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The Metaphysical Foundations of Buddhism and Modern Science:

Nagarjuna and Alfred North Whitehead

This essay is dedicated to the American Philosopher Edwin Arthur Burtt (1892 – 1989) and his ground-braking doctoral thesis: "The Metaphysical Foundations of Modern (Physical) Science", London 1924, 1925

"Newton, we are told, was the first great positivist".(...) "With his work the era of great speculative systems ended, and a new day of exactitude and promise for man's intellectual conquest of nature dawned. How, then, speak of him as a metaphysician"?(...) "The only way to avoid becoming a metaphysician is to say nothing".(p. 223-224)

Contents

1.Summary

The key terms.

1. Key term: 'Emptiness'. The Indian philosopher Nagarjuna (2nd century Current Era) is known in the history of Buddhism mainly by his keyword 'sunyata'. This word is translated into English by the word 'emptiness'. The translation and the traditional interpretations create the impression that Nagarjuna declares the objects as empty or illusionary or not real or not existing. What is the assertion and concrete statement made by this interpretation? That nothing can be found, that there is nothing, that nothing exists? Was Nagarjuna denying the external world? Did he wish to refute that which evidently is? Did he want to call into question the world in which we live? Did he wish to deny the presence of things that somehow arise? My first point is the refutation of this traditional translation and interpretation.

2. Key terms: 'Dependence' or 'relational view'. My second point consists in a transcription of the keyword of 'sunyata' by the word 'dependence'. This is something that Nagarjuna himself has done. Now Nagarjuna's central view can be named 'dependence of things'. Nagarjuna is not looking for a material or immaterial object which can be declared as a fundamental reality of this world. His fundamental reality is not an object. It is a relation between objects. This is a relational view of reality. Reality is without foundation. Or: Reality has the wide open space as foundation.

3. Key terms: 'Arm in arm'. But Nagarjuna did not stop there. He was not content to repeat this discovery of relational reality. He went on one step further indicating that what is happening between two things. He gave indications to the space between two things. He realized that not the

behaviour of bodies, but the behaviour of something between them may be essential for understanding the reality. This open space is not at all empty. It is full of energy. The open space is the middle between things. Things are going arm in arm. The middle might be considered as a force that bounds men to the world and it might be seen as well as a force of liberation. It might be seen as a bondage to the infinite space.

4. Key term: Philosophy. Nagarjuna, we are told, was a Buddhist philosopher. This statement is not wrong when we take the notion 'philosophy' in a deep sense as a love to wisdom, not as wisdom itself. Philosophy is a way to wisdom. Where this way has an end wisdom begins and philosophy is no more necessary. A.N. Whitehead gives philosophy the commission of descriptive generalization. We do not need necessarily a philosophical building of universal dimensions. Some steps of descriptive generalization might be enough in order to see and understand reality. There is another criterion of Nagarjuna's philosophy. Not his keywords 'sunyata' and 'pratityasamutpada' but his 25 philosophical examples are the heart of his philosophy. His examples are images. They do not speak to rational and conceptual understanding. They speak to our eyes. Images, metaphors, allegories or symbolic examples have a freshness which rational ideas do not possess. Buddhist dharma and philosophy is a philosophy of allegories. This kind of philosophy is not completely new and unknown to European philosophy. Since Plato's allegory of the cave it is already a little known. (Plato 424 – 348 Before Current Era) The German philosopher Hans Blumenberg has underlined the importance of metaphors in European philosophy.

5. Key terms: Quantum Physics. Why quantum physics? European modes of thought had no idea of the space between two things. They were bound to the

ideas of substance or subject, two main metaphysical traditions of European philosophical history, two main principles. These substances and these subjects are two immaterial bodies which were considered by traditional European metaphysics as lying, as a sort of core, inside the objects or underlying the empirical reality of our world. The first European scientist who saw with his inner eye the forces between two things had been Michael Faraday (1791-1867). Faraday was an English scientist who contributed to the fields of electromagnetism. Later physicists like Albert Einstein, Niels Bohr, Erwin Schrödinger, Werner Heisenberg and others followed his view in modern physics. This is a fifth point of my work. I compare Nagarjuna with European scientific modes of thought for a better understanding of Asia. I do not compare Nagarjuna with European philosophers like Hegel, Heidegger, Wittgenstein. The principles and metaphysical foundations of physical sciences are more representative for European modes of thought than the ideas of Hegel, Heidegger and Wittgenstein and they are more precise. And slowly we are beginning to understand these principles.

Let me take as an example the interpretation of quantum entanglement by the British mathematician Roger Penrose. Penrose discusses in the year of 2000 the experiences of quantum entanglement where light is separated over a distance of 100 kilometers and still remains connected in an unknown way. These are well known experiments in the last 30 years. Very strange for European modes of thought. The light should be either separated or connected. That is the expectation most European modes of thought tell us. Aristotle had been the first. Aristotle (384 - 322 Before Current Era) was a Greek philosopher, a student of Plato and a teacher of Alexander the Great. He told us the following principle as a metaphysical foundation: Either a

situation exists or not. There is not a third possibility. Now listen to Roger Penrose:

"Quantum entanglement is a very strange type of thing. It is somewhere between objects being separate and being in communication with each other" (Roger Penrose, *The Large, the Small and the Human Mind,* Cambridge University Press. 2000 page 66). This sentence of Roger Penrose is a first step of a philosophical generalization in a Whiteheadian sense.

6. Key terms: 'The metaphysical foundations of modern science' had been examined particularly by three European and American philosophers: E. A. Burtt, A.N. Whitehead and Hans-Georg Gadamer, by Gadamer eminently in his late writings on Heraclitus and Parmenides. I try to follow the approaches of these philosophers of relational views and of anti-substantialism. By 'metaphysical foundations' Edwin Arthur Burtt does not understand transcendental ideas but simply the principles that are underlying sciences.

7. Key terms: 'Complementarity', 'interactions', 'entanglements'. Since 1927 quantum physics has three key terms which give an indication to the fundamental physical reality: Complementarity, interactions and entanglement. These three notions are akin to Nagarjuna's relational view of reality. They are akin and they are very precise, so that Buddhism might learn something from these descriptions and quantum physicists might learn from Nagarjuna's examples and views of reality. They might learn to do a first step in a philosophical generalisation of quantum physical experiments. All of us we might learn how objects are entangled or going arm in arm. [The end of the summary.]

2. Nagarjuna

Preliminary note

We should be cautious about hastily translating the Sanskrit terms 'pratityasamutpada' and 'sunyata' before having understood the full spectrum of their meaning. Rather than dealing with the abstract term 'pratityasamutpada' and sunyata', this essay will work with the images which Nagarjuna used to illustrate his concepts. The images are evidences of relations, intervals and intermediate states. [1]

Nagarjuna's view of reality.

Nagarjuna was the most significant Buddhist philosopher of India. He was the founder of the Middle Way School, Madhyamaka, which is of great topical interest because it became fundamental to all later Buddhist scholarly thought, known as Mahayana (Great Vehicle). It is a path of inner liberation which avoids the extreme views of substantialism and subjectivism. Apart from various unconfirmed legends, we have no assured biographical knowledge of Nagarjuna. The authenticity of thirteen of his works has been more or less established by research. The Danish scholar Lindtner has examined and translated these works into English. Nagarjuna's main work, *Mulamadhyamaka-karika* (MMK) has been translated into several European languages [2] In the

MMK the Middle Way is described as: "What arises dependently (pratityasamutpada) is pronounced to be substancelessness (sunyata). This is nothing but a dependent concept (prajnapti). Substancelessness (sunyata) constitutes the middle way". [MMK: chapter 24, verse 18] Nagarjuna's view consists principally of two aspects. The first is an exposition of his view of reality (*sunyata, pratityasamutpada*), according to which reality has no firm core and does not consist of independent, substantial components. Reality is rather a system of two-bodies or many bodies which reciprocally affect each other [3]. This view of reality is diametrically opposed to another key concept: '*svabhava',* 'own being' or 'inherent existence', also known in the Greek tradition as 'substance'.

The second aspect of Nagarjuna's philosophy is an answer to the inner contradictions of four extreme modes of thought which can be subsumed under the headings: 'substantialism', 'subjectivism', 'holism' and 'instrumentalism'. My thesis is that these four modes of thought are unsustainable.

(1) Substantialism

Substance (or own being) is defined as something that has independent existence. [4] Substantialism is at the centre of traditional metaphysics, beginning with pre-Socratic philosophers, for example Parmenides and Heraclitus, who were two critics of substantial thought, and going right up to Immanuel Kant (1724-1804). Substance is considered to exist by itself, i.e. the unchangeable, eternal and underlying basis for the entire non-material foundation of the world in which we live. Plato (4th century BCE) made a

distinction between two forms of being in his *Parmenides*: on the one hand, singular objects which exist exclusively through participation without own being and, on the other hand, ideas that do have own being. Traditional metaphysics adopted Plato's dualism. An independent own being is characterised as something that, as an existing thing is not dependent on anything else (Descartes); is existing by itself and subsisting through itself (More); is completely unlimited by others and free from any kind of foreign command (Spinoza); and exists of itself without anything else (Schelling). The highest substance was often understood as God.

Since Kant's 'Copernican Revolution' the primary question of philosophy has no longer been to comprehend reality, but rather to fathom the mind, i.e. the source of perception and knowledge.

For this reason traditional metaphysics has lost ground in the modern world. In fact its central concepts, such as 'substance', 'reality', 'essence' and 'being' have been replaced by the reductionist modes of thought of modern science. Now 'atoms', 'elementary particles', 'energy', 'fields of force' and other concepts derived from the 'laws of nature' are viewed as the fundamental ground.

(2) Subjectivism

Subjectivism is the philosophical theory that all knowledge is subjective, and relative. According to René Descartes (1596-1650) consciousness is primarily existent and everything else is sheer content or form, a creation of consciousness. The summit of subjectivism is the idealism of George Berkeley (1685-1753). The subjectivism of Immanuel Kant can be considered as moderated idealism. Hans-Georg Gadamer (1900-2002) emphasises that

subjectivity i.e. self-awareness has become the fulcrum of modern philosophical thought which provides us with evidential proof and certainty. This view has been continually brought into doubt by modern physical science. However, these doubts have not led to a new view of reality but to a fatal separation of philosophy and the sciences. This separation has exacerbated the dualism that preoccupies modern thought. Accordingly, the physicist P.C.W. Davies, expounds in his 1986 book that electrons, photons or atoms do not exist; they are nothing but models of thought. [5]

(3) Holism

The third approach avoids the fatal either-or dichotomy of the first two approaches by merging subject and object into one entity, such that there are no longer any separate parts but only one identity: all is one. Holism is "the view that an organic or integrated whole has a reality independent of and greater than the sum of its parts"[6]. 'Wholeness' is made absolute, is mystified and becomes an independent unity that exists without dependence on its parts. Wholeness is understood as something concrete as if it was a matter of fact or an object of experience. As a philosophical approach found in great periods of European history of philosophy, this view is connected with names like Thomas Aquinas (1224-1274), Leibniz (1646-1716) and Schelling (1775-1854). In quantum physics, holism is represented by David Bohm. His key concept is 'holomovement', an undivided wholeness in flowing movement. [7]

(4) Instrumentalism

Instead of favoring subject or object or the two together, the fourth approach ignores the existence of the three. According to this viewpoint the search for reality is insignificant and meaningless. Instrumentalism is quite modern, intelligent (see the philosophy of Ernst Cassierer) and sometimes hair-splitting and hypercritical. It is difficult to disengage from it. It is an extension of subjectivism and it regards the process of thinking as model making and as working with information, without concern as to what phenomena the information is about. What philosopher Donald Davidson (1917-2003) said about subjectivism, might be true for instrumentalism also: "Once one makes the decision for the Cartesian approach, it seems that one is unable to indicate what one's proofs are evidence for". [8]

For instrumentalism, theories are not a description of the world but an instrument for a systematic classification and explanation of observations, and for the prediction of facts.

The instrumentalist approach is outlined by the experimental physicist Anton Zeilinger who stated in an interview, "In classical physics we speak of a world of things that exists somewhere outside and we describe their nature. In quantum physics we have learned that we have to be very careful about this. Ultimately physical sciences are not sciences of nature but sciences of statements about nature. Nature in itself is always a construction of mind. Niels Bohr once put it like this: 'There is no world of quantum, there is only a quantum mechanical description'". [9]

Nagarjuna's viewpoint.

Nagarjuna presents these four extreme views of reality in a scheme that is called in Sanskrit: '*catuskoti*', the equivalent of the Ancient Greek '*tetralemma*', as follows: *things have no substance: 1. neither out of themselves, 2. nor out of something else, 3. nor out of both, 4. nor without a cause.* (tetralemma: a figure in Ancient Greek and Eastern logic with four possibilities.) This kind of tetralemma refutes the four modern views of reality as above mentioned. This shows that Nagarjuna does not fall into any of these extremes and that his view is completely up-to-date. In the very first verse of the MMK a tetralemma is pointed out: "Neither from itself nor from another, nor from both, nor without a cause, does anything whatever anywhere arise". [10] This verse can be understood as the principal statement of the MMK: the refutation of the four extreme metaphysical views which cannot be reconciled with the dependent arising of things. If this is the case, the remainder of the MMK would be a clarification of this verse. This requires careful examination. What is the assertion made by this verse? That nothing can be found, that there is nothing, that nothing exists? Was Nagarjuna denying the external world? Did he wish to refute what evidently is? Did he want to call into question the world in which we live? Did he wish to deny the everywhere presence of things that somehow arise? If 'to arise' refers to the empirical data, then we are obliged to argue that if a thing does not arise out of itself, it must arise out of something else. So we should ask: what is the significance of the notion 'to arise'? In another text, Nagarjuna gives some indications how to understand this view. He writes in his *Yuktisastika* (YS):

19. "That which has arisen dependently on this and that *that* has not arisen substantially (svabhavatah). What has not arisen substantially, how can it literally (nama) be called 'arisen'? […] That which originates due to a cause and does not abide without (certain) conditions but disappears when the conditions are absent, how can it be understood as 'to exist'? [11]

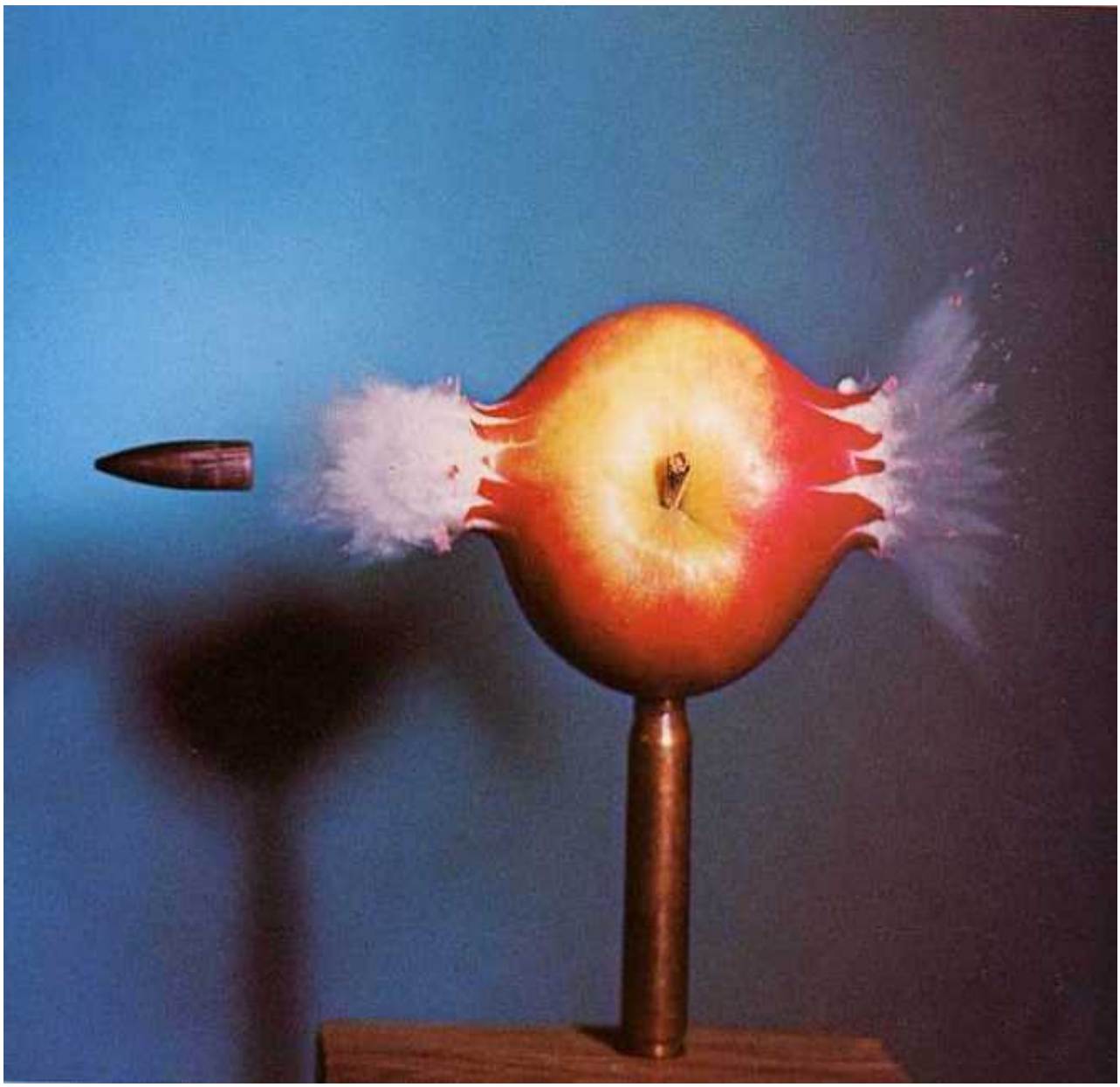
By the notions of 'to arise' and 'to exist', Nagarjuna does not mean the empirical existence but the substantial existence, as we will see in the following examples. When in many passages of MMK Nagarjuna states that things do not arise (MMK 7.29), that they do not exist (MMK 3.7, 5.8, 14.6), that they are not to be found (MMK 2.25, 9.11), that they are not (MMK 15.10), that they are unreal (MMK 13.1), then clearly this has the meaning: things do not arise substantially. They do not exist out of themselves; their independence cannot be found. They are dependent and in this sense they are substantially unreal. Nagarjuna only rejects the idea of a substantial arising of things which bear an absolute and independent existence. He does not refute the empirical existence of things as explained in the following: "It exists implies grasping after eternity. It does not exist implies the philosophy of annihilation. Therefore, a discerning person should not decide on either existence or non-existence". (MMK 15.10)

