

Pratityasamutpada in Eastern and Western Modes of Thought

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Introduction:

There is a surprising parallel between Nagarjuna's philosophical view of reality and the physical view of reality of quantum physics. The fundamental reality has no firm core but consists of systems of interacting objects. This paper will show that these philosophical and physical views of reality are inconsistent with the substantial, subjective, holistic and instrumentalist views of reality which form the foundation of modern modes of thought.

Preliminary Note:

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

1. Nagarjuna's View of Reality

Nagarjuna, who lived in the second century after Christ, was the most significant Buddhist philosopher of India. He was the founder of the philosophical school Madhyamaka or Middle Way which is of great topical interest because it determines the thinking of all traditions of Tibetan Buddhism right to this day. It indicates a spiritual and philosophical path that aspires to avoid extreme metaphysical views, particularly the views of substantial and subjective thinking in their various forms.

Apart from various unconfirmed legends, we have no assured biographical knowledge of Nagarjuna. The authenticity of thirteen of his works is regarded to be more or less established by academic research. In particular, the Danish scholar Christian Lindtner has examined and translated Nagarjuna's thirteen works extensively.² Nagarjuna's main work, *Mulamadhyamaka-karika* (MMK) has been translated into several European languages.³

In his main work (MMK) the Middle Way is described as follows: "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 his view 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 which reciprocally affect each other.⁴ This view of

¹ See Appendix 1 for the term pratityasamutpada in eastern and western modes of thought.

² Lindtner, Christian. *Nagarjuniana: Studies in the writings and philosophy of Nagarjuna*. India: 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." In: *Asiatische Studien XLVI*, 1992. pp. 492-506.

³ For two well-known translations, see: Kalupahana, David J. *Mulamadhyamakakarika Nagarjuna: The philosophy of the middle way*. India: Motilal Banarsidass. 1999; Garfield, Jay L. *The fundamental wisdom of the middle way: Nagarjuna's 'Mulamadhyamakakarika' (MMK)*. New York: Oxford University Press. 1996.

⁴ I use the expression 'body' synonymously with 'quantum object' or 'particle' or 'field' or 'system' or 'entity'. There is just a small difference between these expressions that can be neglected.

reality is diametrically opposed to one of the key concepts of traditional Indian metaphysics: 'svabhava' or 'own being'.

The second aspect of Nagarjuna's philosophy is an answer to the inner contradictions of four extreme modes of thought which are not exhaustively presented by Nagarjuna but only indicated in principle. This is not only a debate within the traditional metaphysics of India because the principles can be related to *our* extreme modes of thought that make it impossible for us to recognize the nature of reality. I relate the four extreme propositions to the substantial, subjective, holistic and instrumentalist modes of thought found in the modern world. In order to effectively demonstrate that these modes of thought are unsustainable, at first we have to recognize them as such. Therefore, without intending to be complete, a brief outline of the four modes of thought will follow.

(1) Substantialism

Substance is something that has independent existence.⁵ In Europe, substantialism is at the center of traditional metaphysics, beginning with pre-Socratic philosophers (like Parmenides and Heraclitus, two critics of substantial thought) via Plato right 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 the entire 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 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 characterized in traditional metaphysics 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). 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 the 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. have been replaced by the reductionist modes of thought of modern sciences. Now atoms, elementary particles, energy, fields of force, laws of nature etc., are seen as the fundamental ground for everything else.

(2) 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 his doctrine, consciousness is primarily existent and everything else is sheer content or a form or a creation of the consciousness. The high point of this kind of subjectivism is represented by the idealism of Berkeley while the ideas of Kant can be considered as a moderated subjectivism or idealism. Hans-Georg Gadamer emphasizes that subjectivity or self-awareness has become the fulcrum of modern philosophical thought which provides for evidential proof and certainty. This view has been continually brought into doubt by the modern physical sciences. However, the doubts have not lead to a new and complementary view of reality but to a fatal separation of philosophy and the modern

⁵ Webster's New World Dictionary, New York. 1968.

physical sciences. This process of separation has enforced the 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.⁶

