much from their original meanings. 'Esoteric' and 'esotericism' are used today to refer to secret or hidden knowledge and associated doctrines and practices, reserved for a chosen elite and of a spiritual or religious nature. A widespread assumption is that this esoteric knowledge is obtained by an intimate communion with God during which a privileged vision of reality is experienced which grants access to the direct perception of the wholeness of the Universe. This knowledge is not obtained by the exclusive use of reason or by mere compliance with a religious creed, but demands a

[5]For a more elaborated discussion of the origins of these terms see Antoine Faivre, 'Renaissance Hermetism and Western Esotericism', in *Gnosis and Hermeticism. From Antiquity to Modern Times*, ed. by Roelof van den Broek and Wouter J. Hanegraaff (New York: State University of New York Press, 1998), pp. 193–216; Wouter J. Hanegraaff, 'Esotericism', in *Dictionary of Gnosis & Western Esotericism*, ed. by Wouter J. Hanegraaff (Leiden: Brill, 2005).

special quality on the part of the receiver, an aptitude that needs to be nurtured by preparatory practice and study that sets the seeker apart from the rest of humanity, and makes him fit to receive this special wisdom in private.

Esotericists tend to believe in the existence of a 'perennial philosophy', a single divine foundation of all religious knowledge, which is usually identified with the 'Prisca Theologia', or ancient theology, revealed to ancient sages and preserved through a long chain of transmission.[6] According to these ideas, each great world religion, independent of its cultural or historical context, is simply a re-interpretation of a unique ancient wisdom, and the particularities of the diverse religions are seen as localized developments and re-interpretations to fit the social and spiritual needs of their respective epoch and culture, but nevertheless rooted in the same universal truth.

During the Renaissance, the rediscovery of the religions of the Hellenistic world — Hermeticism, Neoplatonism and Gnosticism — and the reintroduction to the Christian West of the associated ancient texts in Greek, Arabic and Hebrew, led the way to a scholarly revival of the ancient arts of magic, astrology and alchemy.[7] At the same time, the new study of

[6]Strictly speaking 'Prisca Theologia' and 'Philosophia Perennis' refer to different things. The term 'Philosophia Perennis' was introduced by the theologian Agostino Steuco (1497–1548) in *De Perenni Philosophia* (1540), whereas the idea of a 'Prisca Theologia' was elaborated by Marsilio Ficino (1433–1499) in his *Theologia Platonica* (1482) and other works. For more details see Wouter J. Hanegraaff, 'Tradition', in *Dictionary of Gnosis & Western Esotericism*, ed. by Wouter J. Hanegraaff (Leiden: Brill, 2005), pp. 1125–1135.

[7]Hermeticism, or Hermetism, derives its name from its mythical founding father, Hermes Trismegistus, the thrice-great Hermes. Hermetists had a positive view about the material world and believed that human beings could find their original divinity by means of an intuitive mystical gnosis. *The Corpus Hermeticum*, an important collection of texts attributed to Hermes, was translated into Latin in the second half of the Fifteenth century by the Neoplatonic philosopher Marsilio Ficino. This resulted in a widespread revival during the Renaissance which has exerted an important cultural influence up to our present

biblical sources led the way to the discovery of the Kabbalah, a Jewish form of mysticism. Influenced by these sources, Renaissance scholars introduced many innovations into these practices. Particularly important among these was the development of a Christian version of the Kabbalah, an event that inspired the further development of the esoteric traditions within Christianity. The modern reformulation of these 'Hermetic sciences' gave rise to Theosophy, Rosicrucianism and Freemasonry in the eighteen century. Further developments inspired the proliferation of esoteric rites and systems during the Enlightenment, many of which are still in vogue.

The Romantic imagination had its own esoteric revival during which not only older esoteric traditions found a new life, but also many new esoteric manifestations were born: German *Naturphilosophie*, Occultism, Swedenborgianism, Mesmerism, Spiritualism, and many varieties of Freemason and Rosicrucian orders. The Romantic fascination with the exoticism of the East had an important impact on esotericism which has been flexible enough to enhance its pedigree by now adding Buddhist, Indian, Chinese and other Eastern influences into its perennial sources of 'true wisdom'. These developments paved the way to today's major esoteric currents and teachings: Helena Blavatsky's Theosophical Society; Rudolf Steiner's Anthroposophy; C. G. Jung and his archetypal psychology; Jiddu Krishnamurti's school; the Fourth Way movements inspired by Gurdjieff and Ouspensky; and contemporary versions of Freemasonry and Rosicrucianism. All these esoteric currents have never been as popular as they are today. [8]

day. See Frances Yates, *Giordano Bruno and the Hermetic Tradition* (London: Routledge & Kegan Paul, 1964); Roelof van den Broek and Wouter J. Hanegraaff, eds., *Gnosis and Hermeticism: From Antiquity to Modern Times* (New York: State University of New York Press, 1998); Antoine Faivre, *The Eternal Hermes: From Greek God to Alchemical Magus* (Grand Rapids, Mich: Phanes Press, 1995).

[8]For an overview of the religious currents and traditions mentioned above see Wouter

In the twentieth century esotericism found new forms of expression, among them the New Thought movement, a development which is experiencing a revival in the early years of the twenty first century. Also worth mention is the New Age, a complex and amorphous religious movement with roots in the esoteric tradition, born from the counter-cultural currents of the 1960s, it started to gain momentum in the 1970s and that has grown into a multi million dollar market.[9]

1.3.2 Esotericism and the Academia

Esotericism is conceived in the West as a religious expression and in consequence its academic study should fall naturally within the field of Religious Studies. But this has not been an easy relationship as the academic community has been suspicious of any research connected with esotericism. The received view places esotericism as an alternative to religion and science. To orthodox faith esotericism is akin to heresy, whereas for scientific reason it looks as an irrational form of thought plagued with meta-

J. Hanegraaff, ed., *Dictionary of Gnosis & Western Esotericism* (Leiden: Brill, 2005). Also the reader can consult any of the general surveys existing in English: Pierre A. Riffard, *L'Ésotérisme* (Paris: Robert Laffont, 1990); Antoine Faivre and Jacob Needleman, eds., *Modern Esoteric Spirituality* World Spirituality (London: SC, 1992); Antoine Faivre, *Access to Western Esotericism* (Albany: State University of New York Press, 1994); Broek and Hanegraaff, *Gnosis and Hermeticism*; Kocku von Stuckrad, *Western Esotericism: A Brief History of Secret Knowledge* (London: Equinox, 2005); Arthur Versluis, *Magic and Mysticism: An Introduction to Western Esotericism* (Plymouth, UK: Rowman & Littlefield, 2007); Nicholas Goodrick-Clarke, *The Western Esoteric Traditions: A Historical Introduction* (New York: Oxford University Press, 2008).

[9]For scholarly studies of the New Age see Wouter J. Hanegraaff, *New Age Religion and Western Culture: Esotericism in the Mirror of Secular Thought* (Leiden, New York, Köln: E.J. Brill, 1996); Paul Heelas, *The New Age Movement: The Celebration of the Self and the Sacralization of Modernity* (Oxford: Blackwell, 1996); Olav Hammer, ed., *Claiming Knowledge: Strategies of Epistemology from Theosophy to the New Age* (Leiden, Boston: Brill, 2004).

physical presumptions.[10] Most scholars and certainly the vast majority of scientists have chosen to ignore esotericism, and when it has been impossible to ignore its presence, many authors have chosen to avoid the mention of the word itself by substituting it with more acceptable terms — mysticism, mythological, metaphysics, gnosticism, and similar — and thus allowing to somewhat include esotericism without mentioning it explicitly.[11] Even today invoking esotericism is a dubious affair. As Wouter Hanegraaff writes in the introduction to the *Dictionary of Gnosis & Western Esotericism*:

> Perhaps no other domain in the study of religion has suffered from such biases as seriously as the one to which this Dictionary is devoted, for it covers more or less all currents and phenomena that have, at one time or another, come to be perceived as problematic (misguided, heretical, irrational, dangerous, evil, or simply ridiculous) from the perspectives of established religion, philosophy, science, and academic research.[12]

[10]This state of affairs has not been simplified by the identification of modern Western Esotericism with the New Age movement. Vigorously prolific, New Age religion has inspired several accounts of relative value relating modern science with diverse spiritual currents, not always in the pursuit of religious or scientific values, but rather at the service of political, financial or other more dubious agendas. Fritjof Capra, *The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism* (Berkeley: Shambhala Publications, 1975) launched an industry dedicated to explore the spiritual dimensions of contemporary science in a popular style that has been adopted as one of the principal components of the New Age movement under the title of 'New Age Science'.

[11]An example of the way in which esotericism has been handled by the academia is Arthur Lovejoy's (1873-1962) *The Great Chain of Being* (1936). Although the idea of a 'Great Chain of Being' is a fundamental aspect of the esoteric imagination, and despite Lovejoy's recognition of an 'esoteric pathos', he does not include in his study any of the important esoteric thinkers that have contributed to its history. Lovejoy uses the word 'esoteric' briefly in page 5 of *The Great Chain of Being*, and it is missing from the rest of the work.

[12]Hanegraaff, *Dictionary of Gnosis & Western Esotericism*, p. xiii. For a further development of Hanegraaff's argument about esotericism as 'rejected knowledge' see Wouter J. Hanegraaff, *Esotericism and the Academy: Rejected Knowledge in Western Culture*

Despite this official neglect, the scholarly study of esotericism flourished for years camouflaged as historical research and was confined to obscure and specialized works, without any ambition to place these studies in a larger context. However, since the middle of the twentieth century there has been a continued effort to place the study of esotericism in an academic setting. To do this it has been necessary to justify the field and to find a suitable definition, as the popular notion of esotericism described above is too vague and subjective to permit an approach from a scholarly point of view. However the academic effort to define precisely what is meant by the term 'esotericism' has been confronted with difficulties. But these are to be expected as esotericism inherits many of the issues confronted by its parent academic field: Religious Studies.

The academic field of Religious Studies originated in the nineteenth century, when the first analytical and historical approaches to the study of the Bible were developed, and the religious texts of other religions begin to be translated into the main European languages. This form of scholarship developed first as an effort to disentangle the study of religion from Christian theology and reaching for the values of scientific rationality associated with the Enlightenment.[13] The formal establishment of an academic discipline to study 'religion' requires a definition of its subject, a demarcation of its scope, as well as the development of methodologies to approach

(Cambridge: Cambridge University Press, 2012).

[13]For further references on the formation and the methodological issues related to the field of religious studies see: Joseph D. Bettis, ed., *Phenomenology of Religion* (London: SCM Press, 1969); Eric J. Sharpe, ed., *Comparative Religion: A History* (London: Duckworth, 1975); Eric J. Sharpe, ed., *Understanding Religion* (London: Duckworth, 1983); Peter Connolly, ed., *Approaches to the Study of Religion* (London and New York: Casell, 1999); Willi Braun and Russell T. McCutcheon, eds., *Guide to the Study of Religion* (London and New York: Casell, 2000); Ian S. Markham and Tinu Ruparell, eds., *Encountering Religion* (Oxford: Blackwell Publishers, 2001). In its early years Religious Studies was known in England as Comparative Religion. In Germany it is called *Religionswissenschaft* and in France *Science de la Religion*.

the material, and there are good reasons why this has been problematic. The field aims to account for the religions of all peoples, and this ambition poses immediately a problem, as the term religion itself is primarily a Christian term with connotations that are difficult to export into other cultures. Despite more than a century of research, study, and much argumentation, scholars have not reached an agreement: there is no standard definition of religion, neither is there a standard methodological approach to the subject. Many complementary 'varieties of Religious Studies methodologies' co-exist today in the academic world, none of which pretend to be the last word regarding religion.

The most influential methodological approach to the study of religion during the twentieth century was phenomenology.[14] The foundational document that established phenomenology as an approach to the study of religion is *Phänomenologie der Religion* (1933) by Gerardus van der Leeuw (1890–1950).[15] On this work van der Leeuw aims to apply the philosophical methodology formulated by Edmund Husserl (1859–1938) in his *Logical Investigations* (1901) to the problem of religion.

The phenomenological method consists primarily in adopting a detached state of mind when approaching a subject. This state of mind has two characteristics or 'phenomenological reductions': first, *epoché*, also known as phenomenological reduction or bracketing, involves a sus-

[14]The genealogy of this approach includes many notorious scholars: William James (1842–1910), Pierre Daniel Chantepie de la Saussaye (1848–1920), Nathan Soderblom (1866–1931), William Brede Kristensen (1867–1953) and Rudolf Otto (1869–1937). For the history and further analysis see Bettis, *Phenomenology of Religion*; George A. James, 'Phenomenology and the study of religion: the archeology of an approach', *The Journal of Religion*, 5.3 (1985), pp. 317–335; Douglas Allen, 'Phenomenology of Religion', in *The Routledge Companion to the Study of Religions*, ed. by John R. Hinnells (New York: Routledge, 2005).

[15]Published in England under the title of *Religion in Essence and Manifestation: A Study in Phenomenology* (1938).

pension or restraint of judgment, aiming to observe phenomena 'in and of themselves', rather than from the perspective of the researcher; second, *eidetic vision*, which relates to the ability to see what actually is there, aiming to observe without any preliminary belief that may influence the understanding of what is observed.[16] Many famous scholars of religion adopted explicitly a phenomenological outlook: Mircea Eliade (1907–1986), Wilfred Cantwell Smith (1916–2000) and Ninian Smart (1927–2001) among others.

However, the phenomenology of religion is quite problematic.[17] One of the issues is that there has been a certain level of confusion concerning its application:

> It seems that the science of religion is in the peculiar position of having used a term to distinguish an approach to religion that itself contains more connotations than any particular exponent of such an approach could have desired. Because it had already been used in a variety of ways, it was easily applied by different individuals in the study of religion to quite different kinds of activities. This to the point that it is now almost impossible to find any agreement about the nature of such a study.[18]

A more serious problem has been phenomenology's rhetoric of impartiality and critical distance. It is by no means obvious that it is really possible to perform the phenomenological reductions. The debate is centred on the question of the possibility of an 'outsider' to effectively enter the world of

[16]Clive Erricker, 'Phenomenological Approaches', in *Approaches to the Study of Religion*, ed. by Peter Connolly (London and New York: Casell, 1999), pp. 73–104.

[17]See Gavin Flood, ed., *Beyond Phenomenology: Rethinking the Study of Religion* (London: Continuum, 1999) for an account of the issues raised against phenomenology.

[18]James, 'Phenomenology and the study of religion', pp.

an ‘insider’. The contemporary form in which this issue is articulated is characterized by the use of the terms ‘emic’ and ‘etic’ which refer to the points of view of an ‘insider’ and an ‘outsider’ respectively.[19] By the end of the 1980s the two terms were in common use in the social sciences, but unfortunately for those who expected that their use may deliver some clarification to the insider/outsider debate, their introduction only added a new level to the confusion, as there is little agreement on the exact meaning of the terms when they are used to refer to something that goes beyond the straightforward distinction between an ‘insider’ and an ‘outsider’.[20] In the particular case of Religious Studies the insider/outsider problem has been permanently at the heart of the methodological debates introduced by the phenomenological approach.[21]

[19]These two neologisms were introduced by the linguist Kenneth Pike (1912–2000) in his *Language in Relation to a Unified Theory of the Structure of Human Behavior* (1954), deriving them from the existing linguistic terms ‘phonemic’ and ‘phonetic’. Following Pike, the anthropologist Marvin Harris (1927–2001) makes use of these terms in *The Nature of Cultural Things* (1964) defining them as: ‘Emic statements refer to logico-empirical systems whose phenomenal distinctions or ‘things’ are built up out of contrasts and discriminations significant, meaningful, real, accurate, or in some other fashion regarded as appropriate by the actors themselves [. . .] Etic statements depend upon phenomenal distinctions judged appropriate by the community of scientific observers’, Marvin Harris, ed., *The Rise of Anthropological Theory* (New York: Crowell, 1968), pp. 571, 575. Pike and Harris both agree that both views are partial and that there is a need to consider both points of view. Nevertheless Harris claims that the etic approach is superior and is at the heart of a scientific method.

[20]For a survey of the various uses of the two terms see Thomas N. Headland, Henneth L. Pike and Marvin Harris, eds., *Emics and etics: The insider/outsider debate* (Newbury Park, London, New Dehli: Sage, 1990); Christina Hahn, ‘Clear-Cut Concepts vs. Methodological Ritual: Etic and Emic Revisited’, <http://www.allacademic.com/meta/p92120_index.html> [accessed 8 January 2012].

[21]For a recent review of the situation see Russell T. McCutcheon, ed., *The Insider/Outsider Problem in the Study of Religion* (London and New York: Casell, 1999). In the introduction to this work McCutcheon classifies in four categories the different attitudes to the insider/outsider problem in the study of religion: (i) the autonomy of religious experience, which he associated with the phenomenological approach; (ii) reductionism, exemplified by those claiming to take an unapologetic scientific, objective outsider stance; (iii) neutrality and methodological agnosticism, as adopted by those such as Ninian Smart who relied on insider accounts without evaluating their truth or falsity; and (iv) reflexivity suggesting that the role of the researcher is more pervasive than is often granted.

Today there are no phenomenologists of religion with the status and influence once enjoyed by van der Leeuw, Eliade or Smart, and religion scholars with phenomenological tendencies may feel uncomfortable with the term as it seems to carry a baggage of outdated philosophy. But despite losing ground as the dominant approach, phenomenology remains highly influential and has had the effect of making contemporary scholars of religion, whether they subscribe to phenomenology or not, more sensitive to the context of their study, and more modest in their claims, trying to do justice to the experience of the 'insider'.

1.3.3 Yates' Paradigm

The defining event that eventually led to the recognition of a specialized academic field devoted to the study of the esoteric tradition was the publication of Dame Francis Yates' (1899–1981) *Giordano Bruno and the Hermetic Tradition* (1964).[22] In this book Yates puts forward the idea that a forgotten 'Renaissance Hermetic Tradition', in this case embodied by Giordano Bruno (1548–1600), was an important element in the thought of important Renaissance intellectuals. She argued that this ignored tradition was not only crucial, but that in many ways it was the cause of the development of early modern science.[23] As Yates explains, the Renaissance witnessed the formation of a new syncretism in which a number of diverse traditions — Neoplatonism, mysticism, Jewish Kabbalah, Hermeticism, astrology, magic, alchemy — were combined together to form a new independent current that can be set apart from other practices. Yates further develops this thesis in her article 'The Hermetic Tradition in Renaissance

[22] Yates, *Giordano Bruno and the Hermetic Tradition*.
[23] Ibid.

Science' (1968) and later in *The Rosicrucian Enlightenment* (1972).[24]

Yates' contends that historians have missed an important element in the general study of the Renaissance. Her claim was that the Hermetic Tradition had a powerful and yet unacknowledged influence on the scientific revolution. The exotic appeal of the related materials, and her imaginative writing style, all this made her work refreshing and excitingly original, and helped to bring out the study of esotericism to the surface of academic research, and reaching even to the general public. For many years the 'Yates Paradigm', as Wouter Hanegraaff called it, was the dominant approach in the academic study of the esoteric tradition:[25]

> So in Yates' writings we have, firstly, the picture of the 'Hermetic Tradition' as a quasi-autonomous counter-culture of magic and mysticism, pitted against the dominant powers of church and rationality; and secondly, we have a modernist set of assumptions about science and progress, which underlies her presentation of this hermetic Tradition. The combination of these two results in a 'grand narrative' about hermeticism, which I will refer to as the 'Yates Paradigm'.[26]

Following Yates' pioneering work, there have been produced numerous studies on the influence of the esoteric tradition on the work of many Renaissance thinkers, helping to establish without any doubt that many of

[24]Frances Yates, 'The Hermetic Tradition in Renaissance Science', in *Art, Science and History in the Renaissance*, ed. by Charles Singleton (Baltimore, Md: John Hopkins Press, 1967); Frances Yates, *The Rosicrucian Enlightenment* (London and New York: Routledge & Kegan Paul, 1972).

[25]This paradigm was not a conscious methodological definition on the part of Yates, but only her basic assumptions retrospectively elicited by Hanegraaff.

[26]Wouter J. Hanegraaff, 'Beyond The Yates Paradigm: The Study of Western Esotericism Between Counterculture and New Complexity', *Aries*, 1.1 (2001), pp. 5–37.

the founders of modern science were indeed deeply involved with esotericism.[27]

Yates' writings remain very influential and continue to inspire many academic works devoted to the study of the esoteric tradition. However her methodological assumptions of the existence of an Hermetic Tradition and its role in the rise of science are nowadays questioned, and later analysis has shown gaps in her argumentation. In addition there is an apologetic aspect transpiring in her work, that justifies the study of esotericism by the role that it played in the history of early modern science.

1.3.4 Faivre's Characterization

During the early 1990s an important milestone was achieved by the French scholar Antoine Faivre who produced the first comprehensive academic definition of esotericism. According to this model, Western esotericism is a form of thought identified by the following characteristics:

1. Correspondences: 'As above, so below', meaning that there are levels of manifestation, from the subtle, above, to the concrete, below, in a sympathetic correlation. These correspondences are both

[27]The unearthing of Isaac Newton's (1642–1727) alchemical manuscripts revealed to an unsuspecting public the profound engagement with practical alchemy of one of the main heroes of modern science. The interesting story of the recovery of Newton's manuscripts and a scholarly exploration of the relationship between Newton's esoteric thought and the development of his scientific ideas are reviewed in Betty Jo Teeter Dobbs, *The Foundations of Newton's Alchemy: Or The Hunting of the Greene Lyon* (Cambridge: Cambridge University Press, 1983); Betty Jo Teeter Dobbs, *The Janus Faces of Genius: The Role of Alchemy in Newton's Thought* (Cambridge: Cambridge University Press, 1991); Michael White, *Issac Newton, the Last Sorcerer* (London: Fourth Estate, 1997). Newton is not an isolated case, many other important scientific figures of the Renaissance were as involved in esoteric pursuits as Newton was. See A. Coudert, *Leibniz and the Kabbalah* (Boston: Kluwer, 1995); Lawrence M. Principe, *The Aspiring Adept: Robert Boyle and his Alchemical Quest* (Princeton, New Jersey: Princeton University Press, 2000).

symbolic and real, visible and invisible, and includes the entire universe. In particular the microcosmic human reflecting the majesty of the macrocosm.

2. Living Nature: The natural universe is alive, and through it a hidden and subtle living energy circulates. This and the notion of correspondences establish an ontology in which the universe is seen as a single whole: anything done in a certain place and time has energetic reverberations everywhere. This is the basis of *magia naturalis* which aims to awaken these relationships. The different levels of the world are inhabited by living creatures.

3. Mediation and Imagination: Imagination, meaning an insight into the subtle worlds, the *mundus imaginalis*, is seen as the organ of the soul through which man can have access to the inner levels of creation.[28] It functions in conjunction with meditation to make possible the use of symbols, and to profit from the inhabitants of the intermediary levels — angels, spirits, symbols — to access the higher levels.

4. Transformation: Parts of nature, but also human beings, can be

[28]Faivre was influenced by the French philosopher Henri Corbin (1903–1978) who introduced the term *mundus imaginalis* to refer to the imagination as an autonomous world of intermediaries, where visions, angels, and other spiritual beings exist independently of the physical world. In Henri Corbin, *Alone with the Alone: Creative Imagination in the Sufism of Ibn Arabi* (Princeton, N.J.: Princeton University Press, 1997), p. 4 he writes that the mundus imaginalis:

> . . . is as real and objective, as consistent and subsistent as the intelligible and sensible worlds; it is an intermediate universe 'where the spiritual takes body and the body becomes spiritual', a world consisting of real matter and real extension, though by comparison with sensible, corruptible matter these are subtle and immaterial. The organ of this universe is the active Imagination; it is the place of theophanic visions, the scene on which visionary events and symbolic histories appear in their true reality.

See also Henri Corbin, 'Mundus Imaginalis, the Imaginary and the Imaginal', *Spring, Analytical Psychology Club of New York, Inc.* (1972), pp. 1–19.

transmuted. This is a metamorphosis, a change of nature, a second birth subsequent to a mystical death. In metals this is represented by the celebrated alchemical transmutation of gross metals into gold. In humans, it is the achievement of illumination, gnosis, individuation.

5. Concordance: The search for common denominators in different traditions, or in all traditions.

6. Transmission: Emphasis in initiation, the reception of secret knowledge from an illuminated master who has accepted the receptor as a disciple.

The first four characteristics are mandatory in the sense that they have to be present in order to fulfil the definition of esoteric thought. The last two may or may not appear, but frequently they do, so their absence does not disqualify a thought system as esoteric.[29]

This framework is 'empirical' and 'historical' in the sense that Faivre started with a predefined set of texts and currents that he was willing to call esoteric, from which he extracted the characteristics listed above. The texts and traditions used by Faivre were post medieval and located in the Christian west, and to specifically refer to these forms of esoteric traditions scholars use the term 'Modern Western Esotericism'. An important point to note is that Faivre's sees esotericism as a continuous family of forms of thought (formes de pensée), connected from the Renaissance up to the present day through invariant and generic characteristics, which makes this approach a form of phenomenology.

[29]Faivre, *Access to Western Esotericism*, pp. 10–15; Antoine Faivre and Karen-Claire Voss, 'Western Esotericism and the Science of Religions', *Numen*, 42 (1995), pp. 48–77; Faivre, 'Renaissance Hermetism and Western Esotericism', pp. 119–120.

Faivre's framework helped to establish Western esotericism as a recognized academic field.[30] Also the scholar's attitude towards the subject changed as the esoteric tradition is now approached on its own terms, with no need to justify its existence, or its study, by the role that it may have had in the rise of science, and with the conviction that no comprehensive understanding of our culture can be complete, whether in the past or in the present, without including esotericism. That this tradition has influenced and interacted with other intellectual and spiritual traditions is not any more the justification to consider it, but a *raison de plus* for its serious

[30]There are several academic positions in American and European universities, numerous academic societies, specialized journals and libraries as well as international conferences dedicated to the exploration of the subject. In 1966 the French École Pratique des Hautes Études at the Sorbonne established the first academic chair dedicated to esoteric studies: *Histoire des courants ésoteriques dans l'Europe moderne et contemporaine*. The University of Amsterdam offers a Master's programme *Mysticism and Western Esotericism* since 1999. In 2005 the University of Exeter in the UK started offering postgraduate studies. In America the *Association for the Study of Esotericism* (ASE) was founded in 2002, and its European counterpart the *European Society for the Study of Western Esotericism* (ESSWE) was founded in 2005. *The Societas Magica* was established in 1994 with the purpose of sponsoring the study of the history of magic. *The Center for Studies on New Religions* (CESNUR) established in 1988 with headquarters in Torino, Italy, although devoted to the larger study of new religious movements, gives an important place to esotericism. *The Enlightenment in the Referential Context of Modern Esotericism* of the German Research Foundation DFG, and the *Exeter Centre for the Study of Esotericism* (EXESESO) of the University of Exeter are research centres devoted entirely to the Western esoteric tradition. The European *Aries* and the American *Esoterica* are among the principal periodicals devoted to the academic study of esotericism. *The Bibliotheca Philosophica Hermetica* located in Amsterdam and in London *The Warburg Institute*, today part of the University of London's School for Advanced Study, both contain important collections specializing on the esoteric tradition. Other libraries in the UK containing important esoteric collections are The Wellcome Institute, The British Library and the libraries at the universities of Oxford and Cambridge. Besides many other smaller meetings in Europe and in America, the ASE and the ESSWE alternate the organization of a yearly conference purely devoted to esotericism. This academic effort has also produced several important general surveys of the field: Riffard, *L'Ésotérisme*; Faivre and Needleman, *Modern Esoteric Spirituality*; Faivre, *Access to Western Esotericism*; Broek and Hanegraaff, *Gnosis and Hermeticism*; Stuckrad, *Western Esotericism*; Versluis, *Magic and Mysticism*; Goodrick-Clarke, *The Western Esoteric Traditions*. Since its publication Hanegraaff, *Dictionary of Gnosis & Western Esotericism* has established itself as the standard academic reference. For more information about the history of the academic field see Hanegraaff, *Esotericism and the Academy*.

study.

1.3.5 Definition Issues

Despite the formation of an academic status-quo, scholars have failed to reach a methodological agreement. Although Faivre's characterization is in wide use, having replaced Yates' initial approach, it is not universally accepted as the ultimate definition of esotericism. There is an ongoing scholarly debate regarding the methodology, the definition and the demarcation of the field.

One of the main participants in this debate is the Dutch scholar Wouter Hanegraaff from the University of Amsterdam who argues that Faivre's typology is well suited to deal with the esoteric movements of the early modern period, but that it only partially accounts for later developments, especially for the esotericism of the nineteenth and twentieth centuries.[31] Hanegraaff does not question Faivre's homogeneous line of esoteric traditions, neither his typology, but argues that it needs to be used with caution as the concept of esotericism suffered crucial transformations since the eighteenth century. He complains about what he calls the 'check list' use of Faivre's typology to test whether something is esoteric:

> Actually, however, since all definitions are scholarly constructs, no answer is possible to the question of 'whether movement x is *really* esoteric'; we can only know 'whether movement x qualifies as esoteric according to definition y'. Obviously this makes

[31] Hanegraaff, *New Age Religion and Western Culture*; Wouter J. Hanegraaff, 'The Study of Western Esotericism: New Approaches to Christian and Secular Culture', in *New Approaches to the Study of Religion Volume 1: Regional, Critical and Historical Approaches*, ed. by Peter Antes, Armin W. Geertz and Randi R. Warne (Berlin, New York: Walter de Gruyter, 2004).

> the exercise of applying Faivre's definition as a litmus test for their 'esoteric' nature rather futile; and the frequency of such attempts illustrates the continuing — but often barely conscious — influence of *sui generis* assumptions among methodologically less sophisticated students of Western esotericism.[32]

In a series of articles, Hanegraaff attempts to overcome the weaknesses of Faivre's definition by demanding a stronger historicism, stressing transformations and discontinuities in the use of concepts related to the esoteric tradition.[33] He starts his argumentation by importing the emic/etic construct from Religious Studies.[34] Without any pretension of making a more sophisticated use of this dichotomy beyond the straightforward reference to an outsider and an insider, he emphasizes the importance of an etic approach to the study of esotericism as essential to make it credible to the eyes of the academic community, as for him the issue of respectability and acceptance will remain a fundamental preoccupation. He classifies the major approaches to the study of esotericism in three major categories, based on the subjective motivations of scholars.

First the 'religionist' approach produced by scholars that personally believe in the truth of esotericism, scholar-insiders dissatisfied with the spiritual status-quo and on a 'personal search for a spiritual home', represen-

[32]Hanegraaff, 'The Study of Western Esotericism: New Approaches to Christian and Secular Culture', p. 508.

[33]Wouter J. Hanegraaff, 'Empirical Method in the Study of Esotericism', *Method & Theory in the Study of Religion*, 7.2 (1995), pp. 99–129; Hanegraaff, 'Beyond The Yates Paradigm'; Wouter J. Hanegraaff, 'Forbidden Knowledge: Anti-esoteric Polemics and Academic Research', *Aries*, 5 (2005), pp. 225–254; Wouter J. Hanegraaff, 'On the Construction of 'Esoteric Traditions'', in *Western Esotericism and the Science of Religion*, ed. by Antoine faivre and Wouter J. Hanegraaff (Leuven: Peeters, 1998); Hanegraaff, 'The Study of Western Esotericism: New Approaches to Christian and Secular Culture'; Hanegraaff, 'Esotericism'; Hanegraaff, *Esotericism and the Academy*.

[34]Hanegraaff, 'On the Construction of 'Esoteric Traditions'', pp. 56–61.

ted by scholars in the tradition of Mircea Eliade (1907–1986), Henry Corbin (1903–1978), and Carl Jung (1875–1961).[35] Scholars with this motivation tend to promote esotericism as the true core of spirituality, opposing it to the merely exoteric dimensions embodied by social institutions and official dogmas. Hanegraaff believes that these kinds of approaches result in considerable confusion about what is really meant by esotericism. He uses the term 'crypto-esotericism' to refer to these kind of approaches as he reckons that scholarship produced under this banner represents apologetics for esotericism in academic disguise.[36] For Hanegraaff, religionist approaches 'tend to confuse the study of esotericism with the propagation of esotericism'.[37]

Diametrically opposed to these are the anti-esoteric approaches, produced by scholars that tend to associate esotericism with irrationality and superstition, considering it basically a dangerous mistake, a disease that is important to understand in order to eradicate it.[38] The scholars representative of this approach champion a world view that is incompatible with the esoteric one. These approaches are problematic as being a form of religionism in reverse, they tend towards an ideological promotion of a certain world view, in this case the orthodox one, becoming more of a justification for the statu-quo rather than an impartial assessment.

A third kind of approach is the 'historical constructs with an empir-

[35]Hanegraaff, 'On the Construction of 'Esoteric Traditions'', p. 17.

[36]Hanegraaff, *Dictionary of Gnosis & Western Esotericism*, p. 339.

[37]Hanegraaff, 'On the Construction of 'Esoteric Traditions'', p. 28. One extreme case of religionism that Hanegraaff finds particularly problematic is 'Perenialism', an esoteric current with scholar tendencies, exemplified by Ananda K. Coomaraswamy (1877–1947) and Frithjof Schuon (1907–1998) and popularized by Aldous Huxley (1894–1963). This approach, uncompromisingly open about its doctrinal nature, is based on the assumption of a un-historical, transcendental unity in all great religious traditions.

[38]Examples of this approach are the political historian Eric Voegelin, the historian of religions Carl A. Raschke, and the sociologist Marcello Truzzi.

ical foundation' which, according to Hanegraaff, are motivated by a desire for historical objectivity as certain persons and movements who have been influential in their own time are now neglected because they become 'marginal'.[39] Placing himself in this category, along with Faivre's approach, Hanegraaff articulates his view according to which esotericism is an academic construct that is not 'discovered' but 'produced', being the result of a polemical discourse of exclusion operated by the academic status quo.[40] For Hanegraaff esotericism does not have an existence on its own, but only as a contra position to the dominant academic paradigm, a construct that enables the scholar to articulate the forbidden aspects of Western philosophy and religion. His proposition is to characterize esotericism as a label for those dimensions of the general culture that have been neglected, and justifying their study as a corrective to the one sided study of religion in Europe.[41] For Hanegraaff there is nothing special about esotericism, it is just philosophy that for some cultural bias has been rejected.[42] But this is not really a new proposal as it is not much different from the 'rejected knowledge' exposed in James Webb's *The Flight From reason* (1971).[43] It looks like Hanegraaff is simply dressing up an old idea in terms of the fashionable language of 'discourses' and 'grand narratives' to rend it attractive to contemporary academic circles.

Another critic of Faivre's definition is the German historian of religion Kocku von Stuckrad who in two of his recent publications tries to go bey-

[39]Hanegraaff, 'On the Construction of 'Esoteric Traditions'', p. 42.

[40]Hanegraaff, 'On the Construction of 'Esoteric Traditions'', p. 16; Hanegraaff, 'Forbidden Knowledge'.

[41]Hanegraaff, 'Empirical Method in the Study of Esotericism'; Hanegraaff, 'Beyond The Yates Paradigm'.

[42]For a complete exposition of Hanegraaff's view see Hanegraaff, *Esotericism and the Academy*.

[43]In its 1974 second edition the title of the book was changed to James Webb, *The Occult Underground* (La Salle, IL: Open Court Publishing, 1974).

ond Faivre's approach.[44] His main concern is that Faivre's characterization narrows down arbitrarily the field by using a predefined textual corpus as the basic reference. These limitations are of two dimensions: a temporal dimension by the exclusion of antiquity and the Middle Ages; and a contextual dimension by the exclusion of the esotericism of non Christian religions, in particular Judaism, Islam and Buddhism. He joins Hanegraaff appeal for an etic approach.[45] His specific proposal is to understand esotericism as an 'element of discourse' characterized by two features: the claim of higher or secret wisdom, and a way to attain it. These two characteristics of his definition are held explicitly disconnected from an esoteric corpus, and they are neither historically nor culturally determined.

In aiming at compliance with an academically approved method, Hanegraaff's and Stuckard's approaches are both rooted in a post-modern world view in frontal collision with the grand narratives that are characteristic of the esoteric world view and constitute, from the outset, an a priori judgment on its content. They are in line with contemporary discussions in Religious Studies claiming that the locus of academic research is created by the research itself, and that the associated names are arbitrary. This relativism wants to view esotericism as a purely ad-hoc construct serving only the articulation of specific research questions. Hanegraaff's and Stuckard's approaches are designed to comply with the academic status quo with the aim to ensure methodological respectability and academic acceptance. But this has to do with the politics of research and the economics of scholarship, and not with the actualities of understanding the specific contents of the esoteric material.[46] Both approaches are also based on the assumption of an

[44]Kocku von Stuckrad, 'Western Esotericism: Towards and Integrative Model of Interpretation', *Religion*, 35 (2005), pp. 78–97; Stuckrad, *Western Esotericism*.

[45]See distinction between emic and etic on page 28.

[46]Relativist and post-modern approaches in the Humanities were overtly dominant in

academic consensus about the core contents of esotericism; however it is precisely the nature and extent of this consensus that is being debated in the discussion about the definition of esotericism.[47]

These approaches, and this is also true for Faivre's characterization, reduce the esoteric tradition to a set of texts, turning it into a form of literature, an arm-chair 'thought form', or a 'discourse', with little or no interest in the actual experiences to which the esoteric texts relate. Indeed, one of the issues with the current status of the academic study of esotericism is that it tends to ignore the core esoteric experience: gnosis, altered states of consciousness, and the controversial and embarrassing subject of the paranormal. All these experiences are valid esoteric dimensions that need to be accounted for and included in any definition of esotericism.

In line with this inclusion of the experiential aspects of esotericism, the American scholar of religion Arthur Versluis proposes another perspective that he calls 'sympathetic empiricism'. He argues that by using Faivre's characterization many legitimate esoteric manifestations become excluded. He proposes a definition of esotericism based on the acknowledgement of two broad themes: a magical-cosmological theme that is well described using Faivre typology; and a mystical theme centred in the experience of gnosis.[48]

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the last part of the twentieth century and they are still widely represented in the academic boards. However they are not the dominant position today. A good review of the contemporary critique to these approaches is contained in chapter 2 and 3 of Edward Slingerland, *The Concept of Nature: Integrating Body and Culture* (Cambridge: Cambridge University Press, 2008).

[47]Michael Bergunder, 'What is Esotericism?: Cultural Studies Approaches and the Problems of Definition in Religious Studies', *Method & Theory in the Study of Religion*, 42.1 (2000), pp. 9–36.

[48]Arthur Versluis, 'Methods in the Study of Esotericism: Part I, What is Esoteric?', *Esoterica*, IV (2002), <http://www.esoteric.msu.edu/VolumeIV/Methods.htm> [accessed January 15 2012], pp. 1–15; Arthur Versluis, 'Methods in the Study of Esotericism: Part II, Mysticism and the Study of Esotericism', *Esoterica*, IV (2002), <http://www.esoteric.msu.edu/VolumeIV/Methods.htm> [accessed January 15 2012], pp. 1–

> Both magic and mysticism belong under the broad rubric of 'esotericism' because both magicians and mystics pursue or claim esoteric knowledge that belongs only to them or to their tradition [...] Indeed, we can go further than that: for we may also say that magic and mysticism form the twin currents that, like the intertwined serpents of Hermes's caduceus, together make up much of the stream of Western esotericism.[49]

He argues that these two tendencies are present in any esoteric current, although particular currents are more inclined to one or the other. In Versluis' view, a purely historical approach, like Faivre's or Hanegraaff's, seeking only to trace genealogies of influence, may turn into a total denial of the esoteric phenomenon itself:

> We must acknowledge that there is a phenomenon to be considered that is not merely a written object — rather, 'behind' the written work is a mystical phenomenon in itself that the mystic experienced.[50]

Versluis continues questioning Hanegraaff's division between 'religionist' and 'empiricist-historical' approaches considering the rejection of an emic approach as an arrogant dismissal of the actual philosophical content of the esoteric texts. Appealing to Eliade, he remarks that the reduction of culture to something else — economics, politics, gender, class, race, etc. — is often a failure to believe in higher meanings, and it reflects the imposition of some form of ideology upon the subject of one's study. His sympathetic empiricism asks for a phenomenological neutrality that may

15; Versluis, *Magic and Mysticism*, pp. 1–10.

[49]Versluis, *Magic and Mysticism*, p. 3.

[50]Versluis, 'Methods in the Study of Esotericism' p. 29

allow the scholar to enter into an alternative world view, communicate with it, and communicate it.[51]

1.4 An Integrative-Sympathetic-Corporate-Critical Approach

Versluis' sympathetic empiricism provides a sound basis from where to proceed, to which we need to add some additional remarks. One needs to remember that the original problem that gave rise to the etc/emic distinction was among scholars of linguistics and anthropologists trying to understand a wide range of cultures, some of them having a significant degree of contrast with the Christian West. This distinction became popular among scholars of religion because the insider/outsider problem is pervasive when studying religion in a global sense. In these cases, 'the other' to which the emic part of this distinction applies is a member of a decisively different culture, language and customs. The scholar needs to deploy significant intellectual and moral efforts to understand the world-view of the peoples he is trying to know. But in the case of Western esotericism we may as well ask, to whom is this emic distinction being applied? Can we apply this distinction to members of our own family, raised in the same house, with the same cultural traditions, language and even religion? What does it means to be an outsider, or an insider in this case? In this case, constructing esotericism as 'the discourse of the Other' is somewhat artificial and it rather highlights some of the metaphysical tensions within our own culture. Everybody in the West understands perfectly well what the esoteric tradition is communicating, the problem is that the communication

[51] Versluis, 'Methods in the Study of Esotericism' p. 2

challenges the received scientific, philosophical and religious views.

These remarks point to the need to revisit the idea of 'the Other'. To do this I approach my study taking on board the 'Corporate-Critical' approach proposed by the Canadian Religious Studies scholar Wilfred Cantwell Smith.[52] In an influential article, Smith summarizes the motivations of his approach:

> The traditional form of Western scholarship in the study of other meanings of religion was that of an impersonal presentation of an 'it'. The first great innovation in recent times has been the personalization of the faiths observed, so that one finds a discussion of a 'they'. Presently the observer becomes personally involved, so that the situation is one of a 'we' talking about a 'they'. The next step is a dialogue, where 'we' talk to 'you'. If there is listening and mutuality, this may become that 'we' talk with 'you'. The culmination of this progress is when 'we all' are talking with each other about 'us'.[53]

This intellectual progression can be applied to the study of esotericism. I would like to approach the study of esotericism accordingly to these later stages, recognizing that when we are talking about esotericism we are talking about ourselves.

One of the main principles of this approach is that when writing about the values and beliefs of a different group of people, the scholar needs to do it in a way that the people being portrayed recognize themselves in the

[52]Wilfred Cantwell Smith, 'Comparative Religion: Wither – and Why?', in *Religious Diversity: Essays by Wilfred Cantwell Smith*, ed. by Willard G. Oxtoby (New York: Harper & Row, 1976), pp. 138–157; Wilfred Cantwell Smith, *The Meaning and End of Religion* (New York: Macmillan, 1962); Wilfred Cantwell Smith, *Towards a World Theology: Faith and the Comparative History of Religion* (London: Macmillan, 1981).

[53]Smith, 'Comparative Religion', p. 142.

description. I will therefore endeavour to present a picture of science and the scientist with which the scientific community can identify, and a picture of the esotericist that can be accepted by the esoteric community as its own image. I respect both and want to be understood by both. This does not mean that I am aiming for an agreement. However I aim to produce a genuine dialogue, not a battle of identifications. Although this thesis aims to be critical, I depart from those studies whose methodologies are based on a philosophical position that patronize the world-views that they are trying to understand. In consequence, I want to fully acknowledge esotericism when it appears, in the present case in the work of David Bohm.

Moreover, as already noted, the constructivist approaches to the study of the esoteric tradition are based on an anti-realist position that collides from the outset with the realism inherent in esotericism and some versions of realism in the philosophy of science.[54] The current anti-realist/realist debate is of particular importance for our purposes as an anti-realist position not only counters the philosophical tenants of the esoteric tradition, but is also opposed to Bohm's philosophical program. As we will see in the following chapters, one of Bohm's important contributions is a realist alternative to the interpretation of quantum mechanics, an option which is today at the center of the modern debate about realism in physics. As Bohm shows, it is possible to adopt a coherent realist position in quantum mechanics, disproving the assumption that the anti-realism of the scientific status quo is the only possibility that follows from scientific data. This is an important point as it has been argued that the difficulties encountered in interpreting quantum mechanics are an important component of the reasons

[54] Alexander Miller, 'Realism', in *The Stanford Encyclopedia of Philosophy*, ed. by Edward N. Zalta (2012); Christopher Norris, *Quantum Theory and the Flight from Realism: Philosophical Responses to Quantum Mechanics* (London: Routledge, 2000).

behind the twentieth-century turn to anti-realism.[55]

In order to deal with the relationship between contemporary science and esotericism, of which the case of David Bohm is a particular example, we are assuming a position that takes on board the experiences claimed by esotericism, as well as an approach that, if not decisively siding with realism, at least keeps abreast the possibility of a viable form of it.

1.5 The History of Science and Esotericism

The position articulated in the last paragraph regards the relationship between science and esotericism as coexisting harmoniously, being mutually influential, and even intimately related. This is not an original claim as an 'integrative systematic synthesis' is one of the many ways in which religion and science can relate to each other, according to the American scholar Ian Barbour (1923 – 2013) whose *Issues in Science and Religion* (1966) marked the establishment of the academic study of the relationship between science and religion.[56] Barbour proposes four main categories under which the interaction between science and religion can be classified:.

1. Conflict

   The relationship between science and religion has often been regarded as a series of conflicts between the 'progressive', freedom-loving and ultimately triumphant scientists against the limited and

[55]Norris, *Quantum Theory and the Flight from Realism*.

[56]Ian Barbour, *Issues in Science and Religion* (New York: Harper and Row, 1966); Ian Barbour, *Religion and Science: Historical and Contemporary Issues* (London: SCM Press, 1998); Ian Barbour, *When Science Meets Religion: Enemies, Strangers Or Partners?* (New York: Harper Collins, 2000).

prejudiced religious orthodox, usually portrayed as a biblical fanatic, taking scripture uncritically, making claims about the natural world based on theological assumptions. It is not unusual that the scientist is taken to be a materialist and a self-declared atheist, which makes broad philosophical claims about the the scientific method as the only reliable path to knowledge. This 'conflict thesis' is deeply embedded in the culture of the West, and it has generated a considerable amount of literature which started with John William Draper's *History of the Conflict Between Religion and Science* (1874), and Andrew Dickson White's *A History of the Warfare of Science with Theology in Christendom* (1896). These two books achieved a wide circulation, and they are still reprinted. This view of mutual hostility between science and religion has been routinely exploited by popular science writers, by the media, and in a few older academic histories of science. Very often a very simplified view of Galileo's trial and Darwin's religious troubles figure prominently in support of this view.[57] Although this thesis enjoys the support of many celebrated scientists, like Richard Dawkins and Stephen Hawkins, its many problems have been exposed by many historians and philosophers of science.[58]

2. Independence

[57] Far from being a simple case of science versus religion, Galileo's trial is an extremely complex event, which includes a large number of philosophical and social issues that must be considered for an objective view. This is explored in detail in Maurice A. Finocchiaro, *The Galileo Affair: A Documentary History* (Berkeley: University of California Press, 1989). The complexity of Darwin's case is reviewed in John Hedley Brooke, *Science and Religion: Some Historical Perspectives* (Cambridge: Cambridge University Press, 1991)

[58] Brooke, *Science and Religion*; Gary Ferngren, ed., *The History of Science and Religion in the Western Tradition: An Encyclopedia* (New York: Garland Publishing, 2000); Philip Clayton and Zachary R. Simpson, eds., *The Oxford Handbook of Religion and Science* (New York, Oxford: Oxford University Press, 2006).

One suggestion to avoid the problems associated with the conflict thesis is to regard science and religion as entirely different and independent, with distinctive domains and methods, each one of them justified on its own terms. This position maintains that to assure peace each domain must address its own concerns and not try to rule the other. One of the main contributors to this view is the biologist Stephen J. Gould (1941 – 2002).

3. Dialogue

   A more direct relationship is when scientific theories influence religious beliefs, or when they both contribute to the formulation of a coherent world view or a systematic metaphysics. In this view there are recognized certain boundary questions that are not neatly scientific or religious and can't be established squarely within any domain. In contemporary science the interpretation of quantum mechanics, the Big Bang, evolutionary theory and many other questions lend themselves to a sustained dialogue 'on the border' between religion and science. Most experts tend to uphold a variation of this dialogue model.

4. Integration

   Some authors' view is that a complete integration of the scientific and the religious is possible. Barbour distinguishes three distinct versions of this view. In natural theology it is claimed that the existence of God can be inferred from the evidences of design in nature (a contemporary example is the use of the anthropic principle with religious purposes). In a theology of nature, although the main sources of theology remain outside science, certain doctrines may be reformulated

on the light of scientific theories (for example the doctrine of creation on the light of the Big Bang). In a systematic synthesis, both science and religion contribute to the development of an inclusive metaphysics, such as that of process philosophy and most of the contemporary esoteric movements. Scientists that upheld this view are Rupert Sheldrake, FritjofCapra, Amit Goswami, Basarab Nicolescu and most importantly for our purposes, David Bohm.

What has become clear is that the relationship between science and religion exhibits the complexity typical of all human endeavours and cannot be reduced to any of these views:

> Serious scholarship in the history of science has revealed so extraordinarily rich and complex relationship between science and religion in the past that general theses are difficult to sustain. The real lesson turns out to be the complexity. Members of the Christian churches have not all been obscurantists; many scientists of stature have professed a religious faith, even if their theology was sometimes suspect. Conflicts allegedly between science and religion may turn out to be between rival scientific interests, or conversely between rival theological factions. Issues of political power, social prestige, and intellectual authority have repeatedly been at stake.[59]

That a close harmony can exist between science and religion is exemplified by the mere existence of the academic study of Western esotericism. Although nowadays recognized as a sub-field of religious studies, the scholarly study of esotericism started with Francis Yates' studies of

[59]Brooke, *Science and Religion*, p. 5.

the early history of science, as was explained above in 1.3.3. But despite these promising initial steps focused on the Renaissance, further research devoted to the later relationship between science and the esoteric tradition has been partial and sketchy.

Although my aim is not to fill this gap, Bohm's case shows that an harmonious and creative relationship between science and esotericism is not particular to the birth of modernity. Bohm is not an isolated case. In his *How the Hippies Saved Physics* (2011), David Kaiser studies another example of a creative coexistence of science and the esoteric tradition with an important impact in relevant contemporary science.[60] Many of the scientists in Kaiser's story were directly influenced by David Bohm. My hope is that this study will inspire other researchers to pay attention to the constructive relationship between science and the esoteric tradition in historical periods after the Renaissance.

Indeed, the interaction between science and the esoteric tradition shares the complexity of the more general relationship between science and religion, with some nuances particular to the case of esotericism. I find useful the categories listed above that include a strong integration model, as for the contemporary period there are substantially more cases that emphasize an integration between science and esotericism.[61]

[60] David Kaiser, *How the Hippies Saved Physics: Science, Counterculture and the Quantum Revival* (New York, London: Norton, 2011).

[61] Angela Tilby, *Science and the Soul: New Cosmology, the Self and God* (SPCK, 1992); Jeff Love, *Quantum Gods: The Origin and Nature of Matter and Consciousness* (San Jose, New York: Authors Choice Press, 2000); Amit Goswami, *The Self-Aware Universe: How Consciousness Creates the Material World* (New York: Tarcher Putnam, 1995); Capra, *The Tao of Physics*; Marilyn Ferguson, *The Aquarian Conspiracy: Personal and Social Transformation In Our Time* (Los Angeles: J.P. Tarcher, 1980); Donald Hatch Andrews, *The Symphony of Life* (Lee's Summit, MO: Unity Books, 1966); Gary Zukav, *The Dancing Wu Li Masters* (London: Flamingo, 1989); Fred Alan Wolf, *Matter Into Feeling: A New Alchemy of Science and Spirit* (Needham, MA: Moment Point Press, 2002); Rupert Sheldrake, *The Presence of the Past: Morphic Resonance and the Habits of Nature* (New York: Random House, 1988); Ervin Laszlo, *The Creative Cosmos: A Uni-*

fied Science of Matter, Life, and Mind (Edinburgh: Floris, 1993); David J. Hess, *Science in the New Age: The Paranormal, its Defenders and Debunkers, and American Culture* (Madison: University of Wisconsin Press, 1993); Stephen Phillips, *ESP of Quarks and Superstrings* (Adyar: The Theosophical Publishing Hopuse, 2000); Patrick Grim, *Philosophy of Science and the Occult* (Albany: SUNY Press, 1990); Michael Talbot, *The Holographic Universe* (London: Grafton Books, 1991); Philip Clayton et al., eds., *Science and the Spiritual Quest: New Essays by Leading Scientists* (London: Routledge, 2002); Kaiser, *How the Hippies Saved Physics*; Ken Wilber, *Quantum Questions* (Boston, London: Shambala, 1985); Michael Talbot, *Mysticism and the New Physics* (London: Routledge and Kegan Paul, 1981); Lynne Mctaggart, *The Field: The Quest for the Secret Force of the Universe* (New York: HarperColins Publishers, 2002); Danah Zohar, *The Quantum Self: Human Nature and Consciousness Defined By The New Physics* (New York: William Morrow, 1990).

Chapter 2

Sources

2.1 Primary Sources

To situate Bohm's thought within the esoteric I will make reference to remarks made in his published works, articles, unpublished manuscripts, interviews, correspondence and recordings in relation to authors he had read or individuals he is known to have corresponded with or met. These sources does not pose a philological problem as they were written in English during the last half of the twentieth century, and published in England or in America. Most of Bohm's published works are still in print and can be easily found in libraries.

2.1.1 Unpublished Sources

Most of our sources can be found in the comprehensive source of material regarding David Bohm kept in *The National Cataloging Unit for the Archives of Contemporary Scientists 66.4.97*, or NCUACS 66.4.97 for short,

deposed in the library of Birkbeck College, University of London.[1] This archive consists of about 400 folders containing many unpublished manuscripts and typescripts, articles, lectures and books and it also includes the original manuscripts of many of his published works. The archive contains also a collection of 140 CDs with a fairly complete audio recording of the Ojai seminars which provide a vivid window to Bohm's thought during the last ten years of his life. There is also the transcriptions of many important interviews, many of them unpublished. The most relevant part of his correspondence, including letters from and to Albert Einstein, Wolfgang Pauli and other important scientists is also recorded. An important collection of writings about Bohm can also be found in the archive, including papers related to his personal life and career. NCUACS 66.4.97 is the most complete collection of material regarding David Bohm.

NCUACS 66.4.97 is organized in four broad sections and each section is subsequently organized in sequentially numbered folders: Section A, 'Biographical' contains folders A.1 to A.181; Section B, 'Drafts Publications and Lectures' consists of folders B.1 to B.192; Section C, 'Correspondence Material' contains folders C.1 to C.129; Section D 'Non Textual material' consists of CD's and tapes and contains entries D.1 to D.20. To refer to a document in this archive we will use the form NCUACS X.N which refers to the contents of folder N in section X.

[1] NCUACS, *66.4.97: Catalogue of the papers and correspondence of David Joseph Bohm FRS (1917-1992), physicist.* <http://www.nationalarchives.gov.uk/a2a/records.aspx?cat=1832-ncuacs66497&cid=0>.

2.1.2 Books

Virtually all of Bohm's published books are still in print and can be easily found in bookstores, libraries or on–line:[2]

- 1951 *Quantum Theory*: Bohm's first book. It is a standard textbook on quantum mechanics presenting the standard — or Copenhagen — interpretation of quantum mechanics, with emphasis on the physical content of the theory, as opposed to its mathematical formalism. Contains long sections regarding the philosophical issues.[3]

- (1952) 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables I and II': Bohm's original articles on the Causal Interpretation.[4]

- 1957 *Causality and Chance in Modern Physics*: Bohm's first philosophy of physics book. It was written under a heavy Hegelian–Marxist influence. In this book Bohm reviews the limitations of both the Copenhagen and the Causal Interpretation of quantum mechanics.[5]

- 1963 *Problems in the Basic Concepts of Physics*: Bohm's inaugural lecture as Chair of Theoretical Physics at Birkbeck College, University of London, delivered on the 13 February 1963. It explains the

[2]A complete list of references to Bohm published books, his philosophical articles and his main scientific articles is included in the thesis bibliography. A more comprehensive list regarding his scientific papers is included in Basil Hiley, 'David Joseph Bohm: 20 December 1917 – 27 October 1992', *Biographical Memoirs of Fellows of the Royal Society*, 43 (1997), pp. 107–131.

