Buddhism and Quantum Physics

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Abstract. Rudyard Kipling, the famous english author of "The Jungle Book", born in India, wrote one day these words: "Oh, East is East and West is West, and never the twain shall meet." In my paper I show that Kipling was not completely right. I try to show the common ground between buddhist philosophy and quantum physics. There is a surprising parallelism between the philosophical concept of reality articulated by Nagarjuna and the physical concept of reality implied by quantum physics. For neither is there a fundamental core to reality, rather reality consists of systems of interacting objects. Such concepts of reality cannot be reconciled with the substantial, subjective, holistic or instrumentalistic concepts of reality which underlie modern modes of thought.

1. Nagarjuna's concept of reality

Nagarjuna was the most significant Buddhist philosopher of India. According to Etienne Lamotte he lived in the second part of the third century after Christ [1]. His philosophy is of great topical interest. Right to this day it determines the thinking of all the traditions of Tibetan Buddhism. We have no assured biographical knowledge about him, other than various legends which I will not enter into here. The authenticity of thirteen of his works is nevertheless regarded as etablished by the scholastic research. The Danish scholar Ch. Lindtner was particularly concerned with the examination and translation of these thirteen works [2]. Nagarjuna's main work, *Mulamadhyamaka-karika [MMK]***,** is translated into German, English, French and other European languages [3]. Nagarjuna is the founder of the philosophical school called Madhyamaka oder Middle Way. The Middle Way indicates a spiritual and philosophical path that aspires to avoid extreme metaphysical concepts, particularly the concepts of substantial and subjective thinking in their various forms. In his main work [MMK] the Middle Way is described as follows: 24.18 "What arises dependently [pratityasamutpada] is pronounced to be substancelessness [sunyata]. This is nothing but a dependent concept [prajnapti]. Substancelessness [sunyata] constitutes the middle way." [chapter 24, verse 18].

Nagarjuna's philosophy consists principally of two aspects. The first aspect is an exposition of a concept of reality [sunyata, pratityasamutpada], according to which fundamental reality has no firm core and does not consist of independent, substantial components but of two-body-systems. Of material or immaterial bodies which reciprocally affect each other. This concept of reality is diametrically opposed to one of the key concepts of traditional Indian metaphysics: 'svabhava' or 'own being'. The second aspect is an answer to the inner contradictions of four extreme concepts of reality which are not exhaustively presented but only indicated in principle. Nevertheless it is easy to recognize the systems of thought to which these indications relate. This is important as it

is from this recognition that we can identify those aspects of *our* extreme metaphysical positions that make it impossible for us to recognize the nature of reality. This is not only a debate within the traditional metaphysics of India. I relate these four extreme propositions to the substantial, subjective, holistic and instrumentalist modes of thought found in the modern world. In order to effectively undermine these modes of thought one first has to recognize them as such. Therefore without any claim to completeness I will give a brief outline of these four modes of thought:

Substantialism

Substance is something that has independent existence [Webster's New World Dictionary, New York 1968]. In Europe, substantialism is at the centre of traditional metaphysics, beginning with pre-Socratic philosophers [like Parmenides and Heraclitus, two critics of substantial thought] through Plato, up to Immanuel Kant. According to traditional metaphysics, substance or own being is something that has independent existence, something unchangeable, eternal and existing by itself. Substance is the underlying basis for everything else, the non-material foundation of the world in which we live. Plato made a distinction between two forms of being. Particularly in the second part of his 'Parmenides' he distinguished between on the one hand singular objects, which exist exclusively through participation and insofar as this is the case they have no own being and on the other hand ideas that do have an own being. Traditional metaphysics adopted this dualism from Plato. An independent own being is characzerised in traditional metaphysics as something that, as an existing thing, is not dependent on anything else [Descartes], existing by itself, subsisting through itself [More], which is completely unlimited by others and free from any kind of foreign command [Spinoza], and exists of itself without anything else [Schelling].In traditional metaphysics the highest substance was often understood as God or as a divine being. Since Kant's so called 'Copernican revolution' the primary question of philosophy is no longer to know reality, but rather to know mind or the source of perception and knowledge. For this reason the traditional metaphysics has lost ground in the modern world. In fact the central concepts of the traditional metaphysics such as being, substance, reality, essence, etc had been replaced by the reductionist modes of thought of modern sciences. Now atoms, elementary particles, energy, fields of force, lows of nature etc are seen as the fundamental ground for everything else.