(3) Holism

The third approach tries to avoid 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.”⁷ The whole entity 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, Leibniz, Schelling. In quantum physics, holism is represented by David Bohm.⁸

(4) Instrumentalism

Instead of favoring subject or object or the two together, the fourth metaphysical approach refutes or ignores the existence of both. According to this viewpoint, the search for reality is 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 regards the process of thinking as thinking in models and as working with information, without concern as to what phenomena the information is about. The philosopher Donald Davidson said about this problem of instrumentalism which is a legacy of subjectivism, “Once one makes the decision for the Cartesian approach, it seems that one is unable to indicate what one’s proofs are evidence for.”⁹ “Instrumentalism is a collective term that denotes a variety of scientific approaches. They all have the common feature that they do not at all or not primarily consider the totality of human knowledge or scientific constructs, statements and theories as realistic reproductions of the structure of reality. Rather instrumentalism considers human knowledge to be the result of interactions of humans with nature, for the purpose of establishing theoretically and practically successful models. For instrumentalism, theories are not a description of the world but an instrument for a systematic classification and explanation of observations, and for the predictions of facts.”¹⁰

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

⁶ Davies, P.C.W. *The Ghost in the Atom*. Cambridge. 1986.

⁷ Webster’s Dictionary, New York 1968.

⁸ Bohm’s key word is ‘holomovement’, an ‘undivided wholeness in flowing movement’ (Bohm, David. *Wholeness and the Implicate Order*. London: Routledge Classics. 2000).

⁹ Davidson, Donald. “The myth of the subjective”. In: Davidson, Donald. *Subjective, intersubjective, objective*. New York: Oxford University Press. 1988.

¹⁰ Kuno Lorenz, *Enzyklopädie Philosophie und Wissenschaftstheorie*. 4 Bände. Jürgen Mittelstraß (H.G). Stuttgart Weimar 1980 ff. -My own translation

construction of mind. Niels Bohr once put it like this: ‘There is no world of quantum, there is only a quantum mechanical description.’”¹¹

Nagarjuna presents these four extreme views 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 mentioned before, four views 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 order 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 with 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 they are the exact four extreme metaphysical views 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 anywhere arise.”¹² 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 everywhere 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 notion ‘to arise’?

In another text, Nagarjuna himself gives some indication of how to understand this view. 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’?¹³

¹¹ Zeilinger, Anton. Interview in the German newspaper Tagesspiegel 20 December 1999 (my own translation). Steven Hawking 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” (“The Objections of an Unashamed Reductionist.” In: Penrose, Roger. *The Large, the Small and the Human Mind*, 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.

¹² Garfield, Jay L. *The fundamental wisdom of the middle way: Nagarjuna’s ‘Mulamadhyamakakarika’ (MMK)*. New York: Oxford University Press. 1996. p. 3.

¹³ See: Lindtner, Christian. op.cit., pp. 109, 113.

By the notions of ‘arising’ and ‘exist’, Nagarjuna does not mean the empirical but the substantial arising or existence. When in many other passages of *Mulamadhyamakarika* 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: “‘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 ‘to exist substantially’. His issue is not the empirical existence of things (dharma) 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, they do not exist absolutely, their permanent being is not to be found, they are not independent but they are dependent.

The many interpretations of Nagarjuna that claim that he is also refuting the empirical existence of objects, are making an inadmissible generalization that moves Nagarjuna near to subjectivism, nihilism 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? He presents his ideas mainly in images.¹⁴ Before I will give my own interpretation of the 25 chapters of Nagarjuna’s main work, *Mulamadhyamaka-karika*, The Fundamental Verses of the Middle Way (MMK), I would like to proceed to a rapid review of the 25 chapters.

Rapid Review of the 25 Chapters of MMK

1. A thing and its cause; 2. A mover and the space to be moved; 3. A seer and a vision or view; 4. A cause and an effect; 5. A characteristic and a characterized; 6. Affection and the person affected; 7. Origination, duration and decay; 8. Action and agent; 9. A seer 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.