[3]David Bohm, *Quantum Theory* (Engewood Cliffs: Prentice Hall, 1951).

[4]David Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables I', *Physical Review*, 85 (1952), pp. 166–179; David Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables II', *Physical Review*, 85 (1952), pp. 180–193.

[5]David Bohm, *Causality and Chance in Modern Physics* (London: Routledge, 1957).

need to abandon the 'Cartesian' paradigm and search for new fundamental concepts in physics.[6]

- 1965 *The Special Theory of Relativity*: An standard exposition of Einstein's theory of relativity. The more interesting part is an appendix on 'Physics and Perception' where he introduces his ideas about the nature of thought, its relation to reality and the dichotomy of wholeness and fragmentation.[7]

- 1980 *Wholeness and the Implicate Order*: His most famous book. A collection of articles written during the 1970s. In it he explains his ideas about the Implicate Order.[8]

- 1987 *Science, Order and Creativity*: A sort of continuation of *Wholeness and the Implicate Order*. This book is full of esotericism, Bohm at his more radical.[9]

- 1993 'A New Theory of the Relationship of Mind and Matter': In this article Bohm applies the Implicate Order to the mind–body problem proposing a panpsychic ontology based on a chain of Implicate-Explicate Orders.[10]

- 1993 *The Undivided Universe: An Ontological Interpretation of quantum theory*: Bohm's last work. Bohm died going back home after a meet-

[6]David Bohm, 'Problems in the Basic Concepts of Physics', *NCUACS 66.4.97*, A.124 (1963).

[7]David Bohm, *The Special Theory of Relativity* (New York: Routledge, 1996), First published in 1965 by W. A. Benjamin.

[8]Bohm, *Wholeness and the Implicate Order*.

[9]David Bohm and F. David Peat, *Science, Order and Creativity* (London: Routledge, 1987).

[10]David Bohm, 'A New Theory of the Relationship of Mind and Matter', *Philosophical Psychology*, 3.2 (1990), pp. 271–286.

ing with Hiley in which they finalized the book.[11]

To this list we can add three collection of articles published recently by Lee Nichol: *On Dialogue* (1996), *On Creativity*, and *The Essential David Bohm*.[12]

2.1.3 Dialogues

Many of the conversations between Bohm and Krishnamurti were recorded. The first six recorded dialogues were conducted at the end of August 1965 in Tannegg and Gstaad, Switzerland. A transcription of these can be found in NCUACS A.65. A conversation of the 7 of October 1972 in Brockwood, England is published in Krishnamurti's *Awakening of Intelligence*. Eleven dialogues in Brockwood, England and Gstaad, between May and October 1975 are found in NCUACS A.75.5 of them are published in *Limits of Thought* (1999).[13] The dialogues of 17 to 20 of May 1976 in Brockwood are published in *Wholeness of Life*.[14] Eight dialogues conducted in April 1980 in Ojai California and five during June and September of the same year appear in *The Ending of Time* (1985).[15] Two additional dialogues of 1980 conducted in Brockwood in September 1980 are published in *Limits of Thought*. Two dialogues in Brockwood on June 11and June 20 of 1983

[11]David Bohm and Basil Hiley, *The Undivided Universe: An ontological interpretation of quantum mechanics* (London: Routledge, 1993).

[12]David Bohm, *On Dialogue* (Oxon and New York: Routledge, 1996); David Bohm, *On Creativity* (Oxon and New York: Routledge, 1998); David Bohm, *The Essential David Bohm* (Oxon and New York: Routledge, 2002).

[13]David Bohm and Jiddu Krishnamurti, *Limits of Thought* (London: Routledge, 1999).

[14]David Bohm and Jiddu Krishnamurti, 'Wholeness of Life', in *The Complete Published Works 1933–1986* (Brockwood Park, Hampshire, England: Krishnamurti Foundation Trust, 1980).

[15]David Bohm and Jiddu Krishnamurti, *The Ending of Time* (San Francisco, CA: Harper, 1985).

are published as *The Future of Humanity* (1980).[16] Transcriptions of many of these dialogues can be downloaded from J.Krishnamurti online.[17] This repository includes a large collection of recorded dialogues between Bohm and Krishnamurti.

Transcriptions of several of Bohm's seminars in Ojai, all of them conducted after the death of Krishnamurti, have been published as well: *Unfolding Meaning* (1985) is a transcription of a seminar held in Mickleton, Gloucestershire on 11 May 1984.[18] *Thought as a System* (1992) is a seminar held in Ojai, California, on 30 November to 2 December 1990.[19]

There is a YouTube channel dedicated to David Bohm that contains recordings of some of this material.[20]. The recording of fourteen of *The Ending of Time* series, the recording of the Friday session in *Thought as a System* and *Beyond Limits*, an interview conducted by Bill Angelos described below in 2.1.4 caan also be found in the Internet.[21]

2.1.4 Interviews

Bohm offered some remarkable interviews where he gives important indications on the influences on his thought. Undoubtedly the more important of these is the one conducted by his colleague and Nobel Laureate

[16] David Bohm and Jiddu Krishnamurti, *The Future of Humanity: A Conversation* (London: Harpercollins, 1986).

[17] JKO, *J.Krishnamurti Online: Text collection of all of Krishnamurti's published works from 1933 to 1986*, <http://www.jkrishnamurti.org/>.

[18] David Bohm, *Unfolding Meaning* (Mickleton, Gloucestershire: Foundation House Publications, 1985).

[19] David Bohm, *Thought as a System* (London: Routledge, 1992).

[20] <http://www.youtube.com/channel/HCyCkUOYt8b0k?feature=relchannel> [accessed 1 September 2015]

[21] <http://bohmkrishnamurti.com/bohm-consciousness-seminars> [accessed 1 September 2015]

Professor Maurice Wilkins, at London during 1986.[22] Spanning several months, it was recorded on 16 tapes, and had the purpose of helping Bohm to review his entire career in order to help him to write an intellectual biography. Although the autobiography never saw the light, the record of the conversation between Wilkins and Bohm is of great interest as it contains many details that are not found anywhere else. In particular Bohm reviews Hegel's philosophy and its influence on his thought. The recording of this interview, as well as a transcript, is kept on a DVD on NCUACS section D.

Of more modest proportions but very revealing is the interview conducted by Bill Angelos in Amsterdam in September 1990 during a conference on 'Art, Science and Spirituality' and attended by many important personalities, including the Dalai Lama. This interview was published in the form of a booklet with the title *Beyond Limits*.[23]. The aim of the interview was to trace Bohm's interest on the relationship between physics and consciousness and reviews Bohm's entire career containing many important details about the relationship between Bohm and Krishnamurti.

There are other interviews that despite their more limited scope and size, add some insight to particular aspects of his work. An intelligent interview was conducted by the German psychotherapist Dr. Angelika C. Wagner of Hamburg University in London on 9 January 1987. The main object of the interview was a discussion of Bohm's ideas on how consciousness gets into conflict with itself, and how does the notion of an holographic mind relate to the issues of change which are central to the

[22]New Zealand born Maurice Wilkins (1916–2004) was a distinguished physicist and molecular biologist. A Nobel Laureate, he is best known for his work at King's College London on the structure of DNA, closely related to Watson and Crick's double helix model.

[23]David Bohm and William M. Angelos, 'Beyond Limits: A Conversation with Professor David Bohm', *NCUACS 66.4.97*, A.46 (1990).

field of education and psychotherapy.[24] A transcript of this interview is present in NCUACS A.31–32.

Professor Lillian Hoddeson interviewed Bohm at Bohm's residence in London in 1981.[25] This interview was conducted as part of the revival of interest on the Manhattan project, in the effort to understand the consequences of McCarthyism for scientific research in America. This tape–recorded interview is deposited at the Center for History of Physics of the American Institute of Physics. It revisits Bohm's interest in plasma at the Lawrence Radiation Laboratory during World War II and its further development at Berkeley and Princeton.

The philosopher Dr. Renée Weber interviewed Bohm several times.[26] In these interviews Bohm is always portrayed as a visionary, aiming to

[24]The 'Holographic mind' refers to the ideas of the Austrian psychiatrist and neurosurgeon Karl H. Pribram (1919 - 2015), who developed a model of the brain that was partially inspired by Bohm's ideas of the Implicate Order. In this model, Pribram suggests that the brain stores its information as an hologram, a device in which the information contained in the whole is distributed in every one of its parts, in such a way that the whole can be recovered from any one of them. For further details see Karl Pribram, 'The Implicate Brain', in *Quantum Implications*, ed. by Basil Hiley and David Peat (London: Routledge, 1991), pp. 365–371.

[25]Lillian Hoddeson and David Bohm, 'Interview with Dr. David Bohm at the home of the Bohms, Edgware, London May 8, 1981', *Niels Bohr Library and Archives, American Institute of Physics, College Park, MD USA,*, (1981), <http://www.aip.org/history/ohilist/4513.html> [accessed 1 September 2015] Dr Hoddeson is a distinguished professor of history at Illinois as well as a research physicist. She has been committed to rigorous academic research and to the translation of that work into more popular forms and forums. Dr Hoddeson specializes in the history of twentieth-century science and technology.

[26]David Bohm and Renée Weber, 'The Physicist and the Mystic: Is a Dialogue Between Them Possible ReVision', *ReVision*, (Spring 1981), pp. 22–35; David Bohm and Renée Weber, 'The Enfolding–Unfolding Universe: A Conversation with David Bohm', *ReVision*, (Summer–Fall 1978), pp. 24–51; David Bohm and Renée Weber, 'Nature as Creativity', *ReVision*, (Fall 1982), pp. 35–40; David Bohm and Renée Weber, 'Of Matter and Meaning: The Super–Implicate Order', *ReVision*, (Spring 1983), pp. 34–44; Renée Weber, ed., *Dialogues With Scientists and Sages: The Search for Unity* (London and New York: Routledge and Kegan Paul, 1986). Renée Weber was a professor emeritus of philosophy at Rutgers, the State University of New Jersey, and an active member of the New York Theosophical Society. She was keen to bring to the attention of the lay reader how modern science points dramatically towards a harmony between the scientific and spiritual.

reach the harmony that exists between science and religion.

Bohm was interviewed by the well-known process theologian and philosopher Professor John B. Cobb in 1984.[27] In this interview Bohm gives some insights on the relationship between religion and science in the context of the Implicate Order. It is an interesting interview that inevitably brings to the fore some process philosophy concepts.

Many other interviews exist, but with much more modest aims. In most of these Bohm explains over and over again the Implicate Order, the dialogue technique, the hidden variables, etc. Most of these interviews are just re-elaborations of his main ideas targeted at the general public, usually very briefly stated and hardly adding anything to what he has already say elsewhere.

2.1.5 Letters

An important source of information about Bohm and the development of his ideas can be found in his voluminous correspondence. A good part of it is of biographical interest only, as it relates to Bohm's health, working conditions, feelings and other personal issues. Of historical interest is his correspondence with Einstein, Pauli and other important scientists.

NCUACS C.110–114 contains the letters to his brother-in-law Yitzhak Woolfson (Isidore), which are of particular interest as in these Bohm talks extensively about his association with Krishnamurti, his philosophical standpoint and the development of his ideas.

The most important part of the extensive exchanges between Bohm and the American painter Charles Joseph Biederman (1906–2004) from

[27] Precise dates are unknown. This interview can be downloaded from the Internet: <http://www.ctr4process.org/media/page2.shtml> [accessed 1 September 2015]

1960 to 1969 is present in NCUACS C.66–92. These letters are an important source of information on Bohm's thought in the 1960s. There are plans to publish the entire Bohm-Biedermann correspondence of which Volume 1 has already appeared.[28]

NCUACS C.93 is a spiral bound volume containing the surviving letters between Bohm and the British esotericist John Godolphin Bennett (1897–1974) from 1962 to 1964. These documents witness Bohm's engagement with the esoteric philosophy of the Armenian teacher G. Gurdjieff which will be explored in a subsequent chapter.

Bohm's 1963 correspondence with professor John R. Platt (1918–1992), a biophysicist of the University of Chicago, is recorded in NCUACS C.51–54. The bulk of this correspondence is centred around the problem of perception.

The 1983 correspondence with the theologian Professor David L. Schindler, kept in NCUACS 101–104, is of particular interest as its main object is religion and contains many insights into Bohm's esoteric philosophy.

2.2 Secondary Sources

2.2.1 Biographical and Historical

Bohm has a special place in the popular imagination. The figure of an outstanding scientist that challenged the scientific and social status quo and was committed to stand up for what he believed regardless of the consequences, has resonated with the general public and converted Bohm in a popular hero. There is no lack of popular reviews about the work of

[28] David Bohm and Charles Biederman, *Bohm–Biederman Correspondence: Creativity and Science* ed. by Paavo Pylkkänen (London and New York: Routledge, 1999).

David Bohm in newspapers, magazines and books that exploit this aspect of Bohm's legend. Although some of these publications aim to provide a faithful description of Bohm's thought, within the limits of what can be accomplished in few pages in a popular presentation, they all tend to be rather superficial, repetitive, and partial, selecting carefully the material they present and limiting themselves to the more entertaining Bohmian themes: the conflict triggered by 'hidden variables' in quantum mechanics; the colourful metaphors of the Implicate Order produced by Bohm as mental pictures to indicate what he maintains is unexplainable; and sometimes the drama of Bohm's difficulties with McCarthyism and his exile.

Bohm also appears in many popular accounts of the history of quantum mechanics and its interpretation. Broadly these presentations remain confined to a description of the Causal Interpretation of 1952, and in most cases the complexities of the interpretation problem are only superficially addressed. Missing from these works are the realist Ontological Interpretation, the subtle and intellectually challenging elaborations of his process philosophy, his approach to thought, and other important subjects. All these popular presentations hardly add anything to the understanding of Bohm's thought, and although they could be useful material for the sociological study of the reception of scientific ideas by the general public, they do not serve our aim, which is to achieve a broader understanding of Bohm thought and its sources. Consequentially we will not deal with them in any detail.

There are two main texts that stand out as biographical essays. A first attempt was made by Basil Hiley, Bohm's long-term collaborator at Birkbeck College, who wrote a scientific biographical memoir for the Royal

Society.[29] It is an interesting read from the scientific point of view as it contains many important remarks regarding the scientific development of Bohm, especially from the 1960s onwards, when Bohm and Hiley begin to collaborate. However this essay concentrates on the science of David Bohm and leaves aside Bohm's more philosophical and controversial interests.[30]

An assessment of David Bohm's entire work is attempted in Bohm's standard biography: David Peat, *Infinite Potential: The Life and Times of David Bohm* (New York: Basic Books, 1997). Peat was a close friend and a collaborator.[31] In this work the influence of Hegel, Bohm's relationship with Krishnamurti, and the interest that Bohm had in the work of Gurdjieff and Ouspensky are mentioned, but Peat dealt with these only superficially. Although Bohm is portrayed as a mystic of sorts, Peat does not associate Bohm, nor any of his influences, with the Western esoteric traditions.

In recent years there has been a revival of interest in the work of Bohm coming from several sources. As a result of the development of quantum computers there is a new emphasis on entanglement and non–locality, a fundamental aspect of this new technology. The history of quantum mechanics from the standpoint of entanglement is the approach taken by Louisa Gilder in *The Age of Entanglement* (2008).[32] In this context the history of Bohm's Causal Interpretation is reviewed, along with his life and early career.

[29] Hiley, 'David Joseph Bohm'.

[30] Another scientific biographical note is offered by Max Jammer, 'David Bohm and His Work: On the Occasion of His Seventieth Birthday', *Foundations of Physics*, 18.7 (1988), pp. 691–699.

[31] Bohm and Peat, *Science, Order and Creativity*. Bohm and Peat planned a second book, *The Order Between*, that never saw the light. The editorial proposal can be found in NCUACS B.28.

[32] Louisa Gilder, *The Age of Entanglement: When Quantum Physics Was Reborn* (New York: Knopf, 2008).

Another stream of interest comes from the effort made by some American academic organizations trying to understand the research conducted during the war effort, the scientific events that contributed to the Manhattan project, and the adverse consequences that McCarthism had for America's scientific development.[33]

A different source of interest in Bohm's thought comes from the reinvigorated philosophical research on the interpretation of quantum mechanics and quantum field theory, and the scholarly effort to understand the formation of the Copenhagen Interpretation that rejected Bohm's early ideas.[34] The *tour de force* in this area is undoubtedly the work of the late James T. Cushing (1937–2002), who wrote the most revealing critique so far on the reception of Bohm's interpretation of quantum mechanics.[35]

Rebecca Newberger Goldstein, published an erotic novel inspired by the history of Bohm's Causal Interpretation: Rebecca Goldstein, *Properties of Light: A Novel of Love, Betrayal, and Quantum Physics* (Boston, New York: Houghton Mifflin Company, 2000). The main character of the novel, Samuel Mallach, is an embittered old theorist based on David Bohm. Samuel is not meant to portray the real David Bohm, however his

[33]Olwell Russel, 'Physical Isolation and Marginalization in Physics: DB Cold War Exile', *Isis*, 90 (1999); Alexei Kojevnikov, 'David Bohm and Collective Movement', *Historical Studies in the Physical and Biological Sciences*, 33.1 (2002), pp. 161–192; Christian Forstner, 'Dialectical Materialism and the Construction of a New Quantum Theory: David Joseph Bohm, 1917–1992', *Max Plank Institut Für Wissenschaftsgeschichte Preprints*, 303 (2005); Olival Freire, 'Science and exile: David Bohm, the cold war, and a new interpretation of quantum mechanics', *Historical Studies in the Physical and Biological Sciences*, 36.1 (2005), pp. 1–34; R.I.G. Hughes, 'Theoretical Practice: the Bohm-Pines Quartet', *Perspectives on Science*, 14.4 (2006), pp. 457–523.

[34]Wayne C. Myrvold, 'On Some Early Objections to Bohm's Theory', *International Studies in the Philosophy of Science*, 17.1 (2003), pp. 7–24.

[35]James T. Cushing, 'Bohm's Theory: Common Sense Dismissed', *Studies on the History of the Philosophy of Science*, 24.5 (1993), pp. 815–842; James T. Cushing, *Quantum Mechanics: Historical Contingency and the 'Copenhagen' Hegemony* (Chicago: The University of Chicago Press, 1994).

physics are Bohm's early interpretation which are very well described in the novel.

2.2.2 Scientific

There are many good expositions of the Causal Interpretation, most of them concentrating on the physical and mathematical aspects of the theory and giving very little attention to, if not ignoring altogether, the philosophical aspects of Bohm's theories. An exception to this is David Z. Albert, *Quantum Mechanics and Experience* (Cambridge MA, London: Harvard University Press, 1992) in which the relevant philosophical questions regarding the interpretation problem are asked and several responses are given. However the space devoted to Bohm is limited and it does not go deep into the more subtle aspects of Bohm philosophy.[36]

A surprisingly interesting assessment of Bohm's later views on space and time was produced by the British writer Alex Comfort (1920–2000).[37] Comfort had several conversations with Bohm, and in *Reality And Empathy: Physics, Mind, and Science in the 21st Century* (2000) he shows an unusual grasp of Bohm's agenda for a new kind of physics, in contrast with so many physicist that fail to understand the message that Bohm was trying to convey.[38]

A physics book for physicists, and devoted entirely to Bohm's theory is Peter R. Holland, *The Quantum Theory of Motion: An account of the de*

[36]See also David Z. Albert, *Quantum Mechanics and Experience* (Cambridge MA, London: Harvard University Press, 1992).

[37]The British gerontologist, anarchist, pacifist, and writer Alex Comfort (1920 –2000) was a brilliant intellectual whose prolific output of novels, poetry and philosophy remains overshadowed by his celebrated manual *The Joy of Sex* (1972).

[38]Alex Comfort, *Reality And Empathy: Physics, Mind, and Science in the 21st Century* (Albany, New York: SUNY Press, 1984).

Broglie-Bohm Causal Interpretation of Quantum Mechanics (Cambridge: Cambridge University Press, 1993). This book was published at roughly the same time as David Bohm and Basil Hiley, *The Undivided Universe: An ontological interpretation of quantum mechanics* (London: Routledge, 1993), Bohm's last work.

A good account of Bohm's theory and some contemporary developments is given by Oliver Passons in three review articles where he describes the several scientific directions in which the Causal Interpretation has been developed.[39]

One of these directions is Bohm's own research group, the Theoretical Physics Research Unit of Birkbeck College, University of London led by Basil Hiley, which remains close to Bohm's scientific and philosophical ideals, although not completely in agreement but neither in contradiction with Bohm's more esoteric leanings. The main focus of this group has been to carry on with the scientific vision sketched in the last chapters of Bohm and Hiley's *The Undivided Universe* (1993).[40]

2.2.3 Academic

If scientists reviewing Bohm's work tend to concentrate mainly on his scientific work, ignoring his most philosophical and esoteric angles, scholars, philosophers and psychologists tend to avoid the more technical material, relying on popularizations of the scientific ideas and achieving only a

[39] O. Passon, 'Why isn't every physicist a Bohmian?', *ArXiv Quantum Physics e-prints*, (Dec. 2004), <http://adsabs.harvard.edu/abs/2004quant.ph.12119P> [accessed 1 September 2015], eprint: arXiv:quant-ph/0412119; O. Passon, 'How to teach quantum mechanics', *European Journal of Physics*, 25.6 (2004), pp. 765–769; O. Passon, 'What you always wanted to know about Bohmian mechanics but were afraid to ask', *ArXiv Quantum Physics e-prints*, (Nov. 2006), <http://adsabs.harvard.edu/abs/2006quant.ph.11032P> [accessed 1 September 2015], eprint: arXiv:quant-ph/0611032.

[40] Bohm and Hiley, *The Undivided Universe*.

partial understanding of the subtle scientific issues.

A good assessment of Bohm's broad intellectual interests is presented in the introductory comments offered by Lee Nichol in his compilation of Bohm's writings, *The Essential David Bohm* (2003).[41] Nichol's aim is to highlight the most important aspects of Bohm's thought using selected readings from his writings. The book includes a curious foreword by the Dalai Lama in which he admits that Bohm was his 'scientific guru'. The book is a comprehensive overview of Bohm's thought from a non-technical perspective, however it fails to account for Bohm's esoteric dimension, and fails to highlight his esoteric influences. Hegel is not mentioned and Krishnamurti is mentioned only incidentally in a few places.

A philosophical analysis of Bohm's thought has been attempted a few times, concentrating mainly on Bohm's ontology and comparing it with the ideas of other thinkers.[42] The articles published in Zygon, vol. 20, no. 2 of June 1985 were first read during a conference sponsored by the Center for Theology and the Natural Sciences entitled 'David Bohm Implicate Order: Physics and Theology', held in Berkeley, California in April 1983 with the participation of Bohm himself,.[43] From the philosophical point of view, all these essays are interesting and provide enlightening remarks concern-

[41] Lee Nichol, ed., *The Essential David Bohm* (London: Routledge, 2003).

[42] Steven M. Rosen, 'David Bohm's Wholeness and the Implicate Order: An Interpretive Essay', *Man-Environment Systems*, 12.1 (1982), pp. 9–18; Paul K. Feyerabend, 'Professor Bohm's Philosophy of Nature: Review of Causality and Chance in Modern Physics', *The British Journal for the Philosophy of Science*, 10.40 (1960), pp. 321–338; Tomas Germinario, 'The Quantum Metaphysics of David Bohm', in *Mind in Time: The Dynamics of Thought, Reality, and Consciousness*, ed. by Allan Combs, Mark Germine and Ben Goertzel (Cresskil NJ: Hampton Press, 2003), chap. 10, pp. 215–225.

[43] Ted Peters, 'David Bohm, Postmodernism and the Divine', *Zygon*, 20.2 (1985), pp. 193–217; Robert John Russell, 'The Physics of David Bohm and its Relevance to Philosophy and Theology', *Zygon*, 20:2 (1985), pp. 135–158; David Ray Griffin, 'Whitehead on Wholeness, Freedom, Causality, and Time', *Zygon*, 20:2 (1985), pp. 165–191; Geoffrey Chew, 'Gentle Quantum Events as the Source of Explicate Orders', *Zygon*, 20:2 (1985), pp. 159–164.

ing Bohm's ontological models, however they tend to remain on the safe side, avoiding to enter into the consideration of Bohm's more controversial esoteric ideas. More paradoxical is that the philosophers publishing these papers largely ignore the important influence that Hegel had on Bohm's thought. The only author that deals at some extent with Bohm's reception of Hegel is Sean Kelley, who also wrote an article in collaboration with Bohm in which Hegel figures prominently.[44]

Much more philosophically ambitious is Paavo Pylkkanen, *Mind, Matter and the Implicate Order* (Heidelberg, Berlin: Springer-Verlag, 2007). This work aims to be a close approximation to an integral assessment of Bohm's philosophy. However it remains a partial review. Bohm's scientific theories are only considered as they are presented in other philosophical works or in popularizations, and it is no clear how much science does Pylkkänen actually understands. The focus of the book is an exploration of the Implicate Order regarding its applications to the philosophy of mind. Hegel is again completely absent and this is more surprising here because this is a philosophy book, and because Bohm was very interested in Hegel precisely in relation to the philosophy of mind. More disturbing is that Bohm's relationship with Krishnamurti is only briefly mentioned in two small paragraphs, despite Pylkkänen meeting Bohm on the background of Krishnamurti's organization, of which he and Bohm were members. Nevertheless this work is a valuable reference and it contains important insights and reflections on Bohm's themes.

In his PhD dissertation Ibn Ravn tries to extend the Implicate Order into a moral order with applications to the practical problem of the day to day

[44]David Bohm and Sean Kelly, 'Dialogue on Science, Society and the Generative Order', *Zygon*, 25.4 (1990), pp. 449–467; Sean Kelley, 'Beyond Materialism and Idealism: Reflections on the Work of David Bohm and Edgar Morin', *Idealistic Studies*, 22.1 (1992), pp. 28–38.

living.[45] He writes that:

> The physicist David Bohm suggests that at the deepest level, physical reality is ordered in such a way that every part contains information about the whole (he calls this ordering principle "Implicate Order"). My dissertation explores the idea that human reality might be ordered in a similar fashion or, rather, should be. In other words, I suggest that the good life may be measured by the degree to which human experience and society is ordered in such a way that people experience themselves and their neighbours as parts of a larger, coherent whole. [. . .] I use David Bohm?s very holistic concept of Implicate Order to fashion a view of what the good life ought to feel like. Just as 'Implicate Order' denotes a certain kind of wholeness in the quantum domain, so this kind of wholeness might also characterize human experience under certain conditions. Where these conditions obtain, we find the good life.[46]

Ravn aims to use the Implicate Order in a pragmatic way is interesting, but his review is partial and opinionated, and in common with many other works, many aspects of Bohm's work are simply ignored, including the esoteric. This is another example of the fragmentation that Bohm was so eager to expose.

Although there are several groups claiming to follow Bohm's guidelines for the implementation of the introspective technique that he called 'Dia-

[45] Ib Ravn, 'Implicate Order and the Good Life', NCUACS 66.4.97 A.86 and <http://www.ibravn.dk/2212-impordgoodlife.htm> [accessed 10 April 2009], PhD thesis, Department of Social Systems Sciences, The Wharton School of Business. University of Pennsylvania, 1987.

[46] Abstract ibid.

logue', very little has been written about it.[47]

An interesting attempt to relate the spiritual and scientific sides of Bohm is Kevin J. Sharpe, 'The Physics and the Religion of David Bohm', *Zygon*, 25.1 (1990), pp. 105–122, and its later elaboration in Kevin J. Sharpe, *David Bohm's World: New Physics and New Religion* (London and Toronto: Bucknell University Press, 1993). I agree with Sharpe's identification of Bohm's main philosophical ideas: Infinite depth of reality; wholeness; movement; levels; and creativity. In his main argument he tries to prove that Bohm is using religious ideas in his physics. This is close to what I am trying to show, except that Sharpe is dealing with religion rather than with esotericism, that he never identifies. He also draws an interesting parallel between Bohm and Fritjof Capra, the author of *The Tao of Physics* (1985).[48] Although this comparison is not without value, it is rather wanting. Capra cannot be equated with Bohm in terms of physics, neither in the boldness of the philosophical or even spiritual ideas involved. Capra is talking about standard particle physics in relation to the orthodox and well established religions of the East. Bohm is dealing with his own original scientific ideas in relation to a philosophy of movement and infinite wholeness. Sharpe's effort is a missed opportunity as he rapidly looses credibility due to the inaccuracies and arbitrary extrapolations regarding

[47]Lynda Ellinor, 'Bohm's Journey to Dialogue', in *Dialogue as a Means of Collective Communication*, ed. by Bela Banathy and Patrick M. Jenlink (New York: Kluwer Academic Publishers, 2005), chap. 12, pp. 255–277; Lee Nichol, 'Wholeness Regained', in *Dialogue as a Means of Collective Communication*, ed. by Bela Banathy and Patrick M. Jenlink (New York: Kluwer Academic Publishers, 2005), chap. 2, pp. 17–27; Mario Cayer, 'The Five Dimensions of Bohm's Dialogue', in *Dialogue as a Means of Collective Communication*, ed. by Bela Banathy and Patrick M. Jenlink (New York: Kluwer Academic Publishers, 2005), chap. 8, pp. 161–191; William Keepin, 'David Bohm: A Life of Dialoge Between Science and Spirit', *NCUACS 66.4.97*, A.96 (1994), <http://kc.mslater.com/~kfi/kc/viewitem.php?id=145&catid=144&kbid=ionsikc> [accessed 20 October 2011].

[48]Capra, *The Tao of Physics*.

science.

Chapter 3

David Joseph Bohm (1917-1992)

3.1 Pennsylvania, Berkeley and Princeton

David Joseph Bohm was born in the mining town of Wilkes–Barre, Pennsylvania, on the 20 December 1917, the first son of a family of immigrant Jews.[1] David grew up in his poverty–stricken native town where his father had a furniture store. Witnessing the conditions of the working class during the Great Depression, David developed a lifelong interest in politics. He also developed a passion for science reacting somewhat to the pragmatic, down to earth spirit of his father that expected David to carry on with the family business. Despite his father low regard for science, he supported David who left Wilkes–Barre in 1935 to study physics at Pennsylvania State University where he received a B.S. in 1939. He then moved to the California Institute of Technology for postgraduate work. However Cal-

[1] His father Shmuel Düm was born in an Orthodox Hasidic family in Munkács, a Hungarian town in Carpato–Ukraine notorious for its learned Hasidic scholars. The region became part of the USSR in 1945 and it is now part of Western Ukraine. Shmuel anglicized his name to Samuel Bohm when he arrived to America as a young immigrant. His mother Frieda Popky was the daughter of an Orthodox Jewish couple from Lithuania. David's brother Robert was born in 1921.

Tech disappointed Bohm, who hoped to learn more about the philosophical foundations of physics and to start some research of his own. Instead he found a pervasive spirit of competition, a general lack of interest amongst teachers and fellow students regarding the deep questions of nature, and professors who were more concerned in teaching how to perform mathematical calculations than explaining deep principles of physics:

> And then I went to CalTech, I went out in 1939. And there I was rather unhappy because the atmosphere was very oppressive. They constantly were giving exams and competing and were not interested in what the subject was about.[2]

Bohm begin to look for alternatives and he was advised to contact J. Robert Oppenheimer (1904–1967) who offered him a place in the school of theoretical physics at the University of California at Berkeley. After only a year in CalTech Bohm moved to Berkeley to join the research group led by Oppenheimer, who proposed that Bohm work on the scattering of protons and deuterons for his PhD. Bohm didn't see much of his tutor, as soon after his arrival to Berkeley Oppenheimer and many of his students moved to Los Alamos to work on the Manhattan project. Bohm applied to go as well but he was rejected and was forced to stay in Berkeley where he took over Oppenheimer's lectures in quantum mechanics. Reaching the end of his research, the calculations that he had completed proved useful for the Manhattan project and his work was classified. Bohm could no longer have access to his own work to write his thesis: however Oppenheimer vouched for him and he was awarded his Ph.D. in 1943.

[2]Hoddeson and Bohm, 'Interview with Dr. David Bohm at the home of the Bohms, Edgware, London May 8, 1981'

3.2 Plasma as a Model of Collective Organization

After graduation Bohm joined the Lawrence Radiation Laboratory in Berkeley where he served as a research fellow. He became an active member of the Federation of Architects, Engineers, Chemists and Technicians (FAECT), a trade union which had a chapter operating in the Radiation Laboratory. Indeed, Bohm's passion for politics – for thinking and intellectual discussion rather than for action – had not waned and Berkeley had proved to be ideal for the development of his social interests. He began to read Marx, Engels and Lenin and became deeply committed to Marxism. In November 1942 he joined the Communist Party, but he left after nine months because he found that the members of the CP were too concerned with petty issues and not sufficiently interested in the greater ideals of reason, social equality and freedom.

The Radiation Laboratory joined the war effort with research dedicated to obtain Uranium 235 for use in the atomic bomb. In 1943 he begin to work under the direction of the Australian physicist Sir Harrie Massey (1908–1983), who came to the Lawrence Laboratory to set up a research program dedicated to improve the techniques associated with the electromagnetic separation of uranium isotopes. For this a thorough theoretical understanding of the behaviour of plasma in an electromagnetic field was required and Bohm was charged with its theoretical investigation. He developed several quantitative estimates regarding the behavior of plasma in a magnetic field of which the most important is what is now called the Bohm diffusion coefficient.

Plasma research proved to be of little use for the Manhattan project;

nevertheless Bohm took an intense interest on it as it offered him a metaphor for a Marxist society. There is ample evidence that Bohm's research during these years was influenced by his Marxist views.[3] He saw his research on plasma as more fundamental than the investigation of the atomic nucleus as it provided a philosophical model that enabled him to think beyond the limits of the purely physical. This gives an early indication of Bohm's taste for metaphors and his tendencies to reach for a comprehensive philosophical standpoint capable of incorporating his several interests within a single whole:

> The plasma became very interesting to me. I could see that this was a kind of analogy to the problem of the individual and society. You had in the plasma what I called collective behaviour [...] When all the electrons move together, they produce an electric field that draws them back so that they'll oscillate [...] in a coherent way [...] I call that a collective movement. The question was how was this collective movement maintained in spite of the random basis of electrons [...] this was the kind of interesting social question [...] it was a self-sustaining motion in such that each electron has its freedom, apparently, to do whatever it would do. But nevertheless, because of the effect of the collective long range effects, each electron was modified a bit and was able therefore to add together to produce the [...] collective motion [...] I saw that as a model of society where I wanted to begin to understand the relation of the individual and the collective. Where one did not greatly interfere with the individual freedom and yet could understand collective action.[4]

[3] See Kojevnikov, 'David Bohm and Collective Movement' for a detailed argument.
[4] David Bohm and Maurice Wilkins, 'Interview Bohm–Wilkins', *NCUACS 66.4.97*, D.8

This idea of two apparently irreducible realms, which upon closer investigation show a deep harmony with each other, that Bohm first explored in the individual and the collective behaviours of electrons in plasma, would later be extended to other dichotomies: the random and deterministic, and later, the Implicate and the Explicate Orders.

Once the war had ended, the Radiation Laboratory became a less interesting place for Bohm who began to look for alternatives. During a visit to Berkeley John Wheeler offered Bohm a position in the physics department of Princeton University, an offer that became very attractive for Bohm when he learned that Oppenheimer would be heading the Princeton Institute for Advanced Study. In 1947 Bohm was appointed Assistant Professor at Princeton University where he continued his research on plasma physics with the help of his research students. His work in collaboration with Eugene Gross laid the foundation for the modern theory of classical plasma.[5] With David Pines he applied the theory of classical plasma that he developed with Gross to understand the movement of electrons in metal.[6]

(1986) Tape 8 Side b

[5]See Gross account in his contribution to Bohm's Festschrift: Eugene P. Gross, 'Collective Variables in Elementary Quantum Mechanics', in *Quantum Implications: Essays in Honor of David Bohm*, ed. by B. J. Hiley and F. David Peat (London: Routledge, 1991), pp. 46–65.

[6]The work of Bohm and Pines was an important milestone in the development of the modern study of complexity and many body systems, fields in which Pines became a renowned expert. This work was the subject of Pines' PhD thesis and was published in four articles: David Bohm and David Pines, 'A Collective Description of Electron Interactions: I. Magnetic Interactions', *Physical Review*, 82 (1951), pp. 625–634; David Pines and David Bohm, 'A Collective Description of Electron Interactions: II. Collective vs. Individual Particle Aspects of the Interactions', *Physical Review*, 85 (1952), pp. 338–353; David Bohm and David Pines, 'A Collective Description of Electron Interactions: III. Coulomb Interactions in a Degenerate Electron Gas', *Physical Review*, 92 (1953), pp. 609–625; David Pines, 'A Collective Description of Electron Interactions: IV Electron Interactions in Metals', *Physical Review*, 92 (1953), pp. 626–636. See also Pines contribution to Bohm's Festschrift: David Pines, 'The Collective description of Particle Interactions: From Plasmas to the Helium Liquids', in *Quantum Implications: Essays in Honour of David Bohm*, ed. by B. J. Hiley and F. David Peat (London: Routledge, 1991), pp. 66–84. The perception of Pines and Bohm about the authorship of the ideas exposed in these

By the end of the 1940s everything looked promising for Bohm who had proved to be a physicist of considerable talent pioneering plasma physics and publishing regularly on the subject.[7] He was lecturing graduate and undergraduate courses; he was supervising Ph.D. students among whom he was very popular; and he was writing a textbook on quantum mechanics. Nothing announced the storm that was soon to break in Bohm's life. As the crusade against Communism launched by the American Senator Joseph R. McCarthy intensified, Bohm came under suspicion because of his political tendencies. He was subpoenaed in April 1949 to appear before the House Committee on Un-American Activities, but Bohm refused to testify pleading the Constitutional Fifth Amendment.[8] As a result Bohm was charged with Contempt of Congress and was arrested on November 1949 and released on bail. Princeton University reacted by suspending Bohm from all duties, while still paying him his salary, and forbade him to enter the University's campus, a prohibition that didn't stop Bohm meeting students and colleagues. Although he was tried in June 1950 and acquitted of all charges in June 1951, his troubles with the administration had just started.

papers was a bit different, see David Peat, *Infinite Potential: The Life and Times of David Bohm* (New York: Basic Books, 1997) p.201-203 for an account.

[7]Bohm participated in the Shelter Island conference in 1947 that was of central importance for the development of post-war physics in the USA. The participants were the leading American physicists of the age. During that meeting the main agenda for physics research in in America was fixed. It consisted mainly of quantum electrodynamics and particle physics. Bohm did some research in these subjects: on the problems of re-normalization and superconductivity. However his main research interest remained plasma physics.

[8]A subpoena for production of evidence is a court summons ordering the recipient to appear before the court and produce documents or other tangible evidence for use at a hearing or trial.

3.3 The Causal Interpretation of Quantum Mechanics

Suspension from the University freed Bohm from the subtle intellectual constraints imposed by the physics collective at Princeton:

> There's a lot of status consciousness, much more at the Institute than at the University. I felt that this status and security were often on people's minds, you see. And this interfered with freedom of thought [. . .] Also, you see, I think there was a kind of pressure to think in a certain way, not that they were explicitly doing any pressure on you, but just simply by being there. If you talked to all these people, you must talk in their language [. . .] Now, what happened was that, not being able to go to the University, I had to work at home. I felt that in some ways it liberated me. I was able to think more easily and more freely, you know, without having to talk the language of other people.[9]

Enjoying all of his time and his new-found freedom of thought, he finished his first book, *Quantum Theory* (1951), based on his graduate lectures at Princeton.[10] This textbook distinguishes itself from other textbooks by the amount of space dedicated to the conceptual foundations of quantum mechanics, and the lucid account of the physical principles behind the theory, aspects that are inadequately treated if not entirely omitted in other presentations published at the time, as these tended to focus on the more mathematical and pragmatic aspects of the theory. Bohm wrote

[9] Hoddeson and Bohm, 'Interview with Dr. David Bohm at the home of the Bohms, Edgware, London May 8, 1981'

[10] Bohm, *Quantum Theory*

the book as an effort to understand better the theory and its usual interpretation, as was put forward by the pioneering school of the Danish physicist Niels Bohr (1885–1962) in Copenhagen. As it is now widely known, quantum phenomena contradicts our common sense and an explanation of what is going on is required. However the explanations found so far tend to be as hard to accept as the raw quantum facts. Bohr's 'Copenhagen interpretation', that maintains that the quantum theory gives a complete account of the micro-world with no need for additional hypotheses, became the standard way to think about the quantum world.[11] However this interpretation was never clearly formulated by Bohr nor by any of its main adherents, who did not always agree among themselves.[12]

At the time Bohm felt that this philosophical outlook was 'of crucial importance in supplying the general philosophical basis needed for a rational understanding of quantum theory', and he set himself to the task of explaining clearly the physical concepts and to present 'Bohr's philosophy of quantum mechanics in the best possible light'.[13]

However, not everybody was convinced by the Copenhagen school. Among the main dissenters was Albert Einstein (1879–1955), one of the

[11]For a review of the many different points of view and the consolidation of the Copenhagen school as a reaction against rival interpretations see Kristian Camilleri, 'Heisenberg, Bohr and the Divergent Viewpoints of Complementarity', *Studies in the History and Philosophy of Modern Physics*, 38.3 (2007), pp. 514–528. For Bohr's views on the interpretation of quantum mechanics see: Niels Bohr, 'Discussion with Einstein on Epistemological Problems in Atomic Physics', in *Albert Einstein: Philosopher Scientist*, ed. by schilpp (Tudor Press, 1949), chap. 7, pp. 199–242; Niels Bohr, *Collected Works Vol 6* vol. Foundations of Quantum Mechanics 1926–1932 (Amsterdam: North–Holland, 1985); Niels Bohr, *Collected Works Vol 7* vol. Foundations of Quantum Mechanics II 1933–1958 (Amsterdam: Elsevier, 1996); Werner Heisenberg, *Physics and Philosophy: The Revolution in Modern Science* (London: George Allen & Unwin, 1958); Werner Heisenberg, 'Quantum Theory and its Interpretation', in *Niels Bohr: His Life and Work as Seen by His Friends*, ed. by Stephan Rozental (North–Holland, 1967), pp. 94–108.

[12]See Kristian Camilleri, 'Constructing the Myth of the Copenhagen Interpretation', *Perspectives on Science*, 17.1 (2009), pp. 26–57 for a review.

[13]Bohm, *Quantum Theory*, p. 5. See also chapter 4.

pioneering figures of the theory. Einstein did not challenge the effectiveness of quantum mechanics as a predictive theory, but he was very critical of its philosophical foundations.[14] His main objection was that Bohr's philosophy of quantum mechanics does not give an account of reality, it is purely phenomenological, concentrating on the description of the quantum effects and the limits of what is possible to know about the phenomenon, with no concern for the actual existence of the object it is describing.[15] In other words, it is purely epistemological giving an essential role to the observer and lacks an ontology.[16]

Bohm sent a copy of his *Quantum Theory* to Einstein whom he met on several occasions:

> Well, I had several conversations with Einstein. After writing this book on quantum mechanics, which I wrote to try to understand it (based on my graduate course), I sent a copy to various

[14]For an account of the Bohr–Einstein debate by the protagonists see: Bohr, 'Discussion with Einstein on Epistemological Problems in Atomic Physics'; Albert Einstein, 'Reply to Criticism', in *Albert Einstein: Philosopher–Scientist*, ed. by Schilpp (Tudor Press, 1957), pp. 663–688. For an academic study of Einstein's problems with Niels Bohr and the foundations of the quantum theory see: Abraham Pais, *Subtle is the Lord: The Science and the Life of Albert Einstein* (New York: Oxford University Press, 1983); Mara Beller, *Quantum Dialogue, The Making of a Revolution* (Chicago: The University of Chicago Press, 1999); Andrew Whitaker, *Einstein, Bohr and the Quantum Dilemma: From Quantum Theory to Quantum Information* (Cambridge: Cambridge University Press, 2006).

[15]The relationship between Einstein and quantum mechanics and its interpretation is much more subtle and complicated than the stubborn-old-man-defeated-by-Bohr caricature that populates most accounts on the subject. For an intelligent examination see: Whitaker, *Einstein, Bohr and the Quantum Dilemma*; Dipankar Home, *Conceptual Foundations of Quantum Physics: An Overview from Modern Perspectives* (New York: Plenum Press, 1997); Dipankar Home and Andrew Whitaker, *Einsteins Struggles with Quantum Theory: A Reappraisal* (Berlin Heidelberg: Springer–Verlag, 2007)

[16]I use the philosophical terms ontology and epistemology rather naively. Traditionally philosophy is divided into two large branches: Ontology, the theory of 'being', what the world is made of, what reality is, and it includes metaphysics, the study of the realms beyond the physical; and Epistemology the theory of knowledge, about what can be known and the ways to achieve this knowledge. For much of the twentieth century ontology was in discredit among the positivist and analytical mainstream in philosophy and science.

> scientists including Einstein. He wanted to discuss it with me, and we discussed it. He felt that the book was as good as you could present the ordinary point-of-view, but he still didn't accept it. So we discussed it for a while, and meanwhile I myself had been feeling that it wasn't all that clear, and that therefore these two things together made me feel that the interpretation of quantum mechanics was not satisfactory. So I began to think about it, and I produced another interpretation, which came out in two papers in *Physics Reviews* in 1952, two papers, using a particle and a wave, the Causal Interpretation I called it. And I discussed all those things with Einstein.[17]

The influence of Einstein's views of quantum mechanics on his young colleague should not be exaggerated as Bohm's challenge to the prevailing conceptual foundations of physics started to loom long before he met Einstein.[18] Nevertheless, inspired by his conversations with Einstein,[19] Bohm published two papers entitled: *A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables I & II* containing a consistent and completely new alternative, the 'Causal Interpretation'.[20] The most important

[17]Hoddeson and Bohm, 'Interview with Dr. David Bohm at the home of the Bohms, Edgware, London May 8, 1981'

[18]In David Bohm and M. Weinstein, 'The Self Oscillation of Charged Particles', *Physical Review*, 74 (1948), pp. 1789–1798 p. 1797, they conclude that 'a systematic relativistic quantum theory of extended charges might readily lead to important revisions of some of our concepts of causality'.

[19]Murray Gell–Mann remembers that Bohm told him once, regarding the unorthodox interpretation of quantum mechanics, that 'He [Einstein] talked me out of it. I'm back where I was before I wrote the book (Quantum Theory])', Murray Gell-Mann, *The Quark and the Jaguar: Adventures in the Simple and the Complex* (New York: W.H. Freeman, 1994) p. 170

[20]Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables I', Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables II'. The title of 'hidden variables' is misleading as there are no real hidden variables in Bohm's theory. He promptly recognized this and rather used the term 'Causal' to refer to his original interpretation.

aspects of the Causal Interpretation are: the introduction of a 'Quantum Potential', $U(x)$, the germ of what later would became the Implicate Order; and the recovery of the notion of particles and of deterministic paths that is abandoned in the Copenhagen Interpretation.[21]

The Causal Interpretation raised many scientific and philosophical objections. From the scientific point of view, after much discussion, Wolfgang Pauli had to accept its logical consistency: the Causal Interpretation reproduced all statistical predictions of standard quantum theory and was free of contradictions. However, many physicists remained convinced that something was wrong with Bohm's papers, but no one could show exactly what. From the philosophical point of view the main objection was that it was a return to the world-view of classical physics as the objectivity of the particle trajectories contradicted the epistemological bent of the Copenhagen interpretation that maintained that nothing could be said about the trajectories, dismissing the possibility of a quantum ontology. The Causal Interpretation on the contrary gave exactly that - a quantum ontology - and pushes to the background the epistemological aspects (calculations, statistics, etc). In few words, the Causal Interpretation provided an explanation to the physical situation that the Copenhagen interpretation maintained it was impossible to explain. Bohm responded to the philosophical objections arguing that his interpretation was not a return to the ontological world of classical physics, as the Quantum Potential has many striking non-classical consequences.[22] Bohm didn't think that the Causal Interpretation was 'the true one', his aim was to show that there existed valid alternatives to the Copenhagen interpretation and that different philosophical positions were possible. He expected that the physics community

[21] See chapter 4 below.

[22] The Quantum Potential has no sources, it is strongly non-local, etc. See chapter 4.

would respond to his proposal with an open mind, and was looking forward to engaging in a scientific debate. He was to be disappointed.

3.4 Into Exile

After being acquitted of all charges on 3 June 1951, Princeton revoked his suspension 3 days later. However Princeton didn't renew Bohm's contract that was due to expire 3 weeks later.[23] From that point on Bohm was blacklisted and he was forced to look for alternatives elsewhere as he was unable to find an academic position in the USA. He finally accepted the Chair of Physics offered to him by The University of Sao Paulo in Brazil. Bohm arrived in Brazil on 10 October 1951.

Bohm found the university of Sao Paulo disorganized, the city chaotic and the food indigestible. Journals and books took longer to arrive and the advanced physics facilities and the thriving community that he had experienced in the USA were non existent in Sao Paulo. His troubles with the American authorities continued as the American Consulate officials confiscated his passport as they feared that Bohm might end up in Russia. In consequence he could not travel to attend any conferences. He became isolated from the American physics community and complained copiously about this in his correspondence. However this isolation was much exaggerated by Bohm and his complaints about the difficulty of carrying on with his work simply do not correspond to what he actually did. Bohm found adequate support for his theoretical research in Brazil and many Brazilian physicists and intellectuals were welcoming and sympathetic to

[23]The Princeton University administration justified the decision invoking professional reasons, however the real reasons were political as Princeton did not want to tarnish its reputation and risk the loss of important anti-communist benefactors.

his science, his dialectic materialism and his Jewish background - a very different story from his native America. He also kept contact with many colleagues abroad and received visits of colleagues from Europe and the USA.[24] The idea of the Causal Interpretation was not completely original. Louis de Broglie had proposed a similar idea in the first Solvay conference in 1927, however he dropped his proposal after several objections were raised against it.[25] Bohm did not know about de Broglie's 'pilot wave' interpretation at the time, but Pauli wrote to him about it. In his two papers Bohm resolved all the objections that were raised against the idea and this convinced de Broglie to support the Causal Interpretation. [26] Jean-Pierre Vigier (1920-2004), assistant of Louis de Broglie and a fervent Marxist, would be one of the most important supporters of Bohm and will stay in Brazil for several months collaborating in the development of the Causal Interpretation.[27] If Bohm had stayed in the USA, this relationship would have never happened, as Vigier was a very active communist and he would not have been able to obtain a visa for the USA during the 1950s.

Bohm had great expectations for the reception of his 1952 papers, as he thought that he had achieved a very important breakthrough. Although the papers were widely discussed, the overall reaction of the international physics community disappointed Bohm enormously. Basil Hiley writes:

[24]Richard Feynmann took a sabbatical year in Brazil as he knew that Bohm was there. Although Feynmann espoused a very different philosophy towards nature, he was one of the few that listened carefully to what Bohm had to say. Both men remained good friends for the rest of their lives.

[25]G. Bacciagaluppi and A. Valentini, *Quantum Theory at The Crossroads: Reconsidering the 1927 Solvay Conference* (Cambridge: Cambridge University Press, 2009)

[26]Louis de Broglie, *Non–Linear Wave Mechanics: A Causal Interpretation* (Amsterdam: Elsevier, 1960)

[27]Vigier was one of the most important supporters of the statistical interpretation. Although both men remained good friends their approaches to science differed enormously, Vigier being completely committed to dialectic materialism. See 5.2.

> Unfortunately Bohm had been forced to leave the US for Brazil before the paper appeared in print so he was never able to defend his ideas directly with physicists who mattered, and a consensus developed that this work must somehow be flawed. The political atmosphere in the US at that time did not help rational debate and in consequence there was little discussion and the interpretation was generally ignored for reasons that had more to do with politics than science.[28]

However, it has been suggested that Bohm's political inclinations may not have been the main issue behind the obstacles he experienced with the reception of the Causal Interpretation, but rather the cultural context of physics at the time.[29] In America, where Bohm's politics were problematic, he was largely ignored as the physics community was more interested in pragmatic problems rather than philosophical ones. The only scientist in America to say anything about the Causal Interpretation was Einstein, but it was nothing good as he found Bohm's approach rather superficial.[30]

The main opposition came from European scientists, Bohr, Born, Pauli, Heisenberg, the old generation of Copenhagen supporters who advocated their philosophy of physics not as one possibility among others, but as the only one possible. For these men Bohm's politics may not have been an issue.

[28]Hiley, 'David Joseph Bohm', pp.

[29]For a more detailed analysis of Bohm's marginalization and the reception of the Causal Interpretation see: Peat, *Infinite Potential*; Russel Olwell, 'Physical Isolation and Marginalization in Physics: David Bohm's Cold War Exile', *Isis*, 90.4 (1999), pp. 738–756; Freire, 'Science and exile'.

[30]That regarding America, the problem had nothing to do with physics or politics but with philosophy is illustrated by the fact that the 'many worlds' interpretation proposed by the American physicist Hugh Everett III in 1957 was similarly treated despite the fact that Everett had no issue with American politics.[31]

However this was not the case for the Belgian physicist Léon Rosenfeld (1904-1974), a close collaborator of Bohr.[32] Rosenfeld was an ardent Marxist and it has been suggested that his opposition to many of his colleagues, in particular to Bohm's theories, may have been politically motivated.

> Rosenfeld's concern and annoyance soon resulted in his taking up the fight against all disbelievers of complementarity, whether Soviet or Western Marxist physicists or just supporters of the causal program with no Marxist agenda. It was a fight in which he used all possible means, including polemical papers, book reviews, and personal connections. In addition, he served as consultant or referee in matters of epistemology of physics and the like at several well-reputed publishing houses and at the influential journal Nature. In this capacity he used his influence effectively, and several books and papers, among them some by Frenkel, Bohm, and de Broglie, were rejected on this account.[33]

The relationship between Bohm and Rosenfeld was not cordial. Rosenfeld used to be sarcastic and incisive when referring to Bohm's work:

> It is understandable that the pioneer who advances in an unknown territory does not find the best way at the outset; it is less understandable that a tourist loses his way again after this

[32] Anja Skaar Jacobsen, *Léon Rosenfeld: Physics, Philosophy, and Politics in the Twentieth Century* (London: World Scientific, 2012); Anja Skaar Jacobsen, 'Léon Rosenfeld's Marxist defense of complementarity', *Historical Studies in the Physical and Biological Sciences*, 37.Supplement (2007), pp. 3–34.

[33] Jacobsen, 'Léon Rosenfeld's Marxist defense of complementarity'.

territory has been drawn and mapped in the twentieth century.[34]

Bohm responded saying that this worked both ways, Bohr being the pioneer who did not find the best way at the outset, and Rosenfeld the lost tourist.

Contrasting these opposition, Bohm's work found a receptive and attentive audience on the margins of the mainstream. Physicists in Brazil, Japan and Hungary found Bohm's ideas interesting and contributed to work on the Causal Interpretation to fashion it into a challenge to the mainstream point of view.

For many years Bohm worked in collaboration with several other scientists to extend the scope of the Causal Interpretation. In its 1952 original form the Causal Interpretation reproduced all the standard results of non-relativistic quantum mechanics. But to bring it to become a full scientific theory beyond a simple counterexample in a philosophical debate, it was imperative to extend it to include the relativistic case and develop quantum field theory in terms of the Quantum Potential. Bohm had already done some of this extension work in an appendix of the original papers where he dealt with the electromagnetic field. He also extended the theory to the case of the Pauli equation, integrating spin into the context of the Causal Interpretation.[35]

Sometime later his interest in the Causal Interpretation waned in favour of more philosophical questions. As the feeling of isolation from the physics mainstream increased, his ideas shifted towards more heterodox subjects, broadening the scope of his research and drifting further apart

[34]Léon Rosenfeld, 'Strife About Complementarity', *Science Progress*, 41.163 (1953), pp. 393–410.