For Nagarjuna, the expression 'to exist' has the meaning of 'to exist substantially'. His issue is not the empirical existence of things but the conception of a permanent thing i.e. the idea of an own being, without dependence on something else. Nagarjuna refutes the concept of independent

existence which is unchangeable, eternal and existing by itself. Things do not arise out of themselves, they do not exist absolutely and are dependent. Their permanent being or existence cannot be found. The many interpretations of Nagarjuna which claim that he is also refuting the empirical existence of objects, are making an inadmissible generalization which moves Nagarjuna near to subjectivism, nihilism and instrumentalism. Such interpretations originate in metaphysical approaches which themselves have a difficulty in recognizing the empirical existence of the data presented. This is not at all the case with Nagarjuna. Nagarjuna presents the dependence of phenomena mainly in images as in the twenty-five chapters of the MMK. [12]

A brief review of the 25 chapters of the *Mulamadhyamaka-karika (MMK):*

1. A thing and its cause; 2. A mover and the distance to be moved; 3. A seer and a vision or view; 4. A cause and its effect; 5. A characteristic and its characterization; 6. Desire and the desirous one; 7. Origination, duration and decay; 8. Action and agent; 9. A viewer and a vision; 10. Fire and fuel; 11. Birth and death; 12. Suffering and the causes of suffering; 13. A teenager and an aged person; 14. Something and a different thing; 15. Being and nothing; 16. Bondage and liberation; 17. Action and its fruit ; 18. Identity and difference; 19. The past, the present and the future; 20. Cause and effect; 21. Coming to be and passing away; 22. The Buddha exists and the Buddha does not exist after death; 23. Pure and impure; 24. Buddha and bodhi; 25. Nirvana and being.



Chapter 1: Cause and effect.

Chapter 1: Cause and effect. A high speed photograph by Harold E. Edgerton.

Picture: http://canibuk.wordpress.com/2011/11/16/harold-edgerton/

Commentary: A projectile after penetrating an apple. The penetration of the projectile is the cause of the direct effect: the beginning of an explosion of the apple. This happens at the same moment. Cause and effect cannot be separated. They are not one object and they are not two separated objects. There is no space and no time between cause and object. The cause leads immediately to a **near** effect. There is not first a cause and later an effect. The most important characteristic of bodies is their interdependence and the resultant, substancelessness, the impossibility of existing individually and independently. A thing is not independent of its cause and conditions, nor is it identical with them.

Chapter 2: A mover and the distance within which to move. Usain Bolt. 2012. Picture: Reuters. A thing is not independent of its conditions, nor is it identical with them. A mover does not exist without the distance within which to move. The mover and the distance are not one. A mover and the distance are neither together nor separated. The most important characteristic of bodies is their interdependence and the resultant, substancelessness, the impossibility of existing individually and independently.

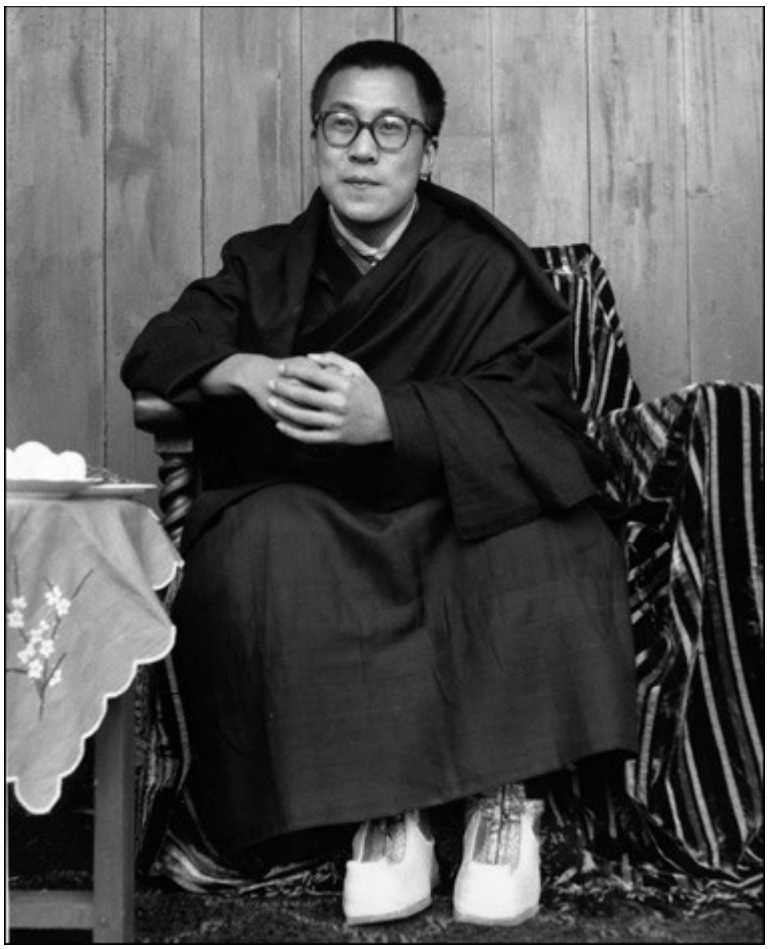
Chapter 8. Action and agent. Picture: Allsport. Description: Cassius Clay (Muhammad Ali) lands a right on Brian London during their Heavyweight World Title Fight at Earls Court, London. Commentary: When there is no action there is no agent, neither exists *per se*. Action and agent are not isolated components; they arise only by their dependence on other bodies. Not the behaviour of bodies but the behaviour of something between them is essential.

Chapter 10: Fire and fuel. Photographer unknown.

The meaning of fuel is: an already burning material.

Commentary: Without fire there can be nothing designated as fuel in the sense of a burning material. The material or immaterial components of a two-body or three-body system do not exist in isolation, they are not one and yet they are not independent of each other. Something is happening between these bodies and because of this, they are not substantially real. Nagarjuna emphasises one central idea: bodies are neither together nor separated. The most important characteristic of bodies is their interdependence and the resultant, substancelessness, the impossibility of an independent and individual existence.

Chapter 12: Suffering and the causes of suffering. Picture: Kevin Carter. hunger1_kevin.carter. Commentary: Suffering is not independent from a cause of suffering and not identical with its cause. There can be no cause without an effect, or an effect without a cause. The notion 'cause' has no meaning without the notion 'effect'. Cause and effect are not one, but they cannot be separated into two independent notions either. Like suffering reality does not consist of single, isolated material or immaterial components; suffering arises only by dependence on other causes. Like everything in this world suffering and its cause are not one and they are not two different objects.

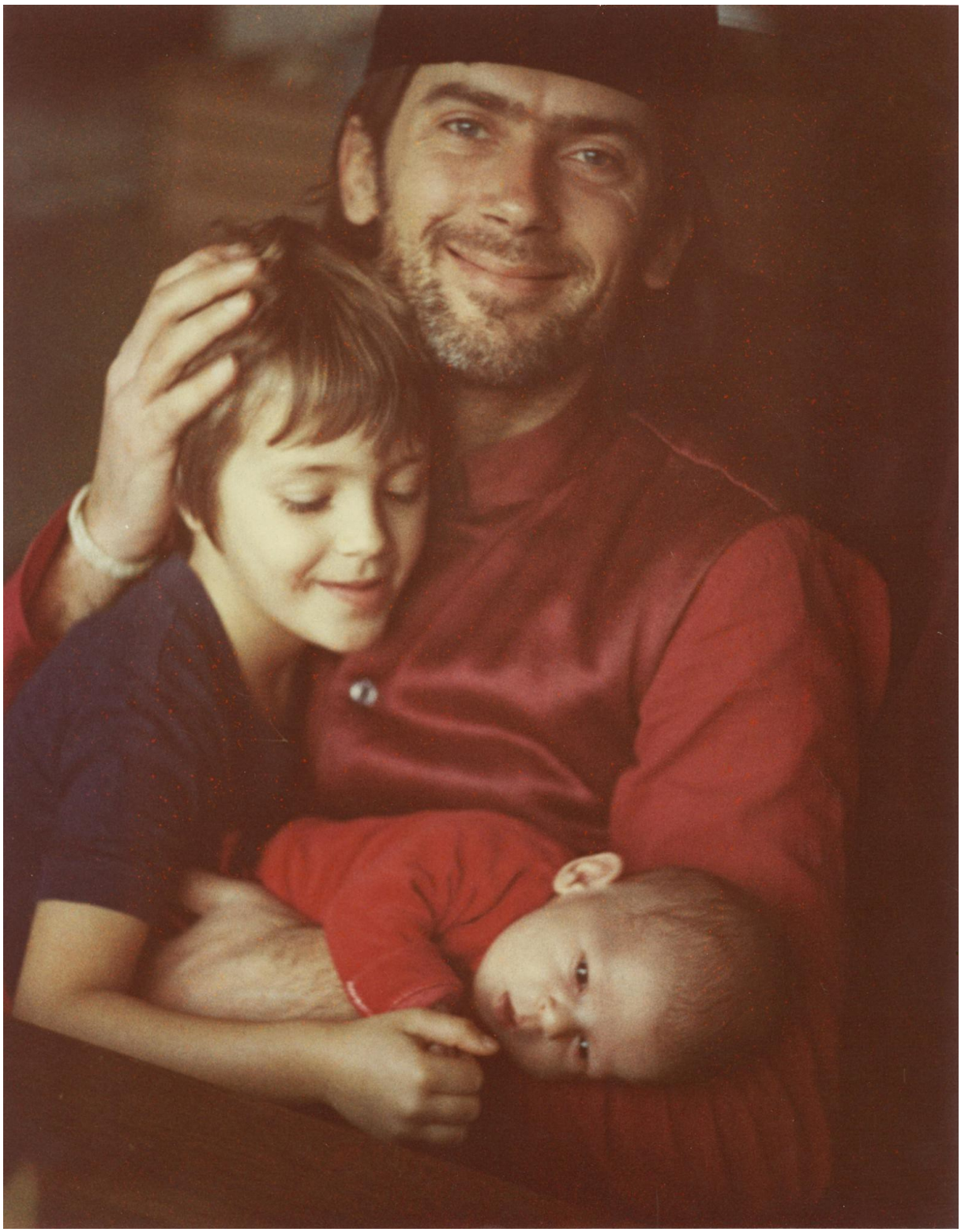


Chapter 13. *A teenager and an aged person.* The 14th Dalai Lama, Tenzin Gyatso in exile in India. 14th of April 1959. Commentary: The Dalai Lama is not properly a teenager. He is a young man of 24 years. Picture: © Keystone Features/Getty Images. Next page: Photography by Wolfgang H. Wögerer, Vienna, Austria. Commentary: The 14th Dalai Lama in 2012 as a man of 77 years. These two men are not the same and they are not two different men.

Chapter 13. A teenager and an aged person.

Chapter 16: Bondage and liberation. 1945. Description: Prisoners of Dachau, at liberation cheering the liberating US soldiers: We are free… free… Picture: http://isurvived.org/TOC-III.html . Commentary: There is no liberation without bondage. For two complementary realities, bondage and liberation, the nature and the existence of each are dependent on the other. There is no fundamental core to reality; rather reality consists of systems of interacting facts or ideas.

Chapter 23. Pure and impure. Rio Negro and the Amazon meet in Manaus, Brazil. Picture: Markus Mauthe. http://www.wildview.de/tag/rio-negro/. Commentary: Usually two waters get mixed when they come together. These two impure waters remain separated in the same river at the beginning of the Amazon. Only after 30 km they are completely mixed. The idea or notion 'pure' has no meaning without the opposite idea or notion 'impure'. A fundamental or elementary or independent idea or notion does not exist. Our ideas or notions are dependent. One notion is contingent upon another.



Father and son. Description: The author, his daughter Larissa (left) and his son Nikolai (right), Dec. 1980. Picture: C.T. Kohl.

"If the son is produced by the father, but the father also produced by that very son, then will you please tell me, which one is the true 'cause' and which the true 'result'?" (Nagarjuna, *Vigrahavyavartani.)*

A solar storm. Something is happening between sun and earth. Picture: http://www.picalls.com/data/media/17/Solar_storm_1.jpg

3. Interpretation of MMK's 25 chapters.

In 25 out of 27 chapters, Nagarjuna emphasizes one central idea: bodies are neither together nor separated. The most important characteristic of bodies is their interdependence and the resultant, substancelessness, the impossibility of existing individually and independently. This is the meaning of *pratityasamutpada* and *sunyata*: bodies are without own being and are not independent of each other. Reality does not consist of single, isolated material or immaterial components. It is not the behaviour of independent bodies but the behaviour of something between them that is essential.

Let us concentrate on the 25 chapters: a thing is not independent of its conditions, nor is it identical with them. A mover does not exist without the distance within which to move. The mover and the distance are not one. A viewer is not the same as the view, but a viewer without a view does not exist. There can be no cause without an effect, or an effect without a cause. The notion 'cause' has no meaning without the notion 'effect'. Cause and effect are not one, but they cannot be separated into two independent notions either. Without a characteristic, we cannot speak of a characterization, and the other way round. How could there be a desirous one without desire? When there is no action there is no agent, neither exists *per se*. Without fire there can be nothing designated as fuel. The material or immaterial components of a two-body or three-body system do not exist in isolation, they are not one and yet they are not independent of each other. Something is happening between these bodies and because of this they are not substantially real. For two or

sometimes three complementary bodies or for two concepts like cause and effect, or bondage and liberation, the nature and the existence of each are dependent on the other. The one arises with the other and disappears with the other. This is why a thing arises substantially, neither out of itself, nor out of another, nor out of both, nor without a cause. There is no fundamental core to reality; rather reality consists of systems of interacting bodies. This view of reality is first and foremost an idea; a pointer to reality which cannot be described in words. One who can speak about concept-free reality has not experienced it. For the Buddhist tradition based on Nagarjuna, the yogic experience of substancelessness, the experience of dependent arising, the direct perception of reality as it is, all presuppose a high level of spiritual realisation which entails the abandonment of extreme views and the demolition of the entire edifice of dualistic thought and philosophy. To experience *pratityasamutpada* or *sunyata* means to become free of all entanglements of this world. *Nirvana* is simply another expression for this.

4. Discussion of Nagarjuna's work.

For Nagarjuna, the primary question was not about mind, nor about the origin of knowledge but about the reality of the physical world. Tarab Tulku Rinpoche presented an all-encompassing position when he said, "everything existing partakes in a fundamental 'mind-field', which is the basic 'substance' from which mind in a more individual way and the individual body develop". [13] In order to emphasise that Nagarjuna does not only speak about views without substance but also about bodies without substance, here is a comparison with the views of reality suggested by quantum physicists. Physics is about views and the conditions of physical reality. It creates models and thus examines only realities which have been posited by physics itself. Nevertheless, as the experimental psychologist Irvin Rock who studied visual perception, describes it, we should not go so far as to consider all our perceptions and thought models to be purely adventitious. While the constructions of our mind are not identical with reality, they are not purely coincidental and usually not deceptive. [14] Behind these models are empirical bodies and there is some approximation of a structural similarity between a physical model and the corresponding physical and tangible reality.