Interpretation of the 25 Chapters of MMK

In the first 25 chapters of MMK, Nagarjuna emphasizes one central idea: bodies are neither together nor 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 *pratityasamutpada* and *sunyata*: phenomena are without own being and without independence. Reality does not consist of

¹⁴ Images, metaphors, allegories or symbolic examples have a freshness which ideas can never claim. 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 (sometimes three bodies) constitute a system of two or three material or immaterial components that complement each other. One of the components cannot exist without the other; each one forms the counterpart of the other.

single, isolated material or immaterial components; phenomena arise only in dependence on other phenomena. Phenomena are in an intermediate state. Not the behavior of things but the behavior of something between them is essential.

Let us now try to understand these 25 chapters: a thing is not independent of its conditions, nor is it identical with them. A mover does not exist without the space to be moved. The mover and the space to be moved are not one. A seer is not the same as the view, but a seer 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 characterized, or the other way round. How could there be an affected person without affection? When there is no action there is no actor, neither exists *per se*. Without fire there can be nothing designated as fuel. The material or immaterial components of a two-body system or a 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 three complementary phenomena or for double concepts the nature and the existence of each is 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 one, 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 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 dualistic thought. To experience *pratityasamutpada* or *sunyata* or dependence means to become free of all entanglements to this world. Nirvana is simply another expression for this.

2. Discussion of Nagarjuna's Work

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. But the interpretations of the most important works 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 'alayavijnana' or the 'fundamental mind', or in tantric Buddhism 'Mahamudra' or 'clear light', refers to the experience and perception of *sunyata*. Nagarjuna's philosophy is referring to *sunyata* itself. In 2003, Tarab Tulku Rinpoche presented an all-encompassing position. He says "that everything existing partakes in a fundamental 'mind-field', which is the basic 'substance' from which basic-mind in a more individual way and the individual body develop"¹⁵.

In order to emphasize that Nagarjuna does not only speak about views without substance but also about objects without substance, I will compare his view of reality to the views of reality suggested by several quantum physicists. Physics is not only about views 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.

¹⁵ Tarab Tulku Rinpoche. UD-Newsletter N. 4, January 2006. Rabten, Geshe. *Mahamudra. Der Weg zur Erkenntnis der Wirklichkeit*. Switzerland: Le Mont Pèlerin. 2002. Keown, Damien. *A Dictionary of Buddhism*. Oxford: Oxford University Press. 2003.

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 either.¹⁶ 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

A courageous scientific imagination was needed to realize fully that not the behavior of bodies, but the behavior 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)¹⁷

This is not a presentation or criticism of quantum physics but a discussion of the metaphysical mindsets and principles that underlie quantum physics. The views of reality in quantum physics can be expressed by the three key words: complementarity, four interactions and entanglements.¹⁸

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 favor of one or the other assumption. Electrons and photons sometimes act like waves and sometimes like particles. This ‘behavior’ 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 view that modern atomism 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 fundamental 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 mentioned before in the first chapter: (1), the philosophical notion of substance indicates 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:

¹⁶ See: Rock, Irvin. *Perception*. New York: H.W. Freeman & Company. 1995.

¹⁷ Einstein, Albert, Infeld, Leopold. *The Evolution of Physics*. London: Cambridge University Press. 1938. pp. 257. 311-312.

¹⁸ Appendix 2 of this paper will explain the term entanglement.

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.¹⁹

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, and 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, 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 the fundamental reality could not be grasped by traditional views of reality. What is the explanatory value of atomism if it becomes 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 completely distinct from the world in which we are living?

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 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 relationship with each other as well as with the instrument of measurement. Niels Bohr 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 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 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 sometimes took an instrumentalist approach.²⁰ For Niels Bohr, the fundamental physical reality consists of interacting and complementary quantum objects.

The Concepts of Interactions in the Standard Model of Quantum Physics

In the meantime, the notion of the four interactions was introduced into the standard model of quantum physics. These four elementary interactions or four forces

¹⁹ Einstein, Albert. *Quantenmechanik und Wirklichkeit*, ‘Dialectica 2’. 1948 (my own translation). pp. 320-324.