Subjectivism

By subjectivist modes of thought I understand the turning of attention to the subject that resulted from the changes created by René Descartes. According to this doctrine, consciousness is that which is primarily existent and everything else is merely content or a form or a creation of that consciousness. The high point of this kind of subjectivism is represented by the idealism of Berkeley. The ideas of Kant can be considered as a moderated subjectivism or idealism. Since René Descartes, subjectivity or self-awareness has become the fulcrum for modern philosophical thought lending evidential proof and certainty of reality. This view has been continually brought into doubt by the modern physical sciences, however these doubts have not lead to a new and complementary

concept of reality but to a calamitous separation between philosophy and the modern physical sciences. It has served only to sharpen that dualism that preoccupies modern thought. According to the physicist P.C.W. Davies electrons, photons or atoms do not exist, they are nothing but models of thought. (*See: P.C.W. Davies, 'The Ghost in the Atom', Cambridge 1986.)*

Holism

The view that an organic or integrated whole has a reality independent of and greater than the sum of its parts [Webster's Dictionary, New York 1968]. This third approach tries to avoid the calamitous either-or-scheme of the first two approaches by fusing subject and object into one whole, such that there are no longer any parts but only one identity: all is one. That whole is made absolute and is mystified. It becomes an independent unity that exists without dependence on its parts. Wholeness is understood as something concrete, as if it were 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, Leibniz, Schelling. In quantum physics holism is represented by David Bohm [4].

Instrumentalism

The fourth approach consists in refuting or ignoring the existence of subject and object. Instead of favouring einther one or the other or the two together, this metaphysical approach refutes them both. The search for reality is according to this viewpoint insignificant or meaningless. Instrumentalism is very modern, intelligent [for example in the person of Ernst Cassirer], and sometimes somewhat captious. It is difficult to disengage from it. As an extension of subjectivism it consists of regarding thinking as thinking in models, which is regarded as a working with information without concern as to what phenomena the information is about. It inherits this problem from subjectivism, about which the philosopher Donald Davidson wrote: "Once one makes the decision for the Cartesian approach, it seems that one is unable to indicate what ones proofs are evidence for"[5]. Instrumentalism is a collective term that denotes a variety of scientific approaches. They have the common feature of considering the totality of human knowledge, including scientific constructs, statements and theories, as not at all or sometimes merely not primarily, realistic reproductions of the structure of reality. Rather it considers them to be the result of human's interactions with nature for the purpose of establishing theoretically and practically successful models. For instrumentalism theories are not a description of the world but are an instrument for a systematic classification and explanation of observations and for the predictions of facts. The instrumentalist approach is outlined by the experimental physicist Anton Zeilinger. Zeilinger 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 desciption"[6].

Nagarjuna presents these four extreme concepts of reality in a scheme that is called in Sanskrit: catuskoti and in Greek: tetralemma. In a short form they can be expressed as follows:

Things do not arise substantially: 1. either out of themselves, 2. nor out of something else, 3. nor out of both, 4. nor without a cause.

Behind this scheme there are, as metioned before, four concepts of reality that can be related to substantial, subjective, holistic and instrumentalist modes of thought in the modern world. It would be difficult to find a modern person who does not, in his own way, hold one of these four extreme views. This shows that Nagarjuna's philosophy is very up-to-date. Nagarjuna did not refute 1. the substantial modes of thought in oder to end up in 2. subjectivism, even though this is often claimed against him. Nor did he refute the either or mode of thought in order to end with a view of 3. holism, identity, or wholeness, which some benevolent interpreters say of him. Nor did he refute holism in order to end up at 4. instrumentalism, as is believed by many modern interpreters in imitation of the philosopher Ludwig Wittgenstein. Nagarjuna does not fall into any of these extremes because these are the exact four extreme metaphysical concepts that he systematically refutes.

Already in the very first verse of the MMK, he points out not only the dilemma but the whole tetralemma of our thinking. That verse states: “Neither from itself nor from another, nor from both, nor without a cause does anything whatever anyehere arises”[Garfield's translation]. This verse can be understood as the principal statement of the Mulamadhyamaka-karika [MMK]: The refutation of the four extreme metaphysical views, that cannot be reconciled with the dependent arising of things. If this is the case, the remainder of the MMK would be merely a clarification of this first verse. Therefore 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 that which evidently is? Did he want to call into question the world in which we live? Did he wish to deny the presence everyehere of things that somehow arise? If by 'arise' we understand the notion of the empirical arising of things 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 concept 'to arise'?