[35]David Bohmn, R. Schiller and J. Tiomno, 'A causal interpretation of the Pauli equation: Parts A and B', *Nuovo Cimento*, Suplemento.1 (1955), pp. 48–49

from the community he once belonged to. Physics remained important as a gauge that he used to keep his philosophical ideas grounded:

> I had become more interested in philosophy gradually all the time. I became interested in causality and the objective existence of things and all sorts of questions like that. It seemed a large part of my interest in physics was in those questions.[36]

During his time in Brazil Bohm had the opportunity to expand his philosophical horizon in a way that might not have been possible anywhere else:

> Being far away from people had this affect that I really went much further into these philosophical things than I would have done probably elsewhere [. . .] I think it was a period when I was in sort of a change looking at these assumptions, which were being taken for granted, as in the dream about the cat, you see. Scientifically not a lot bore fruit [. . .] But I was trying to get free of all sorts of rigid assumptions, which were generally accepted [. . .] I think I still believed in it, that if people could really see science in another way people would change. In other words, it would be a very powerful factor for bringing about unity and peace and raising people's hopes. Being in Brazil helped me to look at it that way because I wasn't in contact with what was really going on in science.[37]

Among other philosophers he began to study the philosophy of G.W.F. Hegel (1770–1831), in particular the *Science of Logic* (1811-1816), whose

[36]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 3 Side B
[37]ibid. Tape 9 Side B

ideas suited him far better than Marx's.[38] Bohm would keep re-reading Hegel's *Logic* until the end of his life, shifting gradually towards a more idealistic outlook:

> [In Brazil] I met a man called Mario Schönberg, who was also interested in Marxism. And he advised me to read Hegel, who was really the source of a lot of Marx's ideas [. . .] I read Hegel's Logic. There I found something very interesting. Well we all know that he was saying: Watch thought as a *process*.[39]

Bohm never felt comfortable in Brazil, resenting the noise, the heat and the food, and he left as soon as he could. Bohm had to give up his American citizenship to be able to travel, so it was as a Brazilian citizen that he left Brazil in January 1955 to take a Professorship at the Technion in Haifa. A few weeks later after his arrival in Israel he met Saral, Sarah Woolfson, an English woman who had emigrated to Israel to work as a hospital volunteer in 1948. Bohm married her in March 1956.

It was during a visit to the Institute Henri Poincaré in Paris to work with Vigier and de Broglie in 1956 that Bohm's Marxist beliefs were finally shaken to the core. He had great hope that Communist Russia would offer the possibility of a better, more just and free human society, and for years he dismissed the reports of Stalin's atrocities, thinking them exaggerations and Western propaganda to discredit Communism. Eventually, Nikita Khrushchev's denunciation of Stalin's rule forced him to acknowledge the real situation of the Soviet Union. His ideological world collapsed, creating a vacuum. Bohm's concern about international politics was very intense:

[38] Georg Wilhelm Friedrich Hegel, *Science of Logic* Muirhead Library of Philosophy (London and New York: Allen and Unwin; MacMilan, 1929)

[39] Bohm and Angelos, 'Beyond Limits: A Conversation with Professor David Bohm' p.4.

he used to take upon his shoulders the problems of the world and many times fell into deep depression because he felt responsible for the situation. He used to believe that the ways of nature would show people the road to a rational life. But his own experience of the irrational reception of the Causal Interpretation by the physics community, and the failure of Communist Russia to establish a just society, made him to loose his faith in science and knowledge. He realized that neither science nor Marxism could fix the problems of human society. With his Marxist beliefs in tatters, he begin to adopt a more idealistic philosophical position:

> [. . .] you say that thought is a material process [. . .] if you want to be a materialist. If you do not, we will put it in Hegel's terms, which is that thought is the primary reality, and that matter itself is like the thought of God. Matter itself is the symbol of God's thought. Not God, we want to say the universal thought or whatever you would like. It took me many years to get that point, because the whole tendency as a scientist is to see it the other way [. . .] I realized by the time that I got to Israel, I began even in Brazil, but by the time I got to Israel I realized it was very important to understand thought because everything depended on thought. If our thoughts were not straight, the whole thing would go wrong. Everything we did depended on thought. Therefore, I said that it was very important to understand thought above all, and it was one of the ideas that came to fruition in Israel.[40]

Bohm found Israel as unbearable as Brazil and he kept searching for alternatives. In 1957 he accepted a five year research fellowship at the

[40] Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 10 Side B

University of Bristol. There he did some important work in physics with two research students. With Gideon Carmi he did some research in plasma physics, after which Bohm abandoned the subject:

> But you see I think that my interests really began to go in other directions, and possibly I began to feel when I got back to Europe that people were not interested in the physical or the general concepts but wanted primarily to have a way of calculating things [. . .] I remember getting to a conference in Holland on this plasma work, and I felt that there was no physics there at all, they were just putting formulae on the board. They were not really interested in questions of what is the collective and what is the individual and things like that.[41]

With the collaboration of Yakir Aharonov, one fo his students, Bohm derived a striking consequence of the Schrödinger equation. They predicted that an electron moving next to a shielded electromagnetic field will be affected if the vector potential is non zero in the moving space. In principle the electron should not feel anything as there are no forces acting on it. However the effect is a consequence of the presence of the vector potential, not of the field. The vector potential is a quantity that no one expected to observe as it is a mathematical device used to give a more elegant presentation of Maxwell equations. Aharonov and Bohm showed that standard quantum mechanics predicted that the potential had an observable effect.[42] The 'Aharonov-Bohm effect', as the phenomenon

[41] Hoddeson and Bohm, 'Interview with Dr. David Bohm at the home of the Bohms, Edgware, London May 8, 1981'.

[42] David Bohm and Yakir Aharonov, 'Significance of electromagnetic potentials in the quantum theory', *Physical Review*, 115 (1959), pp. 485–491; David Bohm and Yakir Aharonov, 'Further considerations on the electromagnetic potentials in the quantum theory',

is now known, was hard to believe, and many were sceptical about it, but all doubts vanished as the effect was promptly confirmed experimentally.

3.5 Movement and the Qualitative Infinite of Nature

When discussed in the literature, Bohm is most of the time narrowly considered in regards to the 'hidden variables' interpretation. However, this overlooks his later scientific and philosophical development which Bohm considered much more important. To a certain extent, the interpretation was secondary as its purpose was only to show an alternative to the standard point of view, and anyway it had several limitations of its own, as Bohm thoroughly recognized. Nevertheless, Bohm felt that behind the interpretation lay something far more subtle, which had been elicited by the development of quantum theory and relativity, and that to reach this what was required was a deep re-examination of many of the basic assumptions of physics like order, space, time, causality, necessity and chance. The core issue for Bohm had always been the scientific and philosophical development of an idea that fascinated him since childhood: the notion that the nature of reality is movement – thus his stress on the need for new categories with an emphasis on process and movement:

> When I was about twelve, or ten or eleven, I was walking with some boys in the backwoods of the mountains there. I don't know if I told you this, we had to cross the stream. This was

Physical Review, 123 (1962), pp. 1511–1524; David Bohm and Yakir Aharonov, 'Remarks on the possibility of quantum electrodynamics without potentials', *Physical Review*, 125 (1962), pp. 2192–2193; David Bohm and Yakir Aharonov, 'Further discussion of the role of electromagnetic potentials in quantum theory', *Physical Review*, 130 (1963), pp. 1625–1632.

> a typical problem that you had to do things and just trust your body. It must have happened many times, but the thing I remember was the stepping stones. But I suddenly took this leap and it worked, you see, whereas before I would have said I must take every step from one stone to the other and stop and see where I then make the next step and so on. So that was the sort of thinking, and suddenly I had that insight that it wasn't necessary, that the movement as itself was a state of being [. . .] there was the idea that motion was first and being was part of it.[43]

Reality as '*an unbroken wholeness of the totality of existence as an undivided flowing movement without borders*' is the key idea to understanding Bohm's philosophy of nature and his wider reach beyond physics.[44] Bohm laboured hard to go beyond the usual assumption of putting the emphasis on 'being' as the reality and 'movement' as the consequence. He proposed the opposite, 'movement' as the fundamental aspect of reality and 'being' as subsidiary:

> This other view is to say movement is what you are. There is no fixed ground [. . .] That theme reoccurred quite often as I went further in my work later.[45]

Bohm begin to make his philosophical agenda clearer in his second book, *Causality and Chance in Modern Physics* (1957), written while he

[43]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 1 Side B

[44]Bohm, *Wholeness and the Implicate Order*, p. 218.

[45]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 3 Side B. There are interesting parallels between Bohm's position and the process philosophy of the British philosopher and mathematician Alfred North Whitehead (1861–1947). Bohm was well aware of the differences and similarities between Whitehead's position and his own, as he comments on this on several occasions. See Bohm, *Wholeness and the Implicate Order* pp. 61, 81, 263.

was living in Brazil but published when he was in Haifa.[46] The central topic of the book is the relationship between determinism and chance in the physical sciences which according to Bohm are in dialectical contradiction. Both categories are necessary but they exclude each other. The tone of *Causality and Chance in Modern Physics* is very different from the philosophical parts in *Quantum Theory*, as one of his main objectives is the discussion of the limitations of the Copenhagen and the Causal Interpretations. This book was written under the philosophical influence of dialectical materialism that Bohm sought actively to incorporate into his physics.[47]

An important idea that appears for the first time in *Causality and Chance* is the 'qualitative infinite of nature' that is brought up by Bohm as a critique of the scientific approach that tries to reduce all laws of nature to a single category:

> [...] nature was not limited, but was infinite in its qualities. Therefore every cause of law was limited by contingencies from beyond its context. Every law of chance was limited by cause of laws from beyond its context. The two kinds of laws wove together in an infinite, very rich structure with no limit. That if we're always working we could extend it as far as we liked, but it would still always be infinite, the amount we haven't learned [...] nature was infinitely rich and all woven together into one whole, that opposites were woven together in this dialectical

[46] Bohm, *Causality and Chance in Modern Physics*

[47] In *Causality and Chance in Modern Physics* Bohm inserted numerous literal correspondences with Friedrich Engel's (1820-1895) *Dialectics of Nature*(1883). For example, the definition of causal law, as an abstraction from empirically observed constant relations is identical in both books. For more on this topic see Forstner, 'Dialectical Materialism and the Construction of a New Quantum Theory: David Joseph Bohm, 1917–1992'

way dynamically.[48]

Bohm will elaborate later this idea within the context of the Implicate Order. He will postulate that this infinitude of things are organized in a series of reality realms, a ladder that will rise to infinitely more subtler orders. Bohm will use this ladder of orders to explain the relationship of mind and matter and consciousness. This construction links Bohm with the Neo-Platonic and Panpsychic tradition.

3.6 London

The beginning of the 1960s marked a turning point for Bohm. His professional worries came to an end in 1961 when he was appointed to the newly created Chair of Theoretical Physics at Birkbeck College, University of London, where he would remain until his retirement in 1983. In his inaugural lecture, *Problems in the Basic Concepts of Physics* delivered on the 13th of February of 1963, Bohm set out boldly into new directions.[49] In it he proposed to replace the coordinate oriented space-time continuum that underlines all physical theories with a more primitive elementary process in terms of a topological structure.[50] Bohm felt that it required a complete re-examination of the categories of thought inherited from classical physics, changing the emphasis to process and movement rather

[48] Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 9 Side B

[49] Bohm, 'Problems in the Basic Concepts of Physics'.

[50] This coordinate-oriented continuum has its mathematical expression in the concept of a differential manifold, an elaboration of the Cartesian coordinate system used in analytic geometry. Relativity theory and Quantum Field Theory, the two pillars of fundamental physics, are constructed mathematically with notions derived from differential manifolds. This 'geometrisation of physics' is the Cartesian prison from which Bohm wanted to liberate physics.

than particles and fields. He thought that topological structures would be more adequate than the metrical structures used in the present theories.[51]

Listening to Bohm's inaugural lecture was a young physicist, Basil Hiley, who had just finished his PhD. On hearing what Bohm had to say, Hiley decided on the spot that this was the kind of science that he wanted to pursue. He joined Birkbeck as a lecturer and become one of Bohm's more important scientific collaborators. For the next 30 years Bohm and Hiley continuously and passionately discussed physics and philosophy and published several important papers, mostly based on the ambitious research direction that Bohm set in his inaugural lecture. Many of the philosophical ideas associated with Bohm appeared for the first time in publications in collaboration with Hiley.[52]

For many years Bohm lost interest in the Causal Interpretation as he felt that it had served its purpose, pointing towards the more subtle and important issues associated with process, movement and order, but he came back to it during the 1970s as a new generation of physicists become interested in the unresolved philosophical problems of the quantum theory and Bohm's work began to be more widely appreciated.[53] Bohm found new

[51] David Bohm, 'A Proposed Topological Formulation of the Quantum Theory', in *The Scientist Speculates*, ed. by I.J. Good (New York: Putnam, 1965), pp. 302–314.

[52] David Bohm, Basil J. Hiley and Allen Stuart, 'On a New Mode of Decription in Physics', *International Journal of Theoretical Physics*, 3.3 (1970); David Bohm and Basil Hiley, 'On the intuitive understanding of nonlocality as implied by quantum theory', *Foundations of Physics*, 5 (1975), pp. 93–109; David Bohm and Basil Hiley, 'On some new notions concerning locality and nonlocality in the quantum theory', *Nuovo Cimento*, 28B (1975), pp. 453–466. David Bohm and Basil Hiley, 'Measurement understood through the quantum potential approac', *Foundations of Physics*, 14 (1984), pp. 255–274; David Bohm and Basil Hiley, 'An ontological basis for the quantum theory: I. Non–relativistic particle system', *Physics Reports*, 144 (1987), pp. 323–348; David Bohm, B.J. Hiley and P.N. Kaloyerou, 'An ontological basis for the quantum theory: II. A causal interpretation of quantum fields', *Physics Reports*, 144 (1987), pp. 349–375; Bohm and Hiley, *The Undivided Universe* to cite a few.

[53] It is within this new wave of interest in philosophical issues that John Bell took Bohm's work to heart and led him to rethink quantum mechanics and produce his famous inequal-

motivation as some of his research students ran computer simulations of the trajectories of particles under the influence of the Quantum Potential, and articles based on the Causal Interpretation begin to appear. At this time many other alternative interpretations of quantum mechanics have already appeared, terminating 'the almost unchallenged monocracy (sic) of the Copenhagen school in the philosophy of quantum mechanics'.[54] To this day none of the existent interpretations is universally accepted as a completely satisfactory explanation of the quantum world.

Bohm's ambitious research programme and his holistic tendencies led him to explore subjects and to meet people well beyond the confines of the Birkbecks's physics department. While still in Bristol he started a copious correspondence with the painter Charles Biederman (1906-2006), who had contacted him after reading *Causality and Chance in Modern Physics*.[55] Bohm's and Biederman's dialogue was about the relationship between art and science, creativity and a more general notion of order. Bohm took a particular interest in the work of the French painter Paul Cézanne (1839-1906), as he thought that the painter had achieved a static description of movement.

Bohm also met in 1962 the British mathematician and author John Godolphin Bennett (1897–1974), best known for his association with the Armenian-Greek esoteric teacher George I. Gurdjieff (1866–1949). Bohm and Bennett carried on a three year debate on the subjects treated in Bennett's *The Foundations of Natural Philosophy* (1956), the first volume of

ity. See A.1.

[54]Max Jammer, *The Philosophy of Quantum Mechanics: The Interpretations of Quantum Mechanics in Historical Perspective* (New York: John Willey & Sons, 1974) pp. 250-251

[55]Bohm's and Biedermann's correspondence between the years 1960-1962 has been published in Bohm and Biederman, *Bohm–Biederman Correspondence*, but there is much more in NCUACS 66.4.97 C.66-92.

his 4 volume series *The Dramatic Universe* (1956-1966), that elaborates upon Gurdjieff's esoteric teachings.[56] Bohm was receptive to Gurdjieff's idea of people living like sleepwalkers, not being completely awake, but he considered that Gurdjieff's methods were only psychological tricks with no real depth. As he become more and more critical of Gurdjieff the conversations came to an end in 1964, both men going their separate ways.[57]

But probably Bohm's most dramatic encounter was with the Indian esoteric teacher Jiddu Krishnamurti (1895-1986) whom Bohm met personally in 1961 in London and with whom he established a close friendship. In 1959, while still in Bristol, his wife Saral brought him a book from the library, *The First and Last Freedom* (1954) by Jiddu Krishnamurti as it contained a discussion about 'the observer and the observed', something she thought that Bohm would find interesting as 'he was talking about it all the time'.[58] Bohm read the book and found it extremely interesting. He went on to read everything he could by Krishnamurti, and eventually meet the man in person. Bohm found in Krishnamurti a man that was totally open, capable of great passion, ready to explore things in a spirit of open dialogue and able to challenge Bohm to the limit. For Krishnamurti the encounter with Bohm was equally thrilling as there had never been an equivalent individual on a common wavelength, sympathetic to his teaching and with the knowledge and intellectual command that came to Krishnamurti's aid when his powers of articulation faltered. Many times Krishnamurti had to leave the room in which he was conversing with Bohm, overwhelmed by

[56] John G. Bennett, *The Dramatic Universe: The Foundations of Natural Philosophy, Vol 1* (1956)

[57] Bohm met Bennet thanks to the efforts of one of his students, Anthony Blake, who arranged and mediated the interviews. Blake published a partial collection of the Blake-Bohm correspondence. See David Bohm and John G. Bennet, *The Bohm–Bennet Correspondence 1962–1964* ed. by Anthony Blake (Charles Town: DuVersity, 1997).

[58] Jiddu Krishnamurti, *The First and Last Freedom* (San Francisco: Harper, 1954)

the profundity of their dialogue.

Bohm became wholeheartedly committed to Krishnamurti's esoteric world. He devoted a great amount of time and expense to participate in Krishnamurti's activities around the world. He visited yearly the Swiss town of Saanen where Krishnamurti used to give lectures during the Summer; in England he became a trustee for Krishnamurti's Brockwood Park School in Hampshire; He was also very involved with the activities related to the centre in Ojai California, where Krishnamurti had his permanent residence; he was also a trustee for the Krishnamurti Foundation. He participated extensively in public dialogues with Krishnamurti, many of which were recorded and published in book form.[59] Bohm was not only Krishnamurti's most famous follower, but for many years Bohm was seen as the closest follower of the Indian teacher and a possible successor, a fact that provoked a great deal of mixed emotions among Krishnamurti's close disciples, Bohm's colleagues at Birkbeck College and even with Bohm's wife.

Given the tremendous influence that Krishnamurti and Hegel had on Bohm, and given Bohm's holistic tendencies that led him to pursue actively the integration of science and philosophy, among all the rest, into a

[59]David Bohm and Jiddu Krishnamurti, 'Truth and Actuality', in *The Complete Published Works 1933–1986* (Brockwood Park, Hampshire, England: Krishnamurti Foundation Trust, 1975); David Bohm and Jiddu Krishnamurti, 'Conversations With David Bohm, Mr. Narayan And 2 Buddhist Scholars 22nd and 23rd of June 1978 Brockwood', in *The Complete Published Works 1933–1986* (Brockwood Park, Hampshire, England: Krishnamurti Foundation Trust, 1978); Bohm and Krishnamurti, *Limits of Thought*; Bohm and Krishnamurti, *The Ending of Time*; Bohm and Krishnamurti, *The Future of Humanity: A Conversation*; Bohm and Krishnamurti, 'Wholeness of Life'; David Bohm and Jiddu Krishnamurti, 'Conversations With David Bohm, 14th and 16th September 1980, Brockwood Park', (1980); David Bohm et al., *The Nature of the Mind* (Brockwood Park, Hampshire, England: Krishnamurti Foundation Trust, 1980); David Bohm, Maurice Wilkins and Jiddu Krishnamurti, 'Brockwood Park Discussions with Maurice Wilkins and David Bohm 12th February 1982', (1982). Some of the original recordings of these conversations are available on DVD or CD-ROM from the Krishnamurti Foundation Trust.

single whole, it is surprising that the extent of this influence is not always fully and objectively acknowledged in the literature. One example is Paavo Pylkkänen's *Mind, Matter and the Implicate Order* (2007), an exploration of the Implicate Order applications to the philosophy of mind.[60] Pylkkänen, a friend of Bohm, wrote an unpublished paper with him on cognitive philosophy, and knew well his relationship with Krishnamurti as he was a former student of the Brockwood Park school, where he met Bohm.[61] However Krishnamurti is only briefly mentioned in two small paragraphs in this book, and Hegel is completely absent. This is surprising because this is a philosophy book and because Bohm's interest in Hegel and Krishnamurti was related precisely to the philosophy of mind.

Another problem is the editorial work on the published dialogues between Krishnamurti and Bohm effected by the Krishnamurti Foundation. Krishnamurti's followers have not been always comfortable with the idea that Bohm led these conversations in many ways. The dialogues that were chosen for publication were specially selected and editorial corrections introduced to 'rectify' this impression. Luckily many of the original recordings and transcripts of the dialogues are now available and a fair comparison between what is published and what actually happened is possible.

Bohm continued his research analysing the way in which the human mind forms concepts. He studied the work of the French educational psychologist Jean Piaget (1886–1980), who was famous for his research on the formation of the concept of space in young children. The influence of Piaget is reflected in the appendix to Bohm's third book, *The Special The-*

[60] Paavo Pylkkanen, *Mind, Matter and the Implicate Order* (Heidelberg, Berlin: Springer-Verlag, 2007)

[61] David Bohm and Paavo Pylkkänen, 'Cognition as a movement towards coherence', *NCUACS 66.4.97*, B.37 (1991).

ory of Relativity (1966), on *Physics and Perception*.[62] He then explored the nature of thought, its relation to reality and the dichotomy of wholeness and fragmentation as the underlying ideas of a more general framework. Bohm's concern was to overcome the confusion produced by the tendency of our thought to fragment:

> Rather what should be said is that wholeness is what is real, and that fragmentation is the response of this whole to man's action, guided by illusory perception, which is shaped by fragmentary thought. In other words, it is just because reality is whole than man, with his fragmentary approach, will inevitably be answered with a correspondingly fragmentary response. So what is needed is for man to give attention to his habit of fragmentary thought, to be aware of it, and thus bring it to an end.[63]

He considered that the fragmentation that our minds produce was reproduced in the way we use language. Motivated by the examples of languages which are based on verbs, like ancient Hebrew, he tried to develop a mode for using language emphasizing the oneness of the content of thought and the actual process of thinking which produces the content. Bohm named this new way of using language the 'rheomode', from a Greek verb meaning 'to flow'. He published this investigations in *Fragmentation and Wholeness* (1976) whose main content was republished in *Wholeness and the Implicated Order* (1980), Bohm's best known book.[64] This book contains two other articles with the title of *Quantum theory as an indication of a new order in physics*, part A published in 1971 and part

[62]Bohm, *The Special Theory of Relativity*.
[63]Bohm, *Wholeness and the Implicate Order*, p. 9.
[64]David Bohm, *Fragmentation and Wholeness* (Jerusalem: The van Leer Jerusalem Foundation, 1976); Bohm, *Wholeness and the Implicate Order*.

B in 1973, in which Bohm introduced the 'Implicate Order' explicitly for the first time.[65] Bohm never gives a precise definition of the Implicate Order, but relies upon a series of metaphors to convey the idea of an unbroken wholeness in movement into which the totality of events and objects that we perceive with our senses, the Explicate Order, is enfolded.[66]

For scholars familiar in the Western esoteric tradition, the rheomode and the Implicate Order will not be new ideas. The closeness of Bohm's ideas to similar concepts within Western esotericism is not a coincidence, as Hegel's *Science of Logic* is an ontological universe directly mapped onto the Christian Kabbalism of nineteenth century German esotericism.[67] The same Christian Kabbalah was integral part of the doctrine of the Theosophical Society, the esoteric organization that had tutored Krishnamurti and launched his career as an esoteric teacher.[68] Bohm himself recognized the importance of the influence of Hegel's and Krishnamurti's esoteric doctrine upon his thought. In an interview conducted by William M. Angelos in September 1990 in Amsterdam, just two years before Bohm's death, he comments regarding the Implicate Order:

> I did follow this thing up with Krishnamurti and we met every year when he came to London [. . .] we had many discussions, you see. I think partly through these discussions, although not

[65]David Bohm, 'Quantum theory as an indication of a new order in physics: Part A: The development of new orders as shown through the history of physics', *Foundations of Physics*, 1.4 (1971), pp. 359–381; David Bohm, 'Quantum theory as an indication of a new order in physics: Part B, Implicate and explicate order in physical law', *Foundations of Physics*, 3.2 (1973), pp. 139–168.

[66]Bohm used two main metaphors in *Wholeness and the Implicated Order* to explain the Implicate Order. The first is an experiment with ink and glycerine and the second the much abused hologram example. Bohm's purpose is to suggest the Implicate Order: neither image is a precise description of it. Authors that have brought this analogy well beyond its intended purpose are missing the point.

[67]Magee, *Hegel and the Hermetic Tradition* Chapter 5, pp. 150-186

[68]See below chapter 6.4.

> entirely, I came to this idea of the Implicate Order. He used to greatly encourage me in that direction. I may have had the idea before in a very germ form.[69]

The influence of the esoteric tradition in the work of a major scientific figure of the late twentieth century has been only tangentially addressed in the context of academic work. Sometimes this influence is unconsciously recognized, as Basil Hiley does in the biographical note that he wrote for the Royal Society:

> The Implicate Order was not introduced simply to accommodate quantum processes. It was much more general and was an attempt to find an overall view that would provide a more coherent framework reflecting the notion of wholeness that Bohm felt to be central to all our experience. It had philosophic similarities with the work of Spinoza and more notably, with the work of Schelling and of Hegel. They began with the assumption of some form of primordial whole and tried to understand the deep relationship between the 'objects' that could be abstracted from this undivided whole.[70]

In other cases, when it is consciously recognized but nevertheless undesired, the esoteric is avoided with terms that are similar but not quite the same. One of the main purposes of the present thesis is to trace the mutual influence of Western esotericism upon the particular case of Bohm.

[69] Bohm and Angelos, 'Beyond Limits: A Conversation with Professor David Bohm' p. 13

[70] Hiley, 'David Joseph Bohm' p.119

3.7 The Last Ten Years

Bohm retired from Birkbeck in 1983. His last ten years were not devoid of difficulties and challenges. He had always been prone to depression and worried continuously about his finances and his health. He had been worried about Krishnamurti for a while, confused by Krishnamurti's preaching about the irrelevance of spiritual teachers on one side and actively supporting the development of his own image as a spiritual teacher on the other. Bohm was also disappointed by the way the Krishnamurti Trust and the schools in Brockwood Park and Ojai were being run. Bohm begin to have serious health problems in 1980. He had his heart arteries almost blocked and in July 1981 he had a triple bypass operation that had complications and caused Bohm falling into a coma for two days. Although he was able to resume his activities and travels, Bohm never recovered fully from his operation. After this Krishnamurti began to neglect Bohm, an attitude that was very distressing for Bohm who had formed a real dependency on the teacher and at one time staked his career and even his marriage on Krishnamurti. The conflict reached its peak during a visit to Ojai in the Spring of 1984. On that occasion Krishnamurti confronted Bohm in a brutal way, accusing him of having just an empty intellectual understanding of his teachings and failing to change the nature of his consciousness according to what they had been talking about for twenty years. Krishnamurti felt that Bohm had far too many dependencies, on him and on his wife, and that these dependencies were an indicator of Bohm's failure to truly grasp his teachings. This was devastating for Bohm who had a very tough period recovering from Krishnamurti's attack. Although the relationship between the two men recovered and became friendly again, they were never to

achieve the electrifying collaboration they used to enjoy. Krishnamurti's death in 1986 didn't end Bohm's mortification as the devastating revelations in Radha Rajagopal Sloss' *Lives in the Shadow with J. Krishnamurti* (1991) disclosed the secret love affairs of Krishnamurti.[71] This scandalized Bohm as it was not only a dishonest aspect of Krishnamurti, but it was also a flagrant contradiction of Krishnamurti's own preaching about celibacy who left Bohm to believe that he led a celibate life.[72] Bohm remained deeply troubled regarding Krishnamurti for the rest of his life, although his doubts concerned the man himself rather than the teachings which Bohm always considered sound.

Bohm continued to expand the framework of the Implicate Order and to apply it beyond the problems of quantum mechanics. First he developed the Implicate Order in the direction of the Neo-Platonic 'qualitative infinite of nature' that he had introduced in *Causality and Chance in Modern Physics*. In the much more radical *Science Order and Creativity* (1987), written in collaboration with David Peat, he introduced the Super-Implicate Order, that arose first in the causal treatment of quantum fields:

> In the particle theory, the Causal Interpretation, with the prominence given to the Quantum Potential, appears, at least at first sight, to be a step away from regarding the Implicate Order as basic. But in the Causal Interpretation of the field theory, this is not so. Indeed, in this case there are *two* Implicate Orders in a specified relationship. The *first Implicate Order* is just the field itself, and its movement, described by Green's functions, is just a form of the Implicate Order. The *second Implicate Or-*

[71] Radha Rajagopal Sloss, *Lives in the Shadow with Jiddu Krishnamurti* (London: Bloomsbury, 1991).

[72] For the full story see Peat, *Infinite Potential*, p. 305.

> *der* is then obtained by considering the super-quantum wave function. This is related to the whole field as the original wave function is related to the particle. A more detailed treatment shows that the super-quantum wave function also moves in a kind of Implicate Order which is, however, far subtler and more complex than is the first Implicate Order. This then comprises the second Implicate Order.[73]

Having introduced a second Implicate Order that enfolds the first, there is a third and so on. Bohm introduced a new neologism to refer to this totality of orders, the 'Holomovement' to emphasize the unbroken and undivided totality of the undefinable and immeasurable ur-movement.[74] Bohm emphasized that although the Super-Implicate Order is first exemplified by the Causal Interpretation of quantum field theory, the idea is not restricted to physics.

Bohm went on to apply these ideas to consider the nature of creativity, consciousness and the relationship between mind and matter. Bohm started addressing these topics in chapter seven of *Wholeness and the Implicate Order* but to further develop the theory of how the Quantum Potential drives the trajectories of particles he introduced the notion of 'active information'. The Quantum Potential acts on particles 'informing' their movement without actually pushing them in any way. The Quantum Potential is not a source of force or energy, but a source of information. The particle, having a rudimentary mind-like aspect, decides how to move according to its reading of the potential. This notion is the springboard from

[73]Bohm and Peat, *Science, Order and Creativity*, pp. 182–183.

[74]This word appears for the first time in David Bohm, Basil J. Hiley and Allen Stuart, 'On a New Mode of Decription in Physics', *International Journal of Theoretical Physics*, 3.3 (1970).

which Bohm addressed the relationship of mind and matter in a purely panpsychic way. He wrote in a 1990 article, *A New Theory of the Relationship of Mind and Matter* that:

> It seems clear from all this that at least in the context of the processes of thought, there is a kind of active information that is simultaneously physical and mental in nature. Active information can thus serve as a kind of or 'bridge' between these two sides of reality as a whole. These two sides are inseparable, in the sense that information contained in thought, which we feel to be on the 'mental' side, is at the same time a related neuro-physiological, chemical, and physical activity (which is clearly what is meant by the 'material' side of this thought) [. . .] This may in turn be surveyed by a higher level of mental activity, as if it were a material object at which one were 'looking'. Out of this may emerge a yet more subtle level of information, whose meaning is an activity that is able to organize the original set of information into a greater whole. But even more subtle information of this kind can, in turn, be surveyed by a yet more subtle level of mental activity, and at least in principle this can go on indefinitely. Each of these levels may then be seen from the material side. From the mental side, it is a potentially active information content. But from the material side, it is an actual activity that operates to organize the less subtle levels, and the latter serve as the material on which such operation takes place. Thus, at each level, information is the link or bridge between the two sides.[75]

[75]Bohm, 'A New Theory of the Relationship of Mind and Matter' p. 278

Bohm did not actually call this dichotomy mind-matter. He felt that this introduced an artificial fragmentation into something that is an undivided wholeness in itself. But to refer to the two directions he used the terms 'somasignificance' and 'signasomatic'. He had developed these ideas in an article written in 1986 but posthumously published in 2004, *Soma-Significance: A New Notion of the Relationship Between the Physical and the Mental* where a striking triangle is used to express the relationship between energy, matter and meaning in which the influence of Hegel is unmistakable, bearing strong resemblance to the cosmological descriptions of the Christian Kabbalah.[76] Bohm was aware of the religious undertones of these considerations:

> There is therefore a close analogy between what happens with matter and what happens with mind. They are thus similar enough to be intimately related. What is the basis of this relationship? I would suggest that this is in some ground deeper and more subtle than are either mind or matter and that they both enfold from this ground, which is the beginning and ending of everything. What is the nature of this ground? At least for the present science is not able to say much about it. However, as I indicated before, different religions have generally been based on different beliefs concerning this ground and these differences have lead to fragmentation. Perhaps the one thing that almost all religions would have in common is to imply that this ground of all being enfolds a supreme intelligence (which is regarded as the source of extraordinary order present in the

[76]David Bohm, 'Soma–Significance: A New Notion of the Relationship Between the Physical and the Mental', in *Mind in Time*, ed. by Combs A., Mark Germin and Ben Goertzel (Cresskill, NJ: Hampton Press, 2004)

> universe, an important example of which is our own bodies and brains). Also, perhaps with less clear evidence, they have in common the feeling that this supreme intelligence is penetrated by love and compassion. [...] I think that it is relevant to add here that modern physics is not incompatible with a religious approach, considered in these broadest possible terms. On the contrary, it is more compatible with this than it is with a mechanistic approach. So, at least fragmentation between science and religion may perhaps thus be capable of being healed.[77]

After his rift with Krishnamurti, Bohm became deeply depressed and began regular treatment with the British psychologist Patrick De Mare (1916-2008) who was running dialogue groups as a form of social therapy. Bohm found De Mare's ideas appealing and developed his own version of a dialogue group in the context of the Implicate Order that became an important part of his last years.[78]

Although the dialogue groups occupied an increasingly important role in Bohm's work, he continued to develop the Causal Interpretation until literally the very last day of his life. Bohm felt that the word 'causal' did not do justice to the main purpose of his interpretation, which was to give an ontology to the quantum world. The 'Ontological Interpretation' is the name he chose for the last rendition of his interpretation as it appears in *The Undivided Universe: an Ontological Interpretation of Quantum Mechanics* (1993) written in collaboration with Basil Hiley.[79] In this book Bohm

[77] David Bohm, 'Fragmentation and Wholeness in Religion and in Science', *Zygon*, 20.2 (1985), pp. 125–133 p. 130

[78] See section 8.4.

[79] Bohm and Hiley, *The Undivided Universe*. Not to confuse last rendition with final word, Bohm considered that theories are always incomplete and that they are always a work in progress. The Ontological Interpretation is just the version that he managed to release before he died. Had he lived longer, later versions would have appeared.

and Hiley summarize the results obtained at the time under the umbrella of Bohm's approach: the complete treatment of the non-relativistic case of one and many particles; the Pauli equation; a preliminary discussion of the electromagnetic field; non-locality and the EPR paradox; comparison with other interpretations. The relativistic case is not included as the result had resisted the best efforts of Bohm and Hiley; however in the last two chapters of their book they drafted a research programme to develop the algebraic approach to address the relativistic case. Unfortunately Bohm could not take part in this plan, he died on the 27 of October 1992 of a heart attack when coming back home from Birkbeck where he had been discussing with Hiley the final touches to *The Undivided Universe*. The book would appear in print in 1993, a year after Bohm's death.[80]

[80]The research programme drafted in *The Undivided Universe* has been pursued successfully by Professor Basil Hiley at Birkbeck College who has recently developed the Ontological Interpretation of the Dirac equation. See A.2.

Chapter 4

The Causal Interpretation

This and the following chapters tell a story of arrivals and departures. The goal in this chapter is to understand the essential philosophical tenets of the Causal Interpretation and why Bohm thought that he could challenge the Copenhagen interpretation. Also we want to prepare the terrain for the analysis of Bohm's criticism of his Causal Interpretation and the need for further philosophical elaboration. This can be done by first reviewing Bohm's initial orthodox position and then contrasting it with the one he adopted later. So in what follows we first explore Bohm's reasons to abandon the philosophical tenets of classical physics, then his departure from the quantum orthodoxy and his arrival to the Causal Interpretation and finally his reasons to depart from it. In later chapters we will explore his arrival at the Implicate Order and the Ontological Interpretation along with its esoteric influences and motivations.

4.1 The Need for Interpretation

Arguably, all physical theories function on three levels: they must be empirically adequate; they must have explanatory power in terms of a mathematical formalism; and they should include an understandable interpretation of the formalism, in other words a model of the world.[1] The formalism of classical physics is built up from an intuitive picture of the world which contains its interpretation 'out of the box', and this ontology is very well understood. Quantum mechanics is entirely different. It is certainly empirically adequate and contains a sophisticated and effective mathematical formalism that explains the physical facts at the quantum level, however this formalism lacks a natural interpretation. There are two difficulties. First the quantum facts, the results of experiments like the famous electron interference patterns produced by the 'double slit' experiments, or the entanglement of particles now used in the development of quantum computers. These unexpected results are counter-intuitive and contradict our daily physical experience. Second is the level of abstraction of the mathematical formalism. The theory consists of a sophisticated mathematical algorithm that enables the user to obtain numbers which represent values of properties that agree with the results of specific experiments. Quantum scientists can correctly predict but doesn't say what the world is made of.[2]

[1] I are following here Cushing, *Quantum Mechanics*, pp. 10–13.

[2] This aspect of quantum theory has been discussed endlessly in the scientific and popular literature. Scientific folklore contains many examples of mainstream scientists confessing their perplexity. In Richard Feynman, *The Character of Physical Law* (Cambridge MA: MIT Press, 1965) he writes: 'I think I can safely say that nobody understands quantum mechanics'. Murray Gell-Mann, 'Questions for the Future', in *The Nature of Metter*, ed. by J. H. Mulvey (Oxford: Oxford University Press, 1981), pp. 169–186 agrees that quantum mechanics is 'that mysterious, confusing discipline, which none of us really understands but which we know how to use'. Einstein's theory of Relativity is another development that challenged classical physics assumptions. However Relativity poses a different problem as from certain point of view Einstein didn't destroy the nineteenth cen-

Since its inception the many counter-intuitive aspects of the theory have provoked endless philosophical controversy. The pioneers of quantum theory were baffled by the quantum facts and spent great efforts trying to come to terms with them. Along with the development of a standard formalism that reached maturity around 1925, an 'orthodox' interpretation was formed around the Danish physicist Niels Bohr (1885–1962) who had contributed fundamentally to the initial development of the physical theory. David Bohm departed from this orthodoxy, but his intellectual trajectory started from a vigorous effort to remain within it, or more precisely with what he understood was the orthodox view. This is an important point as, on close inspection, what has been called the 'Copenhagen interpretation', is not a coherent point of view, but an interrelated mesh of philosophical variations, sometimes in contradiction with each other.[3]

tury scientific ontology, but rather completed it. Relativity does not pose an ontological problem but an epistemological one. Some of its conclusions are counter-intuitive, surprising, and it requires work and imagination to understand them. Bohm's textbook *The Special Theory of Relativity* published in 1965, contains a brilliant appendix on 'Physics and Perception': Bohm, *The Special Theory of Relativity*. See also Tian Yu Cao, *Conceptual Developments of 20th Century Field Theories* (Cambridge: Cambridge University Press, 1997) for an extended and up-to-date discussion of the ontological issues of Relativity.

[3]Bohm explains in Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 8 Side A the differences between the several Copenhagen schools:

> The problem of interpreting the quantum theory was not very easy. Bohr, Heisenberg, and Pauli all have differences though they were the architects of the Copenhagen Interpretation. Bohr almost ignored the reality of what he was talking about and emphasized the phenomenon. Pauli said it's real, but the reality must be apprehended mystically by participation. He was a mystic. He studied Kepler and various other mystics and he was in contact with Jung. He was quite strongly mystically inclined. Heisenberg was about half-way between them. Heisenberg was inclined to think about orbits and then he said you can't define them, or he said the electron is a potentiality which can realize various possibilities of being wave-like or particle-like, and Bohr would not use that language. There were sort of subtle differences between those three, but they sort of ironed out the differences sufficiently, so that people have the impression there was a thing called the 'Copenhagen Interpretation' [...] von Neumann developed another variation of this which was more mathematical and was not the kind adopted by most physi-

Intimately related with the interpretation effort is the thorny problem of explaining how the classical features of the macro-world emerge from a quantum theory of the micro-world. This largely non-resolved issue has been one of the central problems for the interpretation of quantum mechanics. This reductionism lies at the core of the philosophy of physics and we will have a lot more to say about it on this and the following chapters.

I am not concerned here with the elucidation of the precise details of the several 'Copenhagen interpretations'.[4] What I am concerned with here is Bohm's version of the orthodox interpretation, what he took as the received view and which he elaborated in great detail in his first book, *Quantum Theory* (1951). Conceived as a textbook to teach the principles of quantum mechanics to graduate students, *Quantum Theory* is unusual in the amount of material devoted to foundational issues.[5] As explained in

> cists, where people tended to think of the quantum state as really existing in itself. He later became dissatisfied with that and developed a quantum logic to try to make it more objective. On the other hand, Wigner went the other way and he said, 'The quantum state is made objective only by the act of looking at it'. They say the wave function collapses, that the quantum state collapses, which does not make sense because the word 'state' is intended to be something that stands, but what is supposed to stand suddenly collapses. The point is in order to explain that Wigner proposed that when somebody actually looks, the collapse is explained, you see it as the result of looking [. . .] There really was subtle disagreement about the meaning of the theory though everybody could use it to compute.

In Andrew Pickering, *The Mangle of Practice: Time, Agency & Science* (Chicago: University of Chicago Press, 1995) Pickering has used the metaphor of an old washing machine's mangle in relation to the formation of mathematical and scientific theories. The Copenhagen interpretation of quantum mechanics provides a worthy example of a philosophical mangle.

[4]An industry of scholars is busy addressing this issue: Beller, *Quantum Dialogue, The Making of a Revolution*; Camilleri, 'Heisenberg, Bohr and the Divergent Viewpoints of Complementarity'; Camilleri, 'Constructing the Myth of the Copenhagen Interpretation'; Cushing, 'Bohm's Theory'; Cushing, *Quantum Mechanics*; D Howard, 'Who Invented The 'Copenhagen Interpretation'?: A study in mythology', *Philosophy of Science*, 71 (2004), pp. 669–682. H. P Stapp, 'The Copenhagen Interpretation', *American Journal of Physics*, 40 (1972), pp. 1098–1116 and references therein.

[5]Although philosophical discussions are scattered throughout the text of the book, the main issues are discussed in detail in chapters 6, 7, 8, 22 and 23.

chapter 3.3, the book is a serious attempt to make sense of the quantum mechanical orthodoxy.

Although many studies have been devoted to the Causal Interpretation, an analysis of Bohm's initial 'orthodoxy' is usually omitted as it is assumed that this is just a re-statement of the Copenhagen point of view. However it is important to clarify this point of departure because, as mentioned above, there is not such a thing as the 'Copenhagen Interpretation' and Bohm's 'orthodoxy' is not in complete agreement with the views of any foundational figure. When we refer to the Orthodox Interpretation what we mean is Bohm's Orthodox Interpretation to distinguish it from other versions of the 'orthodox' Copenhagen Interpretation.

Bohm details the main points of the orthodox position in chapter 8 of *Quantum Theory*, 'An Attempt to Build a Physical Picture of the Quantum Nature of Matter'. These consist mainly in three interrelated aspects: discontinuity; causality; and holism. When analysing these interpretations, it is important to keep in mind that, as mentioned above, the technical framework of quantum mechanics does not lead to an intuitive picture of the world, and that the interpretation is mainly a philosophical exercise aiming to give meaning to the mathematical formalism. The interpretation is not scientifically established or empirically proved, it is a philosophical position. This will become clearer within the context of the Causal Interpretation that gives a consistent interpretation alternative to the same mathematical formalism as the Orthodox Interpretation. In what follows, we give first a very brief review of the quantum formalism before tackling Bohm's views, Orthodox and Causal.

4.2 Bohm's Orthodox Interpretation

4.2.1 Key Aspects of the Quantum Formalism

The quantum description starts with the assumption that the physical state of a quantum system, for example a particle or an ensemble of particles, is described by a complex function Ψ, called the 'wave function' of the system.[6] The more important property of the collection of wave functions is the 'superposition' principle that says that adding two wave functions results in another wave function. This mathematical requirement is meant to reflect the additive physical properties of waves. The collection of valid wave functions has to satisfy other properties to ensure that all the usual mathematical procedures are consistent. This is summarized by making Ψ to belong to a 'Hilbert Space'.

All the dynamical properties of the quantum system that can be measured, the 'observables' like position, momentum, energy, spin, etc. are obtained by applying well defined mathematical operations to the wave function. Each set of valid mathematical procedures representing a dynamical variable is suitably called an 'operator' and for each observable there is exactly one operator. Given an observable, for example the energy $\mathcal{H}$, there is a collection of real numbers e_i which represent the values of the observable and that can be obtained as a result of a measurement. This collection can be discrete, continuous or mixed (partly discrete, partly continuous). Each of these values has associated a canonical quantum mechanical state, an 'eigenvalue' H_i with the property that

[6] See Albert, *Quantum Mechanics and Experience* for a readable introduction to this formalism, written for to the non specialist but nevertheless containing all the important technical details.

$$\mathcal{H}H_i = e_i H_i \tag{4.1}$$

Using the superposition principle the wave function can be expressed as a sum of the characteristic states of a chosen operator:

$$\Psi = \sum_i \langle \Psi, H_i \rangle H_i \tag{4.2}$$

where $\langle \Psi, H_i \rangle$ is a complex number, the so called inner product of H_i and Ψ.

The aspect of the formalism that connects it to actual experimental practice, is that measuring the property represented by $\mathcal{H}$ on a system in the state Ψ, will give an unpredictable different number in the collection e_i each time the measurement is performed. This is the difference from classical physics in which the measurement of a property on a system in a particular state will give exactly the same number all the time. However regularity in quantum mechanics arises because after a large number of measurements of $\mathcal{H}$, each number of the collection e_i will be obtained with a determined frequency p_i. In classical physics the single vale of a property determines the state, in quantum mechanics is the frequency with which a particular value is measured that determines the state, the state is at the same time in all possible states, the difference between states is the weight with which each possibility participates.

Using a normalization technique a link with probability is established as the frequencies f_i become associated with a probability distribution P. This relates the possible values of a property e_i with the frequencies with which it is measured $p_i = |\langle \Psi, H_i \rangle|^2$. For a given system in the state Ψ, the observable values e_i will have a mean value, $\overline{\mathcal{H}} = \langle \Psi | \mathcal{H} | \Psi \rangle$ and a standard

deviation $\Delta\mathcal{H}$ which is a measure of the spread of values e_i obtained when performing measurements.

The operator used so far is the energy operator $\mathcal{H}$, but any other operator could have been used with no loss of information. This is what is called a 'change of representation'. When a representation is chosen, everything acquires a concrete form on which calculations can be carried out. In different representations the operators and the wave function will have different form and some calculations may be easier. For example, using the position operator $\mathcal{X}$, the wave function will have a form depending on position and time: $\Psi(x,t)$. In the position representation $|\Psi(x,t)|^2$ is interpreted as the probability of finding the system located in x at time t and the operator $\mathcal{X}$ becomes a multiplication by x: $\mathcal{X}[\Psi(x,t)] = x\Psi(x,t)$. The form of the momentum operator $\mathcal{P}$ in the position representation is slightly more complicated: $\mathcal{P}[\Psi(x,t)] = -i\hbar\frac{\partial}{\partial x}\Psi(x,t)$ where $\hbar$ is the Planck constant. Finally the energy operator $\mathcal{H}$, also called the 'Hamiltonian' of the system, is a combination of the position and momentum operators: $\mathcal{H}\Psi = \frac{\hbar^2}{2m}\nabla^2\Psi + V(x)\Psi$.

The energy operator $\mathcal{H}$ is a particularly special one as it determines how the state of the system changes. This evolution is deterministic and obeys Schrödinger's equation:

$$i\hbar\frac{\partial\Psi}{\partial t} = \mathcal{H}\Psi \tag{4.3}$$

.

In the position representation Schrödinger equation for an electron in a potential $V(x)$ is:

$$i\hbar\frac{\partial\Psi(x,t)}{\partial t} = \frac{\hbar^2}{2m}\nabla^2\Psi(x,t) + V(x)\Psi(x,t) \tag{4.4}$$

which determines $\Psi(x,t)$ for all t given the initial condition $\Psi(x,0)$. Quantum mechanics has a built-in random character because the result of an individual measurement is unpredictable: nevertheless it is at the same time deterministic because Schrödinger equation determines the evolution of the state Ψ which in turn ensures that after a large number of measurements a predictable regularity in the observed values is obtained. This probabilistic interpretation is of extreme importance as it is through it that actual predictions are made. In the end what quantum theory predicts is this probability distribution and what quantum experiments determine is a probability distribution. A theory conceptually different from quantum mechanics but nevertheless in agreement with its experimental predictions, means a theory that predicts the same probability distribution for the measurements of an observable. This is exactly what Bohm will try to do in the Causal Interpretation.

An important relation between operators is their commutativity. For any two operators, for example position $\mathcal{X}$ and momentum $\mathcal{P}$, the quantity $[\mathcal{X},\mathcal{P}] = \mathcal{X}\mathcal{P} - \mathcal{P}\mathcal{X}$ is called the commutator. If the commutator is 0 we say that the operators commute. The commutator can be different from 0 as for example $[\mathcal{X},\mathcal{P}] = i\hbar$. This is in contrast with classical mechanics where all observables are real numbers and therefore the commutator is equal to 0 always. A mathematical consequence of the non-vanishing of $[\mathcal{X},\mathcal{P}]$ is that the standard deviations of $\mathcal{X}$ and $\mathcal{P}$ satisfy the inequality $\Delta\mathcal{X}\Delta\mathcal{P} \geq \hbar$. This is the well known 'uncertainty principle', first introduced by Heisenberg, which imposes a limitation on the precise simultaneous measurement of position and momentum: a too precise determination of position destroys the possibility of a precise determination of momentum at the same time, and vice versa. A similar uncertainty obtains for every

non–commuting pair of operators. Despite much ado in the popular literature, non–commutativity and the uncertainty relation, which are a result of the formalism, are not the quintessential quantum mechanical effect, as they exist in classical physics. Non-commutativity is an important and well known aspect of rotations of 3 dimensional bodies. Uncertainty relations exist in the case of standard waves and in the description of Brownian motion. The novelty introduced by quantum theory lie in proposing that at the quantum level matter can be described as waves, in addition to its description as particles, and in consequence these limitations expressed by the uncertainty relation that applies to waves have to apply as well to matter.

The Orthodox Interpretation is centred on the principle that the physical state of a quantum system is completely specified by the wave function. The emphasis is in 'the most complete specification'. This implies that the limitations imposed by the incertitude principle are taken as 'real', not just as a mathematical artefact of the theory, but as an unavoidable natural principle. A consequence of this view is that any theory that correctly models nature has to have a place for the uncertainty relations, either as part of the postulates of the theory or as a consequence of its formalism. There is no empirical fact that enforces this completeness. There exists the possibility that the incertitude relations are just a feature at the quantum level and that they are not an essential characteristic of nature at a more fundamental level. But Bohm's Orthodox Interpretation embraces this realism, as it accepts the uncertainty principle as fundamental, a true aspect of nature at all levels and for all theories. To make the point clearer Bohm suggests that 'uncertainty principle' is a misnomer and that it should be called more appropriately 'the principle of limited determinism in the struc-

ture of matter'.[7]

It is in this context that the issue of 'hidden variables' appears, as the principle of the completeness of the wave function is tantamount to ruling out hidden variables a priori. Hidden variables consist in a further description of the state of a quantum system that are not contained in the wave function and that may give a different description of the quantum system. At this stage Bohm takes the received view that quantum theory is inconsistent with hidden variables and remarks that:

> The idea that a particle has simultaneously well-defined values of position and momentum, which are uncertain to us, is equivalent to the assumption of hidden variables.[8]

However there is certain ambiguity about this issue as he had cautiously remarked before in section 2.5 'Unlikelihood of Completely Deterministic Laws on a Deeper Level' that:

> Perhaps there are hidden variables that really control the exact time and place of a transfer of a quantum, and we simply haven't found them yet. Although this possibility cannot be absolutely ruled out, we can show that this is unlikely.[9]

4.2.2 Causality

The assumption of the fundamental completeness of the wave function and its probabilistic interpretation which declares that although it is impossible to predict individual quantum events it is nevertheless possible

[7]Bohm, *Quantum Theory* p 101.
[8]ibid. p. 101.
[9]ibid. p. 29.

to determine the behaviour of statistical ensembles, gives a very different notion of causality to that encountered in classical physics. To analyse the notion of causality entrained by the quantum world, Bohm postulates two different types of causal laws. First, complete determinism, in which everything is predetermined as if by 'fate' and where there is no room for variation, like in a clock. This is a prescriptive notion of causality in which the emphasis lies in the description rather than in the prediction. On the other hand there is the notion of causes determining general tendencies but not completely prescribing in detail the behaviour of the system. According to Bohm the latter is the causal notion that applies to quantum mechanics as it interprets the wave function as a probability distribution associated with the possible outcomes of measurements, drafting a tendency of an ensemble without compelling the individual event. The quantum algorithm only determines a statistical trend, the pattern of a large number of measurements, but not the outcome of a single measurement that remains uncertain. The causes must be thought of as producing only a tendency towards an effect and Bohm argues that this notion of statistical causality brought up by quantum mechanics is closer to our naive idea of causality.

Bohm points out that classical physics is prescriptive rather than causal as the notion of force as a causal agent is logically unnecessary. Newton's equation guarantees that to know the position and velocity of a particle for all times, past and future, it is enough to know its position and its rate of change at only one particular time. So both the past and the future are determined by the equations of motion and we can say that the past causes the future inasmuch as the future causes the past. The notion of force, although convenient as a place-holder for a complicated set of relation-

ships, is nevertheless redundant because it is always possible to express all classical physics in terms of positions, velocity and acceleration. The space-time order of events is determined without recourse to a force causing the movement. The particle is simply following a trajectory determined by the equation of motion and the force is logically unnecessary. In a similar way the notions of energy and momentum in classical mechanics are redundant as they are derivative concepts defined in terms of positions and velocities. Energy and momentum are not fundamental in classical mechanics, but are a convenient way to talk about constant properties of the movement, or conserved quantities as a physicist will put it. They are useful but not strictly necessary for the description of the movement.

On the contrary, in quantum mechanics momentum is an independent and fundamental quantity that cannot be defined in terms of space-time relations and that can be measured without the use of any detailed space-time prescription of the spatial movement. The momentum description of the movement stands on the same independent footing as the space-time description. Bohm differentiates the space-time description from the momentum-energy description by calling the latter 'causal' as changes in the momenta of the particles involved changes on the space-time statistical tendencies:

> The quantum theoretical concept of causality, therefore differs from its classical counterpart in that it must necessarily describe the relationship between space-time events as being 'caused' by factors existing within matter (i.e. momenta), which are on the same fundamental and not further analysable footing as that of space and time themselves. It is true that these causal factors control only a statistical trend in the course of

> space-time events, but it is just this property of incomplete determinism that prevents the causal factors from becoming redundant, and that thus gives a real content to the concept of causality in quantum theory.[10]

Although in any particular experimental situation only one aspect of the space-time/causal dichotomy is revealed, the need for both aspects for a complete description of matter can be elicited writing the complex wave function in terms of two functions, the amplitude $R(x,t)$ and the phase $\Theta(x,t)$

$$\Psi = R \exp i\Theta \tag{4.5}$$

where R and Θ are real functions.[11] In the position representation both R and Θ will be functions of x and t, so at first sight it may seem that all is needed to describe the behavior of matter is a full description of position. But the determination of the wave function is complete only when the full specification of both phase and amplitude is given because, although the probability distribution associated with $\mathcal{X}$ is controlled by R, the distribution associated with $\mathcal{P}$ is controlled by the phase. In other words the phase relations that control interference phenomena cannot be understood in terms of space-time relations alone, and to have a complete physical description it is necessary to introduce the concept of momentum. This is in contrast with classical physics where, as explained above, the notion of momentum is not absolutely necessary, in quantum mechanics is fundamental and in a concrete physical situation changing the momentum does cause a change

[10] Bohm, *Quantum Theory* p 157.

[11] A complex number $a + bi$ can always be expressed in polar form as $R \exp i\theta$ where R and θ are real numbers.

in the result of the measurement of position.

> We are thus led to conceive of matter as something uniting these two aspects, space time and causal, which would be incompatible if precisely defined, but which exists together in incompletely defined form and oppose each other in the sense that their degrees of definition are reciprocally related.[12]

Both aspects, the spatial-temporal and the causal (momentum), are necessary to give a full account of matter. Although they can't be realized simultaneously they complement each other as ' "interwoven potentialities", representing opposing properties that can be comparatively well defined under different conditions'.[13] This relationship does not apply only to position and momentum, but all observables have a complementary conjugate with which a similar relationship applies.