5. The metaphysical foundations of quantum physics

"A courageous scientific imagination was needed to realize fully that not the behaviour of bodies, but the behaviour of something between them, that is, the field, may be essential for ordering and understanding events" [...] "What impresses our senses as matter is really a great concentration of energy into a comparatively small space" Albert Einstein.[15]

This is not a presentation or criticism of quantum physics but a discussion of the metaphysical mindsets and principles which underlie quantum physics. The views of reality in quantum physics can be expressed by three key terms: 'complementarity', 'four interactions' and 'entanglement'. [16]

In the prehistory of quantum physics it could not be proved experimentally whether the smallest elements of light were particles or waves. Many experiments argued in favor of one or the other assumption. Electrons and photons sometimes act like waves and sometimes like particles. This 'behaviour' was named: wave-particle dualism. The idea of dualism was therein understood to be a logical contradiction, in the sense that only one or the other could actually apply; but paradoxically both appeared.

According to this understanding of atomic theory, electrons and photons cannot be both particles and waves. According to atomic theory, a scientific

explanation consists of a reduction of a variable factor into its permanent components and their applicable mathematical laws. This is the fundamental dualistic view that modern atomic theory has inherited from the natural philosophy of the ancient Greeks who expounded that substance and permanence cannot be found in objects of perception of the world in which we live, but can be found in the fundamental elements making up objects and their mathematical order. These material and immaterial foundations hold the world together, they do not change, although everything else changes. According to the expectation of atomic theory, it should be possible to reduce an object to its *independent* elements, to its mathematical laws, or to its simple and fundamental principles. Until 1927 the fundamental elements had to be either particles or waves, they could not be both. What is to be understood by *independent* elements? As mentioned before, the notion of substance refers to something that has independent existence.

Albert Einstein's contribution to the interpretation of quantum physics

Albert Einstein was following the aforementioned metaphysical tradition when he wrote in the year of 1948 very clearly:

"For the classification of things that are introduced in physics, it is essential that these things have for a certain time an independent existence from each other, in so far as these things lie 'in different parts of space'. Without the assumption of such an independent existence [Einstein uses the German term So-sein, this is akin to terms like substance, or being, or suchness] of things which, in terms of ordinary thought, are spatially distant from each other, physical thought in the usual sense would not be possible". [17]

This idea of an independent reality was projected onto the basic element of the world of matter by atomic theory. For atomic theory, a scientific explanation means to reduce the variability and variety of objects and conditions to their permanent, stable, independent, and indivisible elements and to their conformity with mathematical laws. According to the expectations of atomic theory, all variations in nature can be explained in terms of separation, association and movements of unchanging, independent atoms or still more elementary particles. These particles and their conformity to mathematical laws constitute the core of bodies. They underlie everything and hold the world together. The question whether the fundamental objects are

waves or particles was an explosive issue: at stake were the traditional metaphysical views of reality available to quantum physics.

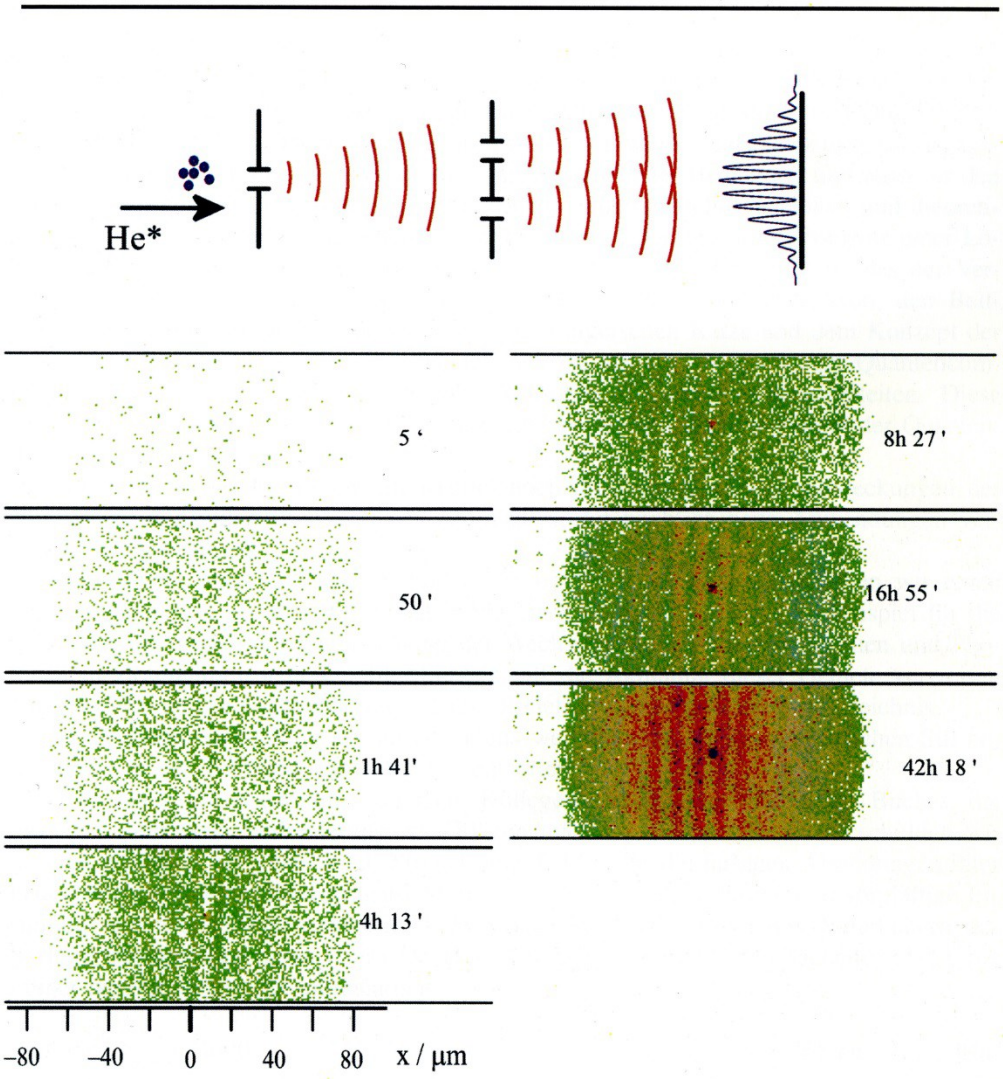
It became evident that fundamental reality could not be grasped by traditional views of reality. What is the explanatory value of atomic theory if it becomes clear that there are no independent, stable atoms or elementary particles, and that objects have no stable core? Are these quantum objects objective, subjective, both or neither? What is reality? Is the quantum world completely distinct from the world in which we live?

Niels Bohr's contribution to the interpretation of quantum physics

In 1927, the physicist Niels Bohr introduced the idea of complementarity into quantum physics. According to this idea, the wave form and the particle form are not two separate forms which contradict and exclude each other but are mutually complementary forms which can provide a complete description of physical manifestations only together. According to Niels Bohr, complementarity means that in the quantum world it is impossible to speak about independent quantum objects because they are in an interactive relationship with each other as well as with the instrument of measurement. He emphasized that this interaction between the quantum object and the instrument of measurement was an inseparable element of quantum objects, because it plays a major part in the development of several features of them. Certain measurements establish electrons or photons as particles and destroy the interference that distinguishes the object as a wave. Other measurements establish the object as a wave. This was Niels Bohr's new idea of reality.

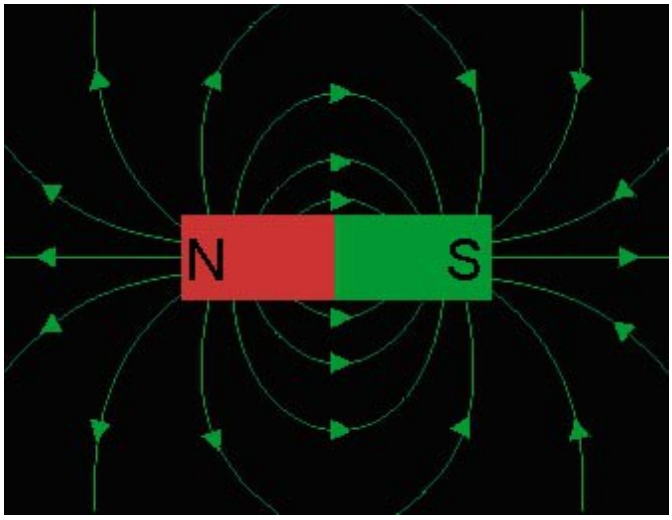
From the insight that the quantum object and the instrument of measurement could not be separated, Niels Bohr did not conclude that there are no quantum objects. At least he did not do so when he was arguing in terms of physics. When he spoke about the metaphysics of quantum physics he took an instrumentalist approach. [18] For the physicist Niels Bohr, quantum physical objects consist of interacting and complementary quantum objects.

Ein grundlegendes Experiment zur Quantenphysik: *Welle-Teilchen Dualismus der Materie*



Schickt man Helium-Atome gleicher Richtung und Geschwindigkeit durch einen Doppelspalt, so erzeugt jedes Atom auf einem Schirm dahinter einen streng lokalisierten Auftreff*punkt*; das Helium-Atom erscheint hierbei seinem Wesen nach als ein Teilchen. Werden die Auftreffpunkte bei einem länger laufenden Experiment häufiger, so tritt ein Interferenzmuster in Analogie zum Youngschen Doppelspalt-Experiment auf. Die sieben Teilbilder wurden im Abstand von 5′ bis 42h 18′ nach Beginn des Experiments aufgenommen. Die Helium-Atome verhalten sich hier als Welle. Dieses Experiment stellt den Welle-Teilchen Dualismus der Materie in eindrucksvoller Weise dar. Wie es der Quantentheorie gelingt, den Widerspruch: punktförmiges Teilchen einerseits, ausgedehnte Welle andererseits zu überbrücken, wird in diesem Buch dargestellt. Diese Experimente mit Helium-Atomen wurden durchgeführt von Carnal, O., Mlynek, J.: Phys. Rev. Lett. *66*, 2689 (1991) und Kurtsiefer, Ch., Pfau, T., Mlynek, J.: Nature *386*, 150 (1997). Mehr dazu in Abschn. 6.6.

The double-slit experiment. (see previous page) If you send an atom of helium through a double-slit, every atom produces a point behind the double-slit. The atoms arrive in discrete lumps. There is no interference in the beginning. The atoms arrive like bullets at the screen. But later they show interference. Their appearance shows the structure of waves in a similar manner to waves on water. The seven pictures shown were taken at intervals ranging from 5 minutes to 42 hours and 18 minutes. Quantum objects show a double quality of particles and of waves. They are dependent on the instrument of measurement: the double-slit. This double quality has been named 'complementarity' by Niels Bohr. Complementarity means that the two qualities are not dualistic. They do not exclude each other but complement each other like the poles of a dipole. Picture: Haken, H./ Wolf, H.C., *Atom- und Quantenphysik.* Springer Verlag Berlin 2000. With the permission of Springer Verlag.



Dipole. Picture: Quelle: leifi.physik.uni-muenchen.de/web_ph07_g8/umwe...

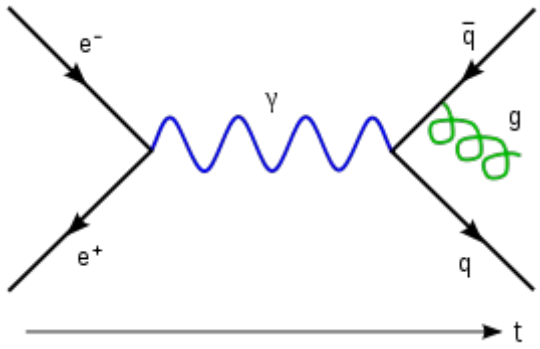


Figure 1: In this Feynman diagram, an electron and a positron annihilate each other, producing a photon (represented by the blue sine wave) that becomes a quark/anti-quark pair. The photon is or represents or creates or realises the electromagnetic interaction or electromagnetic force.

Picture: http://en.wikipedia.org/wiki/Feynman_diagram

The concepts of interactions in the standard model of quantum physics.

The notion of four elementary interactions was introduced in the standard model of quantum physics. These four forces obstruct the reduction of quantum objects into independent objects. Such an idea had already been posited by Democritus in the 3rd century BCE. The interactional forces which operate between the quantum objects, are added to the quantum objects. Instead of singular, independent objects, two-body systems or many-body systems were established as the base of matter. Between the bodies, interacting forces are effective in keeping them together. [19]

These interactions are a composite of the bodies. Mostly they are forces of attraction and in the case of electro-magnetic forces they can also be forces of repulsion. One visualises the interaction *between* the elementary particles as an interaction *of* elementary particles. The physicist Steven Weinberg puts it like this: "At the present moment the closest we can come to a unified view of nature is a description in terms of elementary particles and their mutual interactions. [...] The most familiar are gravitation and electromagnetism, which, because of their long range, are experienced in the everyday world. Gravity holds our feet on the ground and the planets in their orbits. Electromagnetic interactions of electrons and atomic nuclei are responsible for all the familiar chemical and physical properties of ordinary solids, liquids and gases. Next, both in range and familiarity, are the 'strong' interactions, which hold protons and neutrons together in the atomic nucleus. The strong forces are limited in range to about 10^{-13} centimeter and so are quite insignificant in ordinary life, or even in the scale (10^{-8} centimeter) of the atom. Least familiar are the 'weak' interactions. They are of such short range (less than 10^{-15}

centimeter) and are so weak that they do not seem to play a role in holding anything together". [20]

In this respect, the explanations enter into quite difficult and subtle particulars. How, for example, can an electron which consists only of one particle be in interaction with another quantum object? What part of itself can it emit if it consists only of one particle? These questions can be answered by the concept of interaction. In fact an electron does not exist of only a single particle exactly because the interaction of the electron is a part of it. In 1978 The physicists Daniel Z. Freedman and Pieter van Nieuwenhuizen wrote in this regard that "the observed electron mass is the sum of the 'bare mass' and the 'self-energy' resulting from the interaction of the electron with its own electromagnetic field. Only the sum of the two terms is observable". [21] What in quantum physics is known about interactions is here summarized in the words of the physicist and Nobel prize laureate Gerard 't Hooft: "An electron is surrounded by a cloud of virtual particles, which it continually emits and absorbs. This cloud does not consist of photons only, but also of pairs of charged particles, for example electrons and their anti-particles, the positrons. […] Even a quark is surrounded by a cloud of gluons and pairs of quark and anti-quark". [22]

Singular, isolated, independent quarks, a phenomenon which is called 'confinement' in recent research, have never been observed. Quarks are captives, they cannot appear on their own but only as one of a pair or as one of a trio. When you try to separate two quarks by force, new quarks will appear

between them which combine into pairs and trios. Claudio Rebbi and other physicists have reported that, "between the quarks and gluons inside an elementary particle, additional quarks and gluons are continuously formed and after a short time again subside". [23] These clouds of virtual particles represent or produce interactions. The central core of quantum physics consists of a new view of reality that no longer perceives singular, independent elements but rather two-body systems, two states of a quantum object or two concepts, e.g., earth/moon, proton/electron, proton/neutron, quark/anti-quark, wave/measuring instrument, particle/measuring instrument, twin photons, super-positions, spin-up/spin-down, matter/anti-matter, elementary particle/field of force, law of nature/matter, etcetera. These systems cannot be separated into independent parts, or reduced to two separate, independent bodies or states, nor is one fundamental and the other derived, as the metaphysical either-or schemes of substantial materialism and subjectivism try to establish. They are not joined into a seamless unity either, they are not the same, they are not identical and they are not a mysterious wholeness as holism indicates. Finally, we cannot claim, as instrumentalists do, that they are nothing but mathematical models which we have constructed and which do not correspond to physical reality. In physics, there is a fundamental reality that is not a one-body system. It is a two-body system or an assembly of bodies, a cloud of virtual particles which surround the central or 'naked' body. Between these bodies is an interaction that is one of the composites of them. This understanding of physics cannot be dislodged and yet all our metaphysical schemata struggle against it. The cloud does not conform to our traditional expectations of what should delineate and underpin stability, substantiality and order. How can clouds be what we are used to calling the basic elements of matter? How can this small vibrating something be what generations of

philosophers and physicists have been searching for in order to arrive at the core of matter, the ultimate reality? Is this supposed to be it? From these little clouds we attempt to use metaphysical interpretation to distill something that has substance and is enduring. Entirely within the sense of the substance metaphysics of Plato, Heisenberg (1901-1976) contends that the mathematical forms are the idea of elementary particles and that the object of elementary particles corresponds with this mathematical idea. The physicist and philosopher Carl Friedrich von Weizsäcker (1912-2007) called mathematics 'the essence of nature'. According to the physicist Schopper, fields of force are the ultimate reality. [24] Some of us want to see reality as a mysterious whole (holism) or dismiss it as a construction without any correspondence to empirical reality (instrumentalism). All of this only because we do not find it easy to admit that the complex interactions of the world in which we live have their roots in a reality that is in itself complex.