In another text, Nagarjuna himself gives some indication of how to understand this concept. He writes in his work 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'”? [7]. By the concepts of 'arising' and 'exist' Nagarjuna does not mean the empirical but the substantial arising or existence. When in many other passages of Mulamadhyamaka-karika Nagarjuna states that things do not arise [MMK 7.29], that they do not exist [MMK 3.7,

MMK 5.8, MMK 14.6], that they are not to be found [8MMK 2.25, MMK 9.11], that they are not [MMK 15.10], that they are unreal [MMK13.1], 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 refutes the idea of a substantial arising of things, of an absolute and independent existence. He does not refute the empirical existence of things. This is what he is explaining when he states: “MMK 15.10 '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.” For Nagarjuna the expression 'to exist' has the meaning 'to exist substantially'. His issue is not the empirical existence of things but the idea of a permanent thing and of things having a substance. Only the idea of an own being, without dependence to something else, is refuted by Nagarjuna. Things do not arise out of themselves, the do not exist absolutely, their permanent being is not to be found, they are not independent but they are dependently arising.

The many interpretations of Nagarjuna that claim that he is also refuting the empirical existence of objects, are making an inadmissible generalization that suggests Nagarjuna approaches subjectivism or instrumentalism. Such interpretations originate in metaphysical approaches that themselves have a difficulty in recognizing the empirical existence of the presenting data, which is not at all the case with Nagarjuna.

How does Nagarjuna present the dependence of phenomena? The starting point of the MMK is the double nature of phenomena. These fundamental two-body-systems cannot be further analytically divided. The two bodies constitute a system of two material or immaterial components that complement each other. One of the components cannot exist without the other one; each forms the counterpart of the other. In the MMK Nagarjuna concerns himself with such concrete two-body-systems as: a thing & its conditions, a walking person & the way to be walked, seer & seen, cause & effect, an entity & its characteristics, a passion & a passionate person, arising & conditions of arising, agent & action, fire & fuel. Some examples of this dependence of the two parts are duscussed below.

In this way we are led into the centre of Nagarjuna's philosophy. In the first ten, and some subsequent chapters of MMK Nagarjuna emphasises one central idea: material or immaterial bodies of two-body-systems are not identical nor can they be separated. The most important characteristic of phenomena is their interdependence and the resultant: substancelessness: the impossibility of existing individually or independently. This is the meaning of sunyata: phenomena are without own being and without independence. Reality does not consist of single, isolated material or immaterial components; phenomena arise only in dependence on other phenomena. They do not arise substantially because dependent phenomena can have no independent existence.

A thing is not independent of its conditions, nor is it identical with them. Walking does not exist without the way to be walked. The walking person and the way are not one. A Seer is not the same as the seen object, but a seer without an object does not exist. There

can be no cause without an effect, or an affect without a cause. The concept 'cause' has no meaning without the concept 'effect'. Cause and effect are not one, but they cannot be separated into two independent concepts. Without a characteristic we cannot speak of a characterised, or of a characterised without a characteristic. How could there be a passionate person without passion? When there are no conditions of arising there is no arising, neither exists standing alone. Without action there can be no agent, without fire there can be nothing designated as fuel.
The material or immaterial components of a two-body-system do not exist in isolation, they are not one and yet they are not independent of each other: and because of this they are not 'real'. For two complementary phenomena or for double concepts the nature and the existence of each is dependent of 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 anotherone, nor out of both, nor without a cause. There is no fundamental core to reality; rather reality consists of systems of interacting bodies.

This concept of reality is initially merely an idea; a pointer to the 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 ascertainment of dependent arising, the direct perception of reality as it is, all presuppose a high level of a spiritual realization which entails the abandonment of extreme views and the dissolution of the whole edifice of dualisticthought. To experience sunyata or the substancelessness of phenomena means to become free of all entanglements to this world. Nirvana is simply another expression for this.