4.2.3 Discontinuity

An analogous complementarity appears between continuity and discontinuity at the quantum level. The classical description of the movement of a material particle is the description of its position at different times. It is a basic classical assumption that the dynamical parameters of a moving particle change smoothly and continuously and that at any instant all of them can be determined simultaneously with arbitrary precision. The Orthodox Interpretation replaces this notion of continuity by that of indivisible transitions. For example, the energy of the state of electrons in the atom can't take any value: it is constrained to a discrete set of real numbers

[12]Bohm, *Quantum Theory* p. 158.
[13]ibid., p. 159.

$e_0 \leq e_1 \leq e_2 \leq \ldots$ etc. starting with a minimum value e_0. This means that an electron can't take a lower energy value than e_0, which is what explains the stability of matter, but also it is never found in a state with a value in between any pair of values e_i and e_{i+1}. Empirically the electron in an atom is never observed in any other energy state and the quantum algorithm does not specify a gradual passage from one level to the other along a determined trajectory in which the electron is gaining or loosing energy continuously. The Orthodox Interpretation sees the electron moving from one level to another simply 'jumping', avoiding the passage through the intermediate values of the energy. The phenomenon is interpreted as a non analysable and indivisible whole.

Bohm argues that there is not an a priori logical reason for the adoption of the notion of a continuous trajectory in classical physics and that in fact the quantum concept of indivisible transitions is not only logically consistent but also closer to the naive conception of motion that arises from common experience. He maintains that we can't think simultaneously of speed and location, and to illustrate the idea he uses the analogy of the blurred photograph of a speeding car that suggests motion, in contrast with a too sharp image that rather suggests rest. Bohm maintains that the classical idea of continuous motion is a mathematical abstraction that is not in agreement with our intuitive perception.[14] More technically, he adds that the mathematical definition of velocity is founded on a mathematical limiting procedure that is not justified by any physical process and that is challenged by the uncertainty principle. Velocity is formally defined as the quotient of the position change during a small interval of time divided by the size of this interval, and then letting this interval decrease arbitrarily, i.e.

[14]Bohm, *Quantum Theory* p. 144.

passing to the limit. The a priori assumption of continuity and smoothness of the trajectories ensures the existence of this limit, but this assumption is made because of its mathematical convenience, and not by any physical evidence that supports such a procedure. Bohm makes reference to Zeno's paradoxes to point out the tension inherent in the classical notion of continuous trajectories. With the introduction of the uncertainty relations, the passage to the limit is actually physically impossible, challenging the idea that the trajectory of a particle is continuous and smooth.

But introducing discontinuity does not mean that continuity is abandoned. In the quantum realm the relationship between continuity and discontinuity is analogous to the relationship between the causal and spatial aspects. Notice however that in the case of the Copenhagen interpretation the continuity is a property of the wave function, there is no notion of continuous trajectory.

4.2.4 Quantum Wholeness

For Bohm wholeness is the quintessential quantum feature, the one that entails non-locality, arguably the most paradoxical and controversial issue in quantum mechanics, and the one which Bohm emphasized all along in his interpretation effort, continuity and determinism will be regained in the Causal Interpretation. Wholeness also provides Bohm with the basis for his earliest attempt to draft a quantum analogy of the process of thought which appears at the end of chapter 8 in *Quantum Theory*. Bohm's analysis of the interpretation of quantum mechanics starts with an analysis of Niels Bohr holistic 'principle of complementarity', the notion that the properties of matter exist in complementary pairs that cannot be precisely determined simultaneously but that nevertheless are equally needed to give

a complete account of matter. Bohm formulates it in the following terms:

> We now give a more general statement of the principle of complementarity: At the quantum level, the most general physical properties of any system must be expressed in terms of complementary pairs of variables, each of which can be better defined only at the expense of a corresponding loss in the degree of definition of the other [...] one of these is always related to the causal aspects of matter and the other to the space-time aspects.[15]

In a particular situation, which aspect of whole is revealed is determined by the context in which the phenomena occur. For example, in the case of the electron the experiment can give an arbitrary precise measure of position, but all information about momentum is lost. Alternatively a too precise measure of momentum destroys correspondingly all information of position. In most cases a suitable combination of both properties can be performed in a way that the experimental error remains consistent with the uncertainty inequality. This is where the duality wave-particle appears. When the position aspect is privileged the particle aspect becomes preponderant. When momentum is emphasized the wave aspect becomes evident, like the interference fringe in the double slit experiment. All this is determined by the experimental arrangement, or in other words, by the background or context in which the phenomena occur. Quantum mechanical properties are contextual, which means that they are not properties belonging to matter a priory, but formed in the process of being observed. The properties are defined by the context, by the experimental situation

[15]Bohm, *Quantum Theory* p. 160.

designed to observe them. Matter is neither a wave or a particle, but can be potentially instantiated as one or the other, depending on the background. This uncertainty applies to all complementary properties, not just to the pair space/momentum:

> Thus at the quantum level of accuracy, an object does not have any 'intrinsic' properties (for instance wave of particle) belonging to itself alone; instead, it shares all its properties mutually and indivisibly with the systems with which it interacts.[16]

As a quantum system, such as an electron, interacts spontaneously and continuously with many other systems, the electron undergoes continuous transformations between the many potentialities in which it can manifest itself, and the Orthodox Interpretation takes this as a fundamental aspect of the electron that is not further analysable in terms of parts of the electron or its environment. The quantum system is a totality that includes the environment and, at the level of the quantum, this totality cannot be decoupled into two fully independent phenomena.

This holism contrasts with the classical view that assumes that the physical world is a composite of distinct parts that can be independently analysed. There is a subtle interplay between the classical concepts of continuity, determinism and the separability of the world in parts. An object moving continuously and obeying deterministic laws can be identified as a separate object, regardless of the possible strong interactions with its environment. Once these two concepts are challenged, as in the quantum theory, classical separability falls apart.

Bohm furthers this analysis from section 8.16 of *Quantum Theory*, entitled 'The Indivisible Unity of the World', up to section 8.26 where he con-

[16]Bohm, *Quantum Theory*, p. 161.

cludes that at the quantum level the whole universe, not just individual quantum systems, is an indivisible whole which cannot be regarded as composed of distinct parts:

> The entire universe must, on a very accurate level, be regarded as a single indivisible unit in which separate parts appear as idealizations permissible only on a classical level of accuracy of description. This means that the view of the world as being analogous to a huge machine, the predominant view from the sixteenth to nineteenth centuries, is now shown to be only approximately correct. The underlying structure of matter, however, is not mechanical.[17]

It is important to stress this point as it is the core of Bohm's philosophy of nature. He is a non-mechanical philosopher if we understand the term 'mechanical' as the assumption that objects are formed of unrelated parts and that the whole is just the addition of these parts. Bohm stresses the holistic nature of the quantum theory and complains about the term 'quantum mechanics' applied to it, as he reckons that a fundamental change in the general methods of description of nature is needed. He sustains that quantum mechanics is a misnomer and that 'quantum nonmechanics' (sic) is a much better one.[18]

For Bohm, wholeness is the single more important quality of the world elicited by the quantum theory. Although he came back to reconsider the notions of causality and continuity in his Causal Interpretation, the wholeness of the world was at the centre of his general philosophical outlook and of his philosophy of nature.[19]

[17]Bohm, *Quantum Theory*, p.167.
[18]Ibid., p. 167.
[19]See section 4.3 below.

4.2.5 The Classical Limit

Quantum holism entails some seemingly paradoxical situations. There is the problem of the interpretation of the act of measurement which Bohm analyses in chapter 22, 'Quantum Theory of the Process of Measurement'. The wave function consists in general of a superposition of possibilities that exist simultaneously. However in a measurement only one of these possibilities is realized. There is a certain lack of coherence in the postulates of the theory. On the one hand when the quantum state is unperturbed, its evolution is governed by Schrödinger's equation which is a linear equation that preserves the superposition. On the other, when a measurement occurs Schrödinger's equation stops being valid and is replaced by an ad hoc postulate that simply says that the result of the measurement is one of the valid numbers specified by the theory. The superposition is destroyed and all the possibilities melt into a single one. This is what has been called the 'collapse' of the wave function. This is just a suggestive title as in reality there is no such a thing as a collapse of anything as the wave function has no reality in the Orthodox Interpretation. The problem is that there are two mutually exclusive evolution descriptions, and there is no prescription for when or how one applies instead of the other as the theory does not say what is exactly meant by measurement. No other equation of physics stops being valid while a measurement takes place to become valid again once the measurement is done.

The measurement problem is one aspect of the wider problem of the relationship of quantum systems with the classical/macroscopic world . When a quantum experiment is run, the result will be reported in a classical apparatus that is understood in classical terms: the practice observes always a classical event, even if the system under observation is of a

quantum nature. The Orthodox Interpretation assumes a priori the validity of the classical theory, so there are these two contrasting worlds living in parallel: the classical world that will report the measurements, and the quantum world that is observed; the quantum algorithm functions as a link between the two. But in principle the apparatus is also a quantum system and this introduces a discontinuity in the situation in which there is not clarity about where exactly in the series of events that go from the quantum system to the classical system does the quantum stops and the classical begins. Where and how does this 'cut' happens if it happens at all? Bohm's Orthodox Interpretation introduces this bizarre situation in which two regimes with contradictory assumptions about continuity, causality and holism transform into each other in an inexplicable way.

In principle quantum mechanics is a more fundamental theory than that of classical mechanics, so logically classical mechanics should be recovered from the quantum theory as a special case, and the usual classical notions of continuity, causality and separability should be regained from the very different quantum notions. However the situation is not clear, as in effect quantum mechanics supposes and depends on the correctness of classical mechanics. One way in which this is used in practice is that there is no a priori quantum recipe to obtain the particular details of a quantum system. To obtain the details that will lead to the actual quantum mechanical description the classical theoretical knowledge is applied to the quantum situation, after which the equations obtained are declared 'quantized'. This procedure of invoking the classical limit to obtain the quantum description is called the 'canonical quantization' and is the modern version of the 'principle of correspondence' introduced by N. Bohr in his investigations of the atomic structure. This of course ensures that the

correct classical limit is obtained, however it entails the sacrifice of an a priori quantum description of the classical knowledge that could be then obtained as a limit. This is the problem of quantization, and it is paradoxical as it suggests that the logically less fundamental theory, classical mechanics, contains and implies the more general one, quantum mechanics. At this stage Bohm offers no deeper comment on this issue: he just acknowledges it as another form of complementarity:

> Quantum theory presupposes a classical level and the correctness of classical concepts in describing this level [. . .] The classically definite aspects of large-scale systems cannot be deduced from the quantum-mechanical relationships as assumed small scale elements. Instead, classical definiteness and quantum potentialities complement each other in providing a complete description of the system as a whole. [20]

However this quantization procedure is not formal, its justification coming from the predictions that agree with empirical results, and not from theoretical proof. Bohm suggests in the very last paragraph of *Quantum Theory* that a further development with an even more holistic bent is necessary to correct this problem:

> Although these ideas are only implicit in the present form of the quantum theory, we wish to suggest here in a speculative way that the successful extension of quantum theory to the domain of nuclear dimensions may perhaps introduce more explicitly the idea that the nature of what can exist at the nuclear level depends to some extent on the macroscopic environment.[21]

[20] Bohm, *Quantum Theory* pp. 627-628.
[21] ibid. pp. 628.

It can be seen that Bohm is already thinking on something more fundamental than quantum mechanics.

4.2.6 Entanglement

Niels Bohr complementarity is an effort to come to terms with the unfamiliar aspects of quantum mechanics related to the principle of uncertainty. However, if non-commutativity and uncertainty are not unfamiliar in the classical world as was mentioned in 4.2.1, the phenomenon of entanglement is much more striking and arguably more fundamental

Two particles are entangled when the state of the system containing both of them cannot be expressed as a product of the individual states of the two particles.[22] One of the standard principles of quantum mechanics gives a recipe to construct the state of a system composed of two particles: Following on the concepts introduced in 4.2.1, if the one-particle system space of states is the Hilbert Space $\mathcal{H}$, the space of states describing the system of two particles is the tensor product $\mathcal{W} = \mathcal{H} \otimes \mathcal{H}$. Some of the states in this space can be expressed as the product of two wave functions $\Pi(x, y) = \Psi(x) \otimes \Phi(y)$. These states, called product states, allow the distinction of the two particles, and what this means is that the measurement of a particular property in one of the particles will not affect the measurement of the same property in the other. Both measurements are independent, or more technically, uncorrelated.

But most of the states in $\mathcal{W}$ cannot be expressed as a product of the states of the two particles. These states are called 'entangled' and have some remarkable properties. In these states measuring a property in one

[22] Any modern introductory textbook on quantum mechanics will describe entanglement in full detail. For a non specialist explanation see Albert, *Quantum Mechanics and Experience*.

of the particles affect the result of a measurement of the same property in the other, the measurements are correlated. This correlation comes in degrees from some light correlation, all the way to states in which the correlation is in full force. In such states a measurement in one particle completely determines the state in the other. The effect is immediate even if the two measurements are taken at very far apart locations. The immediate influence of a measurement on locations very far apart is what Einstein famously called 'spooky action at a distance'. The initial reaction to non-locality is that quantum mechanics must be wrong because it violates special relativity, allowing the transmission of messages at speeds much larger than the speed of light. However further investigation shows that there is no violation. The non-local aspects of entangled states are consistent with special relativity because this form of correlation cannot be used to send information.

Einstein was interested in studying the properties of strongly correlated states as far back as 1905.[23] These states figure prominently in many of his contributions to quantum theory. He found further use of these states in one of his debates with Bohr. Unable to show that the principle of uncertainty was inconsistent with other parts of physics, he changed his strategy and tried to prove that quantum mechanics was an incomplete theory. In 1935 he published *Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?*, a paper in collaboration with Boris Podolsky (1896–1966) and Nathan Rosen (1909–1995) in which they acknowledge the usefulness of the theory as an effective tool to cal-

[23] D Howard, ''Nicht sein kann was nicht sein darf', or the Prehistory of EPR, 1909-1935: Einstein's Early Worries about the Quantum Mechanics of Composite Systems.', in *Sixty-two Years of Uncertainty: Historical, Philosophical, and Physical Inquiries into the Foundations of Quantum Mechanics*, ed. by Arthur I. Miller (New York: Plenum Press, 1990), pp. 61–111.

culate results of experiments, however they conclude that quantum theory is wanting in regards of the understanding of reality: '[. . .] the quantum-mechanical description of the physical reality given by wave functions is not complete'.[24] The argument given for the incompleteness of quantum theory uses the non-local aspects of a pair of entangled particles. Although Einstein's main goal was not to attack the non-local features of quantum theory, it is nevertheless the aspect of the paper that is emphasized today. The EPR paper, as this publication came to be known, failed to convince the Copenhagen adherents, but the non-locality stressed in the paper remained paradoxical.

The word 'entanglement' was not used by Einstein, he used the term 'correlated'. Shortly after publication of the EPR paper, Schrödinger wrote to Einstein on 7 June 1935 to congratulate him. In this letter Schrödinger uses for the first time the term 'entanglement' to make reference to these correlated states:[25]

> If two separated bodies, about which, individually, we have maximal knowledge, come into a situation in which they influence one another and then again separate themselves, then there regularly arises that which I just called entanglement of our knowledge of the two bodies. At the outset, the joint catalogue of expectations consists of a logical sum of the individual catalogues; during the process the joint catalogue develops necessarily according to the known law [. . .] Our knowledge remains maximal, but at the end, if the bodies have again separated

[24] Albert Einstein, Boris Podolsky and Nathan Rosen, 'Can Quantum–Mechanical Description of Physical Reality be Considered Complete?', *Physical Review*, 47 (1935), ed. by John Archibald Wheeler and Wojciech Hubert Zurek, pp. 777–780 p. 780

[25] The letter is in German, the word translated as entanglement is *Verschränkung*.

> themselves, that knowledge does not again decompose into a logical sum of knowledge of the individual bodies.[26]

For Schrödinger, as for many others, entanglement, rather than superposition is the very essence of quantum phenomena:

> When two systems, of which we know the states by their respective representation, enter into a temporary physical interaction due to known forces between them and when after a time of mutual influence the systems separate again, then they can no longer be described as before, viz., by endowing each of them with a representative of its own. I would not call that one but rather the characteristic trait of quantum mechanics.[27]

In *Quantum Theory* Bohm included an original recast of the EPR paradox in terms of photons and spin instead of the position and momentum of two entangled electrons, as it is done in EPR.[28] Spin has a discrete spectrum which makes the analysis of EPR states much easier to understand and brings out more clearly the non-local aspects of the EPR paradox. This is the form in which the paradox is most usually encountered nowadays in the literature.

4.2.7 Thought

At the end of the first Part of *Quantum Theory*, Bohm introduces a small section on a subject that will grow in importance over the years: the re-

[26] Erwin Schrödinger, 'Die gegenwärtige Situation in der Quantenmechanik', *Die Naturwissenschaften*, 23 (1935) p. 807

[27] Erwin Schrödinger, 'Discussion of Probability Relations Between Separated Systems', *Proceedings of the Cambridge Philosophical Society*, 31 (1935), pp. 555–563 p. 555

[28] Bohm, *Quantum Theory*, pp. 614–615.

lationship between the physical and the mental.[29] In this Bohm suggests that there is a remarkable analogy between the process of thought and the quantum description of matter that may indicate a deep connection between mind and matter. He compares 'the instantaneous state of a thought with the position of a particle and the general direction of change of that thought with the particle momentum' and concludes that 'we have a strong analogy'.[30]

He argues that thought has an inherent indivisibility in analogy with the quantum situation and that:

> Thus, thought processes and quantum systems are analogous in that they cannot be analysed too much in terms of distinct elements, because the 'intrinsic' nature of each element is not a property existing separately from and independently of other elements but is, instead, a property that arises partially from its relation with other elements.[31]

He continues suggesting that classification schemes, which are based on classical logic, are akin to the classical limit when the indivisible non-logical steps occurring in an actual thought process are ignored. Bohm speculates that the reason behind these analogies may be due to the actual quantum mechanical behaviour of our brain, and that in a similar way in which the action of our muscles make us 'feel' the classical forces, the behaviour of our thought process may perhaps reflect the quantum mechanical aspects of matter. This comment hides a wider area regarding Bohm's very original approach to science: science as a form of perception and the language in which that perception is communicated. Bohm

[29] Bohm, *Quantum Theory* pp. 168-172
[30] ibid. p. 169.
[31] ibid. p. 169.

‘felt’ physics intuitively first, then he articulated his perception sometimes stretching language to its limit, then he expressed mathematically the results that he had already obtained if there was a need for this. Although he was capable of doing the mathematics, the priority were the concepts, not the equations. He favoured an approach in which first and foremost it was necessary to understand what the meaning of the physical situation was, ‘to feel’ the physics, then the formal aspects could be dealt with if needed. Because of this many of the mathematical derivations that Bohm produced were actually wrong.

> Later when I wrote this on quantum mechanics in Princeton I made a lot of errors because [. . .] I used to use a non mathematical way of coming to the conclusions always and then I would have to fill in the equations for the book. So naturally the steps were often wrong [. . .] So they would write saying it was very infuriating to have all these mistakes and have the answers always coming out right [. . .] So I’d have to fill in the equations as a matter of convention. You must arrive at the answers by means of equations [. . .] For example, the gyroscope used to puzzle me: exactly why and how does it work? Finally I got a feeling for it of saying as the wheel is turning and you’re also turning the axis then if you imagine yourself moving with one of the particles of the wheel you can see it’s being driven a right angles. It’s going to move at right angles to the way you expected. You can get the feeling of why that happens. That’s the sort of thing I wanted to do. Not merely to explain the thing in purely logic steps, but to get the feeling of how it works.[32]

[32] Bohm and Wilkins, ‘Interview Bohm–Wilkins’ Tape 3 Side b

4.3 The Causal Interpretation

4.3.1 The Physical Foundations of the Causal Interpretation

When Bohm finished *Quantum Theory* he was feeling dissatisfied. He felt that he had not achieved the understanding he was aiming for when he set-out to write the book. Bohm sent copies of *Quantum Theory* to several leading physicists, including Bohr, Pauli and Einstein. Einstein responded enthusiastically and this led to several conversations with Bohm.

Einstein was well aware of the interpretation problems of the quantum theory. He had been present when de Broglie presented his 'pilot wave' theory at Solvay in 1927 and he was also the author of an unpublished and unsuccessful attempt to produce a hidden variables theory of quantum mechanics.[33] At the end of *Quantum Theory* in section 22.19, 'Proof that Quantum Theory is Inconsistent with Hidden Variables', Bohm had dealt with the question of hidden variables in the usual negative way.[34] As already mentioned in chapter 3, the great mathematician John von Neumann had published a mathematical proof of the impossibility of a theory of hidden variables reproducing the same results of quantum theory. In contrast with von Neumann's proof which is very technical and demanding, Bohm's argument in *Quantum Theory* is an heuristic argument based on a philosophical position that is not so far apart from what later became

[33]Bacciagaluppi and Valentini, *Quantum Theory at The Crossroads*; Louis de Broglie, 'La nouvelle dynamique des quanta', in *Électrons et Photons: Rapporst et Discussions du Cinquiéme Conseil de Physique* (Gauthier–Villars, 1928), pp. 105–132; Darrin W. Belousek, 'Einstein's 1927 Unpublished Hidden–Variable Theory: Its Background, Context and Significance', *Studies in the History and Philosophy of Modern Physics*, 27.4 (1996), pp. 437–461.

[34]Bohm, *Quantum Theory* pp. 622-623.

his hidden variables theory. Referring back to section 6.11 of *Quantum Theory* Bohm concludes that:

> the wave aspects of matter are as real as are the particle aspects and that, to obtain a complete and consistent theory, we must consider both aspects, each under its proper conditions.[35]

It seems as if he is not excluding one aspect at the expense of the other, as the Copenhagen interpretation do. His 'proof' of the impossibility of hidden variables is based on the tacit supposition that a hidden variables theory attempts to privilege the particle aspect at the expense of the wave aspect, so maintaining the reality of both aspects counts as an argument against hidden variables.

As Bohm was not entirely satisfied with his own explanations of the orthodox version of the teory, and because he felt that the mathematical argumentation against hidden variables was not completely satisfactory, he set out to search for alternatives. He had been thinking on the issue for a while and in 1952 Bohm finally did what he had declared impossible and what von Neumanns's theorem apparently forbid: he produced a consistent interpretation of quantum mechanics in terms of hidden variables. Bohm needed to explain why von Neumann's theorem was not relevant, and he argued in his original publication that his theory is not subject to von Neumann's theorem because of the context dependence of the quantum mechanical dynamical variables.[36] Although he was right in assuming that von Neumann's theorem contained assumptions that do not apply to his theory, the reason he gave was wrong. Why Bohm's theory

[35]Bohm, *Quantum Theory* p. 136.

[36]Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables II'.

was possible become clear several years later when John Bell analysed von Neumann's proof in excruciating detail concluding that von Neumann's assumption were indeed too restrictive as they assumed local hidden variables. Bohm's hidden variables are non-local, so von Neumann's theorem does not apply to Bohm's theory.[37]

The publication of the new interpretation consist in three papers and two letters. The first two papers were published together in 1952 in the January issue of *Physical Review*.[38] The first paper contained the basic mathematical formalism, the fundamental postulates of the theory, the many-body case is addressed in detail and finishes giving some important examples. The second paper contained a detailed exposition of the measurement problem from the point of view of the new interpretation and proved that under reasonable assumptions regarding the initial distribution of particles, the new theory gave the same predictions as the standard theory. These papers were followed by two letters responding to some points made by Otto Halpern and Saul Epstein.[39]. Halpern's main objection was that the theory was not a relativistic one. Although Bohm believed that he had developed a relativistic version of his theory, on further investigation it turn out that this was not the case and Halpern's objection remained an issue for more than 50 years.[40] However the objection does not invalidate the main point of the Causal Interpretation which was

[37]John S. Bell, 'On the Problem of Hidden Variables in Quantum Mechanics', *Reviews of Modern Physics*, 38 (1966), pp. 447–452. See also A.1

[38]Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables I'; Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables II'.

[39]David Bohm, 'Reply to a Criticism of a Causal Re–Interpretation of the Quantum Theory', *Physical Review*, 87 (1952), p. 389, David Bohm, 'Comments on a Letter Concerning the Causal Interpretation of the Quantum Theory', *Physical Review*, 89 (1952), p. 319

[40]A relativistic version of Bohm's theory has been developed successfully only recently, see section A.2.

to show a valid alternative to the Copenhagen Interpretation in the non-relativistic case, something that was thought as impossible. Epstein's letter was more friendly and suggested the development of alternative causal interpretations using different representations from the position representation that Bohm used in his paper. This is a very important point because what is behind this remark is the loss of the symmetry between position and momentum. As Bohm responded, the Causal Interpretation depends crucially on the position representation, and trying to do the same in a different representation rapidly leads to very difficult technical problems. Bohm argues that position is the only real property of a quantum system, it is intrinsic and defined a priory. Everything else is 'contextual', meaning that any other variable depends on the context of the measurement, the quantum mechanical variables different from position are defined not for the quantum system but for the whole composed of the quantum system and the experimental situation. The third and final paper of the series, published in 1953, was a response to Pauli's objections regarding an assumption made in the second paper about the initial distribution of the particles. The assumption constrained the validity of the theory. In the third paper Bohm generalized this assumption slightly in order to deal with Pauli's objections.[41]

Bohm's theory is a development of the same formalism of the standard theory. What Bohm does is to rewrite the equations to reinterpret some aspects already contained in the formalism and to produce some new equations that follow from it. The orthodox theory interprets these new developments as meaningless and it is in this sense that this is as much a new interpretation as a new theory. Bohm's intuition of the Causal In-

[41] David Bohm, 'Proof That Probability Density Approaches $|\psi|^2$ in Causal Interpretation of the Quantum Theory', *Physical Review*, 85 (1953), pp. 180–193.

terpretation comes from the re-examination of a well known approximation technique, the WKB approximation. In this method the wave function is expressed as an infinite series in terms of powers of the Planck constant $\hbar$. The first term of this expansion turns out to be the Hamilton-Jacobi equation of the classical case.[42] Bohm thought that there was no reason why neglecting terms in the asymptotic expansion turns a random phenomenon into a deterministic one, as it is possible to start in the opposite direction and simply add the higher order terms of the approximation one by one to the main equations of the classical theory. This will simply modify the shape of the classical trajectories, making them look chaotic but not inherently random.[43]

Bohm theory assumes that Schrödinger's equation is correctly describing quantum systems. The first step of the new development is to rewrite the wave function using the polar decomposition of a complex function as

$$\Psi(x,t) = R(x,t)e^{\frac{iS(x,t)}{\hbar}} \tag{4.6}$$

where the amplitude R and the phase S are real functions of position x

[42]The Hamilton-Jacobi equation is a formulation of classical mechanics equivalent to the more familiar Newton equations of motion, see H. Goldstein, *Classical Mechanics* 2nd (Reading, MA: Addison–Wesley, 1980) for the standard treatment, and Peter R. Holland, *The Quantum Theory of Motion: An account of the de Broglie-Bohm Causal Interpretation of Quantum Mechanics* (Cambridge: Cambridge University Press, 1993) chapter 2 for a discussion targeted to deal with the Causal Interpretation.

[43]This is a subtle but important point. The modern theory of chaotic systems is based on classical mechanics. Chaotic behaviour is completely deterministic, but extremely sensitive to initial conditions. The detailed behaviour of deterministic but chaotic systems is possible in principle but as it is extremely complicated this makes the analysis by traditional methods impracticable. Bohm wrote an article in collaboration with W. Schützer pioneering some aspects of chaos theory that passed unfortunately unnoticed: David Bohm and W. Schützer, 'The general statistical problem in physics and the theory of probability', *Nuovo Cimento*, Suplemento.2 (1955), pp. 1044–1047. This article forms part of a much wider reflection of the nature of statistics in physics. I will say more about this in sect 5.2.

and time t. Insert this in Schrödinger's equation (4.4) and separate real and imaginary parts to obtain

$$\frac{\partial R}{\partial t} = -\frac{1}{2m}(R\nabla^2 S + 2\nabla R \cdot \nabla S) \tag{4.7}$$

$$-\frac{\partial S}{\partial t} = \frac{(\nabla S)^2}{2m} + V(x) + -\frac{\hbar^2}{2m}\frac{\nabla^2 R}{R} \tag{4.8}$$

Defining $P(x) = R^2(x)$ equation (4.7) becomes

$$\frac{\partial P}{\partial t} + \nabla \cdot (Pv) = 0 \tag{4.9}$$

On the other hand equation (4.8) has the form of the classical Hamilton-Jacobi equation

$$-\frac{\partial S}{\partial t} = \frac{(\nabla S)^2}{2m} + V(x) + U(x,t) \tag{4.10}$$

which contains in addition of the classical potential V a 'Quantum Potential ' $U(x,t)$ defined by

$$U(x) = -\frac{\hbar^2}{2m}\frac{\nabla^2 R}{R} \tag{4.11}$$

The Quantum Potential is the main new feature of Bohm's interpretation. However it had appeared before in various mathematical forms. It appears originally in de Broglie's pilot-wave model presented at the Solvay Conference and later published in *Ondes et mouvements* (1926). He obtained it as a contribution to the rest mass in a relativistic version of his early work. Extrapolating to the non-relativistic case, he showed that it could be regarded as a extra term in an expression that looked like a Hamilton-Jacobi equation, where it appears to be some form of new 'po-

tential'. Bohm followed closely this idea.

At this point Bohm makes the bold move to postulate that this quantum system is analysable into two perfectly defined components: the wave $\Psi(x,t)$ propagating in space and time; and a particle that moves continuously under the guidance of the wave with the following three assumptions:

1. The wave Ψ satisfies Schrödinger equation.

2. The particle momentum is defined as

$$p(x,t) = \nabla S(x,t) \tag{4.12}$$

   This momentum is well defined at all times, and this formula known as the 'guidance condition' provides a deterministic and continuous trajectory for the particle, that can be obtained using Newton's equation:

$$m\ddot{x} = -\nabla(V(x) + U(x,t)) \tag{4.13}$$

   To solve this equation it is necessary to specify only the initial conditions for position $x(0) = x_0$ because Bohm's equation (4.12) determines the velocity initial condition $\dot{x}(0) = \frac{p}{m} = \frac{\nabla S(x_0,0)}{m}$. For Bohm's causal Interpretation, the particles go through clearly defined paths in contrast with the standard interpretation in where the paths does not exist.

3. Determining the initial position of a single particle is difficult in practice, but if the initial probability distribution of positions of an ensemble of particles is given by

$$P(x) = |\Psi(x,0)|^2 \tag{4.14}$$

the continuity equation (4.9) ensures that at all time $P(x,t) = |\Psi(x,t)|^2$.

The last postulate is needed in order to recover the statistical predictions of quantum theory. The Orthodox Interpretation interprets $|\Psi(x)|^2$ as the probability of finding a particle in x after a suitable measurement is made, position is undefined before the measurement. Bohm on the contrary says that the particle position is defined all the time, even before the measurement is made. Bohm tried to get rid of this postulate and obtain it as a consequence of the other assumptions in his third paper on the Causal Interpretation, but he only succeeded to do it for a limited number of cases. So this assumption is needed and will play an important role in subsequent developments. If $P(x,0)$ is regarded as an initial probability density for particles in an ensemble and Pv the mean current, equation (4.9) indicates that for all time this probability is conserved, that is $P(x,t)$ is a probability distribution for all t. This 'statistical postulate' is of fundamental importance for Bohm's theory, as it guarantees that if only the information about the wave function is given and no information about the exact initial position of an individual particle is available, then the probability of finding it located at any particular point in space is the same as the one predicted by standard quantum mechanics.

It is important to emphasize that the Bohm momentum, equation (4.12), is postulated, it is a new equation that is not derived from the standard formalism. From this postulate and Schrödinger's equation the law of motion (4.13) is derived. This law of motion can give a misleading impression as it looks as if Bohm managed to bring quantum mechanics back to the

classical paradigm. However this equation is far from a return to a classical description as the presence of the Quantum Potential $U(x)$ in the equation of motion has highly non-classical effects.

1. The wave pushes around the particle with a force $-\nabla U$, but the movement of the particle does not have a reciprocal influence on the wave.

2. There is no such a thing as free motion. If $V = 0$ the particle still has a non linear motion $\ddot{x} = -\frac{\nabla U}{m}$ contrasting with the classical uniform and rectilinear motion.

3. The influence of the wave on the particle through the Quantum Potential does not depends on the wave intensity I which can be defined as the squared amplitude, $I = R^2$. If the amplitude is multiplied by a constant the potential remains exactly the same, so contrary to a classical potential the particle does not respond to the intensity of the wave but only to its form.

4. An important consequence of the above is that even if $\Psi(x) \to 0$ as $x \to \infty$ the Quantum Potential remains as influential as anywhere else.

5. Where does the Quantum Potential comes from? There are no sources or sinks for it. The Quantum Potential appears as part of the whole set up in which the quantum phenomena occurs. It is obtained from the wave function which obeys Schrödinger equation, an homogeneous, linear equation. U is not radiated or absorbed, it is intrinsic to both the particle and the environment.[44]

[44]This is a question that is not posed at the level of quantum mechanics, the Quantum

Where are the hidden variables in Bohm's theory? The answer is simply 'nowhere'. The 'hidden variables' in terms of which the theory is stated are the position and momentum, and these are hardly 'hidden' in Bohm's theory. The name was a poor choice and Bohm stopped making reference to the 'hidden variables' interpretation and started calling his theory the Causal Interpretation.[45] With it Bohm successfully proved that the Copenhagen interpretation was not the only philosophical standpoint compatible with the formal and empirical content of quantum mechanics. The theory may have some inadequacies, but it was an effective counter-example to the standard position that thought that it was impossible. Today it sounds almost trivial, but at the time it was a move that no one was expecting.

Causal Entanglement

The non classical aspects of U are more clearly elicited when the analysis is extended to the many-body case.[46] The Quantum Potential of n particles of mass m is

$$U(x) = -\frac{\hbar^2}{2m}\sum_{n=1}^{n}\frac{\nabla_n^2 R}{R} \tag{4.15}$$

The many-body Quantum Potential leads to a strong non-local interaction between all the particles of the system. This is because the influence of the potential does not vanish when the particles are distant from each other. The forces acting on each particle no longer depends on the po-

Potential is simply assumed. However the question remains and further elaborations will try to answer this, see below 5.2.

[45] Bohm, 'Proof That Probability Density Approaches $|\psi|^2$ in Causal Interpretation of the Quantum Theory'.

[46] Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables I' p. 174

sitions of the other particles but on the whole set of conditions in which the system is defined, in other words, the particles depend on each other regardless of the distance between them.

From the standpoint of the Causal Interpretation, the dependency on the over-all environment brought in by the Quantum Potential provides an intuitive explanation of the EPR paradox.[47] Consider the wave function $\Psi(r_1, r_2, t)$ of a two-body system, with r_1 and r_2 the respective position vectors. $\Psi(r_1, r_2, t)$ satisfies Schrödinger's equation

$$i\hbar\frac{\partial\Psi}{\partial t} = (-\frac{\hbar^2}{2m}(\nabla_1^2 + \nabla_2^2) + V(x))\Psi(x,t) \tag{4.16}$$

where ∇_1^2 and ∇_2^2 refer to derivatives with respect to r_1 and r_2. Using the polar form of the wave function $\Psi(r_1, r_2, t) = R(r_1, r_2, t)e^{\frac{iS(r_1,r_2,t)}{\hbar}}$ and using $P = R^2$, as in as in (4.6), we obtain

$$-\frac{\partial S}{\partial t} + \frac{(\nabla_1 S)^2}{2m} + \frac{(\nabla_2 S)^2}{2m} + V(x) + U(x,t) = 0 \tag{4.17}$$

with the 'quantum potential'

$$U(r_1, r_2) = -\frac{\hbar^2}{2m}\frac{(\nabla_1^2 + \nabla_2^2)R}{R} \tag{4.18}$$

the conservation equation

$$\frac{\partial P}{\partial t} + \nabla_1 \cdot (P\frac{\nabla_1 S}{m}) + \nabla_2 \cdot (P\frac{\nabla_2 S}{m}) = 0 \tag{4.19}$$

and the guiding conditions, i.e. the equations for the trajectories of the two particles:

[47] Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables II' p.186

$$\ddot{v}_1 = \frac{dr_1}{dt} = \frac{\nabla_1 S(r_1, r_2, t)}{m} \tag{4.20a}$$

$$\ddot{v}_2 = \frac{dr_2}{dt} = \frac{\nabla_2 S(r_1, r_2, t)}{m} \tag{4.20b}$$

The trajectories of both particles depends on each other, and although the two particles can be separated by a considerable distance they still interact through the Quantum Potential even in the absence of any other classical potential. For the particular situation described in the EPR paper, the two particles are formed in a correlated state and then they separate. The wave function modelling this system takes the form:

$$\Psi(r_1, r_2, t) = \exp i \frac{p(r_1 - r_2)}{2} f(r_1 - r_2, t) \tag{4.21}$$

where $f(r_1 - r_2, t)$ is a sharply peaked function about the point $a(t) = r_1 - r_2$. In the absence of any other potential, the particles are still interacting through a non-zero quantum potential:

$$U(r_1, r_2, t) = -\frac{h^2)}{2m} \frac{(\nabla_1^2 + \nabla_2^2) f(r_1 - r_2, t)}{f(r_1 - r_2, t)} \tag{4.22}$$

The whole dynamics is non-local: if a measure of the momentum of one of the particles is taken, the other particle reacts immediately to produce the appropriate value of its momentum. The Quantum Potential gives a natural and expected character to the non-local behaviour of the quantum phenomena.

The Causal Double Slit

It is instructive to compare the Causal and the Orthodox Interpretations descriptions of quantum phenomena using the 'double slit' experiment. This experiment is used by Bohm extensively in chapter 6 of *Quantum Theory* to introduce the wave–particle duality, and he will keep coming back to it to explain the differences with the Causal Interpretation.[48] The experiment consists of a source of electrons with a definite momentum p_0 that are fired one by one against a panel with two small holes, the slits, that can be closed. Behind the panel, at a certain distance, there is a screen that detects the arrival of an electron producing a spot of light. This is taken as a measurement of position. Firing one electron produces a spot on the screen in a random place, however when a large amount of electrons is fired a pattern emerges. When one of the holes is closed, the pattern that is produced is the same as if what had been fired were bullets, that is, the electrons behave like tiny particles. But when both holes are open what emerges is an interference pattern, as if what had been used was light instead of electrons. The interference pattern appears even if each electrons is fired well after the last one has already hit the screen so there is no possibility of interaction between individual electrons. What the experimenter may see is first isolated random spots as individual electrons begin to hit the screen, and after a while the spots form the interference pattern.

The explanation of this pattern using the Orthodox Interpretation is very difficult to understand. How can the opening of a second hole prevents an

[48]There is an excellent description of the experiment with a minimal use of mathematics in the first chapter of the third volume of Richard Feynman, Robert Leighton and Mathew Sands, *The Feynmann Lectures on Physics* (Reading, Massachusetts: Addison Wesley, 1965).

electron to hit the screen in a place where it could hit when only one hole was open? If electrons were particles this behaviour can't be explained. The electron must have a wave nature, however how can this be reconciled with the fact that what hit the screen is entirely localized unlike a wave that spreads over space. So the principle of complementarity is used and when only one hole is open, the whole set up brings up the particle aspect of the electron at the expense of the wave nature. When the two holes are opened it is the wave nature of the electron which is highlighted. The Orthodox Interpretation not only makes no attempt to provide a conceptual description of what is happening, but maintains that it is impossible to do so. Technically this is described by the wave function of the electron $\Psi(x) = e^{\frac{ip_0 x}{\hbar}}$ and simply states that the frequency of hits at point x of the screen is $|\Psi(x,0)|^2$, which is what gives the interference pattern.

The Causal Interpretation assumes that there is a particle that is influenced by a force produced by the presence of the quantum potential. The particle starts with a definite momentum and position and travels towards the panel. Before the panel the Quantum Potential vanishes as the amplitude of the wave function is constant. The particle passes through a definite slit and as soon as it passes it encounters a Quantum Potential that varies rapidly, as it is governed by Schrödinger's equation, and its action on the particle makes its movement very complicated, but still in a well defined and deterministic way. In practice the initial location of the particle is unknown, but if it is assumed that the initial position of a large number of particles is distributed like $|\Psi(x)|^2$, the frequency of hits at a particular point x is the same as before. The interference pattern arises because at certain points the Quantum Potential will become infinite, where $R = 0$, and these places are unreachable by the particle. The slits affect the Quantum

Potential not the fundamental properties of the particle.

4.3.2 Comparing the Orthodox with the Causal

Bohm proposes a different ontology in which the wave function is interpreted as a real field, different from the particle and whose evolution in time is governed by Schrödinger's equation. For Bohm both a particle and a wave coexist, whereas in the Orthodox Interpretation holds that the wave and particle aspects are mutually exclusive. As previously noted, even in his account of the standard theory Bohm insists on the reality of both aspects, however in his Causal Interpretation instead of making them complementary aspects of the single same thing, he postulates two distinct entities: a particle with distinct trajectories, and a wave field which is responsible for the quantum effects. The wave field pushes around the particles just as any other field will do. The dynamics of this guidance are deterministic in the same sense as in classical physics, as every material particle in the world has a perfectly determinate position and momentum. The Orthodox Interpretation ontology consists in only one thing, the challenging wave-particle. The Causal ontology consists of two, a particle and the wave and with them a quantum potential. In this form Bohm's waives away the problem of trying to imagine a thing that is simultaneously a wave and a particle.

Postulating the particle and the wave, each existing on its own right, as related but nonetheless different parts of the physical situation, is where Bohm departs from everything else done so far. Schrödinger's equation and the law of motion (4.13) determine causally both the wave and the particle. It contradicts the usual quantum interpretation that only talks about particles after a pertinent measurement has instantiated the particle

aspect. For Bohm the particle and its continuous trajectory are well defined all the time. A consequence of this is that there are not quantum jumps in the Causal Interpretation.

For Bohm the uncertainty and the statistics of the quantum theory are not fundamental principles. They are a consequence of the pragmatic inability to determine the initial conditions x_0 because the procedures to determine it perturb the system in a way consistent with the uncertainty principle. This is different from the Orthodox Interpretation where it is not even possible to talk about this perturbation because the properties to perturb does not exist before the measurement is made. In the Causal Interpretation the initial values of both position and momentum could be determined with arbitrary precision in principle, and its only practical considerations that prevents us to do so. So we have to use an ensemble and to describe its related probabilities just as in classical statistical mechanics. Bohm's interpretation gives statistics the same epistemic role as in classical physics. This is an important difference with N. Bohr's point of view for whom there is a threshold of analysis beyond which it makes no sense to speak of momentum and position simultaneously.

The Causal Interpretation privileges position. Everything else, momentum, spin, etc., depends on the experimental situation. In standard quantum mechanics both position and momentum have an essential symmetry that in the Causal Interpretation is lost.

As the influence of the Quantum Potential does not vanish with distance, the theory is non-local, two particles can still feel the influence of each other even when they are sufficiently far removed from each other. Classically, as potentials fall off with distance their effects vanish with distance, they are 'local'. In contrast with the standard theory in which non-

locality is a bit unexpected, uncomfortable and to a certain extent undesirable, in the Causal Interpretation these effects find an intuitive description.

Regarding the measurement problem, it simply vanishes in Bohm's theory. Measurement is just a particular form of a quantum process. Because from the start the conditions are definite, there is no surprise to measure definite results. There is no collapse of a wave function, the particle is always a whole particle with a determined position that is what is measured in the experiments.

The classical limit is easily regained when the dimensions of the problem are of a scale in which the dimensions of $\hbar$ are negligible. In this case the Quantum Potential does not produce a noticeable effect and can be dismissed and the standard equations of classical mechanics are regained.

To summarize, the highlights of Bohm's Orthodox Interpretation are:

1. Gives a fundamental character to the uncertainty relations and assumes that the wave function is the most complete description of a quantum system.

2. Emphasizes holism, and the impossibility of analysis of the quantum phenomena.

3. Takes the different dynamical variables as complementary potentialities that are chosen to manifest depending on the experimental set-up.

4. Measurement is ad hoc and does not fit naturally with the rest of the formalism.

5. Underlines remarkable similarities with the thought process.

6. Argues that hidden variables are not possible

The highlights of Bohm's Causal Interpretation are:

1. Postulates a wave and a well defined particle with a precise simultaneous position and momentum at every time.
2. Introduces a new 'quantum potential' responsible of the 'bizarre' quantum mechanical effects.
3. Obtains exactly the same predictions as the Orthodox Interpretation.
4. The uncertainty relations are statistical not fundamental.
5. Emphasis on non-locality. Entangled states are not conceptually problematic.
6. No measurement problem.

4.3.3 The Reception of the Causal Interpretation

Despite all the differences between the two interpretations, Bohm did not feel that he was parting ways with Bohr regarding the main issues. For Bohm the important point was the holistic aspect of the theory and he thought that in a certain way the Causal Interpretation was making clear Bohr's holistic notion of the indivisibility of the combined system of observing apparatus and observed object, something that is notoriously obscure in Bohr's writings. Bohr describes a measurement as a whole phenomenon that is not possible to analyse and whose description must include a full account of the experimental context as well as the results. Bohm's theory provides an intuitive understanding of this. Despite of this,

Bohr couldn't accept even to consider Bohm's theory. It is not clear what exactly was Bohr's problem with the Causal Interpretation as he simply refused to engage with Bohm.[49] From Bohm's standpoint the development of the Causal Interpretation, and the later Ontological Interpretation, was not a move against Bohr, but rather an effort to clarify what Bohr had only obscurely said. For Bohm the Causal Interpretation was not necessarily in irreconcilable disagreement with the core philosophical position of Bohr. For Bohm wholeness was of extreme importance, and all his further scientific and philosophical development can be seen as an effort to clarify why wholeness is important in physics, how this includes other realms beyond physics, specially thought and the mind, and ultimately how can it be applied to make a difference. However Bohm's theory challenged the assumption of the uncertainty principle as fundamental, which was held in great esteem by Bohr and his entourage, and therein lied some of the problems with the reception of the Causal Interpretation.

Although Bohm's papers did not pass unnoticed they didn't managed to convince the mainstream physicists. The only leading physicist that responded favorably was Louis de Broglie, who became an important supporter of Bohm. Most simply assumed that the theory was wrong because it contradicted von Neumann's theorem, nevertheless at the time no one was able to point out where exactly it was wrong. Some of the early criticism to the Causal Interpretation was based on the assumption that it destroyed the 'new world' revealed by the quantum theory. The particle ontology with its definite trajectories gave the impression of bringing the quantum back into the classical world and Bohm was accused of producing a 'reactionary' theory. But this was not a scientific argument and

[49]See Peat, *Infinite Potential* p. 184-186 for an account of Bohm's meeting with Bohr in Copenhagen in the summer of 1957.

Bohm dealt easily with it pointing out that the Quantum Potential $U(x)$ does not have any of the properties expected from a classical potential.

Several objections based on physics were raised against the theory, starting by reminding Bohm that a very similar idea had already been ruled out in 1927 when de Broglie proposed it in the Solvay congress. Bohm successfully dealt with this initial objections in the 1952 papers.[50]

He also had to clarify the status of his statistical postulate. Responding to Pauli who had criticized the need to assume that the particles were in a particular initial distribution in order to obtain the same statistical results of the Copenhagen Interpretation. Pauli considered that an arbitrary distribution should be aloud. Bohm responded with the third paper in which he proved for some important cases that starting from an ensemble of particles in an arbitrary initial distribution, in a very short characteristic time this distribution will converge to the assumed one.[51] The argument convinced Pauli, but the assumption is still needed for the general case.

More objections came later from Pauli and Heisenberg that criticized Bohm's abandonment of the position-momentum symmetry in his interpretation. This criticism is arguably an aesthetic argument, not a scientific one, although it may be argued that symmetries play a fundamental role in physics. Bohm responded that this didn't mean that his theory was not logically consistent; nevertheless the Copenhagen supporters could not accept it for reasons that are beyond science.[52]

In addition Heisenberg's criticism was related to the lack of new empir-

[50]Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables II'

[51]Bohm, 'Proof That Probability Density Approaches $|\psi|^2$ in Causal Interpretation of the Quantum Theory'

[52]Cushing, 'Bohm's Theory'; Cushing, *Quantum Mechanics*; Myrvold, 'On Some Early Objections to Bohm's Theory'.

ical content, or in other words, the predictions of Bohm's non relativistic theory coincided exactly with the predictions of the Copenhagen Interpretation in the non relativistic case.[53] Heisenberg assumed a positivist position and argued that the Copenhagen interpretation was superior to the Causal as the latter postulated elements of reality that could not be observed. Bohm replied that postulating an object that changed its own nature on demand contradicting our basic intuitions of the physical world, as it is done in the usual interpretation, was hardly better.[54]

One of the main reasons for the widespread suspicion towards alternatives to the Copenhagen interpretation was that in his ground-breaking book *Mathematical Foundations of Quantum Mechanics* of 1931, the Hungarian-American mathematician John von Neumann (1903-1957) included a theoretical proof of the impossibility of 'hidden variables'. This proof was regularly cited in the literature as the main reason to dismiss the Causal Interpretation. However the argument contained a subtle hidden assumption that does not apply to the case of the Causal Interpretation. This was clear to Bohm who argued the point without giving a formal proof.[55] The problem with von Neumann's theorem became completely clear only some years later when the Irish particle physicist John S. Bell (1928–1990), inspired by the existence of the Causal Interpretation, reviewed the proof of the theorem discovering the flaw.[56] I will come back to this later in A.1.

[53]Bohm didn't developed a relativistic version of his theory. The relativistic version has been only recently developed by Basil Hiley and his group. However these are mathematical developments that place Dirac's and Pauli's equations in the context of relativistic versions of the Quantum Potential, aiming to obtain a conceptual clarification of what is already known. See A.2 for more details.

[54]See Myrvold, 'On Some Early Objections to Bohm's Theory' for a complete account of how Bohm dealt with these objections.

[55]Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables II', pp.

[56]John S. Bell, 'On the Einstein–Podolsky–Rosen Paradox', *Physics*, 1 (1964), pp. 195–200.

Einstein didn't support Bohm's interpretation. In an often quoted letter to Max Born, Einstein writes: 'Have you noticed that Bohm believes (as de Broglie did, 25 years ago) that he is able to interpret the quantum theory in deterministic terms? That way seems too cheap to me'.[57] In his contribution to Born's *Festschrift* Einstein raised some physical objections to the Causal Interpretation founded on the passage to the classical limit.[58] However, Einstein's criticism was deeper than what the mere physical argument shows. Einstein didn't like Bohm's theory because he thought that what was needed to solve the conundrum of the quantum theory was a completely new set of ideas and concepts, not just a reinterpretation of the same mathematical formalism. Bohm didn't deal with Einstein's criticism, in the same volume he simply responded that:

> the author would like to state that he would admit only two valid reasons for discarding a theory that explains a wide range of phenomena. One is that the theory is not internally consistent, and the second is that it disagrees with experiment.[59]

which was basically the same answer that N. Bohr was giving to Einstein regarding his own Copenhagen philosophy of quantum mechanics!

The Causal Interpretation was not received as Bohm expected, and this disappointed him enormously. Although the theory was not perfect as it contained many undesirable aspects and limitations, nevertheless it had fulfilled its purpose showing that a coherent alternative interpretation

[57] Max Born and Albert Einstein, *The Born–Einstein Letters* (New York: Macmillan, 1971) p.192 letter of 12 May 1952.

[58] Albert Einstein, 'Elementäre Überlegungen zur Interpretation der Grundlagen der Quanten–Mechanik', in *Scientific Papers Presented to Max Born*, ed. by Edward Appleton (New York: Hafner, 1953), pp. 33–40.

[59] David Bohm, 'A discussion of certain remarks by Einstein on Born's probability interpretation of the ψ–function', in *Scientific Papers Presented to Max Born* (New York: Hafner, 1953), pp. 13–19, p. 18.

was possible. Bohm's aim was not to replace the orthodox view with his theory, he was only showing a counterexample to the received view that maintained that it was wrong to think differently about quantum mechanics:

> It should be kept in mind that before this proposal was made there had existed a widespread impression that no conceptions of hidden variables at all, not even if they were abstract, hypothetical, and 'metaphysical', could possibly be consistent with the quantum theory [. . .] it was therefore sufficient to propose any logically consistent theory that explained the quantum mechanics through hidden variables, no matter how abstract and 'metaphysical' it might be. Thus, the existence of even a single consistent theory of this kind showed that whatever arguments one might continue to use against hidden variables, one could no longer use the argument that they are inconceivable. Of course, the specific theory that was proposed was not satisfactory for general physical reasons. But if one such theory is possible, then other and better theories may also be possible. And the natural implication of this argument is 'Why not try to find them?'.[60]

4.4 Summary

One of the objectives of this chapter was to clarify the differences between Bohm's Causal Interpretations and the Copenhagen's Interpretation. The differences are not in the content of the physics, but in the philosophical

[60] David Bohm, 'Classical and non–classical concepts in the quantum theory: an answer to Heisenberg's Physics and Philosophy', *British Journal for the Philosophy of Science*, 12 (1962), pp. 265–280.

standpoint. The main point in Bohm's theory is the introduction of the Quantum Potential and how Bohm interpreted it to resolve the usual conceptual problems of quantum mechanics. Although not without problems, the Quantum Potential enables a clear picture of the quantum phenomena. The reception of the Causal Interpretation by the physics community disappointed Bohm, who reached further into philosophy to find answers to the conceptual problems that the physics couldn't provide. In the next chapter we examine Bohm's first steps into this new departure.

Chapter 5

Wholeness and Process

As was seen in the last chapter, the development of the Causal Interpretation left Bohm with more questions than answers. Dissatisfied with physics and disenchanted with the mainstream scientific community, Bohm turned to philosophy. But not everyone ignored Bohm; scientists working in places that were not perceived as mainstream, and who shared Bohm's philosophical leanings, were more receptive to the implications of the Causal Interpretation. This community had a great influence in Bohm's thought, who was directed to look into Hegel's idealistic philosophy, on which Bohm's intuition for wholeness found a vigorous resonance. As will be discussed below, this was, arguably, a first decisive step towards the Western esoteric tradition.

5.1 Holism

Holism is nowadays a term with many different meanings. The term was introduced by the South African statesman Jan Smuts (1870–1950) in *Holism and Evolution* (1927), to make reference to complex unities, differen-

tiated from their environments whose behaviour is not explainable by the analysis of its constituents, 'the whole is more than the sum of its parts':

> Holism is the term here coined (from ὅλος = whole) to designate this whole-ward tendency in Nature, this fundamental factor operative towards the making or creation of wholes in the universe.[1]

Smuts' main thesis is that evolution is creating more complex wholes, however these units are in principle independent of the entourage in which they exist, they are given a priori and the whole is the result of the interaction of these components.

Bohm's holism is not that of Smuts, neither it is a simple opposition to the analytic methodology of understanding a phenomenon by dividing it into smaller parts. Bohm's holism is ontological. Rather than thinking of the world as resulting from the interaction of fundamental entities given a priori, it is the very wholeness of the world that sustains the entities and defines their properties. If the holistic background changed, the entities themselves and their relationships would transform into something different.

Bohm's holism is more akin to a mystical unification in which the main category includes everything. This reach for wholeness was not something that Bohm learned by reading about it, but something much deeper in him. Wholeness was inherent in the mystical states he had experienced during his childhood and at some other periods in his life. He describes these experiences as visions of light:

> This goes back to what I said before about earlier childhood of seeing light as reaching out and all the lights reaching out into

[1] Jan Smuts, *Holism and Evolution* (London: MacMillan et Co., 1927), p. 100.

> the darkness and contacting everything [...] I sort of entered the world of light [...] I had this vision of super intense light awareness of something more real [...] super intense awareness of a pervasive light in which everything could be seen as it is.[2]

The search for this wholeness motivated his entire work. It was the motivation behind his political interests in Marxism, and his early attempt to reconcile individual freedom and social justice. As explained in chapter 3, he used the behaviour of electrons in plasma as a metaphor to express his idea of how an individual can be free and at the same time behave coherently within a collective movement.

Bohm's philosophy goes beyond the simple statement of the unity of the world, since for Bohm the nature of this totality is pure movement. Bohm's notion of 'motion' is subtle, it is not the movement of objects, but is something more primitive and it is from this primitive movement that not only objects, but space-time itself arises. This notion of motion is what later became the 'Holomovement'. Bohm proposes that 'movement' is the fundamental aspect of reality and 'being' a subsidiary phenomena. Things are the stable properties of a fundamental movement, useful abstractions objectified by the mind: they are not 'reality'. In Bohm's own words, his key idea is: 'An unbroken wholeness of the totality of existence as an undivided flowing movement without borders'.[3] As I explained in section 3.5, this idea was also well rooted in Bohm's own experience:

> [...] we had to cross the stream [...] I suddenly took this leap and it worked, you see, whereas before I would have said I must

[2]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 5 Side B.
[3]Bohm, *Wholeness and the Implicate Order*, p. 218.