It is impossible to escape from the entanglement of this world in quantum physics and, to find an elementary quantum object that is not dependent on other quantum objects or on parts of itself. It is also impossible to dissolve the double-sided character of quantum objects. The fundamental reality of our physical world consists of clouds of interacting quantum objects.

6. Conclusion.

It seems that reality is not static, solid or independent and does not consist of singular, isolated material or immaterial factors, but of systems of dependent bodies. Most systems consist of more than two bodies, but there is no system that consists of less than two bodies. In quantum physics we call such fundamental two-body systems: earth/moon, electron/positron, quark/anti-quark, particle/field, etcetera. Nagarjuna calls his systems or dependent pairs: mover/distance to move within, fire/fuel, agent/action, viewer/view, etcetera.

Both, quantum physicists and Nagarjuna deal with two-body systems or two entities which have bodies that are neither properly separate, nor properly joined together. They do not unite into one, nor do they fall apart. These bodies are not independent and cannot be observed singly because in their very existence and constitution they are dependent on each other and cannot exist or function independently.

They are entangled by interactions, even at a far distance. One of them cannot be reduced to the other and it is not possible to explain one of them on the basis of the other. The resultant systems have a fragile stability, the components of which are maintained by interactions and mutual dependencies which are sometimes known, sometimes not fully known and sometimes totally unknown (for example as with entangled twin photons).

What is reality? We have become accustomed to believe in a firm ground under our feet and fleeting clouds above in the sky. The view of reality in Nagarjuna's thought and the ideas of complementarity, interactions and entanglement of quantum physics teach us that everything is built on sand. Moreover, even the grains of sand are not endowed with a solid nucleus. Their stability is based on balancing unstable interactions of their components.

Appendix 1.

Meanings of *pratityasamutpada*.

In the first place *pratityasamutpada* is an indication of dependence. Dependent bodies are in an intermediate state, they are not properly separated and they are not one entity. Secondly, they rely on each other and are influenced or determined by something else. Thirdly, their behaviour is influenced by something in-between, for example a mover is attracted by gravitational force, a viewer is dependent on rays of light between his eyes and the object, a piano player's action is determined by the fine motor skills of his fingers, an agent is dependent on his act. *Pratityasamutpada* is an indication of dependence and of something that happens between the objects. One object is bound to the other without being identical to it. The implicit interpretations of *pratityasamutpada*, are in terms of time, structure and space.

The following citations and references illustrate the term *pratityasamutpada*. *Pratityasamutpada* is used:

1. as Dependence in Nagarjuna's *Hymn to the Buddha:* " Dialecticians maintain that suffering is created by itself, created by (someone) else, created by both (or) without a cause, but You have stated that it is dependently born". [25]

2. as an intermediate state by Nagarjuna: Objects are neither together nor separated (Nagarjuna, MMK 6. 10).

3. as bondage in the *Hevajra Tantra:* "Men are bound by the bondage of existence and are liberated by understanding the nature of existence". [26]

4. as an intermediate state by Roger Penrose: "Quantum entanglement is a very strange type of thing. It is somewhere between objects being separate and being in communication with each other". [27]

5. as something between bodies by Albert Einstein: "A courageous scientific imagination was needed to realize fully that not the behaviour of bodies, but the behaviour of something between them, that is, the field, may be essential for ordering and understanding events". [28]

6. as the mean between things in modern mathematics: to quote Gioberti again: "The mean between two or more things, their juncture, union, transit, passage, crossing, interval, distance, bond and contact – all these are mysterious, for they are rooted in the continuum, in the infinite. The interval that runs between one idea and another, one thing and another, is infinite, and can only be surpassed by the creative act.

This is why the dynamic moment and dialectic concept of the mean are no less mysterious than those of the beginning and the end. The mean is a union of two diverse and opposite things in a unity. It is an essentially dialectic concept, and involves an apparent contradiction, namely, the identity of the one and the many, of the same and the diverse. This unity is simple and composite; it is unity and synthesis and harmony. It shares in two extremes without being one or the other. It is the continuum, and therefore the infinite. Now, the infinite identically uniting contraries, clarifies the nature of the interval. In motion, in time, in space, in concepts, the discrete is easy to grasp, because it is finite. The continuum and the interval are mysterious, because they are infinite". [29]

Appendix 2.

What is quantum entanglement? Two very short answers:

According to Clegg:

"Entanglement is a strange feature of quantum physics, the science of the very small. It's possible to link together two quantum particles — photons of light or atoms, for example — in a special way that makes them effectively two parts of the same entity. You can then separate them as far as you like, and a change in one is instantly reflected in the other. This odd, faster than light link, is a fundamental aspect of quantum science. Schrödinger, who came up with the name 'entanglement' called it 'the characteristic trait of quantum mechanics'. Entanglement is fascinating in its own right, but what makes it really special are dramatic practical applications that have become apparent in the last few years". [30]

According to Merali:

"This weird quantum effect inextricably links two or more objects in such a way that measurements carried out on one immediately change the properties of its partners, no matter how far apart they are. Quantum effects, such as entanglement, are usually confined to the invisible microscopic world and are detected only indirectly using precision instruments". [31]

Appendix 3:

Alfred North Whitehead: Adventures of Ideas, The Free Press, New York 1933

Chapter IX

Science and Philosophy

Section I. In one sense, Science and Philosophy are merely different aspects of one great enterprise of the human mind. We will dwell upon their cooperation in the task of raising humanity above the general level of animal life. At this low, animal level, flashes of aesthetic insight, of technological attainment, of sociological organization, of affectionate feeling, display themselves. Nightingales, beavers, ants, the kindly nurture of the young, all witness to the existence of this level of life in the animal world. Of course all these modes of functioning are carried to an immeasurably higher level among mankind. In human beings these various modes of functioning exhibit more variety of adaptation to special circumstances, they are more complex, and they are more interwoven with each other. But without question, among animals they are there, plainly demonstrated to our observation.

Among living things on this planet, so far as direct evidence reaches, Science and Philosophy belong to men alone. They are both concerned with the understanding of individual facts as illustrations of general principles. The principles are understood in the abstract, and the facts are understood in respect to their embodiment of the principles.

For example, animals seem quite familiar with the habit of bodies to fall down. They show no surprise at such occurrence, and they often knock things over. But quite early in the history of modern European science we find Aristotle formulating the law that there is a tendency for material bodies to seek the centre of the Earth. This law was almost certainly not a discovery of Aristotle's. It was a reigning commonplace of Greek thought, although not accepted unanimously. But it is plainly set forth in his writings, and it is beside our point to indulge further in archaeological conjectures. This scientific law seems rather antiquated to us, and in fact not quite true. It is over special, and yet requires severe limitation before the quantitative measurements bear out its statements with any exactness. We shall find that the subsequent history of this law and of its successive modifications throw great light upon the relative functions of Science and Philosophy.

But let us first examine Aristotle's Law, which is one of the earlier doctrines of that Western Science whose history stretches from Thales

of Miletus, alive at the date 600 B.C., to the present day. Roughly speaking, it is a history of about twenty-five hundred years. Of course there were anticipations in Egypt, Mesopotamia, India, and China. But modern science, urged onward by the curiosity of the human spirit, permeated with criticism, and divorced from hereditary superstitions, had its birth with Greeks; and among the Greeks Thales was the earliest exponent known to us

In this general characterization science and philosophy are not discriminated. But the word 'curiosity' somewhat trivializes that inward motive which has driven men. In the greater sense, in which it is here used, 'curiosity' means the craving of reason that the facts discriminated in experience be understood. It means the refusal to be satisfied with the bare welter of fact, or even with the bare habit of routine. The first step in science and philosophy has been made when it is grasped that every routine exemplifies a principle which is capable of statement in abstraction from its particular exemplifications. We are American, or French, or English; and we love our modes of life, with their beauties and their tendernesses. But curiosity drives us to an attempt to define civilization; and in this generalization we soon find that we have lost our beloved America, our beloved France, and our beloved England. The generality stands with a cold impartiality, where our affections cling to one or the other of the particulars.

An examination of Aristotle's Law of Gravitation exemplifies this abstractive process inherent in science. The Law involves a classification of the things around us. There are the heavy bodies with the property of tending downwards, and there are the other elements such as flames, with the intrinsic nature that they tend upwards though they are component things on the Earth's surface. These upward moving things tend to their proper place which is the heavens. The stars and planets form yet a third class of things which by their own nature are in the heavens, things which are ingenerable and incorruptible. In this classification of the components of physical nature yet a fourth component remains over, in its character unique and thus the only member of its class. This component is the Earth, the center of the Universe, by reference to which all these other types of being are defined.

In this classification of the various components of physical nature Aristotle has given to Science and Philosophy its first sweeping analysis of the fact of physical nature. You will notice that the classification proceeds entirely by reference to function, quite in the modern spirit. In the place of an uninterpreted swamp, pestilential with mystery and magic, he sets before our understanding a majestic, coordinated scheme, lucid to the understanding and based upon the obvious, persistent fact of our experience. In the generality of its scope, it is equally philosophic and scientific, and later on it provided the physical background for the

Christian scheme of salvation. Its overthrow, eighteen hundred years later, was resisted equally by Luther and the Church of Rome. As an example of a majestic inductive generalization, appealing to the obvious facts, and neglecting the welter of minor differences, Aristotle's general conception of the physical universe remains unsurpassed. For every feature in it, there is an appeal to observation; and for every observation to which appeal is made, there is the possibility of its indefinite repletion. With Aristotle and Epicurus, the science of modern civilization reached adolescence.

Section II. There is a clear-cut obviousness about Aristotle's doctrines which is entirely lacking to Plato's cosmology. Of course neither Plato, nor Aristotle, originated his own particular line of thought. There was a history behind them of three or four generations of thinkers, back to the dim figures of Thales and Pythagoras, and even beyond them. Also Aristotle worked for twenty years in the Academy of Plato, and derived ideas from that active, speculative group of thinkers, to whom the modern world owes its speculation, its criticism, its deductive and inductive sciences, and the civilization of its religious concepts. They were the narrow channel through which passed the confused traditions of Egypt, Mesopotamia, Syria, and of the sea-borne Greek civilization. From this Academy and its Aristotelian off-shoot, there emerged the various lines of thought which the subsequent schools of Alexandria turned into the first phase of modern science, natural and humane.

Undoubtedly the world then lost picturesqueness. For prophets were superseded by professors. In other words, as the movement has penetrated into habits of thought, intuitive conviction has wilted in the face of criticism. But amid all the limitations of humanity, wandering dazed in the abundant universe, knowledge has reconditioned human life, and has made possible that virtue which requires such measure of intellectual analysis.

Between them, Plato and Aristotle succeed in illustrating the chief connections between science and philosophy. The emphasis of science is upon observation of particular occurences, and upon inductive generalization, issuing in wide classifications of things according to their modes of functioning, in other words according to the laws of nature which they illustrate. The emphasis of philosophy is upon generalizations which almost fail to classify by reason of their universal application. For example, all things are involved in the creative advance of the Universe, that is, in the general temporality which affects all things, even if at all times they remain self-identical. Thus the consideration of weight led Aristotle to his four-fold classification.

Now Plato had already emphasized the importance of this Aristotelian notion of classification, that is to say, of 'division' as he called it. Perhaps indeed he invented the method. It would have been quite in

accordance with his clear-cut intellectual subtlety to have done so. We find in his dialogues the first explicit formulations of the science of Logic. But his applications of the method are feeble in the extreme, from the point of view of the advancement of natural science. Whereas Aristotle in his life's work seized upon the general notion of classification, he gave a masterly analysis of the complexities inherent in the mutual relation of classes. He also applied his theoretical doctrine to the immense material to be collected by direct observation in the field of zoology, physics, sociology. Indeed we must trace to him nearly all our special sciences, both the natural sciences, and those concerning the activities of the spirit of mankind. He is the origin of the striving towards an accurate analysis of each given situation which in the end has created modern European Science. We can see in the labours of his life, the first clear example of a philosophic intuition passing into a scientific method.

Section III. This transition from philosophic intuition to scientific methods is in fact the whole topic of this chapter. A philosophic system, viewed as an attempt to coordinate all such intuitions, is rarely of any direct importance for particular sciences. Each such science in tracing its ideas backward to their basic notions stops at a half-way house. It finds a resting place amid notions which for its immediate purposes and for its immediate methods it need not analyse further. These basic notions are a specialization from the philosophic intuitions which form the background

of the civilized thought of the epoch in question. They are intuitions which, apart from their use in science, ordinary language rarely expresses in any defined accuracy, but habitually presupposes in its current words and expressions. For example, the words 'tables', 'chairs', 'rocks', presuppose the scientific notion of material bodies, which has governed natural science from the seventeenth century to the end of the nineteenth.

But, even from the point of view of the special sciences, philosophic systems with their ambitious aims at full comprehensiveness, are not useless. They are the way in which the human spirit cultivates its deeper intuitions. Such systems give life and motion to detached thoughts. Apart from these efforts at coordination, detached thoughts would flash out in idle moments, illuminate a passing phase of reflection, and would the perish and be forgotten. The scope of an intuition can only be defined by its coordination with other notions of equal generality. Even the discordance of competing philosophic systems is a factor essential for progress. The history of European thought, even to the present day, has been tainted by a fatal misunderstanding. It may be termed The Dogmatic Fallacy. The error consists in the persuasion that we are capable of producing notions which are adequately defined in respect to the complexity of relationship required for their illustrations in the real world. Canst thou by searching describe the Universe? Except perhaps for the simpler notions of arithmetic, even our more familiar ideas,

seemingly obvious, are infected with this incurable vagueness. Our right understanding of the methods of intellectual progress depends on keeping in mind this characteristic of our thoughts. The notions employed in every systematic topic require enlightenment from the perspective of every standpoint. They must be criticized from the standpoint of their own internal consistency within that topic, and from the standpoint of other topics of analogous generality, and from the standpoint of so-called philosophic topics with a wider range. During the medieval epoch in Europe, the theologians were the chief sinners in respect to dogmatic finality. During the last three centuries, their bad preeminence in this habit passed to the men of science. Our task is to understand how in fact the human mind can successfully set to work for the gradual definition of its habitual ideas. It is a step by step process, achieving no triumphs of finality. We cannot produce that final adjustment of well-defined generalities which constitute a complete metaphysics. But we can produce a variety of partial systems of limited generality. The concordance of ideas within any one such system shows the scope and virility of the basic notions of that scheme of thought. Also the discordance of system with system, and success of each system as a partial mode of illumination, warns us of the limitations within which our intuitions are hedged. These undiscovered limitations are the topics for philosophic research.

This doctrine of the limitations to which our best ideas are subject is illustrated by that very notion of material bodies which has just been

mentioned. That notion is so obvious that it has haunted language so far as we can trace history backwards. Finally in the seventeenth century it was given a new precision for the purposes of physical science. Also physical science, thus re-conditioned, proved an overwhelming success for three centuries. It has transformed thought, and has transformed the physical activities of mankind. It seemed that at last mankind had achieved the fundamental notion for all practical purposes, and that beyond it in the way of generality there lay mere aimless speculation. But in the twentieth century this great notion, as shaped for use by Galileo and Newton, has completely collapsed so far as concerns its use as a fundamental notion for physical science. In the modern science, it is a limited notion confined to special purpose.

This collapse of nineteenth century dogmatism is a warning that the special sciences require that the imaginations of men be stored with imaginative possibilities as yet unutilized in the service of scientific explanation. The nearest analogy is to be seen in the history of some species of animal, or plant, or microbe, which lurks for ages as an obscure by-product of nature in some lonely jungle, or morass, or island. Then by some trick of circumstance it escapes into the outer world and transforms a civilization, or destroys an empire or the forests of a continent. Such is the potential power of the ideas which live in the various systems of philosophy.