2. Interpretations

For Nagarjuna the primary question was not about mind, nor about the origin of knowledge but about reality. Such subjective interest applies more readily to the Yogacara School and the philosophical base of tantric Buddhism. But the interpretations of the most important work of Yogacara are controversial because they can be understood in an ontological sense that is denying the external world and is adopting the view of idealism or in an epistemic sense for the study of the nature of knowledge where perception is a projection of mind. What in Yogacara is termed 'alayavijna' or the fundamental mind, or in tantric Buddhism 'clear light' or 'Mahamudra', refers to the *knowledge* of reality. Nagarjuna's philosophy is refering to sunyata itself. In 2003 Tarab Tulku Rinpoche presented an all encompassing position. He says, “that everything existing partakes in a fudamental 'mind-field', which is the basic 'substance' from which basis mind in a more individual way and the individual body develop”[8].

In order to emphasise that Nagarjuna does not speak only about concepts without substance but also about objects without substance, I compare his concept of reality to the concept of reality suggested by quantum physics. Physics is not only about concepts but also about the conditions of physical reality. Undoubtedly physics only creates models and thus examines only realities that had been posited by physics itself. Nevertheless 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 directly identical with reality

they are not purely coincidental and normally they are not deceptive [Irvin Rock] [9]. Behind these models are empirical objects and there is some approximation of a structural similarity between a good physical model and the corresponding physical reality.

3. The metaphysical foundations of quantum physics

This is not a presentation or criticism of quantum physics but a discussion of the metaphysical mindsets and principles that underlie quantum physics. The concept of reality in quantum physics can be expressed by the key words: complementarity, four interactions and entanglements [entanglements will not be explained in this short paper. According 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, p.66].

In the long prehistory of quantum physics it could not be proved experimentally whether the smallest elements of light were particles or waves. Many experiments argued in favour of one or the other assumption. Electrons and photons sometimes act like waves and sometimes like particles. This 'behaviour' was named a wave-particle-dualism. The idea of dualism was therein understood as a logical contradiction, in that only one or the other could actually apply; but paradoxically both appeared. According to this understanding electrons and photons cannot be both particles and waves. This is the understanding according to atomism. According to atomism a scientific explanation consists of a reduction of a variable object into its permanent components or mathematical laws that apply to it. This is the fundamental dualistic concept that modern atomis has adopted from the natural philosophy of the ancient Greeks: According to this substance and permanence cannot to be found in objects of perception of the world in which we live, but can be found in the elementary elements making up objects and the mathematical order applying to them. These material and immaterial foundations hold the world together, they do not change, although everything else changes.
According to the expectation of atomism it should be possible to reduce an object to its *independent* elements or to its mathematical laws or to its simple and fundamental principles and according to these the fundamental elements must be either particles or waves, not both.

What is to be understood by *independent* elements? As I have mentioned before: Plato made a distinction between two forms of being. Particularly in the second part of his 'Parmenides' he distinguished between on the one hand singular objects, which exist exclusively through participation and insofar as this is the case they have no own being and on the other hand ideas that do have an own being. Traditional metaphysics adopted this dualism from Plato. An independent own being is characzerised in traditional metaphysics as something that, as an existing thing, is not dependent on anything else [Descartes], existing by itself, subsisting through itself [More], which is completely unlimited by others and free from any kind of foreign command [Spinoza], and exists of itself without anything else [Schelling]. Albert Einstein was following this metaphysical

tradition when he wrote: “For the classification of things that are introduced in physics, it is essential that these things have for a certain time an independent existence, in so far as these things lie 'in different parts of space'. Without the assumption of such an independent existence [So-sein, 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”[10].

This idea of an independent reality was projected on to the basic element of the world of matter by atomism. For atomism, a scientific explanation means to reduce the variability and variety of objects and conditions to their permanent, stable, independent, indivisible elements or to their conformity with mathematical laws. According to the expectations of atomism 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 things, 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 concepts of reality available to quantum physics. It became evident that the fundamental reality could not be grasped by traditional concepts of reality. What is the explanatory worth of atomism if it become clear that there are no independent, stable atoms or elementary particles and that objects have no stable core? Were these quantum objects objective, subjective, both or neither? What is reality? Is the quantum world distinct from the world in which we are living?

Niels Bohr

In 1927, the physicist Niels Bohr introduced the concept of complementarity into quantum physics. According to this concept the wave form and the particle form are not two separate forms that contradict and exclude each other but are mutually complementary forms that only together can provide a complete description of physical manifestations. According to Niels Bohr, complementarity meant that in the quantum world it is impossible to speak about independent quantum objects because they are in an interactive relashionship with each other, as well as with the instrument if measurement. Niels Bohr emphasised 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 quantum objects. 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 concept 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 sometimes took an instrumentalist approach [11]. For Niels Bohr the fundamental physical reality consists of interacting and complementary quantum objects.