²⁰ 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).

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.²¹

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 visualizes 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.²²

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 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.”²³

What quantum physics knows about interactions is here summarized 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

²¹ “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 readily 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 deuteron, 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, Elliot D. / Feldman, Gary J. „Quarkonium”. Scientific American 246 (5) 1982. pp. 42-53).

²² Weinberg, Steven. “Unified theories of elementary-particle interaction”. Scientific American 231 (1) 1974. pp. 50-59.

²³ Friedman, Daniel Z. / Nieuwenhuizen, Peter. „Supergravity and the unification of the laws of physics”. Scientific American 238 (2) 1978. pp. 126-143.

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.²⁴

Singular, isolated, independent quarks, a phenomenon which is called 'confinement' in recent research, have never been observed. 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, new quarks will appear between them, that 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."²⁵ These clouds of virtual particles represent or produce interactions.

We have now arrived at the central core of quantum physics. It consists of a new view 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, law of nature/matter. These systems cannot be separated into independent parts, reduced to two separate, independent bodies or states, nor is one fundamental and the other derived, as the metaphysical either-or scheme of substantialism or subjectivism usually tries to establish. They are not joined into a seamless unity either, they are not the same, they are not identical, they are not a mysterious wholeness as holism indicates. Finally, we cannot claim that they are nothing but mathematical models which we have constructed and which 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 cloud of virtual particles, which surround the central or the 'naked' body. Between these bodies is an interaction that is one of the composites of these bodies. This understanding of physics cannot be dislodged and yet all our metaphysical schemata struggle against it. The 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 physicists have been searching for in order 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.²⁶ The physicist and philosopher Carl Friedrich von Weizsäcker called mathematics 'the essence of nature.'²⁷ According to the physicist Herwig Schopper, fields of force are the ultimate reality.²⁸ 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

²⁴ 'T Hooft, Gerhard. "Symmetrien in der Physik der Elementarteilchen". In: *Teilchen, Felder und Symmetrien*. Heidelberg: Spektrum. 1995. pp.40-57. (my own translation)

²⁵ Rebbi, Claudio. Quoted in: Frankfurt: Frankfurter Allgemeine Zeitung. September 5th, 2001 (my own translation).

²⁶ Heisenberg, Werner. „Physik und Erkenntnis.” Vol. 3. 1969-1976 . In: Heisenberg, Werner. *Gesammelte Werke*. 1985. 326; Heisenberg, Werner. *Der Teil und das Ganze*, München: Pieper Verlag. 1969. p. 260.

²⁷ Von Weizsäcker, Carl Friedrich. *Ein Blick auf Platon*. Stuttgart: Philipp Reclam jun. 1981. p.134.

²⁸ Schopper, Herwig. Frankfurt: Frankfurter Allgemeine Zeitung. 5 May 1999.

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 in 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.

4. Conclusion

Reality is not static, solid or independent. It does not consist of singular, isolated material or immaterial factors, but of systems of dependent bodies.²⁹ Most systems consist of more than two bodies, but there is no system that consist of less than two bodies. In quantum physics we call such fundamental two-body systems earth/moon, electron/positron, quark/anti-quark, particle/field. Nagarjuna calls his systems or dependent pairs a mover/the distance to be moved, fire/fuel, agent/action, seer/view.

Both, quantum physics 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 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 totally unknown, for example as with entangled twin photons.

What is reality? We have become accustomed to believe in a firm ground beneath our feet and fleeting clouds in the sky. The view of reality of Nagarjuna's philosophy and the ideas of complementarity, interactions and entanglement in quantum physics teach us something quite different that we could express metaphorically in the way that everything is built on sand and not even the grains of sand have a solid core or nucleus. Their stability is based on the unstable interactions of their component parts.