Of course in this action, and reaction, between science and philosophy either helps the other. It is the task of philosophy to work at the concordance of ideas conceived as illustrated in the concrete facts of the real world. It seeks those generalities which characterize the complete reality of fact, and apart from which any fact must sink into an abstraction. But science makes the abstraction, and is content to understand the complete fact in respect to only some of its essential aspects. Science and Philosophy mutually criticize each other, and provide imaginative material for each other. A philosophic system should present an elucidation of concrete fact from which the sciences abstract. Also the sciences should find their principles in the concrete facts which a philosophy system presents. The history of thought is the story of the measure of failure and success in this joint enterprise.

Section IV. Plato's contribution to the basis notions connecting Science and Philosophy, as finally settled in the later portion of his life, has virtues entirely different from that of Aristotle, although of equal use for the progress of thought. It is to be found by reading together the *Theaetetus,* the *Sophist,* the *Timaeus,* and the fifth and tenth books of the *Laws;* and then by recurrence to his earlier work, the *Symposium.* He is never entirely self-consistent, and rarely explicit and devoid of ambiguity. He feels the difficulties, and expresses his perplexities. No one could be perplexed over Aristotle's classifications; whereas Plato

moves about amid a fragmentary system like a man dazed by his own penetration.

A few main doctrines stand out and they are of priceless importance for science, in the largest sense of that term. As to their coordination into a system, he is undogmatic and can only tell 'the most likely tale'. Indeed, in his seventh Epistle (Cf.341, C.) he denounces the notion that a final system can be verbally expressed. His later thought circles round the interweaving of seven main notions namely, The Ideas, The Physical Elements, The Psyche, The Eros, The Harmony, The Mathematical Relations, The Receptacle. These notions are as important for us now, as they were then at the dawn of the modern world, when civilizations of the old type were dying. From their point of view the Athenians were right to condemn Socrates. After the coalescence of Greek and Semitic thought the old order of life was doomed. Western Civilization acquired a new intellectuality, clarified, humanized, moralized.

Considering the Ideas by themselves, Plato points out that any selections are either compatible for joint exemplification, or are incompatible. It thus follows, as he notes, that the determinations of compatibilities and incompatibilities are the key to coherent thought, and to the understanding of the world in its function as the theatre for the

temporal realization of ideas. The Aristotelian logic is only a specialized derivative from this general notion.

Plato then passes on to the agency whereby ideas obtain efficiency in the creative advance. As he conceives them in abstraction, he finds ideas to be static, frozen, and lifeless. They obtain 'life and motion' by their entertainment in a living intelligence. Such a living intelligence with its 'gaze fixed upon ideas' was what Plato termed a Psyche, a word we can translate as 'soul'. We must, however, be careful to divest the associations of the English word from the accretions due to centuries of Christianity. He conceives of a basic Psyche whose active grasp of ideas conditions impartially the whole process of the Universe. This is the Supreme Craftsman, on whom depends that degree of orderliness which the world exhibits. There is a perfection in this Psyche, which Plato finds out of his power to explain. There are also finite souls of varying grades, including human souls, all playing their part in conditioning nature by the inherent persuasiveness of ideas.

But the notion of mere knowledge, that is to say, of mere understanding, is quite alien to Plato's thought. The age of professors had not yet arrived. In his view, the entertainment of ideas is intrinsically associated with an inward ferment, an activity of subjective feeling, which is at once immediate enjoyment, and also an appetition which melts into action. This

is Plato's Eros, which he sublimates into the notion of the soul in the enjoyment of its creative function, arising from its entertainment of ideas. The word Eros means 'Love', and in The *Symposium* Plato gradually elicits his final conception of the urge towards ideal perfection. It is obvious the he should have

written a companion dialogue which might have been named The Furies, dwelling on the horrors lurking within imperfect realization.

Plato, although he neglected to write this missing dialogue, did not overlook the confusion and disorder in Nature. He expressly denies omnipotence to his Supreme Craftsman. The influence of the entertainment of ideas is always persuasive, and can only produce such order as is possible. However, on this point he wavers, and sometimes writes as if the Craftsman were disposing the world according to his supreme will.

The notion of an excellence, partly attained and partly missed, raises another problem which greatly exercised Greek thought at the time of Plato. The problem can take many special forms. In what does beauty consists, for example, the beauty of a musical melody, the beauty of a statue, or of a building such as the Parthenon? Also, there is that other form of beauty, which is rightness of conduct. Probably in this naïve shape, the question has no answer; since 'The God' is an ultimate

qualification not to be analyzed in terms of any things more final than itself. But an analogous question can be asked, to which Greek thought was unanimous as to its answer. To what sort of things does the concept of apply, and in particular what sort of conditions are requisite for its evocation? The Greek answer to that latter pair of questions was that beauty belonged to composite things, and that the composition is beautiful when the many components have obtained in some sense the proper proportions. This was the Greek doctrine of Harmony, in respect to which neither Plato nor Aristotle ever waved.

In respect to Harmony, the Greeks made a discovery which is a landmark in the history of thought. They found out that exact Mathematical Relationships, as they exist in Geometry and in the numerical proportions of measurements, are realized in various outstanding examples of beautiful composition. For instance Archytas discovered that, other circumstances being equal, the note given out by a stretched string depends on the length of the string, and that beautiful compositions of notes correspond to certain simple laws as to the proportional lengths of the strings. Also they investigated the dependence of the beauty of architecture upon the preservation of the proper proportions in the various dimensions. This was an immense discovery, the dependence of the qualitative elements in the world upon mathematical relations. The facts had gradually accumulated through thousands of years. The early Babylonians knew that the qualitative fact of the succession of seasons

depended upon the lapse of definite numbers of days. In fact, they constructed very creditable calendars. But the Greeks, with their power of generalization, grasped the full law of the interweaving of qualitative fact with geometrical and quantitative composition. They had the genius to be astonished.

Plato drew the conclusion that the key to the understanding of the natural world, and in particular of the physical elements, was the study of mathematics. There is good reason to believe that the greater part of the studies of his Academy was devoted to mathematics. The mathematicians of the succeeding generation, and indeed of the next two hundred years, ending with the astronomers Ptolemy and Hipparchus, are the product of the systematic shaped by the example and the doctrine of Plato. Of course the Academy inherited the Pythagorean tradition of Mathematics.

Thus with Plato and Aristotle, a new epoch commences. Science acquires the cleansing of logical and mathematical lucidity. Aristotle established the importance of scientific classification into species and genera; Plato divined the future scope of applied mathematics. Unfortunately, later on, the explicit development of Plato's doctrines has been exclusively in the hands of religious mystics, of literary scholars, and of literary artists.

Plato, the mathematician, for long intervals disappeared from the explicit Platonic tradition.

The notions of Harmony and of Mathematical Relations are only special exemplifications of a yet more general philosophic concept, namely, that of the general interconnectedness of things, which transforms the manifoldness of the many into the unity of the one. We speak in the singular of *The* Universe , of Nature, of φύσις *phýsis* which can be translated as Process. There is the one all-embracing fact which is the advancing history of the Universe. This community of the world, which is the matrix for all begetting, and whose essence is process with retention of connectedness, - this community is what Plato terms The Receptacle […]. In our effort to divine his meaning, we must remember that Plato says that it is an obscure and difficult concept, and that in its own essence the Receptacle is devoid of all forms. It is thus certainly not the ordinary geometrical space with its mathematical relations. Plato calls his Receptacle 'The foster mother of all becoming'. He evidently conceived it as a necessary notion without which our analysis of Nature is defective. It is dangerous to neglect Plato's intuitions. He carefully varies his phrases in referring to it, and implies that what he says is to be taken in its most abstract sense. The Receptacle imposes a common relationship on all that happens, but does not impose what that relationship shall be. It seems to be a somewhat more subtle notion than Aristotle's 'matter' which of course, is not the 'matter' of Galileo and

Newton. Plato's Receptacle may be conceived as the necessary community within which the course of history is set, in abstraction from all the particular historical facts. I have directed attention to Plato's doctrine of the Receptacle because, at the present moment, physical science is nearer to it than at any period since Plato's death. The space-time of modern mathematical physics, conceived in abstraction from the particular mathematical formulae which applies to the happenings in it, is almost exactly Plato's Receptacle. It is to be noted that mathematical physicists are extremely uncertain as to what these formulae are exactly, nor do they believe that any such formulae can be derived from the mere notion of space-time. Thus, as Plato declares, space-time in itself is bare of all forms.

Section V. In the preceding sketch only one incidental generalization, selected from one topic comprised in the enormous labours of Aristotle's life, has brought forward. Aristotle was at once a man of science, a philosopher, a literary critic, and a student of political theory. This particular classification of the things constitutive of the visible universe has been dwelt upon because it is an almost perfect example of a scientific induction satisfying all the conditions insisted on by the modern philosophy of science. It was a generalization from observed fact, and could be confirmed by repeated observation.. In its day – and its day lasted for eighteen hundred years – it was extremely useful; and

now that it is dead, it is stone-dead, an archaeological curiosity. This is the fate of scientific generalizations, so long as they are considered

in relation to their strict scientific purpose. Towards the end of its long life, the doctrine lost its utility and turned into an obstructive agency.

The Platonic group of notions which have been considered have none of the merits of the Aristotelian set. In fact, they are philosophic, and in the narrow sense are not scientific. They suggest no detailed observation. Indeed it has always been a reproach to Plato that he diverted interest from observation of the particular facts. So far as concerns political theory, and in particular jurisprudence, this accusation is certainly untrue, and arises from the habit of concentrating interest on his Dialogues in proportion to their literary brilliance. Nevertheless the assertion is undoubtedly true in respect to physical science. But Plato had another message. Where Aristotle said 'observe' and 'classify', the moral of Plato's teaching is the importance of the study of mathematics. Of course, neither of them was so stupid as to dissuade from observation or, on the other hand, to deny the utility of mathematics. Probably Aristotle thought that the mathematical knowledge of his day was about as much as was wanted for the purpose of physical science. Any further progress could only minister to an unpractical curiosity about subtle abstractions.

An intense belief that a knowledge of mathematical relations would prove the key to unlock the mysteries of the relatedness within Nature was ever at the back of Plato's cosmological speculations. In one passage he reprobates the swinish ignorance of those who have failed to study the doctrine of proportions incapable of expression as numerical ratios. He evidently feels that the chance of some subtle elucidation of the nature of Harmony is being crassly lost. His own speculations as to the course of nature are all founded upon the conjectural application of some mathematical construction. So far as I can remember, in every case he made a sensible shot which, in fact, went wide of the mark.

Although the *Timaeus* was widely influential, yet for about eighteen hundred years after their epoch, it seemed that Aristotle was right and Plato wrong. Some mathematical formulae were interwoven with scientific ideas, but no more than would have been perfectly familiar to Aristotle apart from what were in his day the latest refinements. The cosmological scheme of the active scientists was in fact that of Aristotle. But Plato's divination exemplifies another important function for philosophy. It evokes interest in topics as yet remote from our crude understanding of the interplay of natural forces. The science of the future depends for its ready progress upon the antecedent elucidation of hypothetical complexities of connections, as yet unobservable in nature. Plato's mathematical speculations have been treated as sheer mysticism by scholars who follow the literary traditions of the

Italian Renaissance. In truth, they are the products of genius brooding on the future of intellect exploring a world of mystery.

Greeks, Egyptians, Arabs, Jews, and Mesopotamians advanced the science of mathematics beyond the wildest dreams of Plato. Unfortunately this side of Plato's interest was notably absent among the Christian population. I believe it to be true that no Christian made any original contribution to mathematical science before the revival of science at the time of the Renaissance. Pope Silvester II – Gerbert, who reigned in the year 1000 A.D. – studied mathematics. But he added nothing. Roger Bacon proclaimed the importance of mathematics and named contemporary mathematicians. In the thirteenth and fourteenth centuries the University of Oxford cherished mathematics. But none of these mediaeval Europeans advanced the subject. An exception must be made in favour of Leonardo of Pisa who flourished at the beginning of the thirteenth century. He was the first Christian to make an advance in the science which in his early history illustrates the cultural union of the Hellenistic Greeks with the Near East. But, subject to this qualification, sixteenth-century mathematics was entirely based upon non-Christian sources. Among the Christians mathematics and magic were confused. The Pope himself hardly escaped. We can hardly hope for a better illustration of the curious limitations of epochs and schools of civilization. It is especially interesting in view of the dominant influence of Plato upon Christian thought.

But the Platonic doctrine of the interweaving of Harmony with mathematical relations has been triumphantly vindicated. The Aristotelian classifications based upon qualitative predicates have a very restricted application apart from the introduction of mathematical formulae. Indeed Aristotelian logic, by its neglect of mathematical notions, has done almost as much harm as good for the advancement of science. We can never get away from the quotations: - How much, - In what proportions, - and In what pattern of arrangement with other things. The exact laws of chemical proportions make all the difference: CO will kill you, when CO_2 will only give you a headache. Also CO_2 is a necessary element for the dilution of oxygen in the atmosphere; but too much or too little is equally harmful. Arsenic deals out either health or death, according to its proportions amid a pattern of circumstances. Also when the health-giving proportion of CO_2 to free oxygen has been obtained, a re-arrangement of these proportional quantities of carbon and oxygen into carbon monoxide and free oxygen will provide a poisonous mixture. In Political Economy, the Law of Diminishing Returns points to the conditions for the maximum efficiency of a dose of capital. In fact, there is hardly a question to be asked which should not be fenced round with qualifications as how much, and as to what pattern of circumstances. Aristotelian logic, apart from the guardianship of mathematics, is the fertile matrix of fallacies. It deals with propositional forms only adapted for the expression of high abstractions, the sort of abstractions usual in current conversation where the presupposed background is ignored.

But it is evident that even the appeal to mathematics is too narrow, at least if mathematics is taken to mean those branches hitherto developed. The general science of mathematics is concerned with the investigation of patterns of connectedness, in abstraction from the particular relata and the particular modes of connection. It is only in some special branches of mathematics that notions of quantity and number are dominant themes. **The real point is that the essential connectedness of things can never be safely omitted.** This is the doctrine of the thoroughgoing relativity which infects the universe and which makes the totality of things as it were a Receptacle uniting all that happens.

The Greek doctrine of Composition and Harmony has been vindicated by the progress of thought. Yet the vivid fancy of the Greeks was also apt to invest each factor in the Universe with an independent individuality, for example, the self-sufficient realm of ideas which dominated Plato's earlier thought, and which intermittently intrudes into his later Dialogues. Bu we must not blame the Greeks for this excess of individualization. All language witnesses to the same error. We habitually speak of stones, and planets, and animals, as though each individual thing could exist, even for a passing moment, in separation from an environment which is in truth a necessary factor in its own nature. Such an abstraction is a necessity of thought, and the requisite background of systematic environment can be presupposed. That is true. But it also follows that, in the absence of some understanding of the final nature of

things, and thus of the sorts of backgrounds presupposed in such abstract statements, all science suffers from the vice that it may be combining various propositions which tacitly presuppose inconsistent backgrounds. No science can be more secure than the unconscious metaphysics which tacitly it presupposes. **The individual thing is necessarily a modification of its environment, and cannot be understood in disjunction.** All reasoning, apart from some metaphysical reference, is vicious.

Section VI. Thus the Certainties of Science are a delusion. They are hedged around with unexplored limitations. Our handling of scientific doctrines is controlled by the diffused metaphysical concepts of our epoch. Even so, we are continually led into errors of expectation. Also, whenever some new mode of observational experience is

obtained the old doctrines crumble into a fog of inaccuracies.

Our coordinated knowledge, which in the general sense of the term is Science, is formed by the meeting of two orders of experience. One order is constituted by the direct, immediate discriminations of particular observations. The other order is constituted by our general way of conceiving the Universe. They will be called, the Observational Order, and the Conceptual Order. The first point to remember is that the observational order is invariably interpreted in terms of the

concepts supplied by the conceptual order. The question as to the priority of one or the other is, for the purpose of this discussion, academic. We inherit an observational order, namely types of things which we do in fact discriminate; and we inherit a conceptual order, namely a rough system of ideas in terms of which we do in fact interpret. We can point to no epoch in human history, or even in animal history, at which this interplay began. Also it is true that novel observations modify the conceptual order. But equally, novel concepts suggest novel possibilities of observational discrimination.

The history of thought cannot be understood unless we take account of a grave weakness in the observational order. Observational discrimination is not dictated by the impartial facts. It selects and discards, and what it retains is rearranged in a subjective order of prominence. This order of prominence in observation is in fact a distortion of the facts. Thus we have to rescue the facts as they are from the facts as they appear. We have to rescue the facts in the discard, and we have to discard the subjective order of prominence which is itself a fact of observation. For example, consider the observed facts in early stages of civilization. The observed fact was a flat Earth with the arched dome of the Sky. Even to the contemporaries of Pope Silvester the antipodes were inconceivable, and his reputed belief in them did not credit to the old wizard of a Pope.