> take every step from one stone to the other and stop and see where I then make the next step and so on [...] and suddenly I had that insight that it wasn't necessary, that the movement as itself was a state of being [...] there was the idea that motion was first and being was part of it.[4]

Bohm matured his holistic movement philosophy from these initial insights, a development through many years carried out with the help of his numerous encounters with all kinds of thinkers, many of these lying squarely within the esoteric. These encounters inspired insights that Bohm 'digested' into his philosophy. The process culminated somewhat when Bohm encountered Jiddu Krishnamurti, with whose aid his philosophy found its more eloquent articulation. Before this encounter, his effort to elaborate his thought acquired a definite philosophical form with the publication of his second book *Causality and Chance in Modern Physics* (1957) where he introduces the 'Qualitative Infinite of Nature', a 'quasi–Neo–platonic' infinite ladder of scales in which a dialectic process between statistical and deterministic laws operate, as we will see in this chapter. The philosophical ideas in this book were inspired by Bohm's statistical thought. More importantly this book also shows the influence of the the idealistic philosophy of G.W.F. Hegel, an aspect that remained important in the further development of Bohm's thought.

5.2 What Lies Below 10^{-13} cm

To transform the Causal Interpretation from a curious counterexample to a fully fledged physical theory, Bohm needed to place it in the context of a

[4]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 1 Side B

larger research program. Bohm laboured assiduously in this direction for a few years with the collaboration of several scientists. In its original form the Causal Interpretation was limited to the non-relativistic case, so an obvious line of research was to extend it into the relativistic domain. Although in the 1952 papers there is an initial attempt to deal with the electromagnetic case, Bohm was not successful in extending his interpretation to the Dirac equation, so the Causal Interpretation remained a non-relativistic theory.[5]

Equally important was to find divergences from the standard theory, as mentioned in chapter 4. To reproduce the same results of standard quantum mechanics, it is necessary to assume that the initial probability distribution of the position of an ensemble of particles is already distributed as $|\Psi(x,0)|^2$. Bohm failed to prove that an arbitrary initial distribution will converge rapidly to this, but this was not necessarily a negative aspect of the theory because this implied that to obtain different predictions for quantum phenomena it was enough to find situations in which the initial distributions were different from $|\Psi(x,0)|^2$, and it was expected that this would lead to testable predictions that may give a clue to extend the theory to the case of electromagnetic interactions, in which the quantum theory was having problems. The quantization of the electromagnetic field had been developed by 1948 within the limits of the Copenhagen interpretation, using a technique called re-normalization on which Bohm had worked while he was still in Princeton. However, he thought that it was an ad hoc approach that remained problematic. Although re-normalization techniques are operationally successful, they are not well defined from a

[5]Bohm successfully extended his theory to provide a causal version of Pauli's equation to include the spin of an electron in Bohmn, Schiller and Tiomno, 'A causal interpretation of the Pauli equation: Parts A and B'. Only recently a fully relativistic version of the Causal Interpretation has been developed, see Basil Hiley, 'Clifford algebras and the Dirac-Bohm quantum Hamilton-Jacobi equation', *Foundations of Physics*, 4 (2011), p. 553.

mathematical point of view, and still remain problematic to this day. Bohm also complained about the lack of a solid philosophical background.[6]

What Bohm was looking for were different predictions outside the scope of applicability of standard quantum mechanics. At the time the limit was the scale of the atom, and Bohm was aiming for the atomic nucleus where the processes were much faster ($10^{-23} sec$), the energies bigger (1 GeV), and the dimensions several orders smaller ($10^{-13} cm$). The development of the Causal Interpretation was thus motivated by the hope of finding a better solution to these problems. In the introduction to his first paper of 1952 he makes his intentions clear:

> We shall see, however, that our alternative interpretation permits modifications of the mathematical formulation which could not even be described in terms of the usual interpretation. Moreover, the modifications can be easily formulated in such a way that their effects are insignificant in the atomic domain, where the present quantum theory is in such good agreement with experiment, but of crucial importance in the domain of dimensions of the order of 10^{-13} cm, where as we have seen, the present theory is totally inadequate.[7]

The Causal Interpretation can be seen as a framework delineated by

[6]For an overview of the history of these developments and the further elaboration of Quantum Field Theory and the Standard Model see Andrew Pickering, *Constructing Quarks: A Sociological History of Particle Physics* (Chicago: University of Chicago Press, 1986). For a more philosophical approach see Cao, *Conceptual Developments of 20th Century Field Theories*. For a popular account of some recent developments see Lee Smolin, *The Trouble with Physics: The Rise of String Theory, The Fall of Science, and What comes Next* (New York: Mariner Books, 2007) and Peter Woit, *Not Even wrong: The Failure of String Theory and the Search for Unity in Physical Law* (New York: Basic Books, 2006).

[7]Bohm, 'A Suggested Interpretation of the Quantum Theory in terms of Hidden Variables I' p. 166

the three assumptions described in 4.3.1, and a more fundamental theory needs to include them, or to deduce them. It was in collaboration with Jean-Pierre Vigier (1920–2004) that Bohm started to develop an extension to the Causal Interpretation in this direction, which they hoped would open up the possibility that in the regime of very short times, the predictions of the two interpretations could differ.[8] Bohm presented the desiderata of this theory at a symposium for physicists and philosophers organized by the Colston Research Society, held at the University of Bristol in April 1957 which he attended in the company of Vigier.[9] His presentation was entitled *A Proposed Explanation of Quantum Theory in Terms of Hidden Variables at a Sub-Quantum-Mechanical Level*:

> The new theory would be quite different from the quantum mechanics in a deeper sub quantum-mechanical level, where it would predict qualitatively new properties of matter. We shall see that there are good reasons for supposing that these new properties may be relevant for treating a new domain of phenomena not adequately treated in current theory. This domain is associated with very high energies, very short distances, (of the order of 10^{-13} cm or less) and with the creation and destruction of so called 'elementary particles'.[10]

[8]David Bohm and Jean Pierre Vigier, 'Model of the causal interpretation of quantum theory in terms of a fluid with irregular fluctuations', *Physical Review*, 96 (1954), pp. 208–216; David Bohm, 'A proposed explanation of quantum theory in terms of hidden variables at a sub–quantum–mechanical level', in *Observation and Interpretation: a symposium of philosophers and physicists*, ed. by Stephen Korner (London: Butterworths, 1957), pp. 33–61; David Bohm and Jean Pierre Vigier, 'Relativistic hydrodynamics of rotating fluid masses', 109.6 (1958), pp. 1882–1891.

[9]The philosopher Paul Feyerabend attended the symposium and was very supportive of Bohm's point of view, particularly his challenge of the Copenhagen interpretation.

[10]Bohm, 'A proposed explanation of quantum theory in terms of hidden variables at a sub–quantum–mechanical level', p. 33.

This extension postulated a sub-quantum level in which causal laws apply, thus explaining the quantum probabilistic effects deterministically by the assumption of a process taking place at a deeper level, in a similar way as the explanation of Brownian motion.[11] The main point of Bohm's argument was that uncertainty and determinism coexist together, but at different levels. This deeper sub-quantum level would obey qualitatively new and unknown laws different from the standard quantum laws. He was hoping that this approach would show that the problems in the quantization of the electromagnetic field were due in the first place to an inadequate extrapolation of quantum theory to a domain in which it simply did not apply.

In this extension of his theory, Bohm was trying to give a statistical background to the original Causal Interpretation in which the Quantum Potential becomes just a statistical consequence of a sub-level, thus minimizing its holistic relevance:

> For this [Causal] interpretation had many features that were unsatisfying [...] I began to change the theory until I arrived at the model I described today in which the Quantum Potential is an effect of a certain statistical motion [...] the Quantum Potential therefore ceases to play an essential role because everything is explained in a deeper way.[12]

To further develop their theory, Bohm and Vigier were looking to obtain relevant experimental results to guide their research. The theory predicted some departures from the standard quantum theory and an exper-

[11] Brownian motion, the random movement of pollen in water, or particles of dust in air, is explained as the product of the impact of millions of atoms with particles

[12] S. Korner, ed., *Observation and Interpretation: A Symposium of Philosophers and Physicists* (London: Butterworths Scientific Publications, 1957) p. 60

iment designed to show discrepancies was carried out, however no deviations were found. In addition the approach started to present theoretical complications. After this negative result, Bohm abandoned this approach and returned to his original position in which the Quantum Potential has a prominent role, also adopting a more idealist philosophy. Bohm and Vigier remained close friends, but their scientific collaboration ended.

5.3 Bohm Reception of Hegel's *Logic*

Although the statistical extension of the Causal Interpretation didn't deliver the results that Bohm was expecting, this work was the springboard that motivated Bohm to further develop his thoughts on statistics. Bohm had already published his ideas on the nature of statistics in physics in his article in collaboration with one of his students, Walter Schutzer.[13] In this pioneering incursion into chaos theory, he shows that the deterministic laws of classical mechanics give rise to statistical behaviour. The statistics in this case are not fundamental, but a consequence of the difficulty to solve non-linear equations.

Bohm discussed this issue with one of hie colleagues in the University of Sao Paulo, the Jewish Brazilian physicist Mario Schönberg (1914–1990).[14] Schönberg, who shared with Bohm the idea that philosophy is important to physics, suggested to Bohm that he needed to include the opposite case to have a complete picture: the case of contingency giving rise to causality and thus establishing a dialectical relationship. On

[13]Bohm and Schützer, 'The general statistical problem in physics and the theory of probability'.

[14]Regarded as Brazil's most important theoretical physicists, Mario Schönberg is regarded as one of the most important Brazilian physicist. He was also a member of the Brazilian Communist Party.

one hand we have deterministic laws giving rise to contingency (chaos), and on the other hand statistical laws giving rise to deterministic behaviour (quantum mechanics). A dialectical synthesis was in order and to achieve this Schönberg advised Bohm to read Hegel. Following Schönberg's advice, Bohm began to read Hegel, whom became a major influence upon the further development of his thought. He started using Hegel's philosophy by applying the dialectical transformation to the opposite categories of contingency and necessity:

> Necessity and contingency were the two basic categories. Necessity is what cannot be otherwise and contingency is what can be otherwise. Necessity doesn't yield, but contingency yields. It depends on things and so on in that contingencies are external. Well of course, these two qualities interchange. Because what was necessity seemed to be a contingency we looked at, it depends, actually within in a certain area it's necessary. But when you broaden the context it's contingency. What was contingency is seen as necessity. Like a very large number of random events, which are contingencies add up to kind of statistical necessity. The first thing is that the two categories weave together. They become each other; they turn into each other. They reflect each other because in necessity you see a reflection of contingency and vice versa. Eventually at bottom they are each other. They cannot really distinguish them. Contingency is necessity. Contingency first of all is necessary [. . .] I wrote a book from that point of view.[15]

In *Causality and Chance in Modern Physics* Bohm extended the 'con-

[15]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 9 Side B

tingent/causal' relationship between classical and quantum mechanics introducing an alternate series of levels, each one supporting the processes one level above: a series of contingent and deterministic domains that alternate ad infinitum. Starting with the statistical laws of quantum mechanics that give rise to the deterministic causality of the probability law, this in turn leads to contingency as the complexity of the systems gives rise to contingency, which again gives rise to necessary probability distributions from which deterministic predictions can be made, and so on. On the other hand he assumed the existence of a deterministic sub-quantum level responsible for the contingent quantum behaviour which would be supported by another sub-sub-quantum level obeying contingent laws, and so on.

Many aspects of Bohm's thought show a considerable influence of Hegel's philosophy, mainly through the *Encyclopedia Logic* (1817), which is the work in which Bohm was interested:[16]

> I read Hegel's Logic. There I found something very interesting. Well we all know that he was saying: Watch thought as a process.[17]

The idealistic philosophy of Georg Wilhelm Friedrich Hegel (1770-1831) starts with the suggestion that all human activity is historical: religion, sci-

[16]Hegel's philosophy is systematically exposed in the *Encyclopedia of Philosophical Sciences in Outline* (1817). According to Hegel, philosophy proper starts with the speculative dialectical logic which he elaborated in the *Science of Logic* (also known as the 'Greater Logic') published in two volumes in 1812 and 1816; Hegel summarized the exposition of the Logic in the first part of the *Encyclopedia of Philosophical Sciences in Outline*, the *Encyclopedia Logic* (the 'Lesser Logic'). Hegel's logic has the purpose of clarifying the basic categories of thought without making unwarranted assumptions about it. Hegel wanted thought to think its own nature, thought thinking thought, or in other words, thought being 'the observer and the observed'. For Hegel logic is ontology, it comes from the logos, and what Hegel was trying to understand is the true nature of 'being' itself. This notion of logic contrasts with our contemporary notion which is more related to formal or mathematical systems of logic.

[17]Bohm and Angelos, 'Beyond Limits: A Conversation with Professor David Bohm' p.4.

ence, philosophy, art, etc. are formed within the contingent contents of the culture of a particular time. However, Hegel maintains that there is a higher level of cognition that takes the form of 'thought' that is beyond history, capable of having eternal content. This dichotomy led to the rise of two schools of Hegelians: the more materialistic school that tends to concentrate on the historical contingency, giving less importance to Hegel's metaphysics; and the school that tends to give more relevance to Hegel's systematic and idealistic ontology in which a metaphysical and religious view of the 'Absolute Spirit', is offered. The latter is Bohm's inclination:

> [...] but even if you say that thought is a material process, we could say that it is a subtle material process, and Hegel was thinking about that [...] Yes, if you want to be a materialist. If you do not, we will put it in Hegel's terms, which is that thought is the primary reality, and that matter itself is like the thought of God. Matter itself is the symbol of God's thought. Not God, we want to say the universal thought or whatever you would like.[18]

Although the more idealistic aspects of Hegel's philosophy have been downplayed by the materialistic school, the traditional view of Hegel's philosophy is that it was influenced by mysticism.[19] In *Hegel and the Hermetic Tradition* (2001) Alexander Glenn Magee carries forward the investigation on the influences on Hegel's thought to conclude that:

> Hegel's system is Hermetic in content and form, that Hegel shared in the curious collection of interests that are typical of Hermeticists, and that these parallels between Hegel and the

[18]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 10 Side B.

[19]See for example William Wallace and J. N. Findlay, *Hegel's Logic* (Oxford and New York: Oxford University Press, 1975).

> Hermetic tradition are not accidental, because there is ample evidence that Hegel took an active interest [in Hermeticism] throughout his intellectual career.[20]

Throughout his works, Hegel invokes imagery regularly consistent with the types of Neo-Platonic conceptions of the universe that are associated with the Christian Kabbalah.[21] As Magee points out:

[20]Glenn Alexander Magee, 'Hegel and Mysticism', in *The Cambridge Companion to Hegel and Nineteenth-Century Philosophy*, ed. by Frederick C. Beiser (Cambridge: Cambridge University Press, 2008), pp. 253–280, p. 279; Magee, *Hegel and the Hermetic Tradition*.

[21]The Hebrew term Kabbalah comes from a root that means 'to receive' and is usually translated as 'reception' or 'tradition' meaning the reception of a secret tradition. The Kabbalah claims ancient origins, and is much influenced by Neo-Platonic thought. It includes descriptions of the structure of the Divine manifestation and it is centered around the notion of the ten *Sefirot*, the ten emanations through which God, the ineffable, reveals itself and continuously creates both the physical world and the chain of higher metaphysical realms. Its classical form was developed during the Middle Ages in Spain and culminated with the publication of the *Zepher ha Zohar*, the 'Book of Splendor', written by Moses ben Shem Tov de Léon (1250–1305). The classical Kabbalah concentrates on the Divine wisdom regarding cosmology and the explanation of creation. Its main problem is to understand how God's perfect pure being produces the world of imperfection and limitation in which we live. The Kabbalah answers using the Sefirot as steps of manifestation, offering a coherent numerical and geometrical system organized in triads, in which the descent of influences from the celestial to the material is clearly described. It is also a spiritual ladder, where the mystical endeavour is pictured as an ascent through the Sefiroth. For further details see Gershom Scholem, *Mayor Trends in Jewish Mysticism* (New York: Schoken, 1946); Gershom Scholem, *Kabbalah* (New York: Dorset, 1974); Joseph Dan, *Kabbalah: a Very Short Introduction* (Oxford and New York: Oxford University Press, 2006); Moshe Idel, *Kabbalah: New Perspectives* (New Haven and London: Yale University Press, 1988).

With the expulsion of the Jews from Spain in 1492, the Kabbalistic tradition found a fertile soil in Renaissance Europe that saw the development of a Christian version pioneered by the Italian Giovanni Pico dela Mirandola (1463–1494), the German Hebraist Johannes Reuchlin (1455-1520), and the Venetian Franciscan friar Francesco Giorgio (1466-1540). All of them had a keen interest in Jewish sources and aimed to use the doctrines of the Jewish Kabbalah to improve their own Christian faith. See Francois Secret, *Les Kabbalistes Chrétiens de la Renaissance* (Neully sur Seine: Arma Artis, 1985); Gershom Scholem, 'The beginnings of the Christian Kabbalah: Jewish Mystical Books & their Christian Interpreters', in *The Christian Kabbalah*, ed. by Joseph Dan (Cambridge, MA: Harvard College Library, 1997); Reimund Leicht, 'Jewish Influences II: Christian Middle Ages', in *Dictionary of Gnosis & Western Esotericism*, ed. by Wouter J. Hanegraaff (Leiden: Brill, 2005); Joseph Dan, 'Jewish Influences III: Christian Kabbalah', in *Dictionary of Gnosis & Western Esotericism*, ed. by Wouter J. Hanegraaff (Leiden: Brill,

> Although there is a Boehmean influence on Hegel's *Logic* and on Hegel's conception of the system, the deeper influence is that of the Kabbalah. Boehme is a Christian Kabbalist and so there is an indirect influence of the Kabbalah on Hegel, by way of Boehme.[22]

The reference above is to the German Theosopher Jakob Boehme (1575–1624), one of the most influential esoteric writers in the West, who articulated the wisdom that he believed God had revealed to him using imagery drawn from the Christian Kabbalah..[23]

2005); Ernst Benz, *Christian Kabbalah: Neglected Child of Theology* ed. by Kenneth W. Wesche, trans. by Robert J. Faas (St Paul, MN: Grailstone Press, 2004).

The Jewish Kabbalah had been developing in new ways that would eventually leave a lasting impression on Christianity. The Kabbalah of Rabi Isaac Luria (1534–1572), the most important Kabbalist of the school of Safed, found its way into Christianity through the publication of the *Kabbalah Denudata*, a collection of mainly Lurianic material translated into Latin and published in two volumes in 1677 and 1684 by Christian Knorr von Rosenroth (1636–1689). These tomes represented the Kabbalah for Christian Europe until the middle of the nineteenth century. The emphasis of the Lurianic Kabbalah is different from the classical Kabbalah as it stresses redemption. This Lurianic Kabbalah has had an important influence on several famous scientists and philosophers, see for example Yates, 'The Hermetic Tradition in Renaissance Science'; Coudert, *Leibniz and the Kabbalah*.

[22]Magee, *Hegel and the Hermetic Tradition*, p. 176.

[23]The German Protestant mystic Jacob Boehme (1575–1625) was a shoemaker from Goerlitz in Lusatia, now part of Saxony in Germany. Boehme had a number of mystical experiences throughout his youth, culminating in a spiritual vision in 1600 as he focused his attention on the beauty of a beam of sunlight reflected in a pewter dish. He believed that by this vision God had revealed him the secret spiritual heart of nature. Later in 1610 he experienced another epiphany which convinced him that he had further understood the unity of the world and that God had given him a vocation. Inspired by these experiences he published first *Aurora* in 1612, followed by *De Tribus Principiis* (1619), *De Signature Rerum* (1622), *Mysterium Magnum* (1623) and other works. See Robin Waterfield, *Jacob Boehme* (Berkeley, CA.: North Atlantic Books, 2001); Andrew Weeks, 'Boehme, Jacob', in *Dictionary of Gnosis & Western Esotericism*, ed. by Wouter J. Hanegraaff (Leiden: Brill, 2005)Pierre Deghaye, 'Jacob Boehme and His Followers', in *Modern Esoteric Spirituality*, ed. by Antoine Faivre and J. Needleman (New York: SCM, 1993) for modern academic treatment of Boehme's life and his theology. Franz Hartman, *Jacob Boehme: Life and Doctrines* (London: Kegan Paul, Trench, Trubner and Co., 1891) is dated but still useful. The most comprehensive analysis of Boehme's thought is Alexandre Koyre, *La Philosophie de Jacob Boehme* (Paris: J. Vrin, 1929). Probably one of the most interesting is the study of Boehme's thought made by the Romanian particle physicist Basarab

Bohm never wrote a systematic account of his view on Hegel. However, he talks extensively about Hegel's philosophy and its influence upon his own thought in two interviews. The first one was conducted by Maurice Wilkins in 1986 and was recorded in several tapes, and Hegel figures extensively on tape 13.[24] The second was conducted by Sean Kelly at Birkbeck College in 1987.[25] Bohm's interest in Hegel is mainly on Hegel's description of the dynamics of the thought process:

> Hegel is always discussing the nature of thought as a process. This was something that I felt was very subtle and not appreciated in Hegel; he said pay attention to thought [. . .] Now if you say pay attention to thought, how it goes, you are treating it as a process.[26]

For Bohm, the main message of Hegel's philosophy is about the process of thought as something that keeps going on, even if we stop being aware of it, and what is essential is to build the philosophical skill of paying attention to the process of thought, not so much to the contents but to the actual dynamics of the process, the actual 'flow'. The difficulty is that when one is thinking about thought, the principles must apply to the very thought that one is using. This is not just being conscious of the associative process of one thought leading to another, but being aware of this flow happening while thinking.

Bohm points out that the word consciousness literally means knowingness, whether it means what people know together culturally and socially

Nicolescu, *Science, Meaning, & Evolution: The Cosmology of Jacob Boehme* (New York: Parabola Books, 1991).

[24]Bohm and Wilkins, 'Interview Bohm–Wilkins'.

[25]Bohm and Kelly, 'Dialogue on Science, Society and the Generative Order'.

[26]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 13, Side A.

or individually. This knowingness can be very abstract, like mathematics or the operation of making an image or symbol of something we know. One is conscious of something if one knows about it. For example, in knowing various facts about Mars one is conscious of Mars. Awareness adds something more, it is based on the word 'ware' which means watchful, sensitive, hateful. Therefore it is in some sense being sensitive to the process, to the details, to differences and similarity. Awareness requires attention. Attention means literally stretching the mind towards something. In this context attention is a way of scanning the whole content of the brain to apprehend it into a whole. The eye will scan objects by jumping from one thing to another. Each person has a different pattern and there are all sorts of content in the brain, but this has to be brought together and attended to. Usually we don't need to pay so much attention to the processes that work automatically, like finding our way back home. But attention means stretching the mind to it, in a way 'bringing it'. Attention is a two-way process, it simultaneously changes the consciousness as one moves and learns, so attention is changing the content of the brain as it apprehends the content. Consciousness can include all of them but in the absence of awareness and attention, consciousness is a very limited affair.

According to Bohm, Hegel is considering these two aspects of the thought process. In one, we are capable of becoming aware of thought and attentive to thought itself. In the other, which is the more usual, we are not, we usually just know, we are conscious, we know that thought has gone through a series of stages, but when we are thinking intently we really don't notice the process. These two forms of thought are in a continuous transformation, one into the other, giving thought its peculiar dynamics and resulting in the dialectical transformation of categories:

thought reflects upon a category only to find that it collapses into its own negation, and from this a third category arises that makes sense of the contradiction.

This triadic dynamic is typical of Hegel's metaphysics: an idea, or category, contains its own contradiction, constituting a second category, and their synthesis results in a new third category.[27]

In Hegel's terminology one would say that the first two categories are 'sublated' in the third. In its turn the new category will generate its own negation which demands the rise of a further synthesizing category. In this way the infrastructure of thought is unfolded, with only the use of the inner resources available to thought itself: its capacity for determination and contradiction. For Bohm this dynamic aspect is the reality which lies behind the whole transformation of the categories. He gives special emphasis to the idea that it is the tendency of thought to hold things static that provokes the rise of contradictions: thinking inevitably tries to fix the process, and because it is a dynamic process, a contradiction arises that

[27]The Kabbalistic tradition influenced Hegel's Logic in several ways. First Hegel adopted the conception of God as dynamic and evolving. The Kabbalah rejects the idea of a transcendent God existing beyond the created world in a perfect immobility in favour of the idea of God developing himself through his desire to achieve self-consciousness. This development is carried on through the dialectical tripartite process. In addition Hegel's philosophy is organized in triads, that is, the creative process is not only deployed through the dialectic process but in its constitution it is elaborated following a model of a triangle of triangles:

> Hegel's first triangle, 'God the Father' is analogous to the later *Logic*, with its tripartite structure of Being-Essence-Concept. The second triangle, that of the Son or Earth, corresponds to the *Philosophy of Nature* (Mechanics-Physics-Organics). In Hegel's words, 'the Idea of God' becomes 'the universe of God'. The Idea's *telos* is to become embodied, another element which strongly suggest the influence of Boehme (and also, as we shall see, F.C. Oetinger). In the third triangle, God intuits the Son, or earth, as Himself, and achieves self-awareness, a moment which approximates the role played by Spirit in Hegel's mature system. Magee, 'Hegel and Mysticism', p. 261.

sets everything in movement again.

> Now so the appearance of contradiction is a sign of movement. If we say that the reality is movement, but any time you abstract anything not moving, it will always be the opposite. They will come into contradiction. Any attempt to assert a thought that it is not moving must lead to contradiction [. . .] but it is the function of thought to assert these static things, right? Therefore a thought must come out into contradiction. That part of its process. But contradiction may be taken as something which just makes it worthless, or in certain ways it becomes the step to the new thought.[28]

The very first category with which Hegel begins is with 'Being' as it seems to be the most immediate and simple aspect of any possible thought, but further reflection reveals that it is only meaningful in relation to 'nothing' and the Hegelian way out of this paradox is to posit a third category, 'becoming', which encompasses both categories. Bohm clarifies that Hegel is not maintaining that the being of things and the non-being of things are the same, but that the thought of being and the thought of non-being are the same. The holistic aspect of this process lies in the way in which the opposites are united in a higher level of understanding. Things that are thought to be different end up being identified in the oneness of the mind.

From Being, a series of categorical triads unfold propelled by the sublation of opposites, and thus a chain of categories of thought is generated. Hegel's tripartite philosophy has many correspondences with Bohm's philosophy: in Bohm's layered organization of the Qualitative Infinite of Nature,

[28]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 10 Side B.

one of the central philosophical ideas introduced in Causality and Chance in Modern Physics; in Bohm's later thoughts about the relationship between mind and matter.[29] Therefore, by way of Hegel's *Logic*, it could be argued that there is an influence of the Christian Kabbalah on Bohm.[30]

For Hegel, this chain is not indefinite, it terminates with the production of the Absolute Idea, the conception of being as a self-determining totality which includes all the categories that the Logic has dealt with before. This category is holistic, different from any of its sublated constituents, but a unifying whole.

But despite the importance of Hermeticism for Hegel's philosophy, Hegel is not an esotericist. This is because the mystical tradition emphasizes the ineffability of ultimate reality whereas Hegel thinks that thought can reach the Absolute and articulate it rationally.[31] Even more, he maintains that

[29]Bohm, 'A New Theory of the Relationship of Mind and Matter'; Bohm, 'Soma–Significance'.

[30]Magee, 'Hegel and Mysticism', p. 176 lists nine points to summarize the correspondences between the Kabbalistic doctrine and Hegel's system:

1. God is dynamic.
2. God's process of becoming is delineated in steps: the Sephiroth which are conceived as moments of God's being, just like the categories are sublated moments of a totality.
3. Being = Nothing.
4. Being-Nothing transcends the subject-object distinction and develops into the Absolute Idea which is a return of sorts to its own beginning, the circularity of the system.
5. The highest development of God's personality is being human.
6. All the categories, or Sefiroth, are immanent in the Absolute Idea.
7. The Sefiroth penetrate and inform all being, constituting the skeleton, the animating soul of nature.
8. The Kabbalah is a triadic, dialectical structure.
9. Evil is conceived as the fragmentation of a whole.

[31]In the *Encyclopedia Logic* Hegel claims to agree with mysticism, that speculation

it has actually happened: he did it. This is an important point as this is where Bohm parts company with Hegel. The idea that ultimate reality is unreachable by language or reason will remain an important aspect of Bohm's philosophy.

> It is an objective fact that the world is so constructed that generally speaking, by finding the unity behind the diversity, one will get laws which contain more than the original facts. And here the infinite of nature comes in: the whole scientific method implies that no theory is final. It is always possible there is something that one has missed. *At least as a working hypothesis* science assumes the infinite of nature; and this assumption fits the facts much better than any other point of view that we know.[32]

This aspect of Bohm's thought is highly significant as an indication of its true nature: Bohm follows Hegel as long as Hegel is following the Hermetic tradition, and when Hegel stops agreeing with it, Bohm stops agreeing with Hegel. Although Bohm is not choosing the Hermetic Tradition consciously, he was a true Hermetic thinker in his own right.

5.4 The Qualitative Infinite of Nature

> What I think about Hegel is that it emphasized the notion of reality as movement as process, first of all, and also as process in which opposites were involved. For example, in my

has to transcend the categories of understanding, or the 'opposites'. But in contrast he claims that this is just a step towards a higher level of discursive and rational thought from which the actual nature of God or the Absolute can be known. See Magee, 'Hegel and Mysticism' p. 271 for the whole argument.

[32]Bohm, 'A proposed explanation of quantum theory in terms of hidden variables at a sub–quantum–mechanical level', p. 56.

> book, *Causality and Chance and Modern Physics*, was affected considerably by my talks with Mario Schoenberg in Brazil who had written a lot on Hegel [. . .] any form of necessity is in the context of contingency; and any form of contingency is in the context of necessity. So they interweave in and unlimited structure and that was the content of my book.[33]

Bohm starts Causality and Chance in Modern Physics looking at the conceptual foundations of modern physics, analysing first the category of natural laws. Beginning with a general characterization of them as relationships between phenomena, he rapidly concludes that they can be grouped into two categories: causal and contingent. Causal laws are 'the necessary relationship between objects, events, conditions, or other things at a given time and those at a later time'.[34] But the processes taking place in nature satisfy more general laws than those of causality as contingent relations represent 'essentially independent factors which may exist outside the scope of things that can be treated by the laws of consideration, and which do not follow necessarily from anything that may be specified under the context of these laws'.[35]

> Rather, the categories of necessary causal connection and chance contingencies are seen to represent two ideas of all processes. To consider only one of these sides, then, always constitutes an approximation that cannot apply without limit, but that must eventually be corrected and supplemented by taking into account the other side.[36]

[33]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 13, Side A
[34]Bohm, *Causality and Chance in Modern Physics* p. 2
[35]ibid. p. 2
[36]ibid. p. 29.

Following a Hegelian approach, Bohm conceives these two categories in a dialectical relationship, where by starting from one viewpoint a context will develop in which the opposite view obtains.

> A great many of our physical laws are of that nature. If we accept quantum mechanics to the present view, all of them are, in fact. Therefore, all necessity seems to rise out of contingency. But on the other hand, that seems one-sided. Does not contingency arise out of necessity? That was the work I did with Walter Schützer [...] Therefore, necessity can be contingency and contingency becomes necessity. Each one reflects the other and ultimately, in the totality, they are identical. They are just two sides of one process. That led me to the idea of the infinity of levels, to say that every necessity is limited by a contingency, which is in turn a necessity in a broader context, which in turn as a contingency. Every law is an abstraction of some relatively independent domain of necessity. It is in the context of some contingency. Every law involves necessity and contingency. Classical physics is that way. The laws of motion are necessary, but the initial conditions are contingent. No laws exist which does not unite both.[37]

The categories of *causal laws* and *chance laws* are moments of the category of *laws of nature*. Bohm uses his work on probability with Schutzer and Vigier to exemplify the rise of contingency out of necessity, and his Causal Interpretation to exemplify the opposite movement from contingency giving rise to necessity in a dialectical relationship. This dialectical

[37] Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 10 Side A

relationship is the springboard from which Bohm introduces the idea of levels in the category of laws of nature:

> Besides having the two-sided character of necessity and contingency, the laws of nature show a richness of structure of a much more general character. Thus, considering the causal laws abstracted from contingencies, we find first of all that one obtains level after level of approximation, each involving qualitatively different kinds of causal factors.[38]

From this general setting, Bohm embarks upon a revision of the history of physics from the standpoint of the dialectics of causality and contingency, from which he derives the notion of a ladder of levels. He starts his analysis with the laws of classical mechanics, whose laws are of a causal nature, and whose main characteristic is the ability to draw complete determinate predictions starting from predetermined initial conditions. The predictive success of the laws of classical mechanics led to the formulation of the 'philosophy of mechanism', which consists of the assumption that the basic units out of which the universe is supposed to be built are indivisible atoms, and that a finite set of purely quantitative causal laws governing the motions of these atoms are the laws from which everything else follows. Further developments in physics during the Nineteenth century required serious modifications: first the introduction of chance and contingency in the study of nature due to the development of statistical mechanics; second, the development of the electromagnetic 'field' required a change in the ontology of classical physics. Nevertheless these developments retained the main principle that everything can be reduced, in a

[38]Bohm, *Causality and Chance in Modern Physics* p. 30.

perfect and complete manner, to an ultimate finite set of purely quantitative laws.

The physics developed during the first quarter of the twentieth century posed a serious challenge to the mechanical philosophy received from the nineteenth century. Although the theory of relativity requires important modifications to the form in which causal laws are expressed in physics, it does not go beyond the classical theoretical scheme in which the initial values of the relevant parameters determine the future behavior of a physical system for all time. On the other hand, the standard interpretation of the quantum theory was the first example of a truly essentially statistical theory, which finally exposed the inadequacy of the mechanical philosophy. However this was not entirely the end of a mechanical point of view, as the challenges that quantum mechanics posed to the mechanical philosophy were mollified by the development of what Bohm calls 'the philosophy of indeterministic mechanism', which is basically the philosophical standpoint of the standard interpretation. It is assumed that the whole information content of a physical situation is contained in the wave function whose evolution is determined by Schrödinger's equation, after the initial conditions are given, as was explained in chapter 4. As was explained, the wave function only gives probabilities for single events but predicts accurately the statistical behaviour of a large ensemble of particles, and the standard interpretation regards the statistical properties of the wave function as an epistemological barrier beyond which we can know nothing. In this position the main principle of definite causality is retained. The essential feature of the mechanical philosophy, which is the assumption that every objective and definable property of the world can be described in terms of a finite set of purely quantitative laws that fits into a mathemat-

ical scheme that is regarded as absolute and final, still applies. The only difference with the hardcore mechanical philosophy is that the laws are probabilistic instead of purely deterministic.

Bohm's main point consists of rejecting the statistical aspects of quantum mechanics as fundamental. He is careful to remark that the statistical laws work at what he calls the quantum level, but he does not assume that these laws will apply to other levels and on smaller scales. He postulates a sub-quantum level where the laws of quantum mechanics do not necessarily apply and for which a different theory is needed. A great part of his efforts in developing the Causal Interpretation were directed to show that it could point towards a new theory that might not retain the probabilistic bent of quantum mechanics. For Bohm the Causal Interpretation was not a replacement for the Orthodox Interpretation, as it included many undesirable aspects, but rather a move that opened the way in the search for something different. Philosophically it paved the way for the Qualitative Infinite of Nature, an idea based upon the inexhaustible quality of the relationships between natural processes, so that any reduction to causal or contingent laws, which are finite, will be partial, and a further elaboration will always be possible. For Bohm there is no final articulation that can include all the possibilities:

> Then the idea of the qualitative infinitive nature [...] I said nature was not limited, but was infinite in its qualities. Therefore every cause of law was limited by contingencies from beyond its context. Every law of chance was limited by cause of laws from beyond its context. The two kinds of laws wove together in an infinite, very rich structure with no limit [...] nature was infinitely rich and all woven together into one whole, that op-

> posites were woven together in this dialectal way dynamically [...] It sort of liberated me from the idea that nature could be definitely fixed and known once and for all.[39]

The last chapter of *Causality and Chance* is a radical departure from the Hegelian ideal. As argued above, Bohm parts company with Hegel on the issue of the possibility of attaining absolute knowledge. Bohm articulates his position in detail in the last chapter of *Causality and Chance*. The argument in this part of the book is laid out as a criticism to the assumption that everything can be reduced completely and without approximation to a finite framework of quantitative laws, the main characteristic of the philosophy of mechanism. Bohm's position starts by assuming that the basic properties and qualities of all entities do not depend only on their substructures, but on what is happening in their general background. For Bohm everything is linked, and the main quality of the relationship between things is that this relationship is infinite in content and cannot be reduced to any finite description. Moreover, the pattern of relationships can be very different in each domain, so there is not a repetition of a general pattern of laws that can be found everywhere. The Qualitative Infinite of Nature is not only an infinite gradation of levels, things, and relationships among things, but is also a universal interconnection between everything at all levels. He is not dismissing the value of scientific theories, only stressing their limitations:

> Any given set of qualities and properties of matter and categories of laws that are expressed in terms of these qualities and properties is in general applicable only within limited contexts,

[39] Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 9 Side B

> over limited ranges of conditions and to limited degrees of approximation, these limits being subject to better and better determination with the aid of further scientific research.[40]

The point of view of the Qualitative Infinite of Nature is more than just an alternative to the mechanistic philosophy: it constitutes a broader point of view, as it does not contradict or invalidate the findings of scientific research, it simply places them in a broader context, as it requires that any theory needs to qualify its context, conditions and degrees of approximation in which it is valid. Moreover, this point of view highlights the need to integrate the background as a fundamental condition for the understanding of any phenomena, contrasting with the normal point of view which abstracts the background from the phenomena. Anything, no matter how fundamental it may seem, depends for its existence on its background and its substructures for which it is the background. This interconnection is a reciprocal relationship, not an interaction, as it transforms the things themselves continuously. Bringing it to its ultimate consequences, this reciprocal relationship implies that all things existing in nature make a contribution to the universe as a whole, and ultimately the notion of a stable 'thing' is an abstraction, conceptually separated from its background but that does not exist in reality. These abstractions are always limited in scope and yet necessary, as it is impossible to deal directly with the whole qualitative and quantitative infinite that is the universe at any level.

The Qualitative Infinite of Nature is the core of Bohm's holism, and he further developed the idea and its consequences in many ways. This concept includes not only the whole but also the movement:

> In conclusion, the notion of the qualitative infinite of nature

[40] Bohm, *Causality and Chance in Modern Physics* p. 133.

> leads us to regard the eternal but ever-changing process of motion and development described above as an inherent and essential aspect of what matter is. In this process there is no limit to the number of kinds of things that can come into being, and no limit to the number of kinds of transformations, both qualitative and quantitative, that can occur. This process, in which exist infinitely varied types of natural laws, is just the process of *becoming*, first described by Heraclitus several thousands of years ago.[41]

Bohm considers that in order to deal successfully with things we need to abstract them from their natural processes in which they are always changing their properties and qualities to become something else, and not only living things, but matter and everything else. This process is not smooth or coordinated, but quite complex and self-contradictory: and yet that is the essential mode of all things. The reason why we can experience things as stable is because the sheer number of simultaneous processes level each other out, leaving a process that seems stable and autonomous. If we were to consider things in all their detail we would need to consider this infinitude of complex movements. But because we cannot, no matter what theory we can devise, it will always be an approximation to the thing in itself. Because all things can become qualitatively something else, it is not possible to give a complete and eternal definition of any given thing in terms of a finite number of qualities and attributes. The full content of the process of becoming is impossible to exhaust.[42]

[41] Bohm, *Causality and Chance in Modern Physics* p. 152.

[42] Bohm's position is reminiscent of the Kantian dualism between *noumenon* and *phenomenon*. For Kant the *noumenon* is equated with the world of ideas and is contrasted to *phenomenon*, which is related to the world of physical sensory experience. Kant gave

To finish drafting his position, Bohm considers that the epistemological limitation imposed by the process of becoming which is implied by the Qualitative Infinite of Nature does not lead necessarily to a philosophical position in which there is no objective reality. The fact that we cannot find a set of laws that have an ultimate objective content does not mean that there is no objective reality, it simply means that we are not able to reach it in this way:

> In our point of view, we admit that all the above things do actually colour and influence our knowledge; but we admit also that nevertheless there still exists an absolute unique, and objective reality.[43]

In other words, although there is a reality that underlines the Universe, this reality is unattainable by language or thought. Knowledge will be always limited and relative, in particular scientific knowledge.

5.5 The Limits of Scientific Knowledge

For Bohm, although there is a scientific reality, scientific theories are always a relative move towards this reality: or in other words, the way to study the absolute is by the relative, in its inexhaustible multiplicity and diversity. This is the view that he applied to the Orthodox and the Causal Interpretations. In his papers of 1952, Bohm's intention was not to present a final alternative to quantum theory, but merely to show that an alternative view in which individual particles had definite properties was possible.

the classical version of the philosophical controversy denying the possibility of knowledge independent of the senses. He affirms that the noumenal world may exist, but it is completely unfathomable.

[43]Bohm, *Causality and Chance in Modern Physics*, p. 170.

Bohm never took his proposal as the last word, as he thought that the Causal Interpretation had as many issues as the Orthodox Interpretation:

> At this stage, as pointed out in Section 1, the author's principal purpose had not been to propose a definitive new theory, but was rather mainly to show, with the aid of a concrete example, that alternative interpretations of the quantum theory were in fact possible. Indeed, the theory in its original form, although completely consistent in a logical way, had many aspects which seemed quite artificial and unsatisfactory. Nevertheless, as artificial as some of these aspects were, it did seem that the theory could serve as a useful starting-point for further developments, which it was hoped could modify and enrich it sufficiently to remove these unsatisfactory features.[44]

Bohm thought that to remediate the philosophical inadequacies of quantum theory it was necessary to make a radical departure and investigate deeper structures that underlie physical phenomena. The Causal Interpretation was a first step in this direction, however his proposal was largely misinterpreted as motivated to find a classical order based on a mechanical determinism from which the quantum formalism would emerge. But that was not his intention, his initial proposal was conceived to show that there were optional ways to interpret the quantum phenomena. But this proposal was not final, not even adequate. Bohm had already highlighted the need to go beyond mechanical ideas:

> ...the entire universe must, in a very accurate level, be regarded as a single indivisible unit in which separate parts ap-

[44]Bohm, *Causality and Chance in Modern Physics*, p. 110.

> pear as idealizations permissible only on a classical level of accuracy of the description. This means that the view of the world as being analogous to a huge machine, the predominant view from the sixteenth to nineteenth century, is now shown to be only approximately correct. The underlying structure of matter, however, is not mechanical.[45]

He developed the 'non-mechanics' theme in chapter 5 of *Causality and Chance in Modern Physics* where he gives a detailed criticism of the attempt to apply a mechanical philosophy to the quantum domain. The Quantum Potential is a key element in Bohm's view, as it is this aspect of his approach that makes his theory holistic, as it was the whole that determined the properties of the individual particles and their relationship, not the other way round. For Bohm the universal interconnectedness could not be reduced to an interaction between some fundamental particles given a priori. For him there was no such thing as the fundamental particle: at any layer there are quasi-stable, semi-autonomous features that could be related and organized into a coherent structure which can be called a theory. However these quasi-stable features take their properties from the total process itself. In the case of the Causal Interpretation, the Quantum Potential is the enabler of the quantum properties when the system is seen from the particle point of view, but in doing this the 'particle' is not independent of the background, it is the Quantum Potential that contains the effect of this background. This implies that the particle and Quantum Potential form an indivisible whole.

Bohm insisted that his 1952 papers should not be taken as his dramatic conversion to a deterministic, mechanical viewpoint. He was merely trying

[45]Bohm, *Quantum Theory*, p. 167.

to show that an alternative that attributed properties to an underlying reality was possible. He was not offering these proposals as the final, definitive interpretation of the quantum formalism in the non-relativistic domain. It was only a first draft in a new direction, but much work needed to be done as he felt that the Causal Interpretation was somewhat ad hoc and not totally convincing as a physically intelligible interpretation.

Some of the issues with the the Causal Interpretation were merely technical, but there was also a deeper problem:

> Finally, our model in which wave and particle are regarded as basically different entities, which interact in a way that is not essential to their modes of being, does not seem very plausible. The fact that wave and particle are never found separately suggests instead that they are both different aspects of some fundamentally new kind of entity which is likely to be quite different from a simple wave or a simple particle, but which leads to these two limiting manifestations as approximations that are valid under appropriate conditions.[46]

Bohm did not propose the existence of a classical particle, but rather a quite different kind of entity which is a product of the holism of processes we see in nature. For Bohm the world is not a system of immutable particles with well-defined properties interacting through mechanical forces:

> A fundamental problem in scientific research is then to find what are the things that in a given context, and in a given set

[46]Bohm, *Causality and Chance in Modern Physics*, p. 117.

> of conditions, are able to influence other things without themselves being significantly changed in their basic qualities, properties, and laws. These are, then, the things that are, within the domain under consideration, autonomous in their essential characteristics to an adequate degree of approximation [...] Thus far, we have been discussing the properties and qualities of things mainly in so far as they may be abstracted from the processes in which things are always changing their properties and qualities and becoming other things. We shall now consider in more detail the characteristics of these processes which may be denoted by 'motion'.[47]

After the publication of *Causality and Chance in Modern Physics* Bohm started to move on in new directions which eventually changed his physics thought substantially and in which the interpretation problem acquired a completely different meaning. However the physics community at large has not followed this development. When quoted or referenced, the emphasis is still mainly associated with 'hidden variables', the 1952 papers, and the problem of extending the Causal Interpretation to the relativistic domain. The developments in his thought and science that came after, and which are considerably different, remain largely ignored by the physics community. The other side of the coin is that the community that got interested in Bohm's philosophical research had a limited capacity to understand the role and significance of Bohm's scientific work in his philosophy. This has produced a partial, simplistic and fractured view of Bohm's work which does not represent Bohm's thought, and limits the appreciation of its depth. Our aim is to contribute to a more integrated view of Bohm's

[47] Bohm, *Causality and Chance in Modern Physics*, pp. 145–146.

thought and work.

5.6 Summary

As seen in this chapter, Bohm's philosophical investigations helped him to rethink critically the Causal Interpretation, and resulted in the publication of Bohm's first philosophy book, *Causality and Chance in Modern Physics*, featuring the indirect influence of the Western esoteric tradition through the idealistic philosophy of Hegel. Although at the end of the 1950s Bohm could be consider still a 'materialist', by the early 1960s he was not only ready to include more esoteric ideas in his thought, but to engage actively with the esoteric tradition. In the next chapter I will examine more closely Bohm's esoteric leanings in general and his active involvement with the Indian teacher Jiddu Krishnamurti.

Chapter 6

Encountering the Guru

In his search for new directions Bohm kept an open mind. He pursued a dialogue with a wide variety of thinkers that exerted an important influence on his thought. Although many of these encounters are important to understand Bohm's philosophy, none was as influential as his encounter with the thought and the personality of the Indian esoteric teacher Jiddu Krishnamurti.

6.1 Moving Forward

The beginning of the 1960s marked a turning point for Bohm. In 1961 he was appointed to the newly created Chair of Theoretical Physics at Birkbeck College, University of London, where he would remain until his retirement in 1983.

In *Problems in the Basic Concepts of Physics*, the title of his inaugural lecture delivered on the 13th of February of 1963, Bohm set out boldly into radical new directions.[1] Already in *Causality and Chance in Modern*

[1] Bohm, 'Problems in the Basic Concepts of Physics'.

Physics Bohm had moved closer to Einstein's criticism of the Causal Interpretation. Einstein didn't supported Bohm's theory because he felt that it represented only a refinement of the same old ideas and he thought that the challenge presented by quantum theory and its unification with general relativity required radically new concepts. Bohm agreed with this and he set himself into a new direction for which he needed new mathematical tools, capable of expressing his thoughts, and a philosophical background that could support them. The desiderata delineated in this lecture will guide Bohm for the rest of his scientific career.

He was proposing a re-examination of the basic categories inherited from classical physics, like the notion of order, space, time and chance, going well beyond the search for new equations of motion, as he has done in the Causal Interpretation. He stressed that a new understanding should take physics beyond the notions of particles, interaction fields and the coordinate oriented space-time continuum of both classical and quantum physics, with a more primitive notion of processes and an emphasis on topology rather than on the metrical structures that were commonly used in present theories.[2] These topological structures should include not only the usual quantum holistic phenomena that is consequence of the quantum potential, but also the very small-scale phenomena expected to be relevant in the description of gravity at the quantum level and have the old structures as limiting cases.[3]

In these reflections, the important point for Bohm was not any more the interpretation of quantum mechanics or the finding of an alternative explanation to the conundrums of the quantum theory, but the much wider

[2]Bohm, 'A Proposed Topological Formulation of the Quantum Theory'.

[3]Although the initial topological approach considered in the lecture did not produce the expected results, it paved the way towards the algebraic approach that Bohm will adopt at a later stage.

issue of the fundamental concepts on which the physical theories are built on, and the deep structures that form the way we perceive the world. Bohm's interest moved from the interpretation problem to more philosophical grounds. This new philosophical search had to be inclusive enough as to provide a coherent description of the whole world where the emphasis was not physics any more, but contained physics. [4] He would return later to apply the insights brought by his philosophical investigations on the interpretation of quantum mechanics, but this was not his main concern any more. He will spend the next 30 years producing a new philosophy that was aimed at the mind, consciousness, thought and how is this related to the production of science, art, its relation to language, social reality and human interactions.

This re-examination of the basic categories of physics led Bohm to question how concepts used in physical theories are formed, and more generally how ideas and views of the world are abstracted from the raw sense perception. He felt that physical concepts were constructed using pre-existing abstractions that had already a fair amount of sophistication, and that in order to obtain more powerful and fundamental concepts it was essential to go back to more primitive constructions. This led him to

[4] However, although the interpretation problem was not at centre stage any more, Bohm did not abandoned it completely. During the mid 1960s Bohm would return with a variation of the Causal Interpretation developed with the physicist and philosopher Jeffrey Bub, in which they proposed a stochastic modification to Schrödinger's equation that leads to a model whose predictions disagreed with those of the Copenhagen Interpretation, providing a possible avenue to challenge it in empirical terms. The suggested experiment involved two measurements on conjugate variables performed sufficiently quickly one after the other. The speed at which these measurements were performed was the crucial characteristic of the experiment, as well as its main difficulty. If the time between measurements was too long, then the predicted results will agree with those predicted by the Copenhagen approach. An experiment was made within the time-scale suggested by Bohm and Bub, but unfortunately the results agreed with the Copenhagen approach. Although this result did not invalidate the model, no more experiments were planned and Bohm abandoned this approach.

investigate the psychology of perception, how these perceptions are transformed into language and how this articulation impacts on physics. An idea was that visual perception was an important source of concepts and that a primary notion of order, identity and other fundamental concepts may come through it. Therefore an avenue to find new ways of thinking physics, or anything else for that matter, was to pay more attention to what we visually perceive and how we use language. By changing the way that we perceive things and how we talk about them can change the way that we think and transform our actions and therefore find solutions to many problems affecting humanity. This idea was about freeing oneself in relation to one's visual perception, a motive that Bohm readily connected with the esoteric thinkers he was beginning to explore:

> You see the way of looking is conditioning ... our visual perception is conditioned. And then Ouspensky and Gurdjieff and Krishnamurti ... they raised the hope that you get free of this conditioning.[5]

In his search for more fundamental concepts, Bohm's network of associates became very wide, engaging with thinkers working in very different disciplines from theoretical physics: philosophers, artists, biologists, sociologists and esoteric thinkers who contributed significantly to his ideas.[6] Many of these exchanges were carried out by letter and a record of them was preserved. Of these conversations two of the more productive were:

[5]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 12 Side B.

[6]These encounters very often ended acrimoniously when major disagreements were encountered. Rather than trying to unravel the issues and reach a satisfactory conclusion, the relationships were terminated, people going their separate ways never to speak again. This is a bit surprising given that Bohm maintained very emphatically that the major problems of humanity were due to the lack of effort to sort differences between people's points of view!

his intense dialogue with the American painter Charles Biederman, which touches upon virtually all the main topics that will remain important for Bohm; and his exchanges with John R. Platt with whom Bohm discussed extensively the nature of perception.

A more emphatically esoteric dialogue was Bohm's three years conversation with the British philosopher and mathematician John Godolphin Bennett (1897–1974), best known for his association with the Armenian-Greek esoteric teacher George I. Gurdjieff (1866–1949) and the Russian polymath Peter D. Ouspenski (1878–1947).[7]

Bennet had met Gurdjieff and Ouspensky in Constantinople in 1921 and in the summer of 1923, he spent three months at Gurdjieff's Institute for the Harmonious Development of Man in France. Bennett was convinced that Gurdjieff had a profound understanding of the techniques of spiritual transformation. After returning to England, Bennet worked with Ouspensky's groups for the next fifteen years, and in the summer of 1949 he spent a month working very intensively with Gurdjieff in Paris.

[7]Gurdjieff taught that people cannot perceive reality in their normal state of consciousness, which was a kind of sleeping state that led people to live their lives as 'unconscious automatons'. His teaching is about the possibility and the means to awake from that state to become a fully conscious human being. However is not an easy process, one must expend considerable effort to start the transformation towards consciousness. Gurdjieff calls this conscious effort 'The Work'. Though GurdjieffâĂŹs system is based in many traditional ideas of Western esotericism, it is marked by innovations. It offers a cosmology rich in correspondences and includes a transformational practice through a self-conscious ballet, sacred gymnastics, and other alienating exercises to break down habitual identifications. This were later termed 'the movements'

Ouspensky met Gurdjieff in St. Petersburg who had just returned to Russia after many years seeking esoteric wisdom among masters in Central Asia. Ouspensky believed that Gurdjieff had found a new system of thought and a way to teach it, he sought to systematize GurdjieffâĂŹs teachings in a coherent system, a work he published in 1950 with the title *In Search of the Miraculous* (1950). Gurdjieff never used the term Fourth Way which was the way that Ouspensky used to refer to what Gurdjieff termed 'the work'. The term became popular later when, after his death', Ouspensky's students published a book with that title. Ouspensky's was a prolific author, his influential *Tertium Organum* (1912) was a profoundly esoteric work addressing the development of higher states of consciousness.

Bohm met Bennet thanks to the efforts of one of his students, Anthony Blake, who arranged and mediated their initial interviews.[8] Bohm and Bennett carried on a three year debate on the subjects treated in Bennett's *The Foundations of Natural Philosophy* (1956), the first part of his 4 volume series *The Dramatic Universe* (1956-1966), that elaborates upon Gurdjieff's esoteric teachings.[9] Although Bohm was receptive to Gurdjieff's idea of people living like sleepwalkers, not being completely awake, he considered that Gurdjieff's methods were only psychological tricks with no real depth. Bennet for his part was critical of Bohm's holistic ideas, thinking that Bohm's notion of an undifferentiated and undivided totality was philosophically weak. As the two men became more and more critical of each other ideas the conversations became more tense, until finally in 1964 both men stopped their exchanges going their separate ways.

It is unfortunate that the two men failed to find common ground as it is evident from their correspondence that they were very close in many ways. However the failure to communicate made Bohm more and more keenly aware of the lack of communication between otherwise intelligent people whose positions are not really that far apart.

6.2 A New Order

While still in Bristol Bohm started to correspond with the American painter Karl Charles Biederman (1906-2006). Born in Cleveland and educated in Chicago, Paris and New York, Biederman settled in a farm in Red Wing, Minnesota, where he had his workshop and where he developed his ideas

[8] Blake published a partial collection of the Blake-Bohm correspondence. See Bohm and Bennet, *The Bohm–Bennet Correspondence 1962–1964*.

[9] Bennett, *The Dramatic Universe*

about the relationship between art and nature. He described his work using the term 'Structurism' and was very active developing a new theory of art. He wrote several books on the subject, including the monumental *Art as the Evolution of Visual Knowledge* published in 1948.