Interaction in the standard model of quantum physics

In the meantime the concept of the four interactions was introduced into the standard model of quantum physics. These four elementary interactions or four forces obstruct the reduction of quantum objects into independent objects – as Democritus had suggested. The interactions, the forces that 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 the bodies together [12]. 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 interchange of elementary particles. The physicist Steven Weinberg writes about this: At the present moment the closest we can come to a unified view of nature is a description in terms of elemntary 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 rôle in holding anything together" [13].
In this respect the explanations enter into very difficult and subtle particulars. How for example, can an electron which consists only of one particle have an interaction with another quantum object? What part of itself can it emit if it consists only of one particle? This question can be answered by the concept of interactions. 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 an article from 1978 about super-gravitation the two physicists Daniel Z. Freedman and Pieter von Nieuwenhuizen wrote about it as follows: "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"[14].

What quantum physics knows about interactions is here summarised in the words of the physicist Gerhard 't Hooft who writes: "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" [15].

Singular, isolated, independent quarks have never been observed. In the new research this phenomenon is called 'confinement'. This means quarks are captives, they cannot appear as a single quark but only as one of a pair or as one of a trio. When you try to separate two quarks by force, there will appear new quarks between them, that combine into pairs

and trios. Claudio Rebbi and other physicists have reportet: “Between the quarks and gluons inside an elementary particle, additional quarks and gluons are continously formed and after a short time again subside” [16]. These clouds of virtual particles represent or produce interactions.

We now arrived at the central core of quantum physics. It consists of a new concept of reality, that no longer perceives singular, independent elements as the fundamental unit of reality but rather two-body-systems or two states of a quantum object or two concepts such as earth & moon, proton & electron, proton & neutron, quark & anti-quark, wave & measuring instrument, particle & measuring instrument, twin photons, superpositions, spin up & spin down, matter & anti-matter, elementary particle & field of force, low of nature & matter, symmetry & anti-symmetry etc These systems cannot be separated into independent parts. They cannot be reduced to two separate, independent bodies or states, nor is one fudamental and the other derived as the metaphysical either-or-scheme of substantialism or subjectivism usually try to establish. Nor are they joined into a seamless unity, they are not the same, they are not identical, they are not a mysterious wholeness as holism indicates. Nor can one claim that they are nothing but mathematical models that we have constructed and that do not correspond to physical reality, as instrumentalism claims.

In physics there is a fundamental reality that is not a one-body-system but a two-body-system or an assembly of bodies, a claud of virtual particles, which surround the central or the 'naked' body. Between these bodies there is an interaction that is one of the composite of these bodies. This understanding of physics cannot be disloged and yet all our metaphysical schemata struggle against it. This cloud does not conform to our traditional metaphysical expectations of that which 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 phsicists have been searching for in oder to arrive at the core of matter or at the ultimate reality? Is this supposed to be it? From these little clouds we attempt to use metaphysical interpretation to distil something that has substance and that endures. Entirely within the sense of the substance metaphysics of Plato, Werner Heisenberg said that the mathematical forms are the idea of elementary particles and that the object of elementary particles is corresponding to this mathematical idea. Carl Friedrich von Weizsäcker called mathematics 'the essence of nature'. According to the physicist Herwig Schopper, fields of force are the ultimate reality [17]. Some of us want to see reality as a mysterous whole [holism], or dismiss them 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 itself a complex reality. It is impossible to escape from the entanglement of this world by quantum physics. It is impossible to find an elementary quantum object that is not dependent on other quantum objects or dependent on parts of itself. It is impossible to dissolve the double-sided character of quantum objects. The fundamental reality of our physical world consists of clouds of interacting quantum objects.