Again we view the sky at noon on a fine day. It is blue, flooded by the light of the Sun. The direct fact of observation is the sun as the sole origin of light, and the bare heavens. Conceive the myth of Adam and Eve in the Garden on the first day of human life. They watch the sunset, the stars appear: -'And, Lo!, creation widened to man's view'.

The excess of light discloses facts and also conceals them. It distorts the facts for human observation. It is one task of speculation to urge observation beyond the boundaries of its delusive completeness, and to urge the doctrines of science beyond their delusive air of finality.

We can now briefly characterize the history of the transformation of mediaeval cosmology into our modern standpoint. The effective agency in this transformation has a history of about eighteen hundred years entirely divorced from physical observation. It is a history of abstract thought, namely of the development of mathematics. The interest, which was the motive in its development, was the interest in the coordination of theoretical notions and in the theoretical constructions arising from the domination of such notions. Yet, if many modern philosophers and men of science could have had their way, they would have been dissuading Greeks, Jews, and Muslims from such useless studies, from such pure abstractions for which no foresight could divine the ghost of an application. Luckily they could not get at their ancestors.

Section VII. The services to mankind rendered by the Newtonian System of Nature are incalculable. It combines ideas derived from Plato, Aristotle, and Epicurus, into a consistent scheme of thought which elucidates an incredible number of observed facts. Thereby it has enabled men to obtain a new command over Nature. Where we formerly obeyed, we now direct. But at last the Newton cosmology has broken down.

The story of the breakdown extends over more than a century. For by far the greater part of that period men of science were quite unaware that the ideas which they were introducing, slowly, one after the other, were finally to accumulate into a body of thought inconsistent with the Newtonian ideas dominating their thoughts and shaping their modes of expression. The story commences with the wave-theory of light and ends with the wave-theory of matter. It finally leaves us with the philosophic question, What are the concrete fact which exhibit this mathematical attribute of wave-vibration?

The story in detail is the history of modern physics, which lies beyond the scope of this discussion. We merely require to understand the contrast between the most general notions respectively underlying Newtonian physics and modern physics. Newtonian physics is based upon the independent individuality of each bit of matter. Each stone is

conceived as fully describable apart from any reference to any other portion of matter. It might be alone in the Universe, the sole occupant of uniform space. But it would still be that stone which it is. Also the stone could be adequately described without any reference to past or future. It is to be conceived fully and adequately as wholly constituted within the present moment.

This is the full Newtonian concept, which bit by bit was given away, or dissolved, by the advance of modern physics. It is the thorough-going doctrine of 'simple location' and of 'external relations'. There was some divergence of opinion as to the external relations. Newton himself was inclined to construe them in terms of shock and of stress between contiguous bodies. But his immediate followers, such as Roger Cotes, added the notion of force at a distance. But either alternative was wholly and completely a fact in the present, namely, the fact of that external relation between two bits of matter either contiguous or distant. The opposed doctrine of internal relations has been distorted by reason of its description in terms of language adapted to the presupposition of external relations of the Newtonian type. Even its adherents, such as F.H. Bradley for instance, fall into this pitfall. It must be remembered that just as the relations modify the natures of the relata, so the relata modify the nature of the relation. The relationship is not a universal. It is a concrete fact with the same concreteness as the relata. The notion of the immanence of the cause in the effect illustrates this truth. We

have to discover a doctrine of nature which expresses the concrete relatedness of physical functionings and mental functionings, of the past with the present, and also expresses the concrete composition of physical realities which are individually diverse.

Modern physics has abandoned the doctrine of Simple Location. The physical things which we term stars, planets, lumps of matter, molecules, electrons, protons, quanta of energy are each to be conceived as modifications of conditions within space-time, extending throughout its whole range. There is a focal region, which in common speech is where the thing is. But its influence streams away from it with finite velocity throughout the utmost recesses of space and time. Of course, it is natural, and for certain purposes entirely proper, to speak of the focal region, thus modified, as the thing itself situated there. But difficulties arise if we press this way of thought to far. For physics, the thing itself is what is does, and what it does is this divergent stream of influence. Again the focal region cannot be separated from the external stream. It obstinately refuses to be conceived as an instantaneous fact. It is a state of agitation, only differing from the so-called external stream by its superior dominance within the focal region. Also we are puzzled how to express exactly the existence of these physical things at any definite moment of time. For at every instantaneous point-event, within or without the focal region, the modification to be ascribed to this thing is antecedent to, or successive to, the corresponding modification

introduced by that thing at another point-event. Thus if we endeavor to conceive a complete instance of existence of the physical thing in question, we cannot confine ourselves to one part of space or to one moment of time. The physical thing is a certain coordination of spaces and times and conditions in those spaces at times, this coordination illustrating one exemplification of a certain general rule, expressible in terms of mathematical relations. Here we have returned to a fundamental Platonic doctrine.

Again, with the denial of simple location we must admit that within any region of space-time the innumerable multitude of these physical things are in a sense superposed. Thus the physical fact at each region of space-time is a composition of what the physical entities throughout the Universe mean for that region. But a complete existence is not a composition of mathematical formulae, mere formulae. It is a concrete composition of things illustrating formulae. There is an interweaving of qualitative and quantitative elements. For example, when a living body assimilates food, the fact cannot be *merely* that one mathematical formula assimilates another mathematical formula. The fact cannot be merely that the equality of two and three with five assimilates the fact of the equality of thrice three with nine, nor can the number eleven assimilate the number sixteen. Any of these mathematical notions may be illustrated, but the fact is more than the formulae illustrated.

Section VIII. The final problem is to conceive a complete [the Greek word for complete is often wrongly translated as absolute] fact. We can only form such a conception in terms of fundamental notions concerning the nature of reality. We are thrown back upon philosophy. Centuries ago Plato divined the seven main factors interwoven in fact: - The Ideas, The Physical Elements, The Psyche, The Eros, The Harmony, The Mathematical Relations, The Receptacle. All philosophical systems are endevours to express the interweaving of these components. Of course, it is most unscholarly to identify our modern notions with these archaic thoughts of Plato. For us everything has a subtle difference. But for all these differences, human thought is now endevouring to express analogous elements in the composition of nature. It only dimly discerns, it misdescribes, and it wrongly associates. But always there remain the same beacons that lure. Systems, scientific and philosophic, come and go. Each method of limited understanding is at length exhausted. In its prime each system is a triumphant success: in its decay it is an obstructive nuisance. The transition to new fruitfulness of understanding are achieved by recurrence to the utmost depths of intuition for the refreshment of imagination . In the end – though there is no end – what is being achieved, is width of view, issuing in greater opportunities. But opportunity leads upwards or downwards. In unthinking Nature 'natural selection' is a synonym for 'waste'. Philosophy should now perform its final service. It should seek the insight, dim though it be, to escape the wide wreckage of a race of beings sensitive to values beyond those of mere animal enjoyment.

Alfred North Whitehead: Adventures of Ideas, The Free Press, New York 1933

Chapter XV

Philosophic Method

Section I. In this final chapter of Part III my aim is a discussion of some methods which can usefully be employed in the pursuit of speculative philosophy. In illustration, and as a subsidiary aim, I shall refer to some doctrines of my own, [*Process and Reality* and *Science and The Modern World*], and to some comments upon them. In this chapter the transient aspect of nature will be mainly emphasized.

So far as concerns methodology, the general issue of the discussion will be that theory dictates method, and that any particular method is only applicable to theories of one correlate species. An analogous conclusion holds for the technical terms. This close relation of theory to method partly arises from the fact that the relevance of evidence depends on the theory which is dominating the discussion. This fact is the reason why dominant theories are also termed 'working hypotheses'.

An example is afforded when we interrogate experience for direct evidence of the interconnectedness of things. If we hold with Hume, that the sole data originating reflective experience are impressions of sensation, and also if we also admit with him the obvious fact that no one such impression by its own individual nature discloses any information as to another such impression, then on that hypothesis the direct evidence for interconnectedness vanishes. Again, if we hold the Cartesian doctrine of substantial souls with many adventures of experience, and of substantial material bodies, then on that hypothesis the relations between two occasions of experience qualifying one soul are no evidence as to the connectedness of two such occasions respectively qualifying two different souls, and are no evidence as the connectedness of a soul and a material body, and are no evidence as to the connectedness of two occasions of agitation of one material body, or of two such occasions respectively belonging to different material bodies. But if we hold, as for example in *Process and Reality,* that all final individual actualities have the metaphysical character of occasions of experience, then on that hypothesis the direct evidence as to the connectedness of one's immediate present occasion of experience with one's immediately past occasions, can be validly used to suggest categories applying to the connectedness of all occasions in nature. A great deal of confused philosophical thought has its origin in obliviousness to the fact that the relevance of evidence is dictated by theory. For you cannot prove a theory by evidence which that theory dismisses as irrelevant. This is also the reason that in any science which has failed to produce any theory

with a sufficient scope of application, progress is necessarily very slow. It is impossible to know what to look for, and how to connect the sporadic observations. Philosophical discussion in the absence of a theory has no criterion of the validity of evidence. For example, Hume assumes that his doctrine of association holds for all types of impressions of sensation and of ideas of them indiscriminately. This assumption is part of his theory. In divorce from the theory, a separate appeal to experience is required for each type of impression, for example, tastes, sounds, sights, etc., and likewise, not only for the association of tastes *inter se* and of sounds *inter se,* but for the associations of tastes with sounds, and so on for every possible type, and for every possible conjunction of types.

To sum up this preface, every method is a happy simplification. But only truths of a congenial type can be investigated by any one method, or stated in the terms dictated by the method. For every simplification is an over-simplification. Thus the criticism of a theory does not start from the question, True or false? It consists in noting its scope of useful application and its failure beyond that scope. It is an unguarded statement of a partial truth. Some of its terms embody a general notion with a mistaken specialization, and others of its terms are too general and require discrimination of their possibilities of specialization.

Section II. Philosophy is a difficult subject, from the day of Plato to the present time haunted by subtle perplexities. This existence of such perplexities arising from the common obviousness of speech is the reason why the topic exists. Thus the very purpose of philosophy is to delve below the apparent clarity of common speech. In this connection, it is only necessary to refer to Socrates. Another illustration is to be found in the *Sophist*, where Plato states that 'not-being' is a form of 'being'. This statement is at once an extreme instance of the breakdown of language, and the enunciation of a profound metaphysical truth which lies at the foundation of this discussion.

Section III. Speculative Philosophy ca be defined [*Process and Reality* Pt I, Ch. I, Sect I] as the endevour to frame a coherent, logical, necessary system of general ideas in terms of which every element of our experience can be interpreted. Here 'interpretation' means that each element shall have the character of a particular instance of the general scheme.

Thus speculative philosophy embodies the method of the 'working hypothesis'. The purpose of this working hypothesis for philosophy is to coordinate the current expressions of human experience, in common speech, in social institutions, in actions, in the principles of the various special sciences, elucidating harmony and exposing discrepancies. No systematic thought has made progress apart from some adequately general working hypothesis, adapted to its special topic. Such an

hypothesis directs observation, and decides upon the mutual relevance of various types of evidence. In short, it prescribes method. To venture upon productive thought without such an explicit theory is to abandon oneself to the doctrines derived one's grandfather.

In the preliminary stages of knowledge a haphazard criterion is all that is possible. Progress is then very slow, and most of the effort is wasted. Even an inadequate working hypothesis with some conformation to fact is better than nothing. It coordinates procedure.

The advance of any reasonably developed science is twofold. There is the advance of detailed knowledge within the method prescribed by the reigning working hypothesis; and there is the rectification of the working hypothesis dictated by the inadequacies of the current orthodoxy.

Sometimes it is necessary for a science to entertain concurrently two – or more – working hypotheses, each with its own success and its own failure. Such hypotheses are contradictory as stated; and science awaits their conciliation by the production of a working hypothesis with a wider sweep. When a new working hypothesis is proposed, it must be criticized from its own point of view. For example, it is futile to object to the Newtonian dynamics that, on the Aristotelian system, the loose things on the earth's surface must be left behind by the earth's motion.

Philosophy has been afflicted by the dogmatic fallacy, which is the belief that the principles of its working hypotheses are clear, obvious and irreformable. Then, as a reaction from this fallacy, it has swayed to the other extreme which is the fallacy of discarding method. Philosophers boast that they uphold no system. They are then a prey to the delusive clarities of detached expressions which it is the very purpose of their science to surmount. Another type of reaction is to assume, often tacitly, that if there can be any intellectual analysis it must proceed according to some one discarded dogmatic methods, and thence to deduce that intellect is intrinsically tied to erroneous fictions. This type is illustrated by the anti-intellectualism of Nietzsche and Bergson, and tinges American Pragmatism.

Section IV. A method is a way of dealing with data, with evidence. What are the evidences to which philosophy appeals?

It is customary to contrast the objective approach of the ancient Greeks with the subjective approach of the moderns, initiated by Descartes and further emphasized by Locke and Hume.

But whether we be ancient or modern, we can only deal with things, in some sense, experienced. The Greeks dealt with things that they thought they experienced, and Hume merely asked, what do we experience? This

is exactly the question which Plato and Aristotle thought that they were answering.

To speak of anything, is to speak of something which, by reason of that very speech, is in some way a component in that act of experience. In some sense or other, it is thereby known to exist. This is what Plato pointed out when he wrote, Not-being is itself a sort of being.

Speech consists of noises, or visible shapes, which elicit an experience of things other than themselves. In so far as vocables fail to elicit a stable coordination of sound-character, or shape-character, to meaning, those vocables fail to function as speech. And in so far as some meaning is not in some sense directly experienced, there is no meaning conveyed. To point at nothing is not to point.

To speak of the same thing twice is to demonstrate that the being of that thing is independent of either singular act of speech, unless we believe that the two acts presuppose each other or are both presupposed by the thing spoken of. If we cannot speak of the same thing twice, knowledge vanishes taking philosophy with it. Thus, since speech can be repeated, things spoken of have a determined being in abstraction from the occasion of experience which includes that act of speech.

The difference of ancients and moderns is that the ancients asked what have we experienced, and the moderns asked what can we experience.

But in both cases, they asked about things transcending the act of experience which is the occasion of asking.

Section V. The translation of Hume's question from "What *do* we experience' to What *can* we experience' makes all the difference, though in his 'Treatise' Hume makes the transition, time and again, without explicit comment. For modern epistemology the latter form of the question - with its substitution of *can* for *do* - is accompanied by the implicit presupposition of a method, namely that of placing ourselves in an introspective attitude of attention so as to determine the *given* components of experience in abstraction from our private way of subjective reaction, by reflection, conjecture, emotion, and purpose.

In this attitude of strained attention, there can be no doubt as to the answer. The data are the patterns of sensa provided by the sense organs. This is the sensationalist doctrine of Locke and Hume. Later, Kant has interpreted the patterns as forms introduced by the mode of reception provided by the recipient. Here Kant introduces the Leibnizian notion of the self-development of the experiencing subject. Thus for Kant the data are somewhat narrower than for Hume: they are the sensa devoid of their patterns. Hume's general analysis of the consequences of this doctrine stands unshaken. So also does his final reflection, that the philosophic doctrine fails to justify the practice of daily life. The

justification of this procedure of modern epistemology is twofold, and both of its branches are based upon mistakes. The mistakes go back to the Greek philosophers. What is modern, is the exclusive reliance upon them.

Section VI. The first error is the assumption of a few definite avenues of communication with the external world, the five sense-organs. This leads to the pre-supposition that the search for the data is to be narrowed to the question, what data are directly provided by the activity of the sense-organs - preferably the eyes. This doctrine of sense-organs has a vague, general truth, very important for practical affairs. In particular all exact scientific observation is derived from such data. The scientific categories of thought are obtained elsewhere.

But the living organ of experience is the living body as a whole. Every instability of any part of it – be it chemical, physical, or molar – imposes an activity of readjustment throughout the whole organism. In the course of such physical activities human experience has its origin. The plausible interpretation of such experience is that it is one of the natural activities involved in the functioning of such a high-grade organism. The actualities of nature must be so interpreted as to be explanatory of this fact. This is one *desideratum* to be aimed at in a philosophic scheme.

Such experience seems to be more particularly related to the activities of the brain. But how far an exact doctrine can be based upon this presumption lies beyond our powers of observation. We cannot determine with what molecules the brain begins and the rest of the body ends. Further, we cannot tell with what molecules the body ends and the external world begins. The truth is that the brain is continuous with the body, and the body is continuous with the rest of the natural world. Human experience is an act of self-origination including the whole of nature, limited to the perspective of a focal region [Cf. *Process and Reality* Pt. II, Ch. III, especially Sects. IV-XI, and Pt, Chs. IV and V.], located within the body, but not necessarily persisting in any fixed coordination with a definite part of the brain.