Bohm and Biederman engaged in a vigorous and stimulating correspondence that lasted from March 1960, when Biederman first wrote to Bohm, until April 1969, when Biedermann decided to end the correspondence because he was put off by Bohm's view on Krishnamurti.[10] The record of these exchanges, nearly four thousand pages, include explorations into the relationship between art and science, creativity, determinism, order, perception, consciousness, structure, and the ultimate nature of reality. It is a fascinating record that offers a window to the development of Bohm's and Biederman ideas during the 1960s.[11] In their long association, Bohm and Biederman touched upon many subjects, and some of them will remain important for Bohm who will continue to pursue them usually with the help of other thinkers, notably with Krishnamurti.

The starting point of the Bohm-Biederman conversation was around the idea of nature. After reading *Causality and Chance in Modern Physics* Biederman felt that there was a similar situation in physics and in art. He thought that the traditional views of nature had become inadequate in both areas, and that the initial response of both fields proposing a new view of

[10]There are plans to publish the Bohm–Biederman correspondence in its entirety, The years 1960-1962 has already appeared: Bohm and Biederman, *Bohm–Biederman Correspondence*. The letters from Bohm to Biederman can be found in NCUACS, *66.4.97* C.66-92.

[11]Analysing this material in detail is a task that would requires a considerably amount of resources and deserves a research project on its own right. For pragmatic reasons I am making a rather one-sided and limited use of this material as my main interests are Bohm and his relationship with esoteric thinkers. Biederman is not an esotericist, however Krishnamurti figures regularly in the discussion specially after 1962. This opens the possibility that a more focused reading of these letters may bring to the surface important elements in Bohm's thought during the 1960s that I may be overlooking.

nature, that at the time had become mainstream - was equally inadequate. Biederman identified this initial response with the Copenhagen interpretation of quantum mechanics in the case of physics and with Surrealism in the case of art. Both Bohm and Biederman shared the view that to came out of the impasse in which both disciplines were stuck it was necessary to develop an alternative concept of nature.

The notion of contingency and necessity, that Bohm treated at length in *Causality and Chance in Modern Physics* and that lead him to the notion of the qualitative infinite of nature, gave them entrance to a long discussion on the notion of order, a discussion that Bohm will elaborate later into the Implicate and the Explicate Orders. This notion of orders led Bohm to think on what he called 'the totality'

> I defined totality as all that there is, was, and will be . . . the totality is the process itself, acting creatively in every moment. Only the totality fully determines each part, and this totality is not accessible at any moment, to our knowledge. For the latter, by its very nature, refers only to the past, and not to the actual, living process, in its concrete existence from moment to moment.[12]

One important aspect is our relation to this totality, and Bohm is adamant in the assertion that we can perceive this totality, such perception he calls 'understanding', which he maintains can't be defined but nevertheless it can be described. For Bohm understanding is a quasi-mystical realization of the total process, a glimpse or in some cases a permanent perception of 'all that there is, was, and will be', the something that cannot be described using language, but that can be perceived. In understanding

[12]Bohm and Biederman, *Bohm–Biederman Correspondence*, p. 126.

the parts are no longer independent but sides or aspects generated in the total process. As this process evolves and is never the same, truth is an adequate understanding of each moment rather than something fixed, absolute and everlasting. Truth changes with the totality. In contrast, thought, feeling and action are sides of the process. Thought relies on language, symbols and abstractions to the total process.

> Understanding comes in a 'flash', or is felt by some people as a 'click', in which everything falls into its proper place. Of course, when you perceive this totality, you do not see everything in detail as all at once. This comes out later only as you unfold and develop the full implications of such an understanding. But what is basic to understanding is that you suddenly cease to see certain things as parts that have to be put together, and instead see them as sides or aspects generated in a total process, so that you now understand why they are related as they actually are.[13]

Bohm differentiates between 'thought' and 'understanding. Making clear the difference is of paramount importance as thought processes can become fixed and stiff and get in the way of true understanding. He felt that the confusion of the totality with thought and its by-products, like language, is the root cause of all human problems. He was convinced that obtaining the mental lucidity to distinguish between the totality and the way that we talk about it will give thought a flexibility and tolerance that will help to solve many human problems. In particular he proposed that this confusion was also present in the way physical theories are constructed, and how they

[13]Bohm and Biederman, *Bohm–Biederman Correspondence*, p. 128.

are interpreted. The motivation behind these views about understanding and the perception of the totality was founded in his own mystical experiences, which Bohm was not shy of sharing with Biederman. Bohm writes in his letter of 23rd of March 1962 that:

> I occasionally got a sudden'glimpse' in which one felt that reality is in a different dimension (as two views of an object in a stereoscope fuse on to three dimensions). In this new set of dimensions, one saw that the inner and the outer are basically one. However, this glimpse lasted only for a moment. I think that I saw why it didn't last. In this state of unity of 'inner' and 'outer', the new truth starts to operate. But this operation implies a totally different kind of action - an 'openness' that is at variance with all the norms of common life. It also makes one very vulnerable, as nothing can be kept for oneself or concealed. To continue in such a state would require a kind of love that does not exist in me, and that probably exists in very few people. So fundamentally, our understanding is limited by the absence of love. This is what I indicated in an earlier letter. Understanding without love is impossible, as is also love without understanding.[14]

Clearly Bohm felt that his own experiences were limited but he believed that this 'glimpses' could be developed into a deeper state. He believed this because he thought that he had found the living example of such condition in Krishnamurti who represented for him an actual case of the reality of a deeper and permanent perception of that totality. The question of

[14]Bohm and Biederman, *Bohm–Biederman Correspondence*, p. 204.

how to develop this perception is the central issue in his philosophy. The solutions to all human problems, and developing a new philosophy, a new social order, and a new science could be developed from that state of perception.

In this context Bohm started to talk about evolution of man and the possibility of a purposeful transformation of consciousness to perceive 'the totality'. To do this he proposed that it is necessary to recondition our thought processes by a careful attention to our use of language, and a deep analysis of our perceptions. The possibility and the practical means by which this transformation of perception could be carried out is what will become the main topic in Bohm's dialogues with Krishnamurti.

6.3 On Physics and Perception

Pursuing the idea that new concepts in physics could be developed based on an analysis of how usual concepts are constructed from the process of perception, Bohm did a very careful study of the cognitive development in children based on the work of the Swiss psychologist Jean Piaget (1896–1980). The basic idea was that the cognitive process in children begins with some kind of sensation of the world which presents itself as a totality in a state of flux, in which there is no recognizable structures or permanent characteristics. These perceptions are developed by movements or other operations, by which invariant relationships are abstracted, these invariants that can be reproduced are properties of the movements rather than properties of what is perceived. Each kind of invariance is synthesized in a mental image giving rise to organized language and logic, which function as a 'map' of the perceived reality. As the maps are internalized,

they acquire a life of their own, and soon perception is effected through the structure of these 'maps'. Very soon is forgotten how the map came to be, and how it only represents a convenient illusion based on what has been found to be invariant in the mechanisms of perception, taking the place of the perceived object:

> The map interpenetrates what is perceived in such a way that it seems to be an inevitable and necessary feature of the whole of experience, so obvious that it is very difficult to question its basic features. In order to understand the process of perception it is necessary to go beyond the confusion of the general structural features of our mental 'maps' with features of the world. Rather, one is led to become aware of the broader totality of our perceptive process as a kind of flux, and be conscious of the relatively invariant features that have been abstracted and represented by our maps, and stop pretending that these maps faithfully portray the structure of the world. The theory of relativity was developed taking a similar step by ceasing to regard our concepts of space, time, mass, etc., abstractions of our perception, as representing absolutely permanent and necessary features of the world, and, instead, regarding them as expressions of the invariant relationships that are abstracted to make sense of the world.[15]

Bohm found that similar conclusions were being obtained from other studies about perception in adults. In particular in 1963 Bohm contacted the American biophysicist, social scientist and philosopher of science John

[15]Bohm, *The Special Theory of Relativity*, p. 149.

Rader Platt (1918–1992), asking him for some of his papers on 'the definition of straight lines in vision'. Platt's main idea that motivated Bohm to contact him was that straight lines are an abstraction constructed from the movements of the eye, an idea that had many similarities with what Bohm had learned from Piaget about children:[16]

> The essential point that we wish to emphasize in the work concerning the eye is that nothing is perceived without movements or variations in the image on the retina of the eye, and that the characteristics of these variations play a large part in determining the structure that is actually seen. It is important that such variations shall not only be a result of changes that take place naturally in the environment, but that (as in the case of tactile perception) they also can be produced actively by movements in the sense organs of the observer himself. These variations are not themselves perceived to any appreciable extent. What is perceived is something relatively invariant, e.g., the outline and form of an object, the straightness of lines, the sizes and shapes of things, etc., etc. Yet the invariant could not be perceived unless the image were actively varied.[17]

Bohm continued a long conversation with Platt on the psychology of perception and the transformations and interpretation of what is perceived.

[16]Born in Jacksonville, Florida, Platt earned a doctorate in physics from the University of Michigan in 1941. He worked in molecular biophysics and biophysics, and later shifted to philosophy of science, vision and perception, and social trends. From 1965 to 1977 he was professor of physics at the University of Michigan and associate director of the Mental Health Research Institute. In 1971 he participated in the Club of Rome drawing wide attention with his studies on the advances in the social sciences. Platt's books included 'Step to Man' (John Wiley and Sons, 1966) and 'The Excitement of Science' (Houghton Mifflin, 1962).

[17]Bohm, *The Special Theory of Relativity*, p. 153.

He used many ideas that he discussed with Platt to further develop his philosophy of science. The idea that Bohm had in the back of his mind was that science is a refinement of the basic map making activity that results from the process of perception. As there is in principle no limit to this process of abstraction, science and mathematics are systems of high level abstractions, expressing the invariant features of what has been found in experiments and observations. After the basic development of language and logical thinking we go on to make still higher level abstractions, whole systems of structures of words, ideas and concepts which express the invariant features of the world that were abstracted from the mechanism of perception. All knowledge, and in particular scientific knowledge, is a structure of abstractions.

However he thought that the ultimate test of the validity of this knowledge was the process of coming back to the initial perception of the world, he saw the task of scientific research as a deconstruction of the received concepts and a more sophisticated reconstruction of concepts based on finer invariants abstracted from the basic perception process: once problems or limitations arise in the system of abstractions that are the received theories, we can go back and try to dismantle the concepts we have formed, very importantly destroying the appearance of permanence and necessity in these concepts, and reform new concepts that bring about new more powerful abstractions. Bohm suggests that the nature of the world is closer to what we perceive directly, while classical physics is a very abstract elaboration, somewhat removed from the basic experiential field.

> Rather, the whole of physics is conceived as dealing with the discovery of what is relatively invariant in the ever-changing

> movements that are to be observed in the world. Of course, such invariance will in general hold only in some domain, so that as the domain under investigation is broadened, we may expect to come to new invariant relationships, containing the older ones as approximations and limiting cases. The lawfulness of nature is thus seen to correspond just to the possibility of finding what is invariant. But because each kind of invariance is only relative to a suitable domain, science may be expected to go on to the discovery of ever new kinds of invariant relationships, each of which contributes to the understanding of some new domain of phenomena.[18]

He thought that the development of the theory of relativity was a clear example of this process of questioning familiar concepts to find that they are just convenient constructions that can be re-elaborated. Bohm explained this at length in his third book *The Special Theory of Relativity* (1966), which contains an appendix on *Physics and Perception* in which is explained this psychological philosophy of science.[19]

He also thought that a similar process of conceptual reconstruction had not been accomplished for the case of the quantum theory, mainly because in this case the process of perception presents more difficult problems. However in order to resolve the problems on interpretation of quantum mechanics a similar deconstruction and reconstruction is necessary. So for Bohm the problems related to the foundations of quantum physics are not purely of a technical nature, but included important psychological aspects, that is, it includes a problem of changing consciousness.

[18]Bohm, *The Special Theory of Relativity*, p. 142.
[19]Ibid.

Moving forward in this direction, Bohm connects the psychology of perception with the notion of levels associated with the Qualitative Infinite of Nature developed in *Causality and Chance in Modern Physics*. There are levels of perception and Bohm makes a distinction between the concepts that are elaborated as abstractions from perception, the products of the mind that fragment the intrinsic totality, a process that he identifies with 'thought', and a deeper experience, which he calls 'understanding'. He discussed this notions extensively with Platt:

> About mental processes more generally, I should say that thought is based on symbolism, which elicits a kind of 'positive image' in the mind. The image is usually typical rather than concrete and exact; but it is capable of some accommodations, to adjust to the details of perception. Immediate perception is at the opposite extreme, where functional movements are used to establish the properties of what is unknown or poorly known. There is a higher level of immediate perception, known as <u>understanding</u>, in which the whole of our perceptual and conceptual experience may be subjected to a kind of scrutiny, which can disclose contradiction, conflict, and confusion in old ideas, as well as new relationships, orders and structures, which then become the basis of modified ways of thinking.[20]

He proposes that understanding is possible because the human mind is a 'microcosm' of the total cosmic structure process, having the potentiality for producing an order similar to the order of the universe.[21] Thought based on abstraction is a common human experience, and 'the flash of

[20]NCUACS, 66.4.97 C.51, p. 5
[21]NCUACS, 66.4.97 C.51, p. 21

understanding is the paradigm case of a perception that is unrelated to time'.[22]

However there is still a further mental state, 'awareness of awareness'. This is not the conscious realization of how the formation of concepts operates, but being aware and observing the process while it is happening, perception perceiving itself, the observer being observed:

> To begin with, the content of our awareness is usually something outside itself - either some features of the 'outside' world or some features of the 'inward' world. But whether it is an object before us, or our pains, pleasures, desires, etc., the content of awareness is usually what awareness is not. But just as we can begin to perceive our process of perception itself, and not merely some external objects, so we can begin to be aware of awareness. This is a process of a qualitative different order from being aware of a content external to awareness. For awareness shares with quantum mechanical observation the quality that when it is aware of awareness, it changes what it is aware of. As the observing apparatus participates in the process-structure of the electron, so awareness of awareness participates in the process-structure of awareness, and leads to a different kind of awareness. [23]

Bohm even suggests that experiencing awareness of awareness includes a perception of the quantum mechanical levels of his neural 'structure–process', becoming sensitive to his own fundamental physicality, to the basic process–structure of the universe, in which man comes into contact

[22]NCUACS, 66.4.97 C.52, p. 47
[23]NCUACS, 66.4.97 C.53, p. 62

with the totality. However, to be aware of awareness is not so easy as it is a very dynamic process that may take extraordinary amounts of psychic energy which is not readily available in normal circumstances as the concerns of everyday life absorbs most people's energy. However it is Bohm's belief that there have been and there are some people able to experience this state.[24] He had the example of Krishnamurti in the back of his mind, however he was careful not to bring him explicitly in his exchanges with Platt, as he had already experienced negative reactions from other associates when Krishnamurti was mentioned explicitly.

Being aware of awareness has practical consequences, and can be used to conceive a new world in which many of the problems of the world are resolved as it immediately clarifies, and frees the mind of the confusion brought about by the map-construction processes of thought, showing its limitations and possibilities. More particularly, this conscious state is the basis to develop a new conceptual foundation for physics in which problematic concepts, as in the case of quantum mechanics, can be addressed by feeing ourselves of the tendency to confuse the conceptual map with reality.

Bohm maintains that this insight will free the mind from the illusion that science leads to the knowledge of absolute truth, for the knowledge supplied by science is, like any other knowledge, basically an expression of the structure revealed in the process of coming in contact with a world, the totality of which is beyond our ability to grasp in terms of any given sets of percepts, ideas, concepts or notions.

The first step in the reconstruction of science taking into account a new psychological perspective is to realize that scientific knowledge takes

[24]NCUACS, 66.4.97 C.52, p. 48

the form of structures of fixed general principles, as having certain general invariant relationships. The usual approach takes as fundamental the similarity of basic structures, and differences are superficial, which are described as rearrangements of the basic structures. So the changing reality is described using as a foundation the aspects that don't change.

But Bohm maintains that this conception, although useful for organizing knowledge, is not faithful to the true nature of the world revealed in an act of understanding. Founding a view on what is invariant is inverting the natural order of importance, as in a state of being aware of awareness reveals that the fundamental aspect is the variability, what changes, whereas the superficial components are the invariants. Bohm intimates that understanding turns the usual description of the world 'upside down', as a person which is aware of awareness sees totality as different from moment to moment, while the similar things are abstractions:

> Thus each moment is to him fundamentally new, but it contains superficially similar features of the superstructure (such as forms in space that are familiar to us). Because the basic structure is different from moment to moment, it cannot be recorded in permanent knowledge. Instead, it must be perceived, in its changes. Knowledge is a 'map', in which things are 'inverted'. For the superficial 'permanent' structural features are treated as basic. This is often useful, but it can lead to illusion, in a deep view of the problem.[25]

For Bohm Krishnamurti was such a person.

[25]NCUACS, 66.4.97 C.53, p. 63

6.4 Jiddu Krishnamurti

Bohm's most dramatic encounter was with the Indian esoteric teacher Jiddu Krishnamurti (1895-1986) whom Bohm met personally in 1961 in London and with whom he established a close friendship. In 1959, while still in Bristol, his wife Saral brought him a book from the library, *The First and Last Freedom* (1954) by Jiddu Krishnamurti, as it contained a discussion about 'the observer and the observed', something she thought that Bohm would find interesting as 'he was talking about it all the time'.[26] Bohm read the book and found it extremely interesting. He went on to read everything he could by Krishnamurti, and eventually meet the man in person. Bohm found in Krishnamurti a man that was totally open, capable of great passion, ready to explore things in a spirit of open dialogue and able to challenge Bohm to the limit. For Krishnamurti the encounter with Bohm was equally thrilling as there had never been an equivalent individual on a common wavelength, sympathetic to his teaching and with the knowledge and intellectual command that came to Krishnamurti's aid when his powers of articulation faltered. Many times Krishnamurti had to leave the room in which he was conversing with Bohm, overwhelmed by the profundity of their dialogue.

Jiddu Krishnamurti (1895-1986), the eighth son of a poor Brahmin family, was born on May 12, 1895 in Madanapalle, a small town in Andhra Pradesh, India.[27] After the death of his mother Krishnamurti's father moved the family to Adyar where he begin to work for the Theosophical Society in 1909.

[26] Krishnamurti, *The First and Last Freedom*

[27] For a recent biography of Krishnamurti see Roland Vernon, *Star in the East: Krishnamurti, the Invention of a Messiah* (Boulder, CO: Sentient Publications, 2002)

The Theosophical Society is without a doubt one of the most influential esoteric schools of the twentieth century (and probably we could say 'the' most influential). It was founded in New York by Helena Petrovna Blavatsky (1831-1891) and Henry Steel Olcott (1832-1907) in November 1875 and in 1878 Blavatsky and Olcott moved the headquarters of the society to Adyar, a large neighbourhood located on the southern banks of the Adyar river in south Chennai (formerly Madras), in Tamil Nadu, India.

The doctrinal history of the Theosophical Society can be divided into two broad periods. The first, lasting from November 1875 until the death of Olcott in 1907, is dominated by Blavatsky's personality and her writings. This period can be further subdivided into two phases: the first phase under the background of the American Spiritualism of the 1870's and marked by the production of *Isis Unveiled* (1877); the second phase is characterized by Blavatsky's allegiance to Eastern religious doctrines, in particular Buddhism, and the production of *The Secret Doctrine* (1888), Blavatsky's magnum opus.

The second period started after the death of Olcott in 1907 when the presidency of the society passed to Annie Bessant (1847-1933) who with the help of the Anglican minister Charles Webster Leadbeater (1854-1934), gave a different bent to the doctrine of the society, strongly influenced by the Anglicanism and self proclaimed psychism of Leadbeater. Besant and Leadbeater introduced several innovations into the doctrinal foundation of the Theosophical Society: an emphasis on the practice and development of psychic powers; the adoption of Jiddu Krishnamurti (1896-1986) as the reincarnation of the World Teacher; the creation of the Liberal Catholic Church; promotion of Besant's and Leadbeater's writings as the main

teachings of the Theosophical Society instead of Blavatsky's writings.[28]

It is without a doubt that the Theosophical Society has always been a dominant force in the contemporary esoteric landscape. It is through the Theosophical Society that many important ideas that became the backbone of later esoteric currents in the West were popularized. Indeed, the esotericism of the twentieth century contain endless variations, practical and theoretical, on many of the themes set forth by the Theosophical Society: the occult constitution of man; the notions of karma and reincarnation; the possibility and phenomenology of the spiritual evolution of mankind, individual and collective; the existence of highly evolved human beings that supervise the spiritual development of mankind, the so called 'masters'.

It was Leadbeater who realized the potential of the young Krishnamurti in 1909, recognizing in the boy a very spiritually advanced soul that had a special mission to fulfil. The most ambitious project of the Theosophical Society became the re-education of the young Krishnamurti to prepare him to take his place as the World Teacher and the head of the Order of the Star, an organization created within the Theosophical Society to serve Krishnamurti's mission. For many years the resources of the society were dedicated to the education of Krishnamurti. However this caused no small complications as not everyone saw Krishnamurti in the same light as Leadbeater and Bessant. The final blow to the World Teacher project was given by Krishnamurti himself: in August 1929 when instead of taking the role that was foreseen for him by Leadbeater and Bessant, he dissolved the Order of the Star and renounced his role as the World Teacher, claiming allegiance to no nationality, caste, religion, or philosophy.

[28]To distinguish the doctrines of these two main periods it is usual to apply the term Theosophy to characterize Blavatsky's teachings and Neo-theosophy to refer to the teachings of Bessant and Leadbeater.

He spent the rest of his life travelling the world as an individual speaker, addressing large and small groups, as well as engaging in dialogues with interested individuals. He published a number of books, mainly transcriptions of his talks, among them *The First and Last Freedom*, *The Only Revolution*, and *Krishnamurti's Notebook*. With the help of D. Rajagopalacharya he established several trusts to manage his publications and speaking schedule, as well as the schools that he founded in England and in America. His central headquarters and his principal residence were located in Ojai, California.

Krishnamurti was a complex personality. In 1932 he started a secret love affair with Rosalind Williams, the wife of D. Rajagopalacharya, a friend and business partner. This relationship would last for more than twenty-five years on which Rosalind would became pregnant on several occasions, suffering miscarriages and at least two abortions. The full story of Krishnamurti's hidden love affair is told in a book by Radha Rajagopal Sloss, Rosalind's daughter.[29].

At age 90, he addressed the United Nations on the subject of peace and awareness, and was awarded the 1984 UN Peace Medal. His last public talk was in Madras, India, in January 1986, a month before his death at home in Ojai.

Krishnamurti's teachings can be summarized in few words. Truth is within ourselves, and cannot be communicated directly, each one of us need to discover it by himself. No book, authority, church or organization can help to find that truth. Constant and unrelenting search to find who we are is the only method that will bring that truth to our awareness. We must abandon theories, fantasies and preconceived images and aim for

[29]Sloss, *Lives in the Shadow with Jiddu Krishnamurti*.

the simple facts. It is possible to live in this truth, to be aware permanently in it, to live it in the moment without time, thought, memory or conceptions of past or future. Living this truth fuses the observer and the observed, and this is the state of awareness that we all are looking to achieve. This state can be referred as love, beauty, order, the timeless, and is a state of being that goes beyond death. These teachings are repeated over and over again in Krishnamurti's books.[30]

To reaffirm the basic elements of his message Krishnamurti released the following statement on October 21, 1980 that came to be known as the 'Core of the Teaching':[31]

> Truth is a pathless land'. Man cannot come to it through any organization, through any creed, through any dogma, priest or ritual, not through any philosophic knowledge or psychological technique. He has to find it through the mirror of relationship, through the understanding of the contents of his own mind, through observation and not through intellectual analysis or introspective dissection. Man has built in himself images as a fence of security - religious, political, personal. These manifest as symbols, ideas, beliefs. The burden of these images dominates man's thinking, his relationships and his daily life. These images are the causes of our problems for they divide man from man. His perception of life is shaped by the concepts already established in his mind.

[30] Jiddu Krishnamurti, *The Complete Published Works 1933-1986* (Brockwood Park, Hampshire, England: Krishnamurti Foundation Trust, 2008), [CD-ROM].

[31] Krishnamurti first wrote a statement of the core of the teaching in October 1981 for Mary Lutyens, at her request. She included it in her book *The Years of Fulfilment*, the second volume of her biography of Krishnamurti. The Krishnamurti Foundation Trust claims that on re-reading the statement in 1983, Krishnamurti made changes which are included in 'the complete and final' statement made public by the Trust.

The content of his consciousness is his entire existence. This content is common to all humanity. The individuality is the name, the form and superficial culture he acquires from tradition and environment. The uniqueness of man does not lie in the superficial but in complete freedom from the content of his consciousness, which is common to all mankind. So he is not an individual.

Freedom is not a reaction; freedom is not a choice. It is man's pretence that because he has choice he is free. Freedom is pure observation without direction, without fear of punishment and reward. Freedom is without motive; freedom is not at the end of the evolution of man but lies in the first step of his existence. In observation one begins to discover the lack of freedom. Freedom is found in the choice-less awareness of our daily existence and activity. Thought is time. Thought is born of experience and knowledge which are inseparable from time and the past. Time is the psychological enemy of man. Our action is based on knowledge and therefore time, so man is always a slave to the past. Thought is ever-limited and so we live in constant conflict and struggle. There is no psychological evolution. When man becomes aware of the movement of his own thoughts he will see the division between the thinker and thought, the observer and the observed, the experiencer and the experience. He will discover that this division is an illusion. Then only is there pure observation which is insight without any shadow of the past or of time. This timeless insight brings about a deep radical mutation in the mind.

> Total negation is the essence of the positive. When there is negation of all those things that thought has brought about psychologically, only then is there love, which is compassion and intelligence.

Bohm's philosophical and scientific concerns regarding the essence of the physical world, and the psychological and sociological state of mankind, found parallels in Krishnamurti's philosophy. The two men became close associates for more than thirty years and engaged in a common inquiry in the form of dialogues, sometimes in group discussions with other participants, but more often in one to one discussions. Bohm's involvement helped to widen Krishnamurti's audience whom also met and held discussions with several members of the scientific community thanks to Bohm.

From the side of Krishnamurti's followers the collaboration between the two men is celebrated and advertised, but it is only regarded as one of the many other conversations that Krishnamurti had with important thinkers. In the existing literature they are treated anecdotally, with a lot of emphasis on the marketing value of 'the meeting of these exceptional minds'. [32]

On the other hand most sources that are not published by organizations linked with Krishnamurti tend to ignore Bohm's relationship with the Indian teacher. For a notorious example see Paavo Pylkkanen's *Mind, Matter and the Implicate Order* (2007), which completely ignores Krishnamurti despite

[32] Two examples: Michael Krohnen, *The Kitchen Chronicles: 1001 Lunches with J. Krishnamurti* (Ojai, California: Edwin House Publishing, 1995), written by Krishnamurtis's cook in Ojai, offers a readable but biased account of these encounters, centred in Krishnamurti's dinning table; In his talk at the Ojai Retreat on the 11th of March 2012, David Moody quotes passages from his book that are relevant to the relationship between Krishnamurti and Bohm. See David Moody, *The Unconditioned Mind: J. Krishnamurti and the Oak Grove School* (Wheaton, Il: Quest Books, 2011).

Pylkkanen meeting Bohm in the context of Krishnamurti's organization.[33] David Peat's *Infinite Potential*, the standard Bohm's biography, mentions Krishnamurti only incidentally.[34]

Bohm and Krishnamurti's collaboration has not escaped being the object of ridicule. The American sceptic Martin Gardner wrote in 'David Bohm and Jiddo Krishnamurti' (2000) that:

> Ex-Communists and fellow travellers have a habit of turning from Marxism to another ideology, often Catholicism or some other religion. In Bohm's case it was a bounce toward Buddhism and Hinduism, and the teachings of Krishnamurti. After decades of close friendship, with unbounded admiration largely on Bohm's side, the two had a bitter falling out. Krishnamurti always had a low opinion of physics, and Bohm's pilot wave theory in particular. He had a cruel way of treating Bohm as if he were a stupid child unable to fully appreciate his (Krishnamurti's) vast wisdom [...] Bohm's creative work in physics is indisputable, but in other fields he was almost as gullible as Conan Doyle [...] Bohm often had to be saved from idiots.[35]

Bohm's relationship with Krishnamurti was not without its challenges. As mentioned earlier, their friendship suffered a major set back in 1984 due to Krishnamurti's lack of tact dealing with his ailing friend. Bohm acknowledged the influence of Krishnamurti's teaching on his thought, however he had difficulty with the contrast between Krishnamurti's preaching and

[33]Pylkkanen, *Mind, Matter and the Implicate Order*.
[34]Peat, *Infinite Potential*.
[35]Martin Gardner, 'David Bohm and Jiddo Krishnamurti', *Skeptical Inquirer*, (2000).

his behaviour.[36] Krishnamurti kept advising against spiritual teachers, but at the same time he behaved like one of them. Another complaint was that Krishnamurti didn't acknowledged a changed state of consciousness in anyone but himself. Krishnamurti was under the impression that he was the only one capable of a higher level of awareness. He used to say 'sometimes I acknowledge the Buddha', but beyond that he was very reluctant. Bohm resented the low regard that Krishnamuri's had for his achievements in science and felt that he regarded Bohm as just an intellectual that failed to achieve a real consciousness transformation. After Krishnamurti's death, Bohm read Radha Rajagopal Sloss' book and became aware of his relationship with Rosalind Williams. This mortified Bohm enormously because Krishnamurti advised celibacy to Bohm and so he found this attitude very hypocritical. This caused Bohm a great deal of grief. Nevertheless, for Bohm, the problem was Krishnamurti's personality, not the teachings that he always considered sound.

The Krishnamurti–Bohm Dialogues took place over a span of 25 years. The first six recorded dialogues occurred in August of 1965 after one of Krishnamurti's gatherings in Saanen, Switzerland. The last dialogue took place in 1983 and has been published as *The Future of Humanity*.[37] Many tape recordings exist of informal lunchtime conversations with the Staff and Students of the Brockwood Park School in England and the Krishnamurti Foundation Trust in Ojai, California. Many formal dialogues were recorded, transcribed and published in book form.[38]

[36]NCUACS C.106 to C.109 contains the correspondence between Bohm and Fritz Wilhelm, a follower of Krishnamurti that later became one of his critics. Bohm met Wilhem in 1975 and their exchanges include a fair amount of criticism of Krishnamuri.

[37]Bohm and Krishnamurti, *The Future of Humanity: A Conversation*. A recording is available in YouTube: <http://www.youtube.com/watch?v=ohJuREhJ_0Y> [accessed 1 September 2015]

[38]Bohm and Krishnamurti, 'Truth and Actuality'; Bohm and Krishnamurti, 'Conversa-

As we have mentioned in section 3.6, Bohm acknowledged the importance of Krishnamurti in his thought:

> I did follow this thing up with Krishnamurti . . . I think partly through these discussions, although not entirely, I came to this idea of the Implicate Order.[39]

6.5 Summary

After being appointed to the Chair of Theoretical Physics at Birkbeck College in 1961, Bohm found the economical and emotional stability he had been lacking since his exile from the United States in 1951. At Birkbeck Bohm enjoyed freedom, enough resources and a secure platform from which he could continue his philosophical investigations.

Although Bohm interacted with a wide variety of thinkers who had an important influence on his thought, the esoteric tradition had a most definite influence on him through the Indian teacher Jiddu Krishnamurti, whom Bohm considered as an example of someone enjoying a special state of consciousness. Although this was not the first time that Bohm encountered the esoteric tradition, as he had already an indirect link to it through Hegel's philosophy and through his dialogue with J. G. Bennet, this influence became much more pronounced with his involvement with Krishnamurti.

tions With David Bohm, Mr. Narayan And 2 Buddhist Scholars 22nd and 23rd of June 1978 Brockwood'; Bohm and Krishnamurti, *Limits of Thought*; Bohm and Krishnamurti, *The Ending of Time*; Bohm and Krishnamurti, 'Wholeness of Life'; Bohm and Krishnamurti, 'Conversations With David Bohm, 14th and 16th September 1980, Brockwood Park'; Bohm et al., *The Nature of the Mind*; Bohm, Wilkins and Krishnamurti, 'Brockwood Park Discussions with Maurice Wilkins and David Bohm 12th February 1982'. Some of the original recordings of these conversations are available on DVD or CD-ROM from the Krishnamurti Foundation Trust.

[39]Bohm and Angelos, 'Beyond Limits: A Conversation with Professor David Bohm' p. 13

Having found his spiritual mentor in Krishnamurti and enjoying a stable life, Bohm spent the rest of his career developing and extending the idea of the Implicate Order, a concept that he developed with the help of Krishnamurti, into an integral and coherent philosophy: A realist process ontology founded on the Implicate Order that takes into account the phenomena of physics through an Ontological Interpretation of quantum mechanics; a progressive epistemology that claims that improved knowledge is possible despite the impossibility of reaching absolute certainty or total knowledge through language, science or thought; an introspective praxis, akin to meditation, in the form of a dialogue technique aiming to transform the mind and develop an 'awareness of awareness'.

Chapter 7

The Undivided Universe

In this and the next chapter the emphasis is changed from the diachronic perspective I have followed thus far, to a synchronic presentation of Bohm's main philosophical ideas reorganized with the help of the four mandatory characteristics of Faivre's model of Western esotericism.[1] My aim in doing this is to examine Bohm's philosophy with emphasis on the more esoteric aspects of the Implicate Order and to support the suggestion that Bohm's philosophy resembles a traditional form, albeit with contemporary scientific and philosophical content, of Western esotericism.

Using Faivre's characterization as a methodological tool to present Bohm's philosophy helps to clarify many aspects of Bohm's thought that may seem unconnected, but that when seen through this lens find a natural place. The natural fit of Bohm's thought into Faivre's model helps to

[1] As seen in section 1.3.4 this model considers four mandatory and two optional characteristics that although often present are not required to characterize a form of thought as esoteric. In setting Bohm's philosophy in this framework we are ignoring the two optional characteristics: the search for common denominators in different traditions, and the transmission of knowledge through initiation and the reception of secret knowledge. I make no emphasis on them because Bohm did not pursue actively to establish concordances with other traditions, and despite his dependence on Krishnamurti he did not acknowledged a lineage of teachers.

support my suggestion that Bohm's philosophy is of an esoteric nature.

This chapter will emphasize the first two characteristics of Faivre's model, 'Correspondences' and 'Living Nature', which are of a cosmological and ontological character, aiming to explain the cosmos, how it works and how it is organized. For the Western esoteric tradition, the universe is seen as a corresponding system with levels of manifestation, 'as above, so below', in which the influences from the subtle, above, are channelled to the concrete, below, in a sympathetic correlation. These notions establish an ontology in which the universe is seen as a single whole: anything done in a certain place and time has energetic reverberations everywhere. Bohm's ontology of the Implicate Order, explained in sections 7.1 to 7.4, fits comfortably within these two characteristics. The physical world, as described in Bohm's interpretation of quantum mechanics, is included in this model which is complemented with Bohm's panpsychism, in which the ladder of consciousness planes organized as a series of Orders forms the basis of the mind-body connection.

7.1 The Orders In Between

> Krishnamurti: A mind without . . . order . . . a mind which is order without disorder. And yet it is not order.
>
> Bohm: You mean it's not a fixed order.
>
> Krishnamurti: It is not. When there is order, conscious order is one thing, conscious disorder is another thing; conscious order tries to put disorder into order, and so order again has a stem.
>
> Bohm: Which is disorder. Yes, but I mean, what we say is that

> if order arises from thought, from consciousness and it tries to impose itself then it would be disorder.
>
> Krishnamurti: When there is no stem and therefore the brain is not the soil in which the stem can grow, so the brain itself has undergone a tremendous change. Not change - a revolution or whatever it is.
>
> Bohm: But how do you really know this?
>
> Krishnamurti: I know it because there is no contradiction, there is no detachment, attachment; no order, no disorder and then order - which means constant duality, conflict, opposites and frustrate. So, as we were saying the other day, thought doesn't function there.[2]

As mentioned in section 6.1, in the early 1960s Bohm was searching for new concepts in physics. His intentions were quite ambitious as he was aiming to set physics in a new foundation capable of dealing not only with the shortcomings of the interpretation of quantum mechanics, but also with finding ways to unify relativity and quantum field theory, and ultimately to provide a sufficiently general conceptual platform capable of including the psychology of perception, thought, art, music, social issues and even the spiritual experiences that were at the core of his conversations with Krishnamurti.

To move forward he used as a starting point the conclusions at which he had arrived in his analysis of chance and determinism in *Causality and Chance in Modern Physics*. In this book, Bohm explains that chance and determinism are two extreme frameworks in which the theoretical edifice

[2] JKO 650824

of physics can be organized. In classical physics, the paradigm of determinism and continuity reigns, whereas in modern physics there is a shift towards contingency and discreteness. Bohm though that these two extremes did not exhaust all the possibilities, and that the conceptual problems of physics could be addressed by relaxing the need to adopt one of these two options. There exists the possibility of choosing a more adequate order in between determinism and chance, as these are only just two among many options. He thought that many problems were due to the lack of flexibility in the thought process of the physics community, which was incapable of imagining possibilities lying in between determinism and contingency.

This conclusion expressed at the end of *Causality and Chance in Modern Physics* contains the germ of the idea that Bohm called the general concept of 'order', one of the three core ideas of Bohm's philosophy - the other two are wholeness and process.

> [...] order is something that is more fundamental and more universal than most of what has previously been generally regarded as basic in our thinking. This is because order is common not only to physics and biology, but also to all we can know and all that we can perceive.[3]

Bohm discussed the notion of order with the American painter Charles Biederman, as was mentioned in section 6.2. In these discussions, order

[3]David Bohm, 'Some Remarks on the Notion of Order', in *Towards a Theoretical Biology*, ed. by C. H. Waddington (New York: Edinburgh Press, 1970), pp. 18–40, p. 18. This paper was Bohm's contribution to a conference on theoretical biology organized by Professor C. H. Waddington in 1966. It was published with a companion that elaborated on the ideas presented at the conference: David Bohm, 'Further Remarks on Order', in *Towards a Theoretical Biology*, ed. by C. H. Waddington (New York: Edinburgh Press, 1970), pp. 41–60.

is a concept that subsumes the concept of difference which Bohm regards as a universal category, and in a very Hegelian way contains in itself the concept of similarity - as a 'null difference':

> With these ideas in mind, I accept your replacement of 'sameness' by 'similarity'. So now, identity has been dropped from our set of concepts. I would like to propose an argument here for you to think over. Could we not say that 'difference' is the logically prior category, and that 'similarity is a special kind of difference; i.e., it is a quality that is different from every kind of difference? This may perhaps seem at first sight to be 'word-spinning'. But perhaps it means something really important. Thus, we are led to say that there is nothing in the world but difference, if we go into a very basic analysis. But among all these differences, there are some which do not register or show in a certain field. These are the differences that are different from every form of difference that shows in the field in question. Similarly, we could say that in space and time, asymmetry is the basic category, and that symmetry is a special case of asymmetry; viz., an asymmetry that apparently balances out and doesn't show in a certain field. Thus, you can always get symmetry as a special case of asymmetry, but not the other way around. Likewise, you can always get similarity as a special case of difference, but not the other way around.[4]

Bohm's preliminary thoughts about order were first published in 'Space, time, and the Quantum theory understood in terms of discrete structural

[4]Bohm and Biederman, *Bohm–Biederman Correspondence*, p. 189.

process' and in 'Problems in the Basic Concepts of Physics'.[5] In these, he interprets the history of physics as a succession of changes of 'orders'. Bohm recognized that there were some common ideas between his analysis of the history of science as a change of orders and Thomas Kuhn's changes of paradigms. However Bohm makes it clear that there are significant differences between his approach and that of Kuhn's:

> We differ from Kuhn especially in the interpretation of the breaks that occur in the development of science and in our suggestions of ways in which these can be overcome.[6]

Bohm questions the idea that a scientific revolution is always accompanied by a dislocation of fundamental ideas, leading to incommensurable concepts held between periods. He also argues that in the activity that Kuhn refers to as 'normal science', quite significant changes appear, in contrast to Kuhn.[7] Bohm's main point is that true creativity cannot be limited to 'revolutionary' periods, that creativity can always happen, unless we block it by being too fixed in a particular order. He maintains that the fixation in the current order of physics dominated by the space-time continuum mathematically modelled by differential manifolds, is the main reasons why physics has not been able to find a description of gravity in harmony with quantum mechanics. He thinks that creativity in physics is blocked and suggests that it can be liberated if a more flexible idea of order is elicited, so that the emphasis on the current order is relaxed an other orders with a different and more generic scope can be introduced. For Bohm the general concept of order is of fundamental importance, as shown in the quote

[5] David Bohm, 'Space, time, and the Quantum theory understood in terms of discrete structural process', in *Proceedings of the International Conference on Elementary Particles* (Kyoto, 1965); Bohm, 'Problems in the Basic Concepts of Physics'.

[6] Bohm and Peat, *Science, Order and Creativity*, p. 26.

[7] Ibid., p. 26.

at the beginning of this section, and it is not only the core issue regarding physics or other material processes, it is important as well in understanding our mental processes as well:

> Indeed, wherever one looks, whether outwardly at nature, or inwardly at the thoughts and feelings that are the expression of the operation of the mind, one finds that the essence of things is always in one kind of order or another. Thus, order may well be the basic factor which unites mind and matter, living and non-living things, etc.[8]

He used a development in his notion of order, the Implicate Order, to explain how this unification of mind and matter can be carried out.[9] However, despite being such a fundamental concept, Bohm does not try to give a precise definition of order. He actually maintains that such a definition is impossible:

> The notion of order is so vast and immense in its implications, however, that it cannot be defined in words. Indeed, the best we can do with order is to try to 'point to it' tacitly and by implication, in as wide as possible a range of contexts in which this notion is relevant. We all know order implicitly, and such 'pointing' can perhaps communicate a general and overall meaning of order without the need for a precise verbal definition.[10]

On the other hand, what is possible is to elicit the concept of order because, he maintains, we already know it intuitively. Order is a set of

[8]Bohm, 'Some Remarks on the Notion of Order', p. 18.
[9]See 7.4 bellow.
[10]Bohm, *Wholeness and the Implicate Order*, p. 146.

‘similar differences’, and to explain what this means he uses the example of a geometric curve.[11] Take the simplest curve, a straight line, and divide it in segments of equal length. All the segments are similar, the only difference between them is their position, everything else remains the same. Also the difference between consecutive segments is the same all over, that is the difference in position is repeated from one segment to the next one, over and over again, so all the differences are similar. This set of ‘similar differences and different similarities’ is the order of the straight line. An order of a different kind is represented by a circle. If the circle is divided in segments of equal length, a different variation to the one in the straight line is obtained, as the different arcs will be different not only in position but also in angle, so an order of a higher level of complexity is obtained by the set of similar differences in the order represented by the circle. A new order is obtained if the circle is now replaced by a spiral as now a new angle in a new dimension is introduced.

Bohm defines structure in terms of order by considering the differences between the orders themselves, which give rise to an order of orders’, structure as a hierarchy of orders, or as Bohm says ‘different similarities’.[12] For example, in a house, there is the order of bricks which are similar but positioned differently. Then out of this order there are walls, that in themselves constitute a different order. Walls make rooms, the rooms make houses, and so on. The structure of the house is elicited by the orders themselves and their relations. The important point here is that the different orders can be related to one another.

Order is not limited to static descriptions, it is dynamical as there are

[11] In doing this he is using many of the concepts that he developed with his conversations with Platt about the visual recognition of straight lines. See 6.3 above.

[12] Bohm, ‘Some Remarks on the Notion of Order’, p. 24.

‘orders of change’ like for example reinterpreting the geometrical curve as the description of motion in which the segmentation is based on equal short intervals of time instead of length. In a situation where forces are not present, a similar situation to the case of a line arises as in free space an object moves in a straight line. In the presence of forces, it is necessary to consider second order differences. Classical physics is mostly concerned with second degree orders, but more complex orders can be imagined by the use of higher differences. Biology requires the use of higher order differences, to describe the growth of an organism. Following this pattern, intelligence in animals and man needs even higher orders of ‘similar differences and different similarities’.

The degree of an order has no limits in principle, and can achieve an arbitrarily high level of complexity, and even an infinite degree in which the movement is completely irregular, like in the case of Brownian motion. In this case, randomness appears, but it is not an absence of order, or what may be called ‘disorder’, but an order of an arbitrary high level, and therefore it is not something incompatible with order, but a special case of a more general notion of order. So in the analysis of geometric curves, there is a broad spectrum of order, going from linear and second order to an infinite degree, which contains a rich and unexplored domain.

In this spectrum of order, the quantum theory has introduced a new order in the concepts of physics with the standard notion of essential randomness. But these are not the only possibilities, in between these two orders, a full spectrum of orders can be exploited. Bohm recasts the causal interpretation as a step in the direction of eliciting the different orders in between the full random order of the standard interpretation of quantum

physics, and the regular order of classical physics.[13]

The core idea is that an isolated order is not enough, but the idea of a whole hierarchy of orders, not only in physics, but in all domains.

> Krishnamurti: So first let's begin by asking, if I may ask: is there an order which is not man-made, which is not the result of calculated order out of disturbance, an order that is probably very satisfying and so it is still part of the old conditioning, is there an order which is not man-made, thought-made?
>
> Bohm: Are you referring to the mind? I mean you can say the order of nature exists on its own.
>
> Krishnamurti: The order of nature is order.
>
> Bohm: Yes, it is not made by man.
>
> Krishnamurti: But I am not talking of such. I don't think I want to - I am not sure that it is that kind of order. Is there cosmic order?
>
> Bohm: Well, right that is still the same thing in a sense because the word cosmos means order, but the whole order.
>
> Krishnamurti: The whole order, I mean that.
>
> Bohm: Which includes the order of the universe and the order of the mind?
>
> Krishnamurti: Yes. What I am trying to find out is: is there an order which man can never possibly conceive? You follow? Because any concept is still within the pattern of thought.[14]

[13] Bohm and Peat, *Science, Order and Creativity*, p. 129.
[14] Bohm and Krishnamurti, *The Ending of Time*, p. 204.

The degree of a particular order is the number of conditions that is needed to describe it. For example, Bohm considers natural language as of an 'infinite degree of order, because its potential for meaning is unlimited and cannot be determined by any finite set of differences'.[15] Natural language contains suborders of lower orders. Bohm considers other orders in music and art with the aim of showing that there are subtle orders of infinite degree which are not random nor simple regular, implying that randomness is just one aspect of the general spectrum of order.

However there is a problem that Bohm developed further in his philosophy of thought. Our thought process tends to regard opposed and extreme notions of order as incompatible, and there is the habit of holding on to one of these extremes as if it was the only possible.[16]. However such extremes are part of a wider unity. Any order in general lies within a spectrum between the simple orders of a low degree, and the infinite degrees that appear as chaotic or random. In between the extremes there is an infinite of possibilities.

Herein lies the main difficulty and the crucial point to understand Bohm's aim: to move forward it is necessary to realize that there are many orders in between the simplest and the complex in any domain. To solve our problems we need to learn to accept that not only one order is the final response, or that 'one size fits all'. What enable our minds to perceive and use these orders in between are creativity and insight, and for Bohm it is of the utmost importance to promote these. Harmony can be attained when we learn to live the 'unity in diversity' of all possible orders.[17]

[15]Bohm and Peat, *Science, Order and Creativity*, p. 129.

[16]See below 8.2.

[17]Bohm proposed his dialogue technique as a method to motivate creativity and insight, and exploit this diversity while remaining in unity.

7.2 The Implicate Order

> I wish to mention particularly the formulation of the Implicate Order. This was suggested by the attempt to understand the meaning of the quantum theory in physics, but it can be extended to help throw light on the unity of mind and matter, the observer and the observed, the individual and society, and on similar questions arising in many other areas [. . .] In a certain sense, the Implicate Order united all my previous philosophical interests, as well as going beyond what I had done before in new ways. In particular, it is concerned with the underlying unity of all things, brought about by a focus on their being fundamentally internally related, rather than externally related.[18]

After realizing the importance of the general concept of order, Bohm introduced the notion of the Implicate Order, a concept that connected the general notion of order with his two other main ontological concepts: process and wholeness. As was mentioned above in section 3.6, Bohm developed his ideas about order in his many discussions with Krishnamurti, who encouraged him to follow the path that eventually led to the clear articulation of the Implicate Order.

> Krishnamurti: In the brain. There are these various kinds of movements. That is all we know. And someone comes along and says there is a totally different kind of movement. But to understand that I must be free of the movement of thought, material process and all that, the movement of time, to understand a movement that is not ...

[18] David Bohm, 'Letter to Dr. Jonas Salk', *NCUACS 66.4.97*, C.59 (1986).

Bohm: Well there are two things: it has no beginning and no end but also it is not determined as a series of successions from the past.

Krishnamurti: No causation.

Bohm: It is not a series of causes, one following the other.

Krishnamurti: Of course, of course. No causation.

Bohm: But you see matter can be looked at as a series of causes, though it may not be adequate.

Krishnamurti: Yes, I would say.

Bohm: But now you are saying that this movement has no beginning and no end, it is not the result of a series of causes, one following another without end.

Krishnamurti: So, sir, I want to understand, verbally even, a movement that is not a movement. I don't know if I am making it clear.

Bohm: Then why is it called a movement if it is not a movement?

Krishnamurti: Because it is not still, it is not - it is active, it is dynamic.

. . .

Bohm: Yes, the energy itself - I think that we have to say that the ordinary language does not convey it properly, but the energy itself is still and also moving - is that what you're saying?

Krishnamurti: Yes, but in that movement it is a movement of stillness. Does it sound crazy?

Bohm: The movement can be said to emerge from stillness and draw back into stillness.

Krishnamurti: That's right. You see that is what it is sir. We said this mind, this emptiness is in the mind. That emptiness has no cause and no effect. It is not a movement of causation. It is not a movement of thought, time. It is not a movement of material reactions; none of that. Which means: is the mind capable of that extraordinary stillness without any movement? And when it is so completely still there is a movement out of it.

. . .

Krishnamurti: And is that movement out of stillness, is that the movement of creation? Not the creation which the artist, the poets and the writers and all the painters call creation - to me that is not creation, just a capacity and skill and memory and knowledge operating there. Here I think this creation is not expressed in form.

. . .

Krishnamurti: Would you say, sir, this movement, not being of time, is eternally new?

Bohm: Yes. It is eternally new in the sense that the creation is eternally new.[19]

The idea of the Implicate Order appeared for the first time in an article in two parts: *Quantum theory as an indication of a new order in physics*. The two parts were republished in Bohm's most popular book: *Wholeness*

[19] JKO 800920

and the Implicated Order (1980), a collection of Bohm's articles focusing on the Implicate Order.

In *Part A: The development of new orders as shown through the history of physics* published in 1971, Bohm recasts the history of physics as it had appeared in *Causality and Chance in Modern Physics* to fit into the language of the general concept of order. He emphasizes the emergence of new orders of thought through the history of physics and argues that the development of relativity and quantum theory had enforced a change from the Cartesian order based on parts and reductionism to a form of holism:

> Rather, we have to regard the universe as an undivided and unbroken whole. Division into particles, or into particles and fields, is only a crude abstraction and approximation. Thus, we come to an order that is radically different from that of Galileo and Newton - the order of *undivided wholeness*.[20]

The Cartesian order is the order in which the universe is regarded as analysable into separated parts existing independently of each other. This model was developed during the Renaissance to replace the ancient Aristotelian order, in which the universe was compared to a living organism in which each part had its proper place and function. This ancient order needed to be replaced because the new order gave simpler descriptions of the finer observations of the movements of the planets made possible by the new technological advances, i.e. the telescope.

With the introduction of a new order it is necessary to modify language to make it fit to the new ideas. This led to the introduction of the familiar Cartesian grid of coordinates that enabled Newton to describe movement

[20]Bohm and Hiley, *The Undivided Universe*, p. 158.

using his famous laws. Subsequently all classical physics has been described by generalizations of the basic language of coordinates. Despite their radical differences, both relativity, and quantum mechanics are described in terms of abstract generalizations of the Cartesian order. Relativity uses a Riemannian manifold, a very abstract generalization of the notion of multidimensional curvilinear coordinates. Quantum mechanics is also based on the equally abstract notion of a Hilbert space, in which the number of coordinates used to describe the phenomena can be infinite.

However relativity and quantum mechanics both have issues related to this description that emphasizes independent parts, as both introduce notions of unbroken wholeness. In the case of relativity, the concept of a permanent existing particle is not consistent with the theory:

> As is well known the concept of a permanently existent particle is not consistent with this theory. But rather it is the point event in space-time that is the basic concept. In principle all structures have to be understood as forms in a generalised field which is a function of all the space-time points. In this sort of theory a particle has to be treated either as a singularity in the field, or as a stable pulse of finite extent. The field from each centre decreases with the distance, but it never goes to zero. Therefore ultimately the fields of all the particles will merge to form a single structure that is an unbroken whole.[21]

To bypass these difficulties with the notion of matter, relativity makes its basic concept the notion of an event. Each event is identified with a point in the Cartesian grid, which limits the applicability of the notion of unbroken wholeness.

[21] Bohm and Hiley, *The Undivided Universe*, p. 352.

The case of the quantum theory is even more radical as even in the most conservative and traditional interpretations the quantum processes are indivisible linking different systems in a way that it is impossible to analyse. This raises the issue of the non-local aspects of the quantum formalism which makes wholeness even more dramatic.[22]

Despite their similarities in their departure from the classical ideas, it has not been possible to unite relativity and quantum mechanics in a coherent way. Each of them introduce contradictory notions of wholeness. The order implied in relativity theory requires continuity, causality and locality whereas the order of the quantum theory emphasizes exactly the opposite: discontinuity, contingency and non-locality.

Bohm thought that what was required was a new notion of order that will not only encompass the different kinds of unbroken wholeness introduced by relativity and quantum theory, but could also open the way for new physical content, and even to go beyond both. Bohm was thinking in very ambitious ways, as was not only targeting physics but also psychology, art, society and spirituality.

The proposed new order was introduced in *part B: Implicate and Explicate Order in physical law* published in 1973, where Bohm elaborates on the notion of the Implicate Order:

> This [new] order is not to be understood solely in terms of a regular arrangement of objects (e.g., in rows) or as a regular arrangement of events (e.g. in a series). Rather, a total order is contained, in some implicit sense, in each region of space and time. Now, the word 'implicit' is based on the verb 'to implicate'. This means 'to fold inward' (as multiplication means

[22]For more on non-locality see section A.1 below.

> ‘folding many times’). So we may be led to explore the notion that in some sense each region contains a total structure ‘enfolded’ within it.[23]

As in the case of the general concept of order, the Implicate Order is not a precise and well defined concept. Bohm regards it as a general framework of thought, a philosophical concept with value for its organizing potential and from its suitability for a general discussion of the nature of reality. Of the many Bohm analogies that he uses to illustrate what he means by the Implicate and the Explicate Orders, he was fond of two of them, one regarding a glycerine experiment, and the other concerning holograms.

He saw a BBC documentary on television showing a device consisting of two concentric cylinders. The inner cylinder could be rotated and the space between the walls of these cylinders was filled with glycerine. Then a drop of ink was dropped on the glycerine and the inner cylinder was rotated very slowly, causing the ink to spread out until becoming a fine thread, eventually disappearing from sight. What the experiment was showing was that if the inner cylinder was made to rotate slowly in the opposite direction, after several turns the drop was brought back together again, appearing as reconstituted essentially as it was before. The experiment showed that despite the drop of ink being spread out, it still had an existing implied order that was not manifested explicitly. This order showed itself when the drop was reconstituted. A new notion of order was needed here to understand this process.

Bohm thought that this experiment could be done, at least in principle, with several drops of ink. First drop one, rotate until make it disappear,

[23]Bohm, *Wholeness and the Implicate Order*, p. 188.

drop another closely but not exactly at the same point and rotate, and repeat this procedure several times. Then when rotating the cylinder in the opposite direction, the drops of ink will reconstitute at different times at different places giving the impression of a moving particle. This provided a way of thinking about particles as localized unfoldments from an Implicate Order. A particle is regarded not as a definite object, but as an event that is unfolding. Motion is not a transfer of something solid and independent across space, but a process of unfoldment that manifest itself at different points in space and creating an Explicate Order. Bohm thought that this effect could be developed to give a more intuitive - and analysable - solution to the problem of the discontinuity of motion in the quantum domain.

Bohm began to reflect on the similarities between an hologram and the glycerine experiment. In an hologram the entire image of an object is contained in an interference pattern of light that is not apparent. However this image can be made manifest when projecting light to the hologram, the object reconstitutes itself from the enfolded image in the hologram. In both the glycerine experiment and in the hologram, all the information of an order gets enfolded in another more encompassing one. The hologram provided an excellent metaphor of this process as in this case any part of the order was present, and recoverable from any other, giving a sense of holism that was not evident in the glycerine experiment.