As we have seen, *pratityasamutpada* or the dependence of the objects is a key concept in quantum physics and in the philosophy of Nagarjuna. However, Nagarjuna has been associated with the term of *sunyata*, a term which denotes the substancelessness of the objects. This has led to the wrong impression that Nagarjuna wanted to distinguish himself from the traditional, original Buddhism, which has always, since the Pali Canon, used the term *pratityasamutpada* or *paticcasamuppada* as a cardinal doctrine to describe the fundamental reality. However, Nagarjuna used both terms synonymously: "Whatever is *pratityasamutpada*, that is explained to be *sunyata*, that, being a dependent designation, is itself the Middle Way" (MMK 24.18. Garfield's translation). Both terms have the meaning of dependence, both emphasize that not the behavior of bodies, but the behavior of something between them, may be essential. Both terms occur equally in the writings of Nagarjuna. In this important respect, the separation between Theravada and Mahayana is misleading and void. *Pratityasamutpada* unites all Buddhist traditions.

²⁹ As mentioned in chapter 1, I use the expression 'body' synonymously with 'quantum object' or 'particle' or 'field' or 'system' or 'entity'. There is just a small difference between these expressions that can be neglected.

Appendix 1

Pratityasamutpada in Eastern and Western Modes of Thought

The term pratityasamutpada has a large scale of meanings: First, it is an indication of dependence. Dependent objects are in an intermediate state, they are not really separated and they are not one entity. In the second place, they rely on each other or they are influenced or determined by something else. Finally, their behavior is influenced by something between them, for example a mover is attracted by gravitational force, a seer is dependent on rays of light between his eyes and the seen object, the action of a piano player is determined by fine motor skills of his fingers, an actor is dependent on an action. Pratityasamutpada is an indication of dependence and of something that happens between the objects. One object is bound to the other without being identical. Let us re-examine the meaning of pratityasamutpada.

A Summary of Citations

This part will deal with implicit interpretations of the meaning of pratityasamutpada, in terms of time, structure and space. The following citations and references illustrate the term pratityasamutpada, sometimes without explicitly mentioning the term at all. Pratityasamutpada is used in the meaning of:

1. 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."³⁰
2. An intermediate state in Nagarjuna's view: According to Nagarjuna the objects are neither together nor separated (Nagarjuna, MMK 6. 10).
3. Bondage in the Hevajra Tantra: "Men are bound by the bondage of existence and are liberated by understanding the nature of existence."³¹
4. An intermediate state by Roger Penrose: 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."³²
5. Something between the bodies in Albert Einstein's view: "A courageous scientific imagination was needed to realize fully that not the behavior of bodies, but the behavior of something between them, that is, the field, may be essential for ordering and understanding events."³³
6. The mean between two or more things in modern mathematical modes of thought: "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.

³⁰ Nagarjuna, Catuhstava. „Hymn to the Buddha”. In: Lindtner, Christian. *Nagarjuniana*. Copenhagen. 1982. p. 135.

³¹ Farrow, G.W / Menon, I. *The concealed Essence of the Hevajra Tantra*. Delhi: Motilal Banarsidass Publishers. 2001. p. 10.

³² Penrose, Roger. *The Large, the Small and the Human Mind*. Cambridge University Press. 2000. p. 66.

³³ Einstein, Albert / Infeld, Leopold. *The Evolution of Physics*. London: Cambridge University Press. 1938. pp. 311-312.

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.”³⁴

Appendix 2

What is quantum entanglement? A short answer by two articles:

1. “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. Erwin 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.”³⁵
2. “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.”³⁶

³⁴ Gioberti, Vincenzo. „Della Protologia.” Vol. 1. Naples. 1864. p. 160. In: Zellini, Paolo. *A brief History of Infinity*. London: Penguin Books. 2005. p. 53.

³⁵ Clegg, Brian. „The Strange World of Quantum Entanglement.” *California Literary Review*. 20 March 2007. <http://calitreview.com/51> accessed on October 2011.

³⁶ Merali, Zeeya. „Quantum Effects brought to Light: Results of Entanglement made visible to Human Eeyes.” *Naturenews*. 28 April 2011. Doi:10.1038/news.2011.252. <http://www.nature.com/news/2011/110428/full/news.2011.252.html> accessed on 7 October 2011.

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