Section VII. The second error is the presupposition that the sole way of examining experience is by acts of conscious introspective analysis. Such a doctrine of the exclusive primacy of introspection is already discredited in psychology. Each occasion of experience has its own individual pattern. Each occasion lifts some components into primacy and retreats others into a background enriching the total enjoyment. The attitude of introspection shares this characteristic with all other experimental occasions. It lifts the clear-cut data of sensations into primacy, and cloaks the vague compulsions and derivations which form the main stuff of experience. In particular it rules out that intimate sense of

derivation from the body, which is the reason for our instinctive identification of our bodies with ourselves.

In order to discover some of the major categories under which we can classify the infinitely various components of experience, we must appeal to evidence relating to every variety of occasion. Nothing can be omitted, experience drunk and experience sober, experience sleeping and experience waking, experience drowsy and experience wide-awake, experience self-conscious and experience self-forgetful, experience intellectual and experience physical, experience religious and experience sceptical, experience anxious and experience care-free, experience anticipatory and experience retrospective, experience happy and experience grieving, experience dominated by emotion and experience under self-restraint, experience in the light and experience in the dark, experience normal and experience abnormal.

Section VIII. We have now reached the heart of our topic. What is the store-house of that crude evidence on which philosophy should base its discussion, and in what terms should its discussion be expressed?

The main sources of evidence respecting this width of human experience are language, social institutions, and action, including thereby the fusion of the three which is language interpreting action and social institutions. Language delivers its evidence in three chapters, one on the meanings of

words, another on the meanings enshrined in grammatical forms, and the third on meanings enshrined in grammatical forms, and the third on meanings beyond individual words and beyond grammatical forms, meanings miraculously revealed in great literature.

Language is incomplete and fragmentary, and merely registers a stage in the average advance beyond ape-mentality. But all men flashes of insight beyond meanings already stabilized in etymology and grammar. Hence the role of literature, the role of the special sciences, and the role of philosophy: - in their various ways engaged in finding linguistic expressions for meanings as yet unexpressed.

As a special example, consider the line and a half of poetry in which Euripides [*Trojan Women,* 886-7] compresses the main philosophical problems which have tortured European thought from his day to the present: -"Zeus, whether thou are Compulsion of Nature or Intelligence of Mankind, to thee I prayed." Consider the ideas involved. 'Zeus', 'necessity [compulsion] of nature', 'intelligence of mankind', 'prayer'. These lines have survived the ages with a modern appeal vivid as when first they thrilled an Athenian audience. The biographer [Cf. John Morley's *Life of Gladstone,* Ch. X] of a modern statesman cites them to express the solemnity of the spectacle of life passing into religious emotion.

Yet Hume would be able to find no 'impression of sensation' from which to derive 'Zeus', or 'compulsion', or 'intelligence', or the would-be 'persuasiveness' which we term 'prayer'. John Morley himself selected the quotation in spite of his own positivist bias which should trivialize these meanings. Also, perhaps even for their original author, the lines represent a triumph of dramatic intuition over temperamental scepticism.

The common practice, interpreted by the common language of mankind, tells the same tale. A statesman, or a president of a business corporation, assumes the 'compulsion of recent events' as laying down inexorable conditions for the future. He frames a 'policy' upon this assumption and advises that it be 'acted on', thereby also assuming that the imposed conditions leave room for the effectiveness of 'choice' and 'intelligence'. He assumes alternatives in contrast to the immediate fact. He conceives such ideals as effective in proportion as they are entertained. He praises and he blames by reason of this belief.

In the world, there are elements of order and disorder, which thereby presuppose an essential interconnectedness of things. For disorder shares with order the common characteristic that they imply many things interconnected.

Each experience enjoys a perspective apprehension of the world, and equally is an element in the world by reason of this very prehension, which anchors him to a world transcending his own experience. For, it belongs to the nature of this perspective derivation, that the world thus disclosed proclaims its own transcendence of that disclosure. To every shield, there is another side, hidden.

Thus an appeal to literature, to common language, to common practice, at once carries us away from the narrow basis for epistemology provided by the sense-data disclosed in direct introspection. The world within experience is identical with the world beyond experience, the occasion of experience is within the world and the world is within the occasion. The categories have to elucidate this paradox of the connectedness of things: - the many things, the one world without and within.

Section IX. European philosophy is founded upon Plato's dialogues, which in their methods are mainly an endevour to elicit philosophic categories from a dialectic discussion of the meanings of language taken in combination with shrewd observation of the actions of man and of the forces of nature.

But in one dialogue, the *Sophist,* Plato explicitely considers the methods of philosophy. One of his conclusions is to point out the limitations of

common speech. Mere dialectic, uncriticized is a fallacious instrument, the mark of the *Sophist.* For example, Plato insists that not-being is itself a form of being. Thus in philosophy linguistic discussion is a tool, but should never be a master. Language is imperfect both in its words and in its forms. Thus we discover two main errors to which philosophic method is liable, one is the uncritical trust in the adequacy of language, and the other is the uncritical trust in the strained attitude of introspection as the basis for epistemology.

But since the life-time of Plato nearly two and a half thousand years have intervened, including the continuous activity of European philosophic thought, pagan, Christian, secular. It is widely held that a stable, well-known philosophic vocabulary has been elaborated, and that in philosophic discussion any straying beyond its limits introduces neologisms, unnecessary and therefore to be regretted.

This alleged fact requires examination. In the first place, if the allegation be true, it is very remarkable. It decisively places philosophy apart from the more special sciences. Modern mathematics, most secure and authoritative of sciences, is largely written in verbal and symbolic phrases which would have been unintelligible eighty years ago. In modern physics the old words, where they are still used, convey different meanings, and the new words are abundant. But it is futile to make a

catalogue of the sciences accompanied by this refrain. The conclusion is obvious to the most cursory inspection.

Section X. Undoubtedly, philosophy is dominated by its past literature to greater extent than any other science. And rightly so. But the claim that it has acquired a set of technical terms sufficient for its purposes, and exhaustive of its meanings, is entirely unfounded. Indeed its literature is so vast, and the variations of its schools of thought so large, that there is abundant evidence of most excusable ignorance respecting verbal usages.

A recent instance illustrates the vagueness of philosophical terminology. Logic is, by far, that branch of philosophy best systematized with the aid of stable technical language. Consider the terms Judgement and Proposition. I am not writing a preface to Logic, so I will confine myself to the assertion that there is considerable variation in the usages of these terms among logicians.

Also we may well ask whether there are not subtle variations of meaning stretching far beyond the competence of the two-term vocabulary, - Judgement, Proposition. For example, Mr. Joseph [Cf. *Mind,* Vols. 36, 37, New Series] has been examining Mr. W.E. Johnson's use of the term Proposition in his well-known Logical Treatise. Mr. Joseph finds twenty

distinct meanings. It is to be remembered that we are here referring to two of the most acute of modern logicians. Whether Mr. Joseph has rightly interpreted Mr. Johnson's phrases is not to the point. If Mr. Joseph has found twenty distinct, though allied, meanings closely connected with the term Proposition, there are twenty such meanings, even though for the moment their divergencies may seem unimportant to Mr. Johnson or Mr. Joseph. Importance depends on purpose and on point of view. So at any moment twenty new terms may be required by some advance in the subtlety of logical theory. Again, if Mr. Johnson has employed twenty distinct meanings, it is because they were relevant to his argument, even though his argument may require further completion by reason of their unnoted distinction.

It is safe to confirm that this situation can be repeated over every technical term in philosophy.

Section XI. Another illustration, in which my use of the words [Cf. *Science and Modern World,* Ch. IV and passim and *Process and Reality,* Ch. II and passim] Prehension, Feeling, Satisfaction, is partly concerned, can be drawn from the terms expressive of the connectedness of things. For this topic, the reigning philosophical term is the word Relation. There are various controversies about relations which need not be explicitly

referred to. But there is one discussion which illustrates our immediate topic.

It is generally held that relations are universals, so that A can have the same relation to B as C has to D. For example 'loving', 'believing', 'between', 'greater than', are relations. There can be no objection to this doctrine. For it is a mere definition. Universals which require two or more particulars for their illustration need some term to indicate them, and Relation is the word chosen.

But with this meaning to the term, a relation cannot signify the actual connectedness of the actual individual things which constitute the actual course of history. For example, New York les between Boston and Philadelphia. But the connectedness of the three towns is a real particular fact on the earth's surface involving a particular part of the eastern seaboard of the United States. It is not the universal 'between'. It is a complex actual fact which, among other things, exemplifies the abstract universal 'betweenness'.

This consideration is the basis of Bradley's objection that relations do not relate. Three towns and an abstract universal are not three connected towns. A doctrine of connectedness is wanted. Bradley [Cf. *Essays on Truth and Reality,* Ch. Vi., *On our Knowledge of Immediate*

Experience, Appendix, p. 193. The page references are to the Oxford edition of 1914. Also cf. Appendix to Ch. VI, passim, and Supplementary Note to the same.] writes 'Is there, in the end, such a thing as a relation which is merely *between* terms? Or, on the other hand, does not a relation imply an underlying unity and an inclusive whole?'

Bradley's 'inclusive whole' is the connectedness of which we are in search. Throughout this chapter [loc.cit.] Bradley uses the term Feeling to express the primary activity at the basis of experience. It is experience itself in its origin and with the minimum of analysis. The analysis of Feeling can never disclose anything lying beyond lying beyond the essence of the occasion of experience. Hence Bradley terms it 'non-relational'. There are of course grave differences between my own doctrine and that of Bradley. This was a reason [Cf. *Process and Reality* passim] for expounding my point of view in some independence of Bradley, with due acknowledgement. Surely the proper method of choosing technical terms is to adopt terms from some outstanding exposition of an analogous doctrine. It throws an interesting light on the belief in a well-understood technical phraseology reigning in philosophy, that an accomplished philosopher censured in print, my use of the word Feeling as being in a sense never before employed in philosophy.

I may add that William James also employs the word in much the same sense in his Psychology. For example in the first chapter he writes,

"Sensation is the feeling of first things". And in the second chapter he writes, "In general, this higher consciousness about things is called Perception, the mere inarticulate feeling of their presence is Sensation, so far as we have it at all. To some degree we seem able to lapse into this inarticulate feeling at moments when our attention is entirely dispersed." It is interesting to make a few citations from Bradley, illustrating my general adherence to his doctrine of Feeling, as expressed in his Chapter, "In my general feeling at any moment there is more than the objects before me, and no perception of objects will exhaust the sense of a living emotion"[Bradley, p. 159].

In accordance with this doctrine of Bradley's, I analyze a feeling [or prehension] into the 'datum', which is Bradley's 'living emotion', and into the 'subject' which is Bradley's 'me'. My reason for using the term 'subjective form', is that I stretch its meaning beyond 'emotion'. For example consciousness, if it be present, is an element in the subjective form. This is, of course, a grave divergence from Bradley. Subjective form is the character assumed by the subject by reason of some prehended datum.

But on the whole I conform to Bradley's conception of the function of subjective form. For example, "These puzzles are insoluble unless that which I feel, and which is not an object before me, is present and active. This felt element is used and it must be used in the constitution of that object which satisfies me"[p. 161].

From my point of view there is an ambiguity in this statement, but I adhere to either alternative meaning.

The component of feeling 'which is not an object before me' is the subjective form. If Bradley is stating that the subjective forms of feelings determine the process of integration, I entirely agree. The result, as Bradley states, is the 'satisfaction' which is the final feeling terminating the unrest of the creative process.

Bradley, however, may mean by his phrase "that which I feel, and which is not an object before me" what I terme a "negative prehension". Such a prehension is active *via* its contribution of its subjective form to the creative process, but it dismisses its 'object' from the possibility of entering into the datum of the final satisfaction. This final complex datum will be what Bradley calls "that object that satisfies me". Again I agree.

The doctrine of the 'living emotion' which necessarily clothes each concrete exhibition of the subject-object situation is far older than Bradley. We find its germ in Plato, who insists that the whole character is conformed to the adequate knowledge. He implicitly refuses to abstract the 'living emotion' from the bare intellectual perception, and thereby identifies virtue with knowledge. The advance in psychology has

added to our conscious discrimination, but it has not altered the fact that inevitably perception is clothed with emotion.

The historical importance of the doctrine is stated by George Foot Moore: [In the Prefatory Note to Emotion as the Basis of Civilization, by J.H. Denison, New York, 1928 (Scribner's): a work of importance.] - "Civilization develops only where considerable numbers of men work together for common ends. Such unity is brought about, not so much by community of bare ideas as by community of the feelings by which ideas are 'emotionalized' and become beliefs and motives."

The conventionalized abstractions prevalent in epistemological theory are very far from the concrete facts of experience. The word 'feeling' has the merit of preserving this double significance of subjective form and of the apprehension of an object. It avoids the *disjecta membra* provided by abstraction. [The genetic description of the process of 'emotionalization' is considered in my *'Symbolism, Its Meaning and Effect'* and also in *Process and Reality* Pt. II, Ch. VIII and throughout Pt. III.]

Section XII. Thus an occasion of human experience is one illustration of the required doctrine of connectedness.

Bradley's authority can be quoted in support. He writes: [Loc. cit., p. 175] "At every moment my stage of experience, whatever else it is, is a whole of which I am immediately aware. It is an experienced 'non-relational' unity of many in one." Here Bradley by 'non-relational' apparently means that experience is not a relation of an experient to something external to it, but is itself the 'inclusive whole' which is the required connectedness of 'many in one'.

In this I thoroughly agree, holding that the connectedness of things is nothing else than the togetherness of things in occasions of experience. Of course, such occasions are only rarely occasions of human experience.

Curiously enough Hume also agrees. For his only togetherness of the stream of impressions of sensation, which in his doctrine are distinct existences at distinct times, lies in the 'gentle force' of association which must lie wholly within an occasion of experience. This is also one aspect of Kant's doctrine, that the occasions of experience provide the forms of connectedness.

Of course there are important differences between all these doctrines. But they agree in their general principle - to look on occasions of experience as the ground of connectedness.

Section XIII. Also Leibniz can find no other connectedness between reals except that lying wholly within the individual experiences of the monads, including the Supreme Monad. He employed the terms 'perception' and 'apperception' for the lower and higher way in which one monad can take account of another, namely for ways of awareness. But these terms are too closely allied to the notion of consciousness which in my doctrine is not a necessary accompaniment. Also they are entangled in the notion of representative perception which I reject. But there is the term [This term is used by L.T. Hobhouse, *Theory of Knowledge,* Ch I and developed] 'apprehension' with the meaning of 'thorough understanding'. Accordingly, on the Leibnizian model, I use the term 'prehension' for the general way in which the occasion of experience can include as part of its own essence, any other entity, whether another occasion of experience or an entity of another type. This term is devoid of suggestion either of consciousness or of representative perception. Feelings are the positive type of prehension. In positive prehensions the 'datum' is preserved as part of the final complex object which 'satisfies' the process of self-formation and thereby completes the occasion.

This nomenclature has been made up to conform to the condition, that, as a theory develops, its technical phraseology should grow out of the usages of the great masters who laid its foundations. The immediate verbal usages at any moment prevalent in any school of philosophy are but a small selection from the total vocabulary of the philosophic tradition. This is rightly the case having regard to the variations of doctrine.

The current usage can express the doctrine of the reigning school of thought and of certain accredited variations from it. The demand that an alternative doctrine with other roots in the historic tradition should confine itself to this selection of terms amounts to the dogmatic claim that certain preliminary assumptions should never be revised. Only those schools of thought are to be allowed which can be expressed in the sacred terms. What can reasonably be asked, is that each doctrine should ground its vocabulary on its own proper tradition. If this precaution has been taken, an outcry as to neologisms is a measure of unconscious dogmatism.

Section XIV. The main method of philosophy in dealing with its evidence is that of descriptive generalization. Social institutions exemplify a welter of chraracteristics. No fact is merely such-and-such. It exemplifies many characters at once, all rooted in the specialities of its epoch. Philosophic generalization seizes on those characters of abiding importance, dismissing the trivial and the evanescent. There is an ascent from a particular fact, or from a species, to the genus exemplified.

It is to be noted that the converse procedure is impossible. There can be no descent from a mere genus to a particular fact, or to a species. For facts and species are the product of the mingling of genera. No genus in own essence indicates the other genera with which it is compatible. For

example, the notion of a backbone does not indicate the notions of suckling the young or of swimming in water. Thus no contemplation of the genus vertebrate, taken by itself, can suggest mammals or fishes, even as abstract possibilities. Neither the species nor the instance are to be discovered by the genus alone, since both include forms not 'given' by the genus. A species is a potential mingling of genera, and an individual instance involves, among other things, an actual mingling of many species. A syllogism is a scheme for demonstration of ways of mingling.