Results

Reality is not static, solid or independent. It does not consist of singular, isolated material or immaterial factors, but of systems of dependent bodies. [I use the expression 'body' synonymously like 'quantum object' or 'particle' or 'field' or 'system' or 'entity'. There is just a small difference between these expressions that can be neglected]. Mostly the systems consist of more than two components, but there are no systems that consist of less that two components. In quantum physics we call such fudamental two-body-systems earth & moon, electron & positron, quark & anti-quark, elementary particle & field of force. Nagarjuna calls his systems or dependent pairs walking person & way to be walked, fire & fuel, agent & action, seer & object of seeing. Both of these models describe two-body-systems or two entities which have bodies that are neither properly separate, nor properly joined together. They do not fall into one, nor do they fall apart. These bodies are not independent and they cannot be observed singly because in their very existence and constitution they are dependent on each other and cannot exist or function independently of each other. They are entangled by interactions, even in a far distance. One of them cannot be reduced to the other; 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 that are sometimes known, sometimes not fully known and sometimes as with entangled twin photons for example, totally unknown.

What is reality?

We have become accustomed to firm ground beneath our feet and fleeting clouds in the sky. The concept of reality of Nagarjuna's philosophy and the concepts of complementarity and interactions of quantum physics teach us something quite different that one could express metaphorically as: everything is build on sand and not even the grains of sand have a solid core or nucleus. There stability is based on the unstable interactions of their component parts.

Notes

1. See: Etienne Lamotte, Traité de la Grande Vertu de Sagesse de Nagarjuna, Tome I-V, Louvain 1944 ff, Tome III, p. IX

2. See: Chr. Lindtner, Nagarjuniana, Copenhagen 1982

3. See: David J. Kalupahana, Nagarjuna. The Philosophy of the Middle Way, New York 1986. See: Jay L. Garfield [ed.], The Fundamental Wisdom of the Madhyamakakarika, Oxford 1995

4. See: David Bohm, Die implizite Ordnung, München 1985, S. 200. David Bohm, Wholeness and the Implicate Order (Routledge Classics) London 2000. Bohm's key word is 'holomovement', an 'undivided wholeness in flowing movement'.

5. Donald Davidson, Der Mythos des Subjektiven, Stuttgart 1993, p. 90. English: The Myth of the Subjective

6. Anton Zeilinger, Interview at the german newspaper 'Tagesspiegel', December 20th, 1999. 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”, Stephen Hawkings, in: Roger Penrose. The Large, the Small and the Human Mind, Cambridge 2000, p.169. It is not meaningless to ask about the correspondence between a model & 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. See also: B.C.v. Fraassen, The Scientific Image, Oxford 1980 and B.C.v. Fraassen, Laws and Symmetry, Oxford 1989

7. See: Chr. Lindtner, op.cit., p. 109, 113

8. Tarab Tulku Rinpoche, UD-Newsletter N. 4, January 2006. See: Geshe Rabten, Mahamudra, Le Mont Pélèrin 2002, p. 255. See: Damien Keown, A Dictionary of Buddhism, Oxford University Press 2003

9. See: Irvin Rock, Wahrnehmung: vom visuellen Reiz zum Sehen und Erkennen, Heidelberg, Berlin 1988. See: Irvin Rock, Perception, New York 1984

10. Albert Einstein, Quantenmechanik und Wirklichkeit, 'Dialectica 2', 1948, p.320-324

11. Niels Bohr, Collected Works, Volume 6, North-Holland, Amsterdam, New York, Oxford, Tokyo 1985, p. 103: “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”[1927].

12. “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 massiv 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”[Elliot D. Bloom/Gary J. Feldman, Quarkonium, Scientific American, May 1982, Volume 246, Number 5, p. 42]

13. Steven Weinberg, Unified Theories of Elementary-Particle Interaction, Scientific American, July 1974, Volume 231, Number 1, p. 50

14. Daniel Z. Friedman/Peter Niuwenhuizen, Supergravity and the Unification of the Laws of Physics, Scientific American, February 1978, Volume 238, Number 2, p. 132

15. Gerhard 't Hooft, Symmetrien in der Physik der Elementarteilchen, in: Teilchen, Felder und Symmetrien, Spektrum, Heidelberg 1995, p. 42, 46

16. Claudio Rebbi, quoted in: Frankfurter Allgemeine Zeitung, September 5th, 2001

17. See: Werner Heisenberg, Gesammelte Werke, Band III, München 1985, p. 326. See: Werner Heisenberg, Der Teil und das Ganze, München 1969, p.141 f. See: Carl Friedrich von Weizsäcker, Ein Blick auf Platon, Stuttgart 1988, p. 134. See: Herwig Schopper, 'Frankfurter Allgemeine Zeitung', May 5th, 1999

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