Although these examples can be thought of in the usual way, as an organization of matter, which is the ontological concept, that can be made to produces a process of enfoldment-unfoldment as described, whose existence is derivative. Bohm is proposing to reverse the common idea of taking matter as the fundamental category and the process of enfoldment and unfoldment as derivative. The idea is to take the process of unfolding-

enfolding as the universal principle, and matter a derivation of it. The Implicate Order would be the basic order which is regarded as fundamental, existing in a perpetual state of movement, while matter - and other relatively stable processes phenomena in our common experience - are maintained by a constant underlying movement of enfoldment and unfoldment. That is the Holomovement.

> To generalize so as to emphasize undivided wholeness, we shall say that what 'carries' an Implicate Order is the *Holomovement*, which is an unbroken and undivided totality. In certain cases, we can abstract particular aspects of the Holomovement (e.g., light, electrons, sound, etc.), but more generally, all forms of the Holomovement merge and are inseparable. Thus, in its totality, the Holomovement is not limited in any specifiable way at all. It is not required to conform to any particular order, or to be bounded by any particular measure. Thus, *the Holomovement is undefinable and immeasurable*.[24]

It is important to emphasize that the glycerine and the holograph examples are limited metaphors used to understand the Implicate Order, none of them are meant to be a full description of the Implicate Order:

> Nevertheless, it must be pointed out that the specific analogies of the ink drop and the hologram are limited and do not fully convey all that is meant by the Implicate Order.[25]

Both of these models are things that are already explicated. In the same way any other thing that can be explicated in this way cannot be the

[24]Bohm, *Wholeness and the Implicate Order*, p. 191.

[25]David Bohm, 'Hidden Variables and the Implicate Order', *Zygon*, 20.2 (1985), pp. 111–124, pp.

Implicate Order. The main point is that the Implicate Order constitutes a wholeness that can sustain and organize an Explicate Order:

> What is missing is the fact that the parts or sub-wholes not only unfold from the whole, but they unfold in a self-organizing and stable way. On the other hand, in both these models, there is no inner principle of organization that determines the parts of sub-wholes and makes them stable. In fact, the order enfolded in the whole is obtained from pre-existent, separate, and extended elements (objects photographed in the hologram or ink drops injected into the glycerine). It is then unfolded to give these elements again. Nor is there any natural stability in these elements; they may be totally altered or destroyed by minor further disturbances of the overall arrangement of the equipment.[26]

As this quote indicates, there are some subtle issues that need to be carefully noted. There is a strong correspondence between the enfolded and unfolded orders. What is fundamental is the Holomovement, the process of enfolding and unfolding into different Explicate Orders, which are correlated with one another. The Explicate Order of extended and separate forms is a special case of the full Implicate Order. The extended order is not unreal, it is fully enfolded in the whole. The Implicate Order contains all the information that unfolds into all the possible explications. However an unfolded order contains the whole in a limited way. This is not of secondary significance, but rather it is the way in which an unfolded order expresses the Implicate Order. This limitation is important because it

[26]Bohm, 'Hidden Variables and the Implicate Order' p. 19

is what determines exactly what the particular Explicate Order is, and how it behaves. Although there is a strong correlation between the Implicate and the Explicate Orders, the correspondence is not symmetrical, there is a higher, subtler and more powerful layer, the Implicate Order, and a lower less expressive and more limited, although corresponding layer:

> The whole is, in a deep sense, internally related to the parts. And, since the whole unfolds all the parts, these latter are also internally related, though in a weaker way than they are related to the whole.[27]

The introduction of the Quantum Potential helped to formulate the idea of the Implicate Order. However a different approach was needed to generalize the theory to make it compatible with relativity theory. The Green function description that represents the process of enfoldment-unfoldment gave Bohm a hint on how to proceed using Clifford algebraic geometry.[28]

Bohm got this idea from Mario Schönberg who attempted to develop an algebraic version of quantum mechanics exploiting the connection between quantum physics and Clifford algebraic geometry.[29] Schönberg's developments did not represent a complete theory because, as Schönberg himself remarks, a fuller development requires a deeper change in our conception

[27]Bohm, 'Hidden Variables and the Implicate Order'

[28]The Bristish mathematician and panpsychic philosopher William Kingdon Clifford (1845-1879) re-established the English panpsychic tradition in 1874 with the publication of the article 'Body and Mind' in which he claimed that 'science had bridged the gap between the organic and the inorganic', David Skrbina, *Panpsychism in the West* (Cambridge MA, London: MIT Press, 2005), p. 141. In 1876 Clifford introduced the mathematical structures that are named after him as an attempt to unify the quaternions introduced previously by the Irish mathematician William R. Hamilton (1805–1865) and the universal algebra developed by the German mathematician and linguist Hermann G. Grassmann (1809–1877).

[29]Mario Schönberg was the Brazilian physicist that introduced Bohm to the philosophy of Hegel. See section 3.4 above.

of space and time.[30] The algebraic approach to quantum mechanics is not an original idea of Schönberg: it has been present since its beginnings in Heisenberg's matrix mechanics. More specifically Clifford algebras, a distinctive feature of Clifford algebraic geometry, have been used in quantum mechanics before Schönberg, Bohm and Hiley. Notably they are an essential component of Dirac's relativistic theory of the electron of 1928.[31]

At the end of his life, Bohm was trying to exploit the relationship between quantum theory and Clifford algebraic geometry in order to obtain a relativistic version of the Quantum Potential. In the standard formulation the use of an abstract Hilbert space irons out the differences between Schröedinger's wave mechanics and Heisenberg's matrix mechanics, the original formulations of quantum mechanics. But this is a mathematical trick with no physical justification. Clifford algebraic geometry contains a much richer structure than the standard Hilbert Space, and formulating quantum mechanics in this setting instead of Hilbert space, Bohm and Hiley aimed to obtain a mathematical derivation of all the fundamental equations of quantum mechanics in a more intuitive and elegant way, and facilitating its interpretation in terms of the Implicate Order. This research programme was described in the last two chapters of *The Undivided Universe*, Bohm's last book written in collaboration with Basil Hiley and published a year after Bohm's death in 1992.

Bohm had other motivations behind the idea of using an algebraic approach. One concerned the current state of the mathematical language

[30] Mario Schönberg, 'Quantum Kinematics and Geometry', *Il Nuovo Cimento*, 6.Supplement (1957), pp. 356–380; Mario Schönberg, 'Quantum Mechanics and Geometry', *Anais da Academia Brasileira de Ciências*, 30 (1958), pp. 1–20.

[31] In developing his theory, Dirac was not aware that he was using a Clifford algebra, he reinvented what he needed. However, further study of Dirac's quantum mechanical operators led to the reintroduction of Clifford algebras. Today these structures are intensely studied and have found applications in many areas of physics and computer science.

which Bohm felt that it had severe limitations to express his ideas about order.

> To carry out this kind of inquiry adequately we need a language that describes order and structure properly. In my view we do not at present have such a language. Evidently the common language is inadequate, because its terms referring to order are extremely vague and confused [...] One may then ask whether we could not describe orders and structures properly with the aid of mathematical language. I do not think existing forms of mathematics are really adequate for this purpose either [...] What is needed is to develop a new mathematics of order and structure. [...] To this end it is necessary to formulate a new set of mathematical axioms which treat order and structure as bare concepts [...] So there is no reason why we cannot introduce new axioms, in which the notions of order and structure, defined only tacitly and not explicitly, are taken as the fundamental points of departure for our thinking.[32]

Bohm was probably not aware that a new branch of abstract algebra was experiencing important developments that linked it to logic, geometry, physics and information. Category Theory, one of the most abstract parts of mathematics that has recently literally invaded all mathematics, is dedicated to the study of structure and order, the kind of mathematics that Bohm was lacking. At the time there were some researchers who felt that Category theory could be applied to Bohm's ideas about order. On the 12 of August 1990, the French mathematician Andrée C. Ehresmann wrote a short letter to Bohm:

[32]Bohm, 'Some Remarks on the Notion of Order', pp. 23–24.

> In *Wholeness and the Implicate Order* you say it may be necessary to resort to more general kinds of mathematisation to interpret your theory of Implicate Orders. As a specialist of Category Theory, on which I have been working for many years (in collaboration with my late husband) and directed several theses, I think it might be one of these sorts, for it gives a 'relational' approach to study all kinds of structure.[33]

Bohm never replied to this letter. At the time he was having serious health problems, and he died not long after receiving the letter.[34]

7.3 The Ontological Interpretation of Quantum Mechanics

> Working with Dr. Hiley and others, I have extended the causal interpretation of the quantum theory and connected it with the Implicate Order, in a way that further clarifies the meaning of the theory, and indicates a new way of understanding the relationship of mind and matter.[35]

During the 1960s, Bohm's attention drifted away from the Causal Interpretation, disillusioned with the reaction of the physics community to his papers. But in the early 1970's Bohm would start thinking again about the foundations of quantum mechanics after seeing some numerical calculations showing images of the Quantum Potential for the case of the two

[33] NCUACS, 66.4.97 C.9
[34] See A.2 for recent developments.
[35] Bohm, 'Letter to Dr. Jonas Salk' p. 3

slit interference experiment.[36] This motivated Bohm, now in collaboration with Basil Hiley, to pursue a long-term project dedicated to redevelop the Causal Interpretation in a more philosophical way in terms of the Implicate Order, and to try to extend it to the relativistic realm. The 'Ontological Interpretation', as Bohm and Hiley named this interpretation, would be the product of a long and fruitful collaboration. Appearing first in several research papers, they summarized it in *The Undivided Universe*, a book published in 1993, one year after Bohm's death.

The Causal Interpretation of 1952, which is also associated with Louis de Broglie, has been developed in several ways which differentiate each other by their philosophical assumptions. An important example is the development of 'Bohmian Mechanics', an umbrella term for a set of physical theories inspired by Bohm's papers, making emphasis on the statistical aspects of the theory and founded on a materialistic philosophy.[37] In contrast, Bohm and Hiley proposed to developed the Causal Interpretation emphasizing the Quantum Potential and founding it in his philosophy of the Implicate Order. They named this development the Ontological Interpretation.

As we saw in chapter 4, Bohm interprets the Schrödinger equation as the description of a new field related to the physical experimental situation as a whole. This field is determined by the Quantum Potential which acts causally on the particles. Although there is the temptation to think that this action is similar to the action of a classical potential, which would imply a return to a modified version of the classical order, the similarity to the classical situation is only superficial, as was explained before.

[36] Basil Hiley, C. Philippidis and C. Dewdney, 'Quantum Interference and the Quantum Potential.', *Nuovo Cimento*, 59.1 (1979), pp. 15–28.

[37] See section A.3.

The case of the many body system makes the holistic aspects of quantum mechanics to appear very clearly. For the case of n particles with the same mass m, the wave function Ψ representing the state of the system depends on $6n$ spatial variables.[38] In this case Ψ can no longer be interpreted as a wave in space, as in the one particle case. Using the polar representation $\Psi = Re^{\frac{iS}{\hbar}}$, the Quantum Potential for the many body system is

$$U = -\frac{\hbar^2}{2m}\frac{(\sum \nabla_i^2)R}{R} \tag{7.1}$$

The influence of the potential does not depend on the distance between the particles, it is the same no matter how far apart they are. The Quantum Potential does not act on particles through a force that diminishes with distance, as in the classical case. As was explained before, this influence is not dependent on a magnitude but on a form, and therefore its influence is not a function of distance.

In contrast with other interpretations in which the wave function is regarded as a probability density $P = |\Psi|^2$, in the ontological approach the wave function Ψ is interpreted as a field that determines the Quantum Potential U, regarding the probability density as of secondary significance.

An important aspect of the expression of the Quantum Potential is that it cannot be expressed in general in the form of a sum of independent terms, $\sum F(X_i - X_j)$, each term expressing the interaction of a pair of particles, as it is done in the classical case. Writing a potential in this form would imply that the particles are independent, and that the whole system is the sum of the influence of each of the independent parts. The Quantum Potential cannot be reduced to this form in general, only as an approximation in

[38] In the function $\Psi(X_1, \ldots X_n, t)$, X_i represent the position in space of the particles, each position is determined by three coordinates.

certain special cases, and therefore the interaction between each pair of particles is dependent on the whole.

Furthermore, the Quantum Potential in general depends on the quantum state of the system itself $U(\Psi)$, the system as a whole, not directly on the coordinates X_i. This means that the relationship between the particles depends upon something that goes beyond the particles themselves. Bohm suggests that this relationship may be even dependent on the state of the system in which the particles are contained, and ultimately on the state of the universe as a whole.[39] This feature is what makes quantum mechanics go beyond the mechanical philosophy of Descartes and Newton.

> Something with this sort of independent dynamical significance that refers to the whole system and that is not reducible to a property of the parts and their inter-relationships is thus playing a key role in the theory. As we have stated above *this is the most fundamentally new ontological feature* implied by the quantum theory.[40]

In summary, in contrast to the mechanical philosophy in which the parts interact between themselves to make up the whole, Bohm is interpreting the wave function as something that goes well beyond the sum of the parts. In the Ontological Interpretation, the interaction between parts depend on the whole wave function, which depends on the state of the whole and evolves according to the Schrödinger's equation. This wholeness can be made more evident rewriting the Schrödinger's equation in integral form.[41] In this case the evolution of the wave function Ψ is:

[39] Bohm and Hiley, 'On the intuitive understanding of nonlocality as implied by quantum theory' p. 99

[40] Bohm, Hiley and Kaloyerou, 'An ontological basis for the quantum theory' p. 332.

[41] This is a standard manipulation, many linear partial differential equations can be rewritten as an integral equation. See Bohm and Hiley, *The Undivided Universe*, p. 355.

$$\Psi(X,t) = \int K(X-Y, t-s)\Psi(Y,s)dY \tag{7.2}$$

The value of the wave function at any point in time and space is the sum of the contributions from the whole space at all earlier times weighted by the 'propagator' or Green's function K. Bohm gives a picture of the movement as waves from the whole space enfolding into each region of space and unfold back into the whole.[42]

The important point here is that although the Quantum Potential and the propagator equation have been developed from the Cartesian order, as a consequence of a natural law based on distinct and independently existing particles, Bohm is proposing to reverse this notion and consider the Quantum Potential and the enfoldment-unfoldment expressed by the propagator equation as the ontological aspects of the theory, the ones that are the subject of a natural law, and to regard the particle as the derivative effect. The enfolding and unfolding of the Implicate Order is expressed in the propagator equation, and this can be rewritten using the Cartesian order to find particles as a special case of this more encompassing notion of order. In this way all the fundamental laws of quantum mechanics will correspond to an enfoldment-unfoldment.

> Our proposal to start with the Implicate Order as basic, then, means that what is primary, independently existent, and universal has to be expressed in terms of the Implicate Order. So we are suggesting that it is the Implicate Order that is autonomously active while, as indicated earlier, the Explicate Order flows out of a law of the Implicate Order, so that it is secondary, de-

[42]Bohm and Hiley, *The Undivided Universe*, p. 355.

rivative, and appropriate only in certain limited contexts.[43]

A deeper structure becomes evident when the Causal Interpretation is extended to the quantization of classical fields. In this case a Super Implicate Order related to the Implicate Order in a similar way in which the Implicate Order is related to particles becomes manifest. The normal mode of the classical linear field $\frac{\partial^2\phi}{\partial t^2} = \nabla^2\phi$, corresponding to the wave number k satisfies the harmonic oscillator equation $\frac{d^2q_k}{dt^2} + k^2 q_K = 0$ and they are independent.[44] To quantise the wave functional Bohm writes it in its polar form, and in developing the field equations the expression for the oscillators becomes:

$$\frac{d^2q_k}{dt^2} + k^2 q_k = -\frac{\partial}{\partial q_k} Q(\ldots q_k \ldots t) \tag{7.3}$$

Each of the oscillators for the quantized field theory satisfy a non linear equation coupled with all the other oscillators, that is, they are dependent on each other. The dependence on the whole is through the Quantum Potential Q, which has similar properties to the Quantum Potential in the case of the particle theory, and which is manifested in the field properties, or as Bohm says, its 'beables'.[45] In the particle theory the Implicate Order

[43]Bohm, *Wholeness and the Implicate Order*, p. 235.

[44]Bohm and Hiley, *The Undivided Universe*, p. 244.

[45]John Bell introduced the term beables in *Beables for Quantum Field Theory*, a paper dedicated to David Bohm in which he develops a Causal field theory:

> In particular we will exclude the notion of 'observable' in favour of that of 'beable'. The beables of the theory are those elements which might correspond to elements of reality, to things which exist. Their existence does not depend on 'observation'. Indeed observation and observer must be made out of 'beables'.
>
> I use the term 'beable' rather than some more committed term like 'being' or 'beer' to recall the essentially tentative nature of any physical theory. Such theory is at best a candidate for the description of nature. Terms like 'being', 'beer', 'existent', etc., would seem to me lacking in humility. In fact 'beable' is short for 'maybe-able'.John Bell, 'Beables for Quantum Field Theory', in

makes the behaviour of the particle more like that of a wave. But in the field theory, the effect of the Super Implicate Order on the field beables is to unfold them into particles.[46] In this way the beables of the field are the first Implicate Order that produces the Explicate Order that can be described by a Cartesian grid, whereas the beables themselves are the unfoldment of a Super Implicate Order. [47]

The Implicate Order is enfolded in the Super Implicate Order, but then a whole structure of orders, a ladder of enfoldment-unfoldment processes in the Holomovement, appears naturally. The dependence on higher Implicate Orders carries on as there will be further levels above in a hierarchical order of orders, a continuum of Super Super Implicate Order, in which an order above has a more encompassing scope, with more power, more energy, more relationships. The higher Implicate Orders contain the lower ones as enfolded particular cases. The Holomovement is the whole, unreachable, being the universal process out of which all other orders are generated.

Thus a ladder of Implicate/Explicate Orders that has no limit in principle is established. This is the main difference between Bohm's interpretation and the Copenhagen Interpretation of Niels Bohr. Bohm considered that Bohr's intuition about wholeness was consistent, but inadequate. Bohr treats the entire process of observation as a whole, including the contextual experimental conditions and the meaning of the observed experimental results. That is, not only the spots on a photographic plate are

Quantum Implications: Essays in Honour of David Bohm, ed. by B. J. Hiley and F. David Peat (London: Routledge, 1991), pp. 227–234

[46]Bohm and Hiley, *The Undivided Universe*, pp. 255-260.

[47]The reason why the models of the hologram and the glycerine experiment that Bohm used to introduce the Implicate Order are limited is because they are bounded to the first Implicate Order and leave out the Super Implicate Order.

part of the experiment, but their meaning is part of the experiment as well. Bohr maintains that quantum mechanics is not capable of resolving what happened to produce the spots, it simply gives a statistical description of the results of a large number of events. In the case of a single event, the mathematics give only an ambiguous description. Bohr assumes that there is no need for new concepts because this ambiguity cannot be resolved. The novelty in Bohr's approach is the focus on the wholeness of the quantum situation, the observed and the observer are part of the same whole, which is by nature unresolvable and cannot be understood. The description in terms of classical concepts becomes ambiguous and subject to probability laws, but that is not because the classical concepts are faulty, but because the ambiguity is fundamental. New concepts will just produce a new ambiguity, so the usual classical concepts are as good as any. For Bohr the important aspect is the location where the spots on a photographic plate appear, and the specification of their meaning: in one situation they mean momentum, in a different one position. To explain how they appear is irrelevant. For Bohr the lack of resolution of the whole is a built-in feature of the world. That is, with the quantum description we reach the level of the inexplicable wholeness.

For Bohm the wholeness is never reached and at every stage there is the possibility of introducing new concepts that will clarify the situation, however that will introduce a new level of reality. Using the Quantum Potential, the place where the dot appears can be explained, although not in a mechanical way.

To account for the influence that the Quantum Potential exerts on a particle, Bohm and Hiley introduced the idea of 'active information'. In the Ontological Interpretation the particles behaviour is in-formed by the

Quantum Potential, suggesting that the particles are a much more complex object than a simple point. Bohm used the analogy of a radio wave guiding the movements of a ship.[48] The effect of a radio wave on a ship is not dependent on the distance between the ship and the source of the radio waves, but only on their form, i.e. on the information transmitted to the ship. The ship itself is moving with its own energy, but the movement is in-formed by the form of the wave, not its intensity. In a similar way, the Quantum Potential drives the particles and can have quite considerable effects even over very long distances. It is necessary to bear in mind that the radio analogy is one only used by Bohm to introduce the idea of active information. The analogy is limited because unlike the radio, the effects of the Quantum Potential are not propagated through space as it is readily seen for the case of several particles. In this case the Quantum Potential cannot be described in terms of spatial coordinates. Moreover, when several particles are considered, all of them responding to the same potential, the non local character of quantum mechanics is more obvious. At any moment, the particles read the form of the potential and act accordingly. The Quantum Potential is a sea of information, present everywhere, which is dependent on the whole. This action is not mechanical, does not depends on distance, it is not a force applied to the particle, simply the particles respond to the information.

The ladder of Super Implicate Orders appears when one considers the question of where does the Implicate Order come from? The answer is that Quantum Potential is itself informed by a Super Implicate Order, which in turn is informed by a Super Super Implicate Order, and so on. The Quantum Potential gives an understandable context to the quantum

[48]Bohm, Hiley and Kaloyerou, 'An ontological basis for the quantum theory' p. 326.

phenomena. Introducing it pushes up the ambiguity in the reality of the process. If for Bohr, the quantum theory reached a the world's bottom level which has a built in ambiguity that establishes a limit to the analysis that can be done, for Bohm, there is no final level because the process of analysis of reality can be carried further down with no limit.

7.4 Mind and Matter

The analogies between mental phenomena and the strange behaviour of the subatomic world as expressed in quantum mechanics were also a subject of exploration with Krishnamurti:

> Bohm: You see, the way - you may find this interesting - the way modern physics treats the atoms and the particles of matter is to say they are created out of empty space and that they dissolve into empty space. And to say that a particle is a sort of manifestation of that energy of the whole - right? - so that it's a small change, a form, as it were, within that energy - do you see? - which is transient. Do you see what I mean?
>
> Krishnamurti: Yes, I understand.
>
> Bohm: Now perhaps you could say thought is a similar form - I don't know, you see - or matter as we know it, you know, the mechanical side of matter. But then there is the energy itself - you see, physics disregards that energy itself. It pays mostly attention to matter, you see.
>
> Krishnamurti: Matter - yes, quite.

> Bohm: And it tries to ignore the rest of the energy. And that's what thought does, you see, it only...
>
> Krishnamurti: But from this arises a question: how is a man to empty his mind?[49]

The main topic of conversation between Krishnamurti and Bohm was about the mind, how did it work, its limitations and the problems that this operation produces. They thought that a misunderstanding of these issues was the root cause of many important problems and that an important step in the solution of these problems was to make the mind more conscious of itself. Bohm followed closely Krishnamurti's teachings about how to make the mind conscious of itself and of its operation. They thought that they could do that because Krishnamurti claimed that his own mind was fully conscious of itself, and Bohm believed it:

> Krishnamurti feels that he directly perceives that thought is a material process which is going on inside of the human being in the brain and nervous system as a whole.[50]

With the introduction of the Implicate Order into the interpretation of quantum mechanics through the idea of active information, Bohm found a similarity between matter and thought that lead him to suggests that they could be understood as two related movements within the Implicate Order:

> Such a view of matter makes it rather similar to what we experience as mind. Mind is, indeed, generally felt to be much more subtle than matter. Yet, in mind we have a process of unfoldment similar to what has just been described in connection with

[49] JKO 751004
[50] Bohm and Krishnamurti, *Limits of Thought*, p. viii.

> the quantum theory. For example, thoughts are said to be implicit. According to its Latin root, implicit means enfolded. Such thoughts unfold from some deeper levels of consciousness that are too subtle normally to be seen. There is therefore a close analogy between what happens with matter and what happens with mind. They are thus similar enough to be intimately related.[51]

Even in his scientific publications he usually includes some suggestions about his thoughts on mind and matter. Already in 1952, in *Quantum Theory*, Bohm remarks that:

> A further development of this analogy is that the significance of thought processes appears to have indivisibility of a sort [...] Thus, thought processes and quantum systems are analogous in that they cannot be analysed too much in terms of distinct elements, because the 'intrinsic' nature of each element is not a property existing separately from and independently of other elements but is, instead, a property that arises partially from its relation with other elements.[52]

Bohm elaborated his views about the relationship between mind and matter in the context of the Implicate Order in several publications. *Unfolding Meaning* of 1985, is a collection of essays and transcriptions that contains an important article dedicated entirely to the subject of the mind called: 'Soma–Significance'.[53] In 1986 the American Society for Psychical

[51]Bohm, 'Fragmentation and Wholeness in Religion and in Science' p. 130.
[52]Bohm, *Quantum Theory*, p. 169.
[53]David Bohm, *Unfolding Meaning* (Mickleton, Gloucestershire: Foundation House Publications, 1985). A slightly modified version of this article was published in 2004

Research awarded Bohm the first Gardner Murphy Award. In receiving the award, Bohm gave the first Gardner Murphy Memorial Lecture, in which he further elaborates his thoughts about the relationship of mind and matter.[54] In 1989 he contributed with the article *Meaning and Information* to *The Search for Meaning*, a collection of articles by various authors dedicated to explore Bohm's ideas regarding mind and matter.[55]

By this time, the initial thoughts expressed in *Quantum Theory* had already been transformed into a full pansychic philosophy, suggesting that mind and matter are two sides of the same process that unfold from the Holomovement.

Broadly, it is possible to distinguish two opposed attitudes towards the nature of consciousness that have contended for the soul of the philosophy of mind since the Presocratics: emergentism and panpsychism.[56]

Emergentism, a position that tends to be close to monist materialism, sees consciousness as an emergent property of matter, a product of complex organization. This idea became prominent after the rise of the materialistic interpretation of evolutionary theory that suggests that matter can organize itself into complex forms with guided solely by natural selection, a process ultimately founded on the laws of physics. Thinkers holding this position hope that eventually a mechanism will be found that will explain how these complex forms give rise to consciousness. There have always

with the same title:David Bohm, 'Soma–Significance: A New Notion of the Relationship Between the Physical and the Mental', in *Mind in Time*, ed. by Combs A., Mark Germin and Ben Goertzel (Cresskill, NJ: Hampton Press, 2004).

[54]David Bohm, 'A New Theory of the Relationship of Mind and Matter', *Journal of the American Society for Psychical Research*, 80 (1986), pp. 113–135. In 1990 he published a reviewed version of this article in the journal Philosophical Psychology.

[55]David Bohm, 'Meaning and Information', in *The Search for Meaning*, ed. by Paavo Pylkkanen (Wellingborough England: Aquarian Press, 1989), pp. 43–85.

[56]For a review of the history of panpsychism and its role in Western philosophy see David Skrbina, 'Panpsychism as an Underlying Theme in Western Philosophy', *Journal of Consciousness Studies*, 10.3 (2003), pp. 4–46; Skrbina, *Panpsychism in the West*.

been materialistic philosophers with emergentist views, and it is now the dominant position in the philosophy of consciousness, however this is a contemporary trend, emergentism was hardly a popular point of view before the twentieth century, overshadowed by the much more idealistic oriented panpsychism.

Panpsychism maintains that everything has a dual aspect of matter and consciousness (or mind). Panpsychism is not necessarily a dualism, and can be maintained in a variety of forms, including monism: *Emanationism* sees matter and mind as different levels of the same chain of being. Purely material bodies have still a form of mind that is subdued, whereas the more spiritual forms of being, although material, have a prominence of the mind; *Neutral monism* postulates a reality beyond mind and matter and sees them as dual aspects of the more fundamental and true ontological entity.

Panpsychic ideas have been held since the beginning of Western philosophy. Some of Plato's mature dialogues contain panspsychic ideas: The Sophist, Philebus, Timaeus and Laws. All the Neo-Platonist philosophers were decidedly panpsychic. Panpsychic views became truly articulated during the Renaissance in the works of several important thinkers: Girolamo Cardano (1501-1576), Bernardo Telesio (1509-1588), Francesco Patrizi (1529-1597), Giordano Bruno (1548-1600) and Tommaso Campanella (1568-1639). The word panpsychism is a modern word, coined by Patrizi in his *Nova de Universis Philosophia* (1591), a work devoted to undermine the dominant Aristotelian scholasticism and to place greater emphasis on Plato's philosophy, following the model of Marcilio Ficino (1433-1499).

The panpsychic thinkers of the Renaissance were not only philosophers in the orthodox sense of the word. All of them are intimately associated

with the development of the Christian Kabbalah and the birth of the modern Western esoteric tradition, as explained in 1.3.1. The Jewish and the Christian versions of the Kabbalah are eminently panpsychic, as they are heavily influenced by Neo-Platonism. It is fair to say that the main philosophical position of most - if not all - esoteric thinkers since the Renaissance has been related to panspychism.

Panpsychism was an important aspect of the idealistic philosophers until materialism and emergentism became prominent at the end of the nineteenth century. Nevertheless, some early twentieth century philosophers adopted a panpsychic position. One of the most important is without doubt Alfred North Whitehead (1861-1947), whose process philosophy proposed a radical reform of our understanding of the nature of the world, placing events and the ongoing process of their creation as the main feature of reality, replacing the classical triad of time, space and matter.[57] Another important contemporary thinker holding a definite panpsychic philosophy is the French Jesuit palaeontologist Pierre Teilhard de Chardin (1881-1955). In his celebrated *The Phenomenon of Man* (1955), de Chardin sets forth an account of the spiritual unfolding of the cosmos, advocating for a less strict interpretation of the account of creation in the Biblic Genesis.[58] More recently the long and productive career of Charles Hartshorne (1897-2000), displays a clear and consistent panpsychism.

With the dismissal of logical positivism and the accumulation of unsolved fundamental problems in science, it is increasingly difficult to maintain a one sided materialism. This has opened the door to panpsychism, which is becoming again an attractive alternative. Many contemporary

[57] Alfred North Whitehead, *The Concept of Nature* (Cambridge: Cambridge University Press, 1920)

[58] Teilhard de Chardin, *Le Phénoméne Humain* (Paris: Editions du Seuil, 1955).

philosophers, most of them under the wing of the Whiteheadian current, are beginning to articulate new panspychic propositions.[59] Some scientists had also been attracted by it.[60] Bohm was one of them:

> In our view, however, the mental and the material are two sides of one overall process that are (like form and content) separated only in thought and not in actuality. Rather, there is one energy that is the basis of all reality . . .] There is never any real division between mental and material sides at any stage of the overall process.[61]

To develop his ideas about the mind, Bohm turned to Hegel's philosophy. As was remarked in 3.4, Bohm considered Hegel's philosophy as a philosophy of mind and thought, not thought as a 'thing', but as an actual reflexive process, a process that can be applied upon itself. Following Hegel, Bohm considered thought as a real process to which attention could, and must, be paid:

[59]David J. Chalmers, *The Conscious Mind: In search of a Fundamental Theory* (New York, Oxford: Oxford University Press, 1996); David Ray Griffin, *Unsnarling the World Knot* (Berkeley: University of California Press, 1998); Christian de Quincey, *Radical Nature, Rediscovering the Soul of Matter* (Montpelier, Vermont: Invisible Cities Press, 2002).

[60]Capra, *The Tao of Physics*; Goswami, *The Self-Aware Universe*; Laszlo, *The Creative Cosmos*; Nicolescu, *Science, Meaning, & Evolution*; Roger Penrose, *The Emperor's New Mind: Concerning Computers, Minds, and The Laws of Physics* (Oxford: Oxford University Press, 1989); Roger Penrose, 'Quantum Physics and Conscious Thought', in *Quantum Implications: Essays in Honour of David Bohm*, ed. by B. J. Hiley and F. David Peat (London: Routledge, 1991), pp. 105–120; Roger Penrose, *Shadows of the Mind: A Search for the Missing Science of Consciousness* (Oxford: Oxford University Press, 1994); Rupert Sheldrake, *A New Science of Life: The Hypothesis of Formative Causation* (London: Blond and Briggs, 1981); Rupert Sheldrake, *The Rebirth of Nature: The Greening of Science and God* (New York: Bantam, 1991); Rupert Sheldrake, *The Science Delusion: Freeing the Spirit of Enquiry* (London: Coronet, 2012); Fred Alan Wolf, *Mind into Matter: A New Alchemy of Science and Spirit* (Needham, MA: Moment Point Press, 2001); Zukav, *The Dancing Wu Li Masters*.

[61]Bohm, 'A New Theory of the Relationship of Mind and Matter' p. 129

> For Hegel, the basic reality was mind, the universal mind. You could think of what people have called God as way of personalizing it. The mind is a process. This was his essential step, assumption. He regarded it as a perception. He said, 'You must pay attention to thought as a real process, not just to the content'. Usually we are trained to pay attention to the content of thought and ignore its actuality as a process.[62]

Since thought is a process, a movement, the things which appear as content are rather like vortices with varied levels of stability, but nevertheless transient. The pictures, words, concepts of the mind are all phenomena in the the process of thought itself, which is a flowing stable movement, going on uninterruptedly. The reason that we do not experience it like that is because we get conditioned not to see it.

Bohm proposes to consider thought in a similar way to matter, an unfolded phenomena in an enfolded encompassing movement that transcends it. The fundamental order encompassing the thought process itself that is enfolded in the Holomovement when unfolds in the Explicate Order becomes particular ideas, words, concepts. This idea suggested a parallel between mind and matter, that for Bohm solved the problems which are produced by making a naive distinction between mind and matter.[63]

[62]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 11 Side B.

[63]Bohm explains this at the beginning of Bohm, 'A New Theory of the Relationship of Mind and Matter' andBohm, 'A New Theory of the Relationship of Mind and Matter'.

Chapter 8

Limits of Tought

Continuing with the presentation of Bohm's main philosophical ideas reorganized with the help of Faivre's model of Western esotericism, this chapter emphasizes on the last two mandatory characteristics of Faivre's model, 'Mediation-Imagination' and 'Transformation', which are of an anthropological and epistemological character. Imagination is the door to meaning and insight into the subtle worlds, and it is also the agency that experiences the word. Through its use human beings can be transmuted to produce an 'illumination' which is akin to a change of nature, or a 'second birth'. These characteristics apply particularly to humankind and its fate and they are addressed by Bohm's extension of his ideas about the Implicate Order into psychology, art, religion, social issues, and other humanistic concerns, as explained in sections 8.1 to 8.4 below. At the heart of this aspect of Bohm's philosophy is the issue of the workings of the mind and its limitations. For Bohm the idea of the Implicate Order can be used to understand the limitations of the operation of the mind. Understanding how the mind imagines the world through the use of thought and language in the context of the Implicate Order gives a way to transcend its limitations.

At the core of these issues is an actual mental skill that Bohm describes as 'awareness of awareness', a concept that he and Krishnamurti identify as the basis of 'illumination'. He proposes a dialogue method, a practice akin to meditation, designed to achieve this awareness.

8.1 Meaning is Being

Bohm's proposal that mind and matter come from a similar unfolding movements from within the Holomovement is neither materialist or idealist. He is not suggesting to reduce consciousness to a physical process, neither the opposite regarding matter as an epiphenomenon of thought. The basis of both mind and matter lies within the Holomovement. What Bohm is proposing is a hierarchical structure within the Holomovement in which processes of higher subtlety appear as mental to processes below, which appear as material. In the case of quantum mechanics, the quantum potential is the process informing the particles, whose active response implies a rudimentary mind-like quality. In its turn, what is normally perceived as mental is itself informed by a higher Implicate Order, to which the mental level appears as material.

> Rather there is one energy that is the basis of all reality [. . .] the form of the mental side gives shape to the activity of this energy, which later action less subtle forms of process that constitute, for this activity, the material side.[1]

Going to subtler levels, the mind quality becomes more sensitive to form rather than intensity or substance, with an increasing consciousness aspect. The process can be extended indefinitely both ways, so that

[1] Bohm, 'A New Theory of the Relationship of Mind and Matter' p. 129.

everything has the capacity of being an expression of consciousness or materiality, it all depends at what level they are being experienced.

> All things found in the Explicate Order emerge from the Holomovement and ultimately fall back into it. They endure only for some time, and while they last, their existence is sustained in a constant process of unfoldment and re-enfoldment, which gives rise to their relatively stable and independent forms in the Explicate Order. It takes only a little reflection to see that a similar sort of description will apply even more directly and obviously to consciousness, with its constant flow of evanescent thoughts, feelings, desires, urges and impulses. All of these flow into and out of each other and, in a certain sense, enfold each other (as, for example, we may say that one thought is implicit in another, noting that this word literally means enfolded).[2]

This ladder of Implicate/Explicate Orders is happening within the context of an encompassing reality, which in its most abstract form cannot be articulated. The relationship between the Implicate and the Explicate Orders is through meaning, not as a mechanical influence. Meaning is the activity of information, in the sense that the information is incorporated and acted upon:

> I would like to suggest that the activity, virtual or actual, in the energy and in the soma is the meaning of the information [. . .] the relationship between active information and its meaning is basically similar to that between form and content, which we

[2]Bohm and Hiley, *The Undivided Universe*, p. 382.

> know is a distinction without a real difference or separation between the elements distinguished.[3]

Meaning is the term that Bohm found more appropriate to talk about this relationship. He remarks that the term psychosomatic, that is sometimes used to refer to the relationship between mind and the body, is not satisfactory because it implies two different things interacting, whereas what he means is that there is no real difference, what we distinguish as Implicate and Explicate Order is a whole, the distinctions are fragmentations made by our thought that do not exist in reality.[4]

Meaning is being in the sense that our meanings flow into our beings, each reflecting each other. The activity to which information gives rise is incorporated in our being which is the action that is informed. The ladder is then a ladder of meaning which can be traversed in both directions indefinitely, and because there is no limit to the levels of subtlety of meaning that are possible, the being flowing out of meaning is in principle infinite and inexhaustible. This expansion of meaning, at subtler and subtler levels, gives Bohm opportunity to explain para-psychological phenomena:

> On this basis, psychokinesis could arise if the mental processes of one or more people were focused on meanings that were in harmony with those guiding the basic processes of the material systems in which this psychokinesis was to be brought about [...] telepathy and transmission of thoughts and dreams can always be looked as particular forms of psychokinesis, which

[3]Bohm, 'Meaning and Information', p. 45.

[4]He attempted the introduction of better terminology to refer to this relationship, like soma-significance, sigma-somatic, and similar, but he gave up because he found that somehow they implied the false distinction between mind and matter that he wanted to avoid.

act directly from brain to brain to convey thoughts or dream images.[5]

Bohm continues suggesting that the mathematical developments needed to unravel the para-psychological phenomena based on the Implicate Order may provide guidance in the research to understand the relationship between the super wave function and thermodynamic properties, such as entropy.

This ladder of meaning is not autonomous, what is suggested is that what relates mind and matter is that both are explicit movements in a deeper and subtler 'ground', the Holomovement, which is 'the beginning and ending of everything'.[6] These developments are very close to the doctrines about the constitution of the world found in the Kabbalah, a core component in the Western esoteric tradition.

As it was suggested above in 5.3, The Kabbalah of Jacob Boehme was an important influence in Hegel's philosophy. However, Hegel's philosophy is not strictly Hermetic or Kabbalistic. One of the main issues is that he maintains that the absolute idea not only can be articulated, but this is only the start of philosophy. Hegel took the Kabbalah and contradicted it by articulating a philosophy of the absolute. Bohm did the opposite, he took Hegel's dialectics and put back the Kabbalah into it. In the Kabbalah the source from which everything starts is unreachable, unfathomable and ineffable. This root is called the Ain Suph Aur, the Limitless light, the no thing. In Bohm's ontology, the Holomovement is a model of this 'ultimate ground':

Our overall approach has thus brought together questions of

[5]Bohm, 'A New Theory of the Relationship of Mind and Matter' p. 132.
[6]Bohm, 'Fragmentation and Wholeness in Religion and in Science' p. 130.

> the nature of the cosmos, of matter in general, of life, and of consciousness. All of these have been considered to be projections of a common ground. This we may call the ground of all that is, at least in so far as this may be sensed and known by us, in our present phase of unfoldment of consciousness. Although we have no detailed perception or knowledge of this ground it is still in a certain sense enfolded in our consciousness, in the ways in which we have outlined, as well as perhaps in other ways that are yet to be discovered.[7]

For the Kabbalah, this first ground is unapproachable, as it is expressed in the description of Kether that appears in the traditional text of the Thirty Two paths:

> This is the Light that was originally conceived, and it is the First Glory. No creature can attain its excellence.[8]

The transcendental aspect is not ignored by Bohm:

> [...] and to say no more than that I feel that all emerges from some ultimate ground. When I see the immense order of the universe (and especially the brain of man), I cannot escape feeling that this ground enfolds a supreme intelligence. Although it is not quite so evident, I would say also that this intelligence is permeated with compassion and love.[9]

And even more emphatically:

[7]Bohm, *Wholeness and the Implicate Order*, p. 270.
[8]Aryeh Kaplan, *Sepher Yetzirah: The Book of Creation* (York Beach, Maine: Weiser, 1990), p. 297.
[9]Bohm, 'Hidden Variables and the Implicate Order' p. 124.

> In considering the relationship between the finite and the infinite, we are led to observe that the whole field of the finite is inherently limited, in that it has no independent existence. It has the appearance of independent existence, but that appearance is merely the result of an abstraction of thought. We can see this dependent nature of the finite from the fact that every finite thing is transient.
>
> Our ordinary view holds that the field of the finite is all that there is. But if the finite has no independent existence, it cannot be all that is. We are thus led to propose that the true ground of all being is the infinite, the unlimited; and that the infinite includes and contains the finite. In this view, the finite, which is transient in nature, can only be understood as held suspended, ass it were, beyond time and space, within the infinite.[10]

The Kabbalah proposes that all manifestation proceeds from the Ain Suph Aur in a series of emanations, the Sephiroth.

> The field of the finite is all that we can see, hear touch, remember and describe. This field is basically that which is manifest, or tangible. The essential quality of the infinite, by contrast, is its subtlety, its intangibility. This quality is conveyed in the word 'spirit', whose root meaning is wind, or breath. This suggest an invisible but pervasive energy, to which the manifest world of the finite responds. This energy, or spirit, infuses all living beings, and without it any organism must fall apart into its constituent elements. That which is truly alive in the living being is

[10]NCUACS, 66.4.97 A.64 – II

> this energy or spirit, and this is never born or dies.[11]

Manifestation starts with the establishment of an intention, the expression of The Will, Kether, which is the most abstract idea, and from there there proceeds a ladder of expression, each step becoming a more concrete manifestation until reaching the physical plane of matter in Malkhuth. For Bohm this ladder is established through the series of Implicate/Explicate Orders:

> Thus, intention, value and will [. . .] together with meaning, flow and merge into each other in an unbroken movement. The distinctions between them are only in thought.[12]

The obvious religious connotations were acknowledged by Bohm:

> For example, there is at least an analogy between how the Super Implicate Order organizes and even forms and creates the first Implicate Order and the way in which God is regarded as creating the universe (at least as this is put in many religions).[13]

This principle does not only includes life itself, it is the very essence of life, everything is alive:

> [. . .] in its totality the Holomovement includes the principle of life as well. Inanimate matter is then to be regarded as a relatively autonomous sub-totality in which, at least as far as we now know, life does not significantly manifest. That is to say, inanimate matter is a secondary, derivative, and particular abstraction

[11] NCUACS, 66.4.97 A.64 – II
[12] Bohm, 'Meaning and Information', p. 45.
[13] Bohm, 'Hidden Variables and the Implicate Order' p. 123.

> from the Holomovement (as would also be the notion of a 'life force' entirely independent of matter). Indeed, the Holomovement which is 'life implicit' is the ground both of 'life explicit' and of 'inanimate matter', and this ground is what is primary, self-existent and universal. Thus we do not fragment life and inanimate matter, nor do we try to reduce the former completely to nothing but an outcome of the latter.[14]

For Bohm, our experience is happening within a dynamic living wholeness, the most abstract unapproachable ground that is ever present, the Holomovement, from which experience arises by a series of enfoldments that get more and more concrete until reaching matter. Consciousness and matter are movements in this wholeness.

Thinking that attaining the absolute idea is possible is a delusion, according to Bohm. It seems like this because the particularities of the dynamics of the thought process. But confusing the mechanism of thought with reality itself is essentially the cause of all our problems. How it is this happening, and how this can be addressed, is indeed the subject of Bohm's epistemology.

8.2 The Limits of Thought

> My work in physics had showed me that limitations on ideas in physics come from limiting features in the general structure of thought. When these are seen, then they can change. This led me to the work of J. Krishnamurti and others who have tried to

[14] Bohm, *Wholeness and the Implicate Order*, p. 247.

> penetrate beyond such limitations in their own ways.[15]

Complementing his realist, panpsychic metaphysics, in which reality is conceived as a transcendental holistic process which manifests itself through a multilevel chain of orders, Bohm proposes a relativist epistemology in which complete knowledge about this reality is impossible to achieve or articulate. As explained above, Bohm observes that the thought process is similar to the enfoldment process in which he based his interpretation of the quantum theory, and he uses this observation to justify his proposal that mind and matter are aspects of a common encompassing reality. The common root of mind and matter is an idea consistently present throughout the esoteric tradition, which postulates that the physical universe perceived by our senses is but an aspect of a vaster, imminent transcendent reality, a 'universal consciousness', fundamentally coextensive and continuous with the sentient mind

The connection between mind and matter does not only offer a satisfying theoretical unification, it also has practical applications as this link is creative: our lives are not just shaped, but created by our mind through thought processes. According to Bohm, our mind influences directly the material world in which we live, the mind is responsible for the current situation, no matter how good or desperate it may be, it is our own creation:

> Thought affects everything, It has created everything we see in this building. It has affected all the trees, it has affected the mountains, the plains and the farms and the factories and science and technology [. . .] Thought has produced tremendous effects outwardly.[16]

[15]Bohm, 'Letter to Dr. Jonas Salk' p. 3
[16]Bohm, *Thought as a System*, p. 5.

We are not victims of our minds, despite all the problems that may be caused by a naive and ignorant use of the thought process. Like any other process, it can be controlled and modified to produce a positive outcome. This was a subject of paramount importance for Bohm, and he discussed it extensively with Krishnamurti, as this was one of the main points in Krishnamurti's teaching. For Krishnamurti the mind is the media through which reality is broken in different limited aspects. This is what he calls the phenomenon of 'fragmentation', and the problems that it produces are consequences of being ignorant of its true nature:

> Our lives are broken up, fragmented, divided, they are never whole; we never have holistic observation. We observe from a particular point of view. We are in ourselves broken up so that our lives are in contradiction in themselves, therefore there is constant conflict. We never look at life as a whole, complete and indivisible.[17]

We live our lives with no understanding about how our own mind is creating our conditions, and we tend to identify reality with the process and its arbitrary side effects, influenced by the conditioning provided by our education, environment, parents and teachers. However there are alternatives to this condition, we are not condemned to be subservient to the delusions induced by the fragmentation process. Krishnamurti maintains that there is a mental state (which he enjoys), in which it is possible to look at life as a whole, with the many different activities in our lives as if they were not separated. He is not proposing that in this state of mind the various fragmented parts will become a single whole in themselves, as this is the way

[17] Jiddu Krishnamurti, *The Flame of Attention* (San Francisco: Harper, 1984), Ch 5.

thought is designed to work, but by changing our point of view, the several aspects of our lives can be lived as being aspects of a holistic movement, making our lives harmonious. The aim of this conscious state is not to correct or fix the fragments, but to acknowledge them as part of a whole. This attitude opens the possibility of living life in a new way:

> It is not a matter of what to do about it; because if you attempt to do something about it you are then acting from a fragment and therefore cultivating further fragments and divisions. Whereas, if you can observe holistically, observe the whole movement of life as one, then conflict with its destructive energy not only ceases but also out of that observation comes a totally new approach to life.[18]

The conquest of fragmentation is not the end of living the many aspects of our lives, but a new perception of them. According to Krishnamurti, this does not come from the intellect, from knowledge, or any purely mental exploration that follows the natural thought process of fragmentation. Exhaustive mental examination of the fragments does not bring about understanding but more fragmentation.

> Psychologically I use knowledge; I think I know myself, when I really don't, because I am changing, moving. Or I use knowledge for my own satisfaction - for my position, for my success, for becoming a great man in the world. I am a great scholar, say. I have read a million books. This gives me position, prestige, a status. So is that it - that fragmentation takes

[18]Krishnamurti, *The Flame of Attention*.

> place when there is a desire for security, psychological security, which prevents biological security?[19]

On the other hand approaching the fact without opinion or interpretation in a way that Krishnamurti calls 'meditation' gives tremendous energy to deal with the fragmentation and ultimately it is the tool to liberate us from it.

Bohm followed closely Krishnamurti's esoteric world-view and explored extensively with him the properties of the thought process, its limitations and how can we be liberated from it. In their conversations they usually start with an assessment of the state of the world, usually 'the terrible state in which humanity is found today', rapidly moving to conclude that the causes lie mainly in the problems caused by the fragmenting dynamics of thought.

> Krishnamurti: Suppose you state that there is such a thing, that there is the ground; it is immovable, etc. And I say, I want to find out. Show it, prove it to me. How can my mind, which has evolved through knowledge, which has been highly disciplined in knowledge, even touch that? Because that is not knowledge, it is not put together by thought.
>
> Bohm: Yes, as soon as we say, prove it, we want to turn it into knowledge.
>
> Krishnamurti: That's it!
>
> Bohm: We want to be absolutely certain, so that there can be no doubt. And yet, on the other side of the coin, there is also

[19] Jiddu Krishnamurti, *The Wholeness of Life* (San Francisco: Harpercollins, 1981), 1st Conversation with Dr. David Shainberg and Prof. David Bohm, Brockwood Park 17th May 1976.

the danger of self-deception and delusion.

Krishnamurti: Of course. The ground cannot be touched as long as there is any form of illusion, which is the projection of desire, pleasure or fear. So how do I perceive that thing? Is the ground an idea to be investigated? Or is it something that cannot be investigated? , Because my mind is trained, disciplined, by experience and knowledge, and it can only function in that area. And someone comes along and tells me that this ground is not an idea, is not a philosophic concept; it is not something that can be put together, or perceived by thought.

Bohm: It cannot be experienced, it cannot be perceived or understood through thought.

Krishnamurti: So what have I? What am I to do? I have only this mind that has been conditioned by knowledge. How am I to move away from all that? How am I, an ordinary man, educated, well-read, experienced, to feel this thing, to touch it, to comprehend it? You tell me words will not convey that. You tell me you must have a mind that is free from all knowledge, except that which is technological. And you are asking an impossible thing of me, aren't you? And, if I say I will make an effort, then that also is born out of the self-centred desire. So what shall I do? I think that is a very serious question. That is what every serious person asks.[20]

For Bohm the fragments and divisions produced by thought, in the form of concepts, are valid within certain limits. However, following Krish-

[20]Bohm and Krishnamurti, *The Ending of Time*, p. 97.

namurti's teaching, our conditioning, education, and mental inheritance leads us to take the perceived fragments as reality itself. As we experience our lives in accordance to what we think, our expectations become out of sync with reality and this creates problems as the limits of the validity of the fragments are crossed. Bohm maintains that this is the source of all the troubles faced by humankind.

According to Bohm, these problems are compounded by our expectations. We believe that thought has an unlimited power to solve problems and we try to use it, the very source of our problems, to solve the difficulties that it has created. Having little knowledge of the limitations of the thought process itself, we believe that to solve a problem, we need to think harder. However, in creating new thoughts, we create further fragmentation, making things worse.

The basic limitations of the thought process are reproduced in the construction of language. Language is the way thought is expressed and communicated, so languages, including the language of mathematics, has an intrinsic fragmented nature which makes impossible the articulation of the whole. The whole itself, the Holomovement, cannot be fully apprehended or described in any language, symbol or model, so any concrete articulation is always an approximation to reality.

Bohm interpreted this mental fragmentation in the context of the Implicate Order as a process of enfoldment and unfoldment, and linked the difficulties encountered by modern theoretical physics to the lack of recognition by the physics community of the effects of the limitations of the thought process in the creation of physics theories. As science for Bohm was mainly an issue of perception and communication, this issue was importantly linked to the use of mathematics in physics. Mathematics is the

language of physics, but despite its precision and power of expression, the physical concepts are still subjected to the fragmentation process of thought and the limitations of the mathematical language used to express them. But language, and the use of symbols has inherent limitations, and are incapable of expressing the whole of the Holomovement.

The limitations of language and the problems that arise because the paramount importance given to the word, was one of the most important subjects for Bohm. He had already discussed this with Biederman whom in May 1960 introduced Bohm to the work of the Polish-American philosopher Alfred Korzybski(1879–1950), whose writings influenced Bohm in important ways:

> There was a fellow called Alfred Korzybski who had been an American philosopher of the 1920s mostly, 1930s. Worked a lot on what's called semantics or the study of meaning. Korzybski had written an extensive work called *Science and Sanity*, which Biederman recommended to me and I read it. There were a lot of things in it, but a few points I can probably say. One point is he had of saying whatever we say anything is, it isn't. It's more and it's different, that the word never covers everything. That we however tend to identify things with the meanings of our words, and this is the cause of the vast part of human problems. Because then the way we think about it is going to affect the way we see it.[21]

To explain his ideas about the confusion introduced by our thought process, Bohm liked to quote Korzybski's famous saying 'a map is not the

[21] Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 12 Side B.

territory' to illustrate the idea that the thoughts and concepts formed by our mind, and the words that we use to represent them, are not the whole of it, they are limited models, like maps, and that we become so used to the map that we begin to take it for the terrain.[22] We need to be constantly reminded that thought is a map, not the territory, even if we tend to live in the map.

Bohm thought that when language is used naively, we lose sight of the reproduction of the fragmentation and limitations inherent in thought and this produces countless problems of communication and misunderstanding. The scientific community and the creation of physics theories are not immune to these fundamental limitations.

8.3 Insight

> Bohm: If you use the word 'flash', like the flash of lightening gives you light for that moment but then the next moment you are in darkness until the next flash of lightening.
>
> Krishnamurti: Yes. It is not like that.
>
> Bohm: Right. So what is it? Is it that the light suddenly turns on and stays on? The other view is to say that the light suddenly flashes on and stays on.
>
> Krishnamurti: No, because when we put that question 'stays on and goes off', you are thinking in terms of time.
>
> Bohm: We have to clear this up because the question is one that everybody will put, unless you clear.

[22] Alfred Korzybski, *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics* (Lakeville, CT: Institute of General Semantics, 1994), p. 750.

> Krishnamurti: The material process is working in darkness, in time, in ignorance and so on, in knowledge, ignorance, all that. When that insight takes place there is the dispelling of that darkness. That is all we are saying. Insight dispels that darkness. And thought, which is the material process, is no longer working in darkness, therefore that light has altered, has ended, no, has ended ignorance.
>
> Bohm: So we say this darkness is really something which is built into the content of thought.
>
> Krishnamurti: The content is darkness.
>
> Bohm: Yes. That's right. Then the light has dispelled the ignorance.
>
> Krishnamurti: Dispelled the content.
>
> Bohm: But still we have to be very careful, since you still have content in the usually accepted sense of the word, like you know all kinds of things, you see.
>
> Krishnamurti: Of course.
>
> Bohm: So we can't say the light has dispelled all the content.
>
> Krishnamurti: It has dispelled the centre of darkness.[23]

Following Krishnamurti, Bohm proposes that in order to free ourselves of the limitations of the known a certain 'insight' is necessary:

> The difficulties in these two areas (of physics and the thought process) have a common cure. In both areas, the creative challenge is basically the same. This is to show up the limiting

[23] Bohm and Krishnamurti, *The Ending of Time*, p. 127.

> structures of thought and to bring creative insight to bear on deeper implicit levels of unity, and thus, to unfold the creative potential in human consciousness.[24]

This insight is an inward perception that opens up completely new areas that we have never known before. This is a creative act that is not reason, insight opens a door to places that reason cannot reach by itself. This is an elaboration of Krishnamurti's teaching regarding the limitations of knowledge that Bohm bases upon his study of Hegel's Logic.

According to Bohm, Hegel considers two complementary mental aspects: the first is indicated by the German word '*Verstand*', which Bohm explains that it should be translated as 'logic' or 'reason'. On the other hand the word *Vernunft* which comes from a Latin root that means 'to perceive' and means 'intuitive' or 'flowing' reason, a different from formal logic. Bohm considers that for Hegel *Vernunft* is close to understanding and in a certain way opposite to reason.[25]

[24]Bohm, 'Letter to Dr. Jonas Salk' p. 3.