Thus the business of Logic is not the analysis of generalities but their mingling. [Cf. Plato's *Sophist,* 253]

Philosophy is the ascent to the generalities with the view of understanding their possibilities of combination. The discovery of new generalities thus adds to the fruitfulness of those already known. It lifts into view new possibilities of combination.

Section XV. Even the dim apprehension of some great principle is apt to clothe itself with tremendous emotional force. The welter of particular actions arising out of such complex feelings with their core of deep intuition are in primitive times often brutish and nasty. Finally civilized language provides a whole group of words, each embodying the general idea under its own specialization. If we desire to reach the generality common to these various specializations, we must gather together the whole group of words with the hope of discerning their common element.

This is a necessary procedure for the purpose of philosophical generalization. The premature use of one familiar word inevitably limits the required generalization by importing the familiar special connotation of that word.

For example, [Cf. *Process and Reality* passim, where the second of the doctrines stated below is developed.] let the working hypothesis be that the ultimate realities are the events in their process of origination. Then each event, viewed in its separate individuality, is a passage between two ideal termini, namely, its components in their ideal disjunctive diversity passing into the same components in their concrete togetherness. There are two current doctrines as to this process. One is that of the external Creator, eliciting this final togetherness out of nothing. The other doctrine is that it is a metaphysical principle, belonging to the nature of things, that there is nothing in the Universe other than instances of this passage and components of these instances. Let this latter doctrine be adopted. Then the word Creativity expresses the notion that each event is a process issuing in novelty. Also if guarded in the phrases Immanent Creativity, or Self-Creativity, it avoids the implication of a transcendent Creator. But the mere word Creativity suggests Creator, so that the whole doctrine acquires an air of paradox, or of pantheism. Still it does convey the origination of novelty. The word Concrescence is a derivative from the familiar Latin verb, meaning 'growing together'. It also has the advantage that the participle 'concrete' is familiarly used for the notion

of complete physical reality. Thus Concrescence is useful to convey the notion of many things acquiring complete complex unity. But it fails to suggest the creative novelty involved. For example, it omits the notion of the individual character arising in the concrescence of the aboriginal data. The event is not suggested as 'emotionalized', that is, as with its 'subjective form'.

Again the term 'together' is one of the most misused terms in philosophy. It is a generic term illustrated by an endless variety of species. Thus its use as though it conveyed one definite meaning in diverse illustrations is entirely sophistical. Every meaning of 'together' is to be found in various stages of analysis of occasions of experience. No things are 'together' except in experience; and no things '*are*', except as components in experience or as immediacies of process which are occasions in self-creation.

Section XVI. Thus to arrive at the philosophic generalization which is the notion of a final actuality conceived in the guise of a generalization of an act of experience, an apparent redundancy of terms is required. The words correct each other. We require 'together', 'creativity', 'concrescence', 'prehension', 'feeling', 'subjective form', 'data', 'actuality', 'becoming', 'process'.

Section XVII. At this stage of the generalization a new train of thought arises. Events become and perish. In their becoming they are immediate and then vanish into the past. They are gone; they have perished; they are no more and have passed into not-being. Plato terms [Cf. Timaeus] them things that are 'always becoming and never really are'. But before he wrote this phrase, Plato had made his great metaphysical generalization, a discovery which forms the basis of his present discussion. He wrote in the *Sophist,* not-being is itself a form of being. He only applied the same doctrine to his eternal forms. He should have applied the same doctrine to the things that perish. He would then have illustrated another aspect of the method of philosophic generalization. When a general idea has been obtained, it should not be arbitrarily limited to the topic of its origination.

In framing a philosophic scheme, each metaphysical notion should be given the widest extension of which it seems capable. It is only in this way that the true adjustment of ideas can be explored. More important even that Occam's doctrine of parsimony – if it be not another aspect of the same – is this doctrine that the scope of a metaphysical principle should not be limited otherwise than by the necessity of its meaning.

Thus we should balance Aristotle's – or, more rightly, Plato's – doctrine of becoming by a doctrine of perishing. When they perish, occasions pass

from the immediacy of being into the not-being of immediacy. But that does not mean that they are nothing. They remain 'stubborn fact': -

Pereunt et imputantor.

The common expressions of mankind fashion the past for us in three aspects, - Causation, Memory, and our active transformation of our immediate past experience into the basis of our present modification of it. Thus 'perishing' is the assumption of a role in a transcendent future. The not-being of occasions is their 'objective immortality'. A pure physical prehension is how an occasion in its immediacy of being absorbs another occasion which has passed into the objective immortality of its not-being. It is how the past lives in the present. It is causation. It is memory. It is perception of derivation. It is emotional conformation to a given situation, an emotional continuity of past with present. It is a basis element from which springs the self-creation of each temporal occasion. Thus perishing is the initiation of becoming. How the past perishes is how the future becomes. [End of Chapter XV, Philosophic Method]

Appendix 4.

Albert Einstein.

"Physics really began with the invention of mass, force, and an inertial system. These concepts are all free inventions. They led to the mechanical point of view. For the physicist of the early nineteenth century, the reality of our outer world consisted of particles with simple forces acting between them and depending only on the distance. He tried to retain as long as possible his belief that he would succeed in explaining

All events in nature by these fundamental concepts of reality. The difficulties connected with the deflection of the magnetic needle, the difficulties connected with the structure of the ether, induced us to create a more subtle reality. The important invention of the electromagnetic field appears. A courageous scientific imagination was needed to realize fully that not the behaviour of bodies, but the behaviour of something between them, that is, the field, may be essential for ordering and understanding events"(…) "What impresses our senses as matter is really a great concentration of energy into a comparatively small space"(Albert Einstein / L. Infeld. (1938) The Evolution of Physics. London: Cambridge University Press. Pp. 257, 311-312).

7. Notes

[1] See Appendix 1 for the term pratityasamutpada in Eastern and Western modes of thought.

[2] Lindtner, C. Nagarjuniana: Studies in the writings and philosophy of Nagarjuna. New Delhi: Motilal Banarsidass. 2002. It is worth noting, however, that Tilmann Vetter has raised doubts about the authenticity of one of Nagarjuna's works in: On the Authenticity of the Ratnavali. Asiatische Studien XLVI, 1992. pp. 492-506. For two well-known translations of MMK see: Kalupahana, D. J. Mulamadhyamakakarika Nagarjuna: The philosophy of the middle way. New Delhi: Motilal Banarsidass. 1999; Garfield, J. L. The fundamental wisdom of the middle way: Nagarjuna's 'Mulamadhyamakakarika'. New York: Oxford University Press. 1996.

[3] I use the expression 'body' synonymously with 'object' or 'particle' or 'field' or 'system' or 'entity'.

[4] Cf. Webster's New World Dictionary, Second College Edition, The World Publishing Company, New York and Cleveland. 1968. p. 669

[5] See: Gadamer, H.-G.. Der Anfang des Wissens. Phillip Reclam jun. Stuttgart 1999, p.35. Cf. Davies, P.C.W. and Brown, J.R. The Ghost in the Atom. Cambridge, University Press, 1986.

[6] Webster's New World Dictionary, Second College Edition, The World Publishing Company, New York and Cleveland. 1968.

[7] Cf. Bohm, D. Wholeness and the implicate Order. London: Routledge Classics. 2000.

[8] Cf. Davidson, D. The myth of the subjective. In: Davidson, D., Subjective, intersubjective, objective. New York: Oxford University Press. 1988 (my own translation from German).

[9] Zeilinger, A. Interview in the German newspaper Tagesspiegel 20th of December 1999 (my own translation). Steven Hawkings is defending a very similar position. He says: "I, on the other hand, am a positivist who believes that physical theories are just mathematical models we construct, and that it is meaningless to ask if they correspond to reality, just whether they predict observations". Penrose, R. The Large, the Small and the Human Mind. In M. Longair (Ed.), The Objections of an Unashamed Reductionist. Cambridge: Cambridge University Press. 2000, p. 169. It is not meaningless to ask about the correspondence between a model and object, because if a model is correct then it has structural similarities with the phenomena that it is reconstructing; otherwise it can lead to predictions for which there are no meaningful physical explanation, because they have no correspondence to experimental data.

[10] Garfield, J. L. The fundamental wisdom of the middle way: Nagarjuna's 'Mulamadhyamakakarika' (MMK). New York: Oxford University Press. 1996, page 3.

[11] See: Lindtner, C. op.cit., pp. 109 and 113.

[12] Images, metaphors, allegories or symbolic examples, analogical ideas, have a freshness which rational ideas do not possess. The starting point of the MMK is the double nature of phenomena. These fundamental two-body systems cannot be further divided analytically. The two bodies constitute a system of two material or immaterial components which complement each other. One of

the components cannot exist without the other; each one forms the counterpart of the other.

[13] Tarab Tulku Rinpoche. UD-Newsletter N. 4, January 2006. Rabten, Geshe. Mahamudra. Der Weg zur Erkenntnis der Wirklichkeit. Le Mont Pélèrin. 2002. Keown, D.. A Dictionary of Buddhism. Oxford: Oxford University Press. 2003.

[14] See: Rock, I. Perception. New York: H.W. Freeman & Company. 1995.

[15] Einstein, A. & Infeld, L. The Evolution of Physics. London: Cambridge University Press. 1938. pp. 257, 311/312.

[16] The term entanglement is explained in the Appendix 2.

[17] Einstein, Albert. Quantenmechanik und Wirklichkeit, 'Dialectica 2', 1948. pp. 320-324. http://onlinelibrary.wiley.com/doi/10.1111/j.1746-8361.1948.tb00704.x/pdf.

[18] Niels Bohr says: "I do not know what quantum mechanic is. I think we are dealing with some mathematical methods which are adequate for description of our experiments" (Collected Works. Volume 6, Amsterdam: Elsevier Science Publishers. 1985, p. 103).

[19] "The most convenient context for investigating the forces of nature is a system of two objects bound together by mutual attraction. The earth and the moon, for example, constitute the most readyly accessible system in which to observe the gravitational force. The hydrogen atom, consisting of an electron and a proton, has long been an essential testing ground for theories of the electromagnetic force. The deuterion, made up of a proton and a neutron, represents a model system for studies of the forces in the atomic nucleus. Now there is a bound system in which to investigate the force that acts

between quarks, the constituents of protons, neutrons and many related particles. The system is called quarkonium, and it consists of a heavy quark bound to an equally massive antiquark. The force at work in quarkonium is the strongest one known; it has come to be called the color force, and it is now thought to be the basis of all nuclear forces. Of the various two-body systems the simplest in some respects is the artificial atom called positronium" (Bloom, E. D. & Feldman, G. J. Quarkonium. Scientific American, 246, 5, 1982, pp. 42-53)

[20] Weinberg, S. Unified theories of elementary-particle interaction. Scientific American, 231, 1, 1974, pp. 50-59.

[21] Friedman, D. Z. & Nieuwenhuizen, P. van. Supergravity and the unification of the laws of physics. Scientific American, 238, 2, 1978, pp. 126-143.

[22] 'T Hooft, G. Symmetrien in der Physik der Elementarteilchen. In: Dosch, H. G. (Ed.): Teilchen, Felder und Symmetrien. Heidelberg: Spektrum. 1995, pp. 40-57 (my own translation).

[23] Rebbi, C. Frankfurter Allgemeine Zeitung. September 5th, 2001 (my own translation).

[24] Cf. Heisenberg, W. Der Teil und das Ganze, München 1969, p. 141. Weizsäcker, C.F. von Ein Blick auf Platon. Stuttgart: Philipp Reclam Junior. 1981, p.134. Schopper, H. Frankfurter Allgemeine Zeitung. May 5th, 1999.

[25] Nagarjuna, Catuhstava. Hymn to the Buddha. In: Lindtner, C. Nagarjuniana. New Delhi : Motilal Banarsidass. 1982. p. 135.

[26] Farrow, G.W. & Menon, I. The concealed Essence of the Hevajra Tantra. New Delhi: Motilal Banarsidass Publishers. 2001. p. 10.

[27] Penrose, R. The Large, the Small and the Human Mind. Cambridge: Cambridge University Press. 2000. p. 66.

[28] Einstein, A. & Infeld, L. The Evolution of Physics. London: Cambridge University Press. 1938, pp. 311-312.

[29] Gioberti, V. Della Protologia. Vol. 1. Náples: 1864, p. 160. In: Zellini, P. A brief History of Infinity. London: Penguin Books. 2005, p. 53.

[30] Clegg, B. The strange world of quantum entanglement. California Literary Review. March 20th, 2007. http://www.calitreview.com/51 accessed on October 2011.

[31] Merali, Z. Quantum effects brought to light: Results of entanglement made visible to human eyes. Nature news. April 28th, 2011. Doi:10.1038/news.2011.252.

http://www.nature.com/news/2011/110428/full/news.2011.252.html accessed on October 2011.

8. Bibliography

Bloom, E. D. & Feldman, G. J. *Quarkonium. Scientific American,*1982

Bohm, D. *Wholeness and the implicate Order*. London: Routledge Classics. 2000.

Bohr, N., *Collected Works*. Volume 6, Amsterdam: Elsevier Science Publishers. 1985

Davidson, D. *The myth of the subjective.* In: Davidson, D., *Subjective, intersubjective, objective*. New York: Oxford University Press, 1988.

Davies, P.C.W. and Brown, J.R. *The Ghost in the Atom*. Cambridge: University Press, 1986.

Einstein, A. & Infeld, L. *The Evolution of Physics*. London: Cambridge University Press.1938

Einstein, A. *Quantenmechanik und Wirklichkeit, 'Dialectica 2'*, 1948 http://onlinelibrary.wiley.com/doi/10.1111/j.1746-8361.1948.tb00704.x/pdf

Farrow, G.W. & Menon, I. *The concealed Essence of the Hevajra Tantra*. New Delhi: Motilal Banarsidass Publishers. 2001

Friedman, D. Z. , Nieuwenhuizen, P. van. *Supergravity and the unification of the laws of physics. Scientific American.* 1978

Garfield, J. L. *The fundamental wisdom of the middle way: Nagarjuna's 'Mulamadhyamakakarika' (MMK)*. New York: Oxford University Press. 1996

Haken, H./ Wolf, H.C., *Atom- und Quantenphysik.* Berlin: Springer Verlag. 2000

Heisenberg, W. (Blum, W., Dürr, H-P., Rechenberg, H.,Eds.) *Gesammelte Werke.* Berlin and New York: Springer Verlag, 1985

Heisenberg, W. *Der Teil und das Ganze.* München: Pieper Verlag. 1969

Kalupahana, D. J. *Mulamadhyamakakarika Nagarjuna: The philosophy of the middle way.* New Delhi: Motilal Banarsidass. 1999

Keown, D.. *A Dictionary of Buddhism*. Oxford: Oxford University Press. 2003.

Lindtner, C. *Nagarjuniana: Studies in the writings and philosophy of Nagarjuna*. New Delhi: Motilal Banarsidass. 2002

Lorenz, K., Mittelstraß, J., (Eds.) Enzyklopädie Philosophie und Wissenschaftstheorie (4 Bände). Stuttgart Weimar: Metzler. 1980 ff.

Penrose, The Large, the Small and the Human Mind. Cambridge: Cambridge University Press. 2000

Rabten, Geshe. Mahamudra. Der Weg zur Erkenntnis der Wirklichkeit. Le Mont Pélèrin. 2002

'T Hooft, G. Symmetrien in der Physik der Elementarteilchen. In: Dosch, H. G. (Ed.): Teilchen, Felder und Symmetrien. Heidelberg: Spektrum. 1995

Webster's New World Dictionary, Second College Edition, New York and Cleveland: The World Publishing Company. 1968

Weinberg, S. Unified theories of elementary-particle interaction. Scientific American, 1974

Weizsäcker, C.F. von Ein Blick auf Platon. Stuttgart: Philipp Reclam Junior. 1981

9. Short CV of Christian Thomas Kohl.

Christian Thomas Kohl (2010-2012) lecturer in history and philosophy of physical sciences at Tibet Institute, Rikon, Zurich. He has studied the history

and philosophy of sciences at the Universities of Paris and Berlin and in 1973 he graduated in political science. He tries to follow the approaches of Edwin Arthur Burtt and Alfred North Whitehead. His core areas of research are the metaphysical foundations of quantum physics. He has also studied Indonesian and Indian music and was promoting music from India, Pakistan and China. Since the 1980s, he has been interested in the philosophy and history of Indian Buddhism. Since 1990 he has been working as a lecturer of history of sciences and languages in Switzerland and France. During the past three decades he has worked on 'reconciling' the fundamental principles of quantum physics and Buddhist philosophy. His home university is the University of Education,Freiburg (https://www.phfreiburg.de).

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