[25]Bohm maintains that English translators have turned Hegel's philosophy upside down because they have translated these two words in the opposite sense. *Verstand* is usually translated as 'understanding' and *Vernunft* as 'reason'. He says that British philosophers may have fallen into this translation trap and consequently missing the meaning of the concepts to some extent because they didn't understand German:

> It's a bad translation which throws you way off, because the word 'understand' means to comprehend as well. Hegel clearly uses the word comprehend in the other sense of what he calls reason, but the German word for reason is *Vernunft*, which comes from verb for *Vernehmen* meaning to take hold of, and it means to perceive through the mind. [...] So now the idea is that *Vernunft* is called intuitive reason or a perceptive reason, whereas *Verstand* formal logic and static reason. Now it is necessary for the flowing reason to develop into, crystallize into static reason. But then we make the mistake of saying thatâĂŹs the truth, and when once it is crystallized thatâĂŹs going to stand forever. So I say the word *Verstand* really means to stand, you want something that stands. Which we need. But it doesn't stand forever. And therefore it goes back to flowing reason. Now the contradiction is the way it stops standing; it collapses and starts to flow into something new. So we are thinking thought is a process, which when you try to make it

These two forms of thought are in a continuous transformation, one into the other, giving thought its dynamics. It is to this process that we have to be attentive, according to Bohm, as this interplay of *Verstand* and *Vernunft* results in *Aufgehoben*, insight or the dialectical transformation of categories:

> See, we were making the point that the basic principle of dialectics is twofold. One, that everything is in process and including thought itself, and therefore, any time you pick something you will get a contradiction. Anything fixed must inevitably lead to contradiction. That was the first point. And the second point is that thought always abstracts from the connections, and that also leads to contradiction [...] Hegel points out that in the very internal nature of thought itself there's contradiction [...] you will inevitably come to a contradiction if you follow a logical chain because you have made fixed assumptions [. . .] He says that since the very nature of thought is a process, it must come to contradict itself [. . .] Now, ipso facto if you make some assumption about some things, some facts, or some reality outside of thought, and you hold to it in a fixed way, since that too is a process, then you will also come to a contradiction [...] When you come to contradiction, then the movement of thought, the creative movement, is to rise, *aufgehoben*, to 'put aside' which in German means both 'to get rid of' and also 'to hold', 'to keep' in some sense [. . .] So we say the two contradictory thoughts

stand eventually it must come into contradiction with itself because thought does not stand. Not merely the reality does not stand, thought is part reality, but thought itself cannot stand, it's a process.[26]

> are both dropped and yet kept in some sense within the new thought. But they no longer have a primary independent rule. And then you have a new thought which synthesizes, if you want to put it that way, and that's a creative step.[27]

In this way Bohm understands the dynamics of thought in Hegel's philosophy: starting from nothing but the inner resources available to thought itself, which consists of its capacity for determination and contradiction, seeking for the most fundamental and universal meaning of a category, thought finds that it collapses into its own negation, and from this a third category arises that makes sense of the contradiction. Categories organize naturally into triads, in which an opposition is raised by a category and its negation and reconciled, or 'sublated', (*aufgehoben*), in a third one which is a synthesis containing the opposing categories. But now this new category will generate its own negation and a further synthesizing category. In this way the infrastructure of thought is unfolded. Bohm remarks that the dynamic aspect, the movement or process, and not the categories themselves, is what is real.

The tendency of thought to hold things static, to fix the process, provokes the rise of contradictions and problems:

> Now so the appearance of contradiction is a sign of movement. If we say that the reality is movement, but any time you abstract anything not moving, it will always be the opposite. They will come into contradiction. Any attempt to assert a thought that it is not moving must lead to contradiction [. . .] but it is the function of thought to assert these static things, right? Therefore a thought must come out into contradiction. That part of its

[27] Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 14, Side A.

> process. But contradiction may be taken as something which just makes it worthless, or in certain ways it becomes the step to the new thought.[28]

The sublation process, *aufgehoben* is what Bohm refers to as the unfolding of the Implicate Order in the sense that the new thought was already implicit in the old thought. The contradiction in the first thought was implicit and then it became explicit, then the new thought was implicit in the tension between those two.

> And Hegel says in a sense it's all there already but it unfolds. That has been translated as 'development'. The better translation probably, the meaning would have been 'unfold'. I'm sure it was a good translation of the German word but I think the way Hegel uses the word 'development' is roughly the way you would use the word 'unfolding'.[29]

Sublation, aufgehoben, or the unfolding of the implicate thought is not a logical deduction but a dynamic transformation. It can be further explained by comparing it with the practical reason whose purpose is to bring the object as an extension of the subject. Practical reason assimilates the object to the needs of the subject without trying to understand it. In a way ignoring the object in its own form, and making it subservient to the subject. As in the extreme case of eating something and assimilate it. This means that something in the object is closely related but not really understood. Practical reason is very subjective in its basic orientation, but the trouble is that its aims are superficial and limited. It's like saying that

[28]Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 10 Side B.
[29]ibid. Tape 10 Side B.

the reason cork trees exist is that people can bottle wine. By making the universe dominated by superficial and limited considerations things are not understood.

Sublation is possible when the object is respected and the subject lets it reveal itself. The subject's aims are not imposed on the object, as in the case of practical reason. However this attitude introduces a distinction between the subject and the object. But if the subject aims to understand the object it can't let it stand there separated, the subject has to somehow bring it close. A contradiction of the universal and the particular arises as the object is understood as a special case of the universal, but the object is still separated from the subject because the universal is in the subject and the particular thing is out there and its not understood how they are connected. The solution is to go to the higher level, aufgehoben, not the particular thought of the object but the notion of the object, this includes both the universal and the particular. It's a universal which particularizes itself to create the individual. This unfolding is a creative act that Bohm later calls the Generative Order.

> But now, one attitude would be, well, I have that in my mind, but who knows what's going on out there? That would be the Kantian attitude. That's the thing in itself [. . .] The other attitude of Hegel is that there is an objective notion which does rule the generative process which you could picturesquely call the thought of God. And that when you grasped that notion, you have grasped its essence, you're not separated from that thing at that deep level. By contacting the thought of God out of which that emerges, you are in contact with it at the deepest

level.[30]

8.4 Bohmian Dialogue

> Bohm: If it can reach those who are able to listen . . .
>
> Krishnamurti: Which means that to find the ground the first thing is to listen.
>
> Bohm: You see, scientists cannot always listen. Even Einstein and Bohr were not able at a certain point to listen to each other. Each one was attached to his particular view.[31]

The fragmentation produced by thought is not the problem, it is just the way thought works, however confusing the by-products of the process of thought with the reality in which it is contained causes serious problems. Bohm believed in the possibility of freeing the mind from this delusion as Krishnamurti represented for him a living example of a person whose consciousness was not deluded by the fragmenting process of the mind, a state in which thought is completely aware of how it operates and what is it doing. This state of mind is what Krishnamurt and Bohm meant by the observer being observed.

Bohm also thought that it was possible to become like Krishnamurti, by cultivating insight.

> Krishnamurti: You see I don't meditate in the normal sense of the word. What happens with me is I wake up meditating.
>
> Bohm: In that state?

[30] Bohm and Wilkins, 'Interview Bohm–Wilkins' Tape 10 Side B.
[31] Bohm and Krishnamurti, *The Ending of Time*, p. 76.

Krishnamurti: One night in Rishi Valley I woke up, a series of incidents had taken place, meditation for some days, I woke up one night, in the middle of the night, it was really quarter past twelve, I looked at the watch. And I hesitate to say this because it sounds extravagant and rather childish: that the source of all energy had been reached. And that had an extraordinary effect on the brain, and also physically. And literally any sense of - I don't know how to put it - any sense of the world and me and that, there was no division at all, only this sense of tremendous source of energy. I don't know if I am conveying it.

Bohm: Yes. So the brain was in contact with this source of energy.

. . .

Bohm: Well, is this sustained? Is this situation sustained or is it for that period?

Krishnamurti: It is sustained, obviously, otherwise there is no point in it. It is not sporadic, intermittent and all that. Now how are you to open the door, shut, whatever, how are you to show, help me to say, 'Look, we have been going in the wrong direction, there is only, another non-movement, and if that takes place everything will be correct'.

. . .

Bohm: But I think you are implying that the mind is not originating in the brain but the brain is perhaps an instrument for it, of the mind?

Krishnamurti: And the mind is not time. Just see what that

> means.
>
> Bohm: The mind does not evolve with the brain.
>
> Krishnamurti: The mind not being of time, and the brain being of time - is that the origin of conflict?.[32]

The idea of the possibility of becoming 'aware of awareness' is key to understand Bohm's later philosophy and its links with the Western esoteric tradition. Bohm had finally moved into a philosophical viewpoint in which he adapted into his thought standard esoteric ideas like the dynamics of a multi-level inner reality, as in the case of the Holomovement and its layers, the deep connection between mind-matter, the existence of actual people having achieved a higher states of consciousness, states of mind that are not different from mystical experiences, and even the possibility of pursuing enlightenment by training the mind:

> To sum up, I am proposing that with sufficient sensitivity, man can be directly aware of the 'Noumenal' reality of the 'process-structure' that he is [...] so I assume that behind the Totality of What Is, there is an inner reality, to be distinguished from its phenomenal map-like manifestations.[33]

The main difficulty to progress in this direction is to overcome thought's lack of awareness of itself. According to Bohm, thought is not aware of its effects, and not even of the extent and nature of its own being. For Bohm, thought is a much more encompassing category than just the mere intellectual operation of the mind:

[32] Bohm and Krishnamurti, *The Ending of Time*, p. 18.
[33] NCUACS, 66.4.97 C.53, p. 64

> We were saying that thought is not merely the intellectual activity; rather it is one connected process which includes feeling and the body, and so on. Also it passes between people - it's all one process all over the world. I suggested that we call that process a 'system' in which every part is dependent on every other part.[34]

The intellect part is only a part of the whole thought process, which is not isolated within the mind of a single person. It is a shared process that engages our whole being with emotions, the intellect, our bodies, the subconscious. It is this wider concept of thought that we experience and fragment, isolating it within ourselves, not realizing that it is a wider entity with automatic processes that carry on after we have started them consciously and stop being aware of them.

To illustrate the lack of understanding we have of our thought processes, he compared it with the faculty that the body has of being aware of its own actions. This ability to sense the position, orientation and movement of the body and its parts is called 'proprioception'.[35] We lack the same awareness of our thoughts, which Bohm maintained were 'real' and didn't finish once we stopped being aware of them. Our thoughts, Bohm maintained, carry on producing consequences, despite being out of our awareness for long. Thought is not spontaneously proprioceptive, and therein lies the problem:

> We could say that practically all the problems of the human race

[34]Bohm, *Thought as a System*, p. 42.

[35]From the Latin *proprius*, meaning 'one's own', and perception. In physiology the term proprioception refers to the capacity of the body to have self-awareness of its own movements, its natural awareness of where it is and what it is doing: when we lift an arm we know exactly where the arm is.

are due to the fact that thought is not proprioceptive.[36]

We don't naturally perceive the whole reach of the thought process. Once started, thought carries on following in its automatic path and leading to consequences that we neither anticipate or associate with the initial thought. Then when the thought system comes back later, it is fragmented, reified and treated as independent, when in fact is just part of the same system. It is this that causes the problem as we become too identified with isolated fragments of the whole process and feel threatened by its own other aspects.

Bohm believes that thought can be proprioceptive and become aware of its own movements. The most important aim at which the dialogues between Bohm and Krishnamurty were directed can be summarized as an attempt to figure out how to train thought to develop proprioception:

> Bohm: Thought has entangled the brain in time.
>
> Krishnamurti: In time. All right. Can that entanglement be unravelled, freed, so that the universe is the mind? You follow what I am trying to say? If the universe is not of time, can the mind which has been entangled in time, unravel itself and so be the universe? You follow what I am trying to say?
>
> Bohm: Yes.
>
> Krishnamurti: That is order.
>
> Bohm: That is order. Now would you say that is meditation?
>
> Krishnamurti: That is it. Now I would call that is meditation. Not in the ordinary dictionary sense of pondering over and all that,

[36]Bohm, *On Dialogue*, p. 25.

that is a state of meditation in which there is no element of the past.

Bohm: You say the mind is disentangling itself from time and also really disentangling the brain from time.

Krishnamurti: Yes, sir. Would you accept that?

Bohm: Well, I can see that. Yes.

Krishnamurti: As a theory.

Bohm: Yes, as a proposal.

Krishnamurti: As a proposal. No, I don't want it as a proposal.

Bohm: What do you mean by theory?

Krishnamurti: Theory as somebody comes along and says this is real meditation.

Bohm: All right.

Krishnamurti: Wait. Somebody says one can live this way and life has an extraordinary meaning in it, full of etc., etc, compassion and so on, and every act in a world, in the physical world, can be corrected immediately and so on and so on. Would you, as a scientist, accept such a state, or say this man is cuckoo?

Bohm: No, I wouldn't say that, no. I feel it is perfectly possible, it is quite compatible with anything that I know about nature.

Krishnamurti: Oh, that's all right. So one is not an unbalanced cuckoo![37]

Achieving 'proprioception of thought' is to acquire a mental state in which the observer is observing itself. When the mind is proprioceptive,

[37] JKO 800607.

insight becomes possible. This is identical to what Krishnamurti called meditation.

The theory of proprioception of thought was developed by Bohm in the yearly seminars that he conducted shortly after Krishnamurti's death.[38] In 1992, few months before his death, in the final session of the the last seminar in Ojai, Bohm would claim that there was indeed empirical proof that it was indeed possible to enter into the proprioception of thought because he was in it; He emphasized that this is what he and Krishnamurti had been experiencing in their Dialogues since their earliest exchanges in 1965.

Developing proprioception of thought was of paramount importance for Bohm, as he believed that if thought could be made proprioceptive, our perception could be transformed to become more creative and solve the fundamental difficulties caused by confusing the process of fragmentation. He had first thought that science and rationality could deliver this transformation, but his experience with the lack of dialogue and understanding in science and the failure of Communism, his political difficulties and exile, proved him that reason and science were not enough, something more was needed.

Not understanding the limitations of thought, and believing that thought presents 'a truth' is the problem that prevents communication, making progress and eventually leads to fight and conflict. Not understanding thought leads to the belief that artificial creations of our mind are 'true' or real, when

[38] In early 1986, Bohm started to held a yearly seminar on the grounds of the Oak Grove School in Ojai, California. These annual meetings would last until the end of his life in 1992. The seminars were limited to a small attendance in which it was important for the attendees to participate as much as possible. The Seminars were not 'Bohm Dialogues', although Bohm Dialogue was discussed throughout the course of the Seminars. All the Seminars were audio-recorded and copies are available in the Bohm Archive NCUACS 66.4.97 at Birkbeck College, except for the year 1991 when Bohm was very ill and the meeting was cancelled. A transcription of the 1989 seminar was privately published and edited by Bohm: David Bohm, *Thought as a System* (London: Routledge, 1992).

they are simply creations: countries, religions, education, etc. Even physical theories are artificial creations subjected to the limitations of thought, not 'the truth'. What is required is a transformation of a different state of mind.

To produce this state of mind, it is not necessarily the formation of 'new concepts', as new concepts only repeat the usual dynamics of thought. To foster insight and creativity what is necessary is to make the mind aware of itself, catching itself in the act of being aware and how it is fragmenting, there is a need to observe how the process of thought is working, thinking thought, whether individually or in society.

This is the meaning of transforming the mind to make it proprioceptive, to make 'the observer observed'. Insight happens when the mind becomes aware of the arbitrariness of the fragmentation process to become able to act free of it. To achieve this state of mind consciously, and trigger our full creativity, Bohm proposed a technique that he called a dialogue. Accepting that the operation of the mind produces an arbitrary fragmentation of reality, we are more open to accept different views and not only tolerate diversity in thought, but even to promote it as the source of creativity and insight. This mental transformation leads to find unity in this diversity.

After his rift with Krishnamurti in 1984, Bohm became deeply depressed and began regular treatment with the British psychologist Patrick De Mare (1916-2008) who was running dialogue groups as a form of social therapy. Bohm used De Mare's ideas to developed his own version of a dialogue group in the context of the Implicate Order.[39] Bohm's social concerns took a new form as he found that Krishnamurti's teachings dealt with the individual and religious dimensions of a human being, but they neglected the

[39]Bohm, *On Dialogue*.

social dimension that was always of paramount importance for him. He felt that the dialogue groups, run in the way he designed them, were an opportunity to solve the problems of human society that were rooted in a loss of communication between people as a result of fragmentation in the thought process.

His preoccupation with dialogue and the means to encourage it were not new, as he had already started to think about dialogue and communication when he witnessed how Niels Bohr and Einstein, once close friends, were later estranged and barely talking to each other as a result of their philosophical differences regarding the foundations of the quantum theory.

Understanding and insight require a willingness to listen and be open to new ideas. He had two painful examples of how this willingness to listen can be very difficult to achieve. The first example was his experience with the scientific community when he published his 1952 papers. He expected to engage in dialogue, but this never happened. The scientists that he wanted to discuss his proposal didn't want to listen.

The second example was what he thought was one of the main lessons learnt from the famous debate between Albert Einstein and Niels Bohr on the foundations of quantum mechanics. He used this debate as an example of how even between well-meaning and extremely intelligent men, the undue allegiance to a particular mental set up can prevent understanding and communication.[40]

The major issue of this chapter is the breakdown in communic-

[40]Bohm summarized his conclusions about the Bohr-Einstein debate in Bohm and Peat, *Science, Order and Creativity*, pp. 75–79 in a section entitled 'The Bohr-Einstein Dialogues and the Breakdown of Communication in Physics'. The main lines of the argument are taken from NCUACS, 66.4.97 B.44, an unpublished article written in 1972 in collaboration with D. L. Schumacher entitled 'On the Failure of Communication Between Bohr and Einstein'.

> ation within science, especially as it arises in connection with discontinuities between the formal and the informal languages used by scientists. A particularly significant example of this failure to communicate arose between Bohr and Einstein, which, in a symbolic sense, still prevails in physics today.[41]

The exchanges about the meaning of quantum mechanics popularly known as 'the Bohr-Einstein debate', started with a friendly discussion on the philosophy of quantum mechanics when Bohr first met Einstein during a visit to Berlin in 1920.[42] The discussion intensified during the fifth Solvay conference of 1927, in which Einstein challenged Bohr's views by formulating 'thought-experiments', experimental set-ups not designed to be performed in practice, but useful to focus on conceptual issues. Bohr's job would be to defend his philosophical position by finding suitable explanations to the issues posed by Einstein. This dynamic continued through the sixth Solvay conference of 1930 and culminated in 1935 with the publication of the EPR paper by Einstein, Podolsky and Rosen and Bohr's response to it.[43] The philosophical issues raised by the EPR paper and Bohr's response are very subtle, and from the philosophical standpoint

[41] Bohm and Peat, *Science, Order and Creativity*, p. 75.

[42] The story of this debate and its philosophical consequences has been the object of intense analysis. For a very small selection of the many academic and popular accounts of this debate see: Beller, *Quantum Dialogue, The Making of a Revolution*; Bacciagaluppi and Valentini, *Quantum Theory at The Crossroads*; Cushing, *Quantum Mechanics*; James T. Cushing, *Philosophical Concepts in Physics: The Historical Relation Between Philosophy and Scientific Theories* (Cambridge: Cambridge University Press, 1998); Giancarlo Ghirardi, *Sneraking a Look at God's Cards: Unraveling the Mysteries of Quantum Mechanics* (Princeton, New Jersey: Princeton University Press, 1997); Gilder, *The Age of Entanglement*; Whitaker, *Einstein, Bohr and the Quantum Dilemma*

[43] Einstein, Podolsky and Rosen, 'Can Quantum–Mechanical Description of Physical Reality be Considered Complete?'; Niels Bohr, 'Can Quantum–Mechanical description of Physicala Reality be Considered Complete?', *Physical Review*, 48 (1935), ed. by John Archibald Wheeler and Wojciech Hubert Zurek, pp. 696–702; Bohr, 'Discussion with Einstein on Epistemological Problems in Atomic Physics'. See section 4.2.6 above.

they remain largely unsettled. After the exchanges related to the EPR paper Bohr and Einstein stopped their communication.

> However, in retrospect, it becomes clear that it was never possible to resolve the issues that stood between them because their different uses of informal language implied conflicting notions about the nature of truth and reality and about what is an acceptable type of scientific theory. Bohr began to feel that Einstein had turned in a reactionary way against his own original, revolutionary contributions to relativity and quantum theory. Einstein, for his part, felt that Bohr had become caught in what he called a 'tranquillizer philosophy' which avoided fundamental questions.[44]

In Bohm's view the main problem was not so much the philosophical issues, but language and willingness to meet. According to him, Bohr and Einstein couldn't talk to each other any more because the two men were victims of their own thought processes, preventing them from listening to each other.

> This breakdown between the two men is clearly shown in a story told by Hermann Weyl, who was at the Princeton Institute for Advanced Studies at the same time as Bohr and Einstein. Weyl felt that it was unfortunate that the two men did not get together, so he arranged a party for this purpose. But at the event Bohr and his students congregated at one end of the room and Einstein and his at the other. Clearly the two men had nothing left to say to each other.[45]

[44] Bohm and Peat, *Science, Order and Creativity*, p. 76.
[45] Ibid., p. 77.

If this attachment to prejudice and preconceived ideas, preventing successful communication and understanding could happen to two highly intelligent men, it was not surprising that society at large was a victim of the same phenomenon.

Bohm maintained that the problems that modern society confronts today had their origins in the way that individuals use thought. The confusion of the fragmentation effected by the normal functions of the brain led people to conceptualize the world in an erroneous way. He believed that dialogue groups could help to correct this confusion by confronting the individual to recognize the way in which his mind was functioning. He proposed that to build mental proprioception was one of the main purposes of the dialogue method.

One of the most important aspects of the Bohmian dialogue group is that it presupposes that the individuals taking part in it are capable of suspending their thoughts, impulses and judgements so that they can listen to what the others have to say. In a sense this is similar to the individual introspection practice that esoteric traditions promote, including Krishnamurti's own teachings. Bohm knew that this was the most difficult part:

> Suspension of thoughts, impulses, judgements, etc., lies at the very heart of Dialogue. It is one of its most important new aspects. It is not easily grasped because the activity is both unfamiliar and subtle. Suspension involves attention, listening and looking and is essential to exploration. Speaking is necessary, of course, for without it there would be little in the Dialogue to explore, But the actual process of exploration takes place during listening – not only to others but to oneself.[46]

[46]David Bohm, Donald Factor and Peter Garrett, 'Dialogue: A proposal ', (1991),

Bohm went on to organize groups of dialogues in Europe and the US, some of the transcripts have been been published as a book.[47] He also published a dialogue in collaboration with the photographer Mark Edwards *Changing Consciousness: exploring the hidden sources of the social, political and environmental crisis facing our world* (1991) in which he traces the problems of the world back to our habits of thought.[48]

<http://www.david-bohm.net/dialogue/dialogue_proposal.html> [accessed 1 September 2015]

[47]Bohm, *Thought as a System*

[48]David Bohm and Michael Edwards, *Changing Consciousness: exploring the hidden sources of the social, political and environmental crisis facing our world* (San Francisco: Harper, 1991)

Chapter 9

Conclusion: David Bohm's Esoteric Imagination

As I explained in the introduction, my principal aim in this work has been to explore the relationship between the esoteric imagination and the science and philosophy of David Bohm.

To achieve this aim I started by carrying out a comprehensive review of Bohm's works, trying to cover all important aspects of his thought and considering it as a single unit, an approach to Bohm's work which is in definite contrast with other studies of Bohm's work that tend to be partial, either because important aspects of the scientific research are overseen due to the technical challenges that they present, or because the more philosophical, or esoteric, aspects of Bohm's thought are misunderstood or deemed as irrelevant. In contrast, using what I call an Integrative-Sympathetic-Corporate-Critical approach, as outlined in section 1.4, I took into account every aspect that Bohm considered of importance: scientific and philosophical, his dialogues with several people, his commentaries on psychology, art and social issues, and acknowledging Bohm's relationship with

Krishnamurti, the importance that he gave to Hegel's Logic, and the possibility of a coherent coexistence of an esoteric and a scientific world-view.

Although a quotation showing Bohm referring to himself explicitly as an 'esotericist' does not exist in the material I reviewed, I have argued that the importance of Krishnamurti's influence on Bohm, his lifelong interests in the aspects of Hegel philosophy that can be related to the esoteric tradition, and his pursuit of a holistic world-view in the practice of his physics and the elaboration of his philosophy, elicit a definite inclination for a world-view that is fully in accordance with the general characteristics of the Western esoteric tradition. In the previous chapters I have shown how the Holomovement, the Implicate Order, the Super-Implicate Order, Bohm's ideas on the dynamics of the thought process, and his Dialogue technique, were related to and influenced by Bohm's encounter with esoteric philosophy.

Taking into consideration all these factors, can Bohm be considered an esotericist? All depends on what is meant by this. Bohm may not have called himself an esotericist, and he may even have been uncomfortable with that label if it had been applied to him. However looking at the content of his thought, his experiences, and his overall philosophical inclinations, we can argue that he was indeed close to the esoteric tradition.

In the development of his purely philosophical investigations, Bohm follows Hegel's esoteric leanings up to the point where Hegel stops following the esoteric tradition, as I showed in chapter 5. This noteworthy detail elicits Bohm's inclinations towards an agreement with an important aspect of the esoteric world-view. In contrast to Hegel, Bohm insisted on the impossibility of fully articulating what reality is, i.e. Bohm agreed with core esoteric teachings that the whole is ineffable. Bohm does not deny the

existence of reality, which for him is a holistic process, the Holomovement; however he finds that all forms of expression of this totality are limited. In his reception of Hegel, Bohm follows him as long as Hegel is in agreement with the esoteric tradition, and when Hegel stops agreeing with the esoteric tradition, pretending that absolute knowledge can be attained, Bohm stops agreeing with Hegel. He sides, without being conscious about it, with the traditional esoteric holistic view of the impossibility of reaching a complete articulation of the whole.

Bohm's esoteric tendencies were not just a purely intellectual philosophical pursuit. As explained in section 3.5, Bohm had some experiences that were akin to mystical states. He describes these experiences as visions of reality as an 'holistic movement out of which the world emerged', and about which nothing final could be said. He considered these experiences to be real, and of great value. He didn't dismiss them as purely psychological phenomena created by his own psyche, but took them seriously and tried to understand them, not as hallucinations but as real phenomena. I argued that these holistic experiences were part of the empirical basis informing the development of his holistic world-view.

I have shown how he tried hard to find answers to the questions raised by these experiences in all avenues he could pursue. This endeavour included the esoteric tradition which he pursued actively, recognising that there were important clues to be learned from it. As described in section 6.1, he sustained a prolonged dialogue with one of Gurdjieff's main representatives, the British philosopher and mathematician John Godolphin Bennett.

I have outlined in section 6.4 the powerful influence that Jiddu Krishnamurti had on his thought. Bohm found a spiritual home in Krishnamurti's

organization and became one of his best known disciples. He was an important supporter of many of Krsihsnamurti's activities, including Krishnamurti's school in England. Bohm was a close collaborator of Krishnamurti for more than thirty years, and as mentioned in section 3.6, Bohm acknowledged the influence of Krishnamurti on his own thought, and in particular in the development of his central philosophical idea, the Implicate Order.

Therefore it is not difficult to find concurrences between Krishnamurti's teachings and Bohm's ideas in many important subjects. Many examples of the developments of Bohm's thought can be traced by following his dialogues with Krishnamurti. I give many examples of this, particularly in chapters 7 and 8. These are only a small selection of the enormous collection of relevant exchanges between Bohm and Krishnamurti that can be found in their recorded dialogues.

In agreement with one of the core tenants of the esoteric tradition, Bohm acknowledged the existence of a superior state of human consciousness. More importantly, and this again in full agreement with the esoteric tradition, he believed that it was possible to actively pursue it. Even more, he accepted the existence of people who had already attained these superior levels of consciousness and lived permanently in a state of a superior perception of what can be called 'reality', as explained in section 6.2. For Bohm, the existence of these kinds of people was not a matter of speculation, as I explain in section 7.4: he considered Krishnamurti as an example of a person 'in the flesh' enjoying this more evolved consciousness.

His falling out with Krishnamurti in 1984 and the exposure of Krishnamurti's love affair with the wife of one of his close collaborators tarnished

his view of the man, but not of his teachings, which he always considered sound. He continued to support and participate in the activities of Krishnamurti's organization until the end of his life, despite his disappointment with Krishnamurti. In the end what was important was the content of the teachings, not the particulars of the teacher.

Moreover, in my presentation of the main aspects of Bohm's philosophy, I make use of the methodological tools developed by the academic study of Western esotericism to rearrange this material. This shows that Bohm's main philosophical themes can be reorganised to resonate with the main four aspects of the standard characterisation of Western esotericism: a system of correspondences between levels of manifestation, the process of imagination as a mediator between these levels, the aliveness of the whole and the process of transformation.[1]

- Bohm synthesizes his three main philosophical concepts - wholeness, movement and order - to establish an ontology that sees the universe as a single whole in which a main process, the Holomovement, generates a ladder of orders which form a hierarchy, with the external order below, unfolded from a more subtle Implicate Order, which in its turn is an unfoldment of an even subtler Super Implicate Order above, and so on. These are in sympathetic correlation and establish a system of correspondences.

In section 5.3 the consistency of Hegel's philosophy with the Kab-

[1] As explained in section 1.3.4 this model considers two optional characteristics: the search for common denominators in different traditions, and the transmission of knowledge through initiation and the reception of secret knowledge. Although they are often present, these aspects are not required to characterize a form of thought as esoteric according to the model of Western esotericism. I make no emphasis on them because Bohm's did not pursue actively to establish concordances with other traditions, and despite his dependence on Krishnamurti he did not acknowledge a lineage of teachers.

balah was summarised in a list of nine points. A similar list can be drafted for Bohm's ontology:

1. The Holomovement is a dynamic process that cannot be fully apprehended.
2. The process of becoming is delineated in explicated steps.
3. Being is, and proceeds from a primordial ground, the Nothing.
4. Being-Nothing transcends the subject-object distinction. The meaning and how it acts are the same
5. All the categories, or Sefiroth, or Orders, are immanent in the Holomovement.
6. The Holomovement, and the dynamics of the Implicate/Explicate Order penetrate and inform all being, constituting the skeleton, the animating soul of nature.
7. The manifestation is a triadic, dialectical structure.
8. Evil is conceived as the confusion of the fragmentation process of the mind with the whole.

If, as explained in 5.3 above, the influence of the Kabbalah on Hegel, and that of Hegel on Bohm are acknowledged, then it is not surprising to find some resonance between Bohm's philosophy and the Kabbalah:

- Bohm maintains that everything in the universe contains conscious and material aspects. He proposes that the subtle levels above are experienced as consciousness and the levels below as material. Nature is an Explicate Order of expression of the Holomovement and everything is alive.

- For Bohm our experience in the Explicate Order is the production of our thought processes. He distinguishes the concepts of logic and insight as the way in which we create our experience. Language, with its limitations, is an important aspect of this process of imagination through which the Holomovement manifests the world. Bohm believed that our perception could be transformed to become more creative and solve the problems that are created by ignoring the way that thought naturally works. The main issue is that we have confused a particular order with the whole and lost sight of how we perceive and think.

- The solution to the problems that we are confronted with requires a transmutation at the social and individual level. He designed a form of meditation with the objective of enabling thought to be able to perceive itself in the act of thinking and foster creativity. He called it a dialogue technique, to be practised individually and in groups,

This re-organization accomplishes a clarification of many aspects of Bohm's thought that otherwise may seem confusing or unconnected, but that when seen through this lens find a natural place. The natural fit of Bohm's thought into the standard model of Western esotericism supports my argument that Bohm's philosophy resembles a traditional form, albeit with contemporary scientific and philosophical content, of Western esotericism.

This constitutes an original approach towards the study of the thought of a Twentieth century scientist, that helps to bring to light a definite example of contemporary physics being influenced by the esoteric leanings of a Twentieth century thinker. Indeed, as was shown in section 7.3, the

Ontological Interpretation of Quantum Mechanics was deeply influenced by Bohm's philosophy of the Holomovement.

His scientific proposal regarding the levels of the Explicate, the Implicate, the Super-Implicate Order, and so on are close to the same ideas in the Western esoteric tradition, and supported Bohm's panpsychic theory of the relationship between mind and matter. He exploited this theory to explain paranormal phenomena, which he regarded as an actual possibility, as explained in 7.4.

All things considered, can Bohm be considered an esotericist?

The answer will depend on what one wants to consider an 'esotericist'. He was certainly not performing rituals invoking angels and spirits, but not all esotericists necessarily do that. Many important esotericists had philosophical tendencies and their practice, when there was one, is more akin to a meditation. Bohm went beyond the pure intellectual explorations and engaged in certain forms of meditation with the aim of changing his consciousness. His philosophy resonates with the general form of what is generally accepted to be an esoteric philosophy, and in particular resonates deeply with the teachings of Jiddu Krishnamurti. He pursued actively the incorporation of his philosophy in all areas of his life, including his influential scientific theories.

For some this will be enough to answer in the affirmative the question, or at least to agree that there is ample evidence that there was an important influence of the esoteric tradition on David Bohm, who is perceived by many as one of the most original scientists of the Twentieth century. This exploration shows that Bohm's philosophy can be seen as an esoteric form of thought, and that the elaboration of his Ontological Interpretation of quantum mechanics constitutes an example of the influence that the

esoteric tradition can exert upon contemporary scientific practice.

Why does this matter?

My exploration of Bohm's work shows an unmistakable relationship between the Western esoteric tradition and contemporary physics. Once acknowledging this influence, we can pose wider questions: Is Bohm an isolated case? Does the esoteric tradition have a wider, but not fully recognised influence upon contemporary science? Are science and the esoteric really incompatible? Can contemporary science and esotericism coexist and influence each other in positive ways? Does the esoteric tradition offer contemporary science something of lasting value?

These are thrilling questions, and the case of David Bohm suggests that the answers to these questions may be rather surprising.

Appendix A

Bohm's Legacy

A.1 Non Locality

In physics, locality means that the influence of a physical event travels at a finite speed. The theory of relativity sets an upper bound to this speed to the speed of light. This means that the influence of a physical phenomena takes some time to be felt. Because the speed of light is so great, we feel that physical causality is immediate, but in general it is not. Non locality is encountered when the influence of a physical phenomenon is felt in another location immediately, or when the influence arrives faster than the speed of light. Classical physics and relativity theory are local theories. In classical physics and in relativity we only need to consider the immediacy of the system under study. However quantum mechanics is non local. Given two entangled particles, no matter how far apart, one will immediately react to an influence felt by the other. Today the non-local effects of entangled particles has been tested and is commonly acknowledged, but in Bohm's day it was an undigested and to some extent undesirable concept. The process to fully acknowledge the non-local

effects of quantum mechanics, and exploit the consequences, was pioneered by the Irish particle physicist John S. Bell (1928-1990). As mentioned in section 4.3.3 above, Bell was motivated by Bohm's work. In *Beables for Quantum Field Theory*, an article dedicated to Bohm he remarks that:

> Bohm's 1952 papers on quantum mechanics were for me a revelation. The elimination of indeterminism was very striking. But more important, it seemed to me, was the elimination of any need for a vague division of the world into 'system' on the one hand, and 'apparatus' or 'observer' on the other. I have always felt since that people who have not grasped the ideas of those papers [...] and unfortunately they remain the majority [...] are handicapped in any discussion of the meaning of quantum mechanics.[1]

The non-local issue arouse with Bell's analysis of John von Neumann's theorem about the contradictions of a hidden variable theory. The theorem concludes that hidden variable theories are impossible if they are to obtain the same conclusions as standard quantum mechanics. However the Causal Interpretation existed, was consistent, and used 'hidden' variables, so it was a counter example to von Neumann's theorem and Bell was motivated to understand what exactly was going on. In *On the Impossible Pilot Wave* Bell writes:

> But in 1952 I saw the impossible done. It was in papers by David Bohm. Bohm showed explicitly how parameters could indeed be introduced, into non-relativistic wave mechanics, with

[1] John S. Bell, *Speakable and Unspeakable in Quantum Mechanics* (Cambridge: Cambridge University Press, 1987), p. 173.

> the help of which the indeterministic description could be transformed into a deterministic one. More importantly, in my opinion, the subjectivity of the orthodox version, the necessary reference to the 'observer', could be eliminated.[2]

In a series of brilliant papers, Bell made clear that the issue was that the proof advanced by von Neumann assumed implicitly that the hidden variables satisfied a local condition. In the case of the Causal Interpretation, the 'hidden variables' are entangled, which gives them in general 'a grossly non-local character'.[3] Therefore von Neumann's theorem forbids the existence of theories with local hidden variables, but does not apply to the case of non-local variables.[4] This is what makes the Causal Interpretation possible, non-locality is built-in from the start.

Bell continued the study of the Causal Interpretation focusing on its non-local aspects, which remained an obscure and controversial aspect. His study of the EPR argument in the context of the Causal Interpretation led him to establish his famous inequalities. The machinery of quantum mechanics in both its standard Copenhagen or Causal versions is full of non-local phenomena. But Copenhagen and Causal quantum mechanics are just models about nature, they are not nature itself. They could be very useful interpreting many situations but may be wrong in the case of the non local predictions. Nature itself may very well be local, but being only approximately described by the non local theory of quantum mechanics. Bell provided a mathematical inequality of a very general nature, not related to quantum mechanics in particular, but that was consistent with any theory with local variables. One could say that the inequality expresses what it

[2]Bell, *Speakable and Unspeakable in Quantum Mechanics*, p. 160.
[3]Ibid., p. 11.
[4]Bell, 'On the Einstein–Podolsky–Rosen Paradox'.

means locality. The theoretical machinery of quantum mechanics, Copenhagen or Causal, violates the inequalities. So the problem was to find the experimental situation in which a system could be tested to violate the inequalities and show that nature accepts non-local effects. The experiment that was conducted was basically the one described by Bohm in his book on quantum mechanics. It needs to be stressed that this experiment is about a property of nature, not about quantum mechanics itself. This was done a few years later by Alain Aspect who proved that the properties of two entangled photons violate Bell's inequalities, regardless of the theory describing them.[5] That is, nature includes some non local behaviour and quantum mechanics correctly models this aspect of the world.

Bell's result opened the door for the development of new avenues of industry and research. It also forced the return to a more mature conception of quantum mechanics itself and a deeper exploration into the philosophy of quantum physics and the meaning of superposition and entanglement. It also opened the development of quantum computers which exploit the non local effects of entangled systems.[6]

[5]Alan Aspect, Phillipe Grangier and Gerard Roger, 'Experimental Tests of Realistic Local Theories via Bell's Theorem', *Physical Review Letters*, 47.7 (1981), pp. 460–463; Alain Aspect, Phillipe Grangier and Gerard Roger, 'Experimental Realization of Einstein-Podolsky-Rosen-Bohm Gedankenexperiment: A New Violation of Bell's Inequalities', *Physical Review Letters*, 49.2 (1982), pp. 91–94; Alain Aspect, Jean Dalibard and Gerard Roger, 'Experimental Test of Bell's Inequalities Using Time-Varying Analyzers', *Physical Review Letters*, 49.25 (1982), pp. 1804–1807; Gilder, *The Age of Entanglement*.

[6]For the full story see Nick Herbert, *Quantum Reality, Beyond the New Physics* (New York: Anchor Books, 1985), Albert, *Quantum Mechanics and Experience*, Beller, *Quantum Dialogue, The Making of a Revolution*, Michael Dickson, *Quantum Chance and Non–Locality: Probability and Non–Locality in the Interpretations of quantum mechanics* (Cambridge: Cambridge University Press, 2005), Bernard d'Espagnat, *On Physics and Philosophy* (Princeton, New Jersey: Princeton University Press, 2006), Whitaker, *Einstein, Bohr and the Quantum Dilemma*.

A.2 The Relativistic Quantum Potential

After Bohm's death in 1992, his long term collaborator Basil Hiley continued with the research plan that they drafted in the last two chapters of *The Undivided Universe*. The aims of Hiley's research group summarize Bohm's research vision:

> **Relativity, Quantum Gravity and Space–time Structures**
>
> Our group is continuing to explore the fundamental ideas introduced by the late Professor Bohm and is engaged on an extensive research programme covering a wide range of fundamental issues arising from an examination of the foundations of quantum mechanics and general relativity.
>
> The central new notion introduced by quantum mechanics is not indeterminism, nor uncertainty, but wholeness. This new feature has been described by phrases such as 'the non-separability of spatially separated systems', or more briefly as 'quantum non-locality'. These terms are actually inadequate expressions of the radical implications of the notion of wholeness and reflect a strong desire to cling to a reductionist philosophy. A radically new approach is needed, an approach that does not depend upon the Cartesian Order, but requires the introduction of new orders such as the Implicate Order and the Generative Order. Mathematical descriptions of these new orders are under active development at present.
>
> It is now quite clear that if gravity is to be quantised successfully, a radical change in our understanding of space-time will

> be needed. We begin from a more fundamental level by taking the notion of process as our starting point. Rather than beginning with a space-time continuum, we introduce a structure process which, in some suitable limit, approximates to the continuum. We are exploring the possibility of describing this process by some form of non-commutative algebra, an idea that fits into the general ideas of the Implicate Order. In such a structure, the non-locality of quantum theory can be understood as a specific feature of this more general a-local background and that locality, and indeed time, will emerge as a special feature of this deeper a-local structure. [7]

This approach has produced important results that are in line with David Bohm's philosophical approach to physics.

Hiley was the driving force behind the numerical investigations that rekindled Bohm's interest in the Causal Interpretation during the early years of the 1970s.[8] Although many have succumbed to the temptation to interpret the Quantum Potential as a classical one, making the Causal Interpretation a return to the classical world, Hiley has strongly warned against this tendency. With Bohm, he argued that the Quantum Potential properties are very different from the properties of a classical potential as I have explained before in sections 4.3 and 7.3.

The algebraic approach to quantum mechanics was developed with the aim to better understand why the Quantum Potential appears in the way it does, and to extend the Causal Interpretation to the relativistic case.

[7] <http://www.bbk.ac.uk/tpru/tpru.html> [accessed 1 September 2015]

[8] Hiley, Philippidis and Dewdney, 'Quantum Interference and the Quantum Potential.'; Basil Hiley and C. Dewdney, 'A Quantum Potential Description of One-dimensional Time-dependent Scattering from Square Barriers', *Foundations of Physics*, 12 (1982), pp. 27–48.

Hiley has made emphasis on the detailed examination of the mathematical structure that lies behind the appearance of the Quantum Potential, a complementary approach to Bohm's natural inclinations based on a strong physical intuition and regarding the mathematical structure as secondary. In Hileys's approach the quantum Hamilton-Jacobi equations in which the Quantum Potential appears, equation 4.10 in section 4.3, is not treated in isolation. This equation is only the real part of Schrödinger's equation when the state vector is written in polar form. Although the imaginary part tends to be neglected, the Quantum Potential can be interpreted as the term that couples the two parts to form a single unit. Hiley remarks that in the Causal Interpretation we are dealing with a pair of coupled equations, and in the discussion of the meaning of the Quantum Potential this coupling cannot be neglected.

Hiley's starting point is the search for the Quantum Potential in the Heisenberg picture of quantum mechanics. The standard form of the Causal Interpretation is developed using 'Schrödinger's picture' of quantum mechanics.[9] But there are other equivalent formulations of quantum theory. The 'Heisenberg picture' is an equivalent approach in which the states are fixed and the observables represented by matrices change with time.[10] The Schrödinger's picture is very popular because being based in a partial differential equation allows an analytical treatment, and this provides a solution to many practical problems. In the Heisenberg picture the matrices are interpreted as operators in a linear space, and this carries a very rich mathematical structure, that of a non-commutative algebra, that naturally suggest the development of algebraic approaches to quantum mechan-

[9]Originally called 'wave mechanics'

[10]Originally called matrix mechanics, it is the form in which quantum mechanics was originally published.

ics. The famous Heisenberg inequality is just a consequence of the non-commutativity of the algebra of operators. The deeper fundamental aspect is the non-commutativity.

Using an abstract extension of the algebra of quantum operators, Hiley found that the Quantum Potential does not show up until the abstract operator algebra is represented in a Hilbert space. In this case the expression for the quantum evolution is reduced to exactly the two equations of Bohm's 1952 paper. The conclusion is that the wholeness of the quantum states is explicated as the Quantum Potential only when the abstract setting is projected from the non-commutative algebraic structure into a space-time frame. This is in line with Bohm's philosophical approach in which the wholeness of the situation is primary and the Quantum Potential appears when a Super Implicate Order is unfolded.

This idea has been the guiding principle in Hiley's research. With the help of Robert Callaghan he has successfully completed the first stage of development of a Causal quantum field theory using a similar structure based on Clifford algebras. They have found a hierarchy of algebras that when projected into a space-time representation gives rise to a corresponding hierarchy of Quantum Potentials corresponding to the non relativistic case (Schrödinger), the particle with spin (Pauli), and for the relativistic particle (Dirac). This is a successful continuation of the original research program. The Causal potential for the relativistic case has been found. The next step is to develop a Causal field theory. The main point for Hiley is the elucidation of the deeper mathematical structure from which these potentials emerge, in which the wholeness of the algebra is of fundamental relevance and the expression of the potential is secondary, in agreement with Bohm philosophy of the Holomovement.

Following a similar idea, the French mathematician Maurice de Gosson, a collaborator of Hiley, has developed a geometrical approach based on the covering groups of the symplectic structure that underlies classical mechanics, dual to the approach taken by Hiley. They have shown how one can obtain the Quantum Potential from Green's function. As explained in 7.3, this is the idea that Bohm turns upside down to arrive at the Holomovement.

A.3 Bohmian Mechanics

Not all physicists inspired by Bohm's work share his philosophical views. This is particularly emphatic in the set of physical theories that have flourished under the name of 'Bohmian Mechanics' lead by the German Professor Detlef Dürr of the Mathematics Department of the Ludwig Maximilian University of Munich, and the American physicist Sheldon Goldstein from the Department of Mathematics of the State University of New Jersey.[11]

Bohmian Mechanics tends to ignore the philosophical content that inspired Bohm, as well as much of the scientific work that Bohm did after 1952.[12] They regard the philosophy of quantum mechanics as a disease:

[11] <http://www.mathematik.uni-muenchen.de/~bohmmech/index.html>, <http://www.math.rutgers.edu/~oldstein/> [accessed 1 September 2015].

[12] Detlef Dürr, Sheldon Goldstein and Nino Zanghì, 'Bohmian Mechanics as the Foundation of Quantum Mechanics', in *Bohmian Mechanics and Quantum Theory: An Appraisal*, ed. by James T. Cushing, Arthur Fine and Sheldon Goldstein (Dordrecht, Boston, London: Kluwer Academic Publishers, 1996), pp. 21–44; Detlef Dürr and Stefan Teufel, *Bohmian Mechanics: The Physics and Mathematics of Quantum Theory* (Berlin, Heildeberg: Springer–Verlag, 1996), pp. 21–44; Sheldon Goldstein, 'Bohmian Mechanics', in *The Stanford Encyclopedia of Philosophy*, ed. by Edward N. Zalta, <http://plato.stanford.edu/archives/spr2009/entries/qm-bohm/> [accessed 15 October 2010] (2009).

> Quantum philosophy, a peculiar twentieth century malady, is responsible for most of the conceptual muddle plaguing the foundations of quantum physics. When this philosophy is eschewed, one naturally arrives at Bohmian mechanics, which is what emerges from Schrödinger's equation for a non-relativistic system of particles when we merely insist that 'particles' means particles.[13]

In Bohmian Mechanics the Quantum Potential, the main concept of Bohm's scientific agenda, is explained away as a statistical effect with no important role to play. This begs the question of why to use the adjective 'Bohmian' to refer to an approach that contradicts Bohm's world view?

Bohmian mechanics is a development of the 1952 papers on the Causal Interpretation, in which the Quantum Potential is interpreted as an effect of secondary importance, in pretty much the same way as Bohm did when he was working with Vigier at the of the 1950s.[14] It disregards Bohm's view on the Causal Interpretation as a step in the search for a new direction in physics, which led Bohm to the notion of the Implicate Order. For the Bohmian mechanics this was a mistake and a departure from physics into the realm of unwanted metaphysics. In his review of the *Undivided Universe*, the American physicist Sheldon Goldstein, one of the main supporters of this approach, remarks that:

> In one respect, however, Bohm and Hiley are not radical enough:

[13]Detlef Dürr, Sheldon Goldstein and Nino Zanghì, 'Quantum physics without quantum philosophy', *Studies in the History and Philosophy of Modern Physics*, 26 (1995), pp. 137–149.

[14]Dürr, Goldstein and Zanghì, 'Quantum physics without quantum philosophy'; James T. Cushing, Arthur Fine and Sheldon Goldstein, eds., *Bohmian Mechanics and Quantum Theory: An Appraisal* (Dordrecht, Boston, London: Kluwer Academic Publishers, 1996); Goldstein, 'Bohmian Mechanics'.

> They formulate Bohmian mechanics in terms of the 'Quantum Potential', which permits the guiding equation to be recast into a classical, Newtonian form, but at the price of obscuring the basic structure and the defining equations of the theory and of injecting an appearance of artificiality into its formulation.[15]

For the Bohmian mechanics the Quantum Potential is responsible for this obscurity and artificiality, and the introduction of the Implicate Order is a redundant digression:

> The speculations in the last chapter about the 'Implicate Order' don't enhance our understanding of Bohmian mechanics; on the contrary, before the reader has had time to digest this theory, he is given the impression that it depends upon these speculations for its adequacy.[16]

This approach is continued in *Quantum Physics Without Quantum Philosophy* where it is stated that:

> Quantum philosophy, a peculiar twentieth century malady, is responsible for most of the conceptual muddle plaguing the foundations of quantum physics. When this philosophy is eschewed, one naturally arrives at Bohmian mechanics [. . .][17]

The main emphasis of this approach is inspired by Bohm's papers in the early 1950's, with the additional step of disregarding the Quantum Potential, and explaining it as a statistical effect. Bohm explored this possibility but abandoned it, and started to search for new approaches to physics

[15] Sheldon Goldstein, 'The Undivided Universe: An Ontological Interpretation of Quantum Theory - Review', *Physics Today*, (Sept. 1994), p. 90.
[16] Ibid.
[17] Dürr, Goldstein and Zanghì, 'Quantum physics without quantum philosophy'.

in the early 1960's to return to develop the idea of the Quantum Potential and the Holomovement. He thought that the philosophical materialism of what is now Bohmian mechanics, were unsound. This begs the question of why should these developments be called 'Bohmian'? Their emphasis is in getting rid of the most relevant concepts for Bohm by explaining the guidance conditions using symmetry principles based on the Cartesian grid and so upholding a reductive and materialistic position. Why are these mechanics Bohmian at all if, as was mentioned before, in his first book, *Quantum Theory* he had already stressed that the term 'quantum mechanics' was very much a misnomer, suggesting that it should be better to call these investigations 'quantum non-mechanics'?[18] These may be valid physics theories, worth pursuing on their own, but calling them Bohmian is misleading and suggest an agenda to buy into the Bohm name in order to validate a position.

A.4 Bohm and the New Age

It is not only physicists that use Bohm's name to validate the pursuit of agendas that were not supported by Bohm at all. Bohm's relationship with the New Age movement is founded on his supposed allegiance to a 'Holographic Paradigm'. For Bohm the hologram was a limited metaphor, never to be taken beyond its illustrative limits. Nevertheless, the New Age movement wants to believe that the fundamental nature of reality is an hologram, what may be termed an 'holographic ontology', with a major scientist supporting it. In the presentation of Bohm as an holographer New Age writers ignore important aspects of Bohm's thought. This is disappointing

[18]Bohm, *Quantum Theory*, p. 167.

to say the least, as the obvious place to search for an analysis of Bohm's thought in which his esoteric dimension would be properly accounted is, one would think, in the New Age literature. However, New Age's version of Bohm is of a very limited scope, partial and shallow. Virtually nothing has been devoted to the serious consideration of Bohm's interaction with Jiddu Krishnamurti, neither in the academic or in the New Age literature. The New Age acknowledges this relationship for its anecdotal value, but it disregards the contents of their exchanges. What one usually finds are flat repetitions of what Bohm himself popularized, most of the time out of context and fragmented with the purpose of making Bohm to look as if he was in support of the New Age agenda.

It is as an holographer that Bohm is presented in Wouter Hanegraaff's *New Age Religion and Western Culture: Esotericism in the Mirror of Secular Thought* (1996).[19] Here Bohm is described as being part of an 'holographic model' of the 'new science'. With respect to Bohm's relationship to the esoteric tradition, this poses several problems as it contradicts Bohm's view of his own work. Hanegraaff's analysis is rather superficial as it is based on Bohm's *Wholeness and the Implicate Order* (1980), and the interviews conducted by Renée Weber.[20] Hanegraaff not only ignores Bohm's scientific work but also his more challenging philosophical writings. Bohm's relationship with Krishnamurti is acknowledged but not analysed. The result is a very partial assessment, but this is not necessarily a fault from the part of Hanegraaff as his intention is not to understand Bohm in relation to Western esotericism, but only to address the New Age reception of Bohm's ideas.

[19]Hanegraaff, *New Age Religion and Western Culture*.

[20]Bohm, *Wholeness and the Implicate Order*; Weber, *Dialogues With Scientists and Sages*.

Bohm's membership to the holographers' club is due mainly to Ken Wilber's interviews included in *The Holographic Paradigm and Other Paradoxes*.[21] In this book it is remarked that:

> Bohm's work in subatomic physics and the 'Quantum Potential' had led him to the conclusion that physical entities which seemed to be separate and discrete in space and time were actually linked or unified in an implicit or underlying fashion. In Bohm's terminology, under the *explicate realm* of separate things and events is an *implicate realm* of undivided wholeness, and this implicate whole is simultaneously available to each explicate part. In other words, the physical universe itself seemed to be a gigantic hologram, with each part being in the whole and the whole being in each part.[22]

This quote is misleading because the last phrase does not follow from the first part, and even if it did, for Bohm the hologram was just a limited model to suggest the Implicate Order, as was explained in section 7.2. For Bohm, the universe, or the Holomovement, is not an hologram at all. Simply, there are aspects of the Implicate Order that can be illustrated using an hologram. Bohm uses many other devices to illustrate his ideas, he was fond of using an experiment with glycerine to exemplify the relation of the Implicate and Explicate Orders, but it is not because of this that he is a member of a 'glycerine paradigm'. For Bohm the Implicate Order cannot be defined, it is not a thing, so suggesting that the Implicate Order is an hologram, which is a 'thing', is misleading.

[21] Ken Wilber, ed., *The Holographic Paradigm and Other Paradoxes: Exploring the Leading Edge of Science* (Boston and London: Shambhala, 1985).
[22] Ibid., p. 2.

Bohm's relation to the holographic paradigm is also related to his friendship with the Austrian psychiatrist and neurosurgeon Karl H. Pribram (1919 - 2015), best known for his development of the holonomic brain model that was partially inspired by Bohm. The holographic theme is continued in Michael Talbot, *The Holographic Universe* (London: Grafton Books, 1991), a popular New Age book, but it only repeats what has already been said by Wilber and Pribram.

Norman Friedman, *Bridging Science and Spirit: Common Elements in David Bohm's Physics, The Perennial Philosophy and Seth* (St. Louis, MO: Living Lake Books, 2004) is an interesting work as it tries to provide a comparison of Bohm's philosophy, Ken Wilber's 'Perennial Philosophy', and the material psychically channelled from a spiritual entity named Seth. The problem with this book is that it indulges in exaggerations and gross scientific inaccuracies that make it very difficult for a scientist to take Friedman's allegations seriously. If esotericists want to be seriously considered by the scientific community, it is necessary that they show an understanding of the underlying science.

Danah Zohar, *The Quantum Self: Human Nature and Consciousness Defined By The New Physics* (New York: William Morrow, 1990) is not a book that reviews Bohm's ideas, or tries to portrait Bohm as part of a particular New Age agenda. What Zohar does is to claim compliance to Bohm's ideas and suggest that her aims are an extension of Bohm's agenda, but this claim is not supported in any way and it is not clear how Bohm would have agreed with the many claims contained in the book. This approach is typical of the New Age in which a superficial analogy is extended to the far extremes in order to give the impression that completely unsupported claims are 'proved' or in line with science. This of course is

not taken well by the scientific community.

Bohm's relationship with the New Age movement is well illustrated by the references cited above. There are many other examples in a similar vein, too numerous to be considered here.

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Typeset in LaTeX, <http://www.latex-project.org>>, using Miketex, TeXnicCenter and Biblatex with the verbose-ibid style slightly modified to comply with the MHRA style.