Article

Deconstructing Reality: Is Reality Really Real?

Graham P. Smetham*

Abstract

The seemingly solid entities that sentient beings experience as the 'truth' or mode of apprehension of the everyday world can, seemingly, be broken down into increasingly small particles. The 'ultimate' truth, or 'ultimate' level of reality, would, perhaps, be found when there is a 'particle' which can no longer be divided, if such things 'exist' ultimately. If they do not … well then we arrive at the quantum level, or what Buddhist metaphysics calls 'emptiness'. In this paper I will use the Buddhist philosopher Dharmakirti's imaginative deconstruction of reality, in the context of quantum theory, to try to answer the question which seems to be posed by quantum theory: Is 'Reality' really real? In our search for the ultimate nature of reality we have to leave behind the 'seeming' appearances of the everyday world, however persuasive the appearance may be, and break through to a more 'ultimate truth' concerning the nature of reality. We shall discover that Dharmakirti's philosophical analysis, alongside other Buddhist insights, which lead to the 'ultimate' realm of 'empty' Mindnature, prefigures modern quantum discoveries, particularly the notion of an 'Epiontic Universe' which derives from the 'quantum Darwinism' perspective suggested by Wojciech H. Zurek.

Keywords: Reality, deconstruction, emptiness, quantum physics, Buddhist philosophy, illusion, quantum Darwinism, Epiontic Universe, Epiontic Mindnature

The science writer Jim Baggott, in the very first paragraph of the preface to his recent book *The Quantum Story* writes:

> The last century was defined by physics. From the minds of the world's leading physicists there flowed a river of ideas that would transport mankind to the very pinnacle of wonder and to the very depths of despair. This was a century that began with the certainties of absolute knowledge and ended with the knowledge of absolute uncertainty. It was a century in which physicists developed theories that would deny us the possibility that we can ever properly comprehend the nature of physical reality.

The unsettling development of quantum theory in the twentieth century prompted much soul searching amongst the 'founding fathers' of the new quantum approach to the understanding of the nature of physical 'reality'. Indeed, as Abner Shimony has pointed out regarding the quantum conclusions reached by 'founding father' Niels Bohr as to the implied limitations of human knowledge:

> The theme of renunciation and submission to the unavoidable limitations of the human condition is recurrent in Bohr's writings, and places him, more perhaps

* Correspondence: Graham Smetham, http://www.quantumbuddhism.com E-mail:graham@quantumbuddhsim.com

> than he realised himself, in a philosophical tradition of renunciation of excessive claims to human knowledge, including Hume and Kant. The latter systematically maintained that human beings have no knowledge of "things in themselves," but only objects of experience.[1]

One such occasion on which Bohr exhibited such epistemological pessimism can be found in Volume 2 of Bohr's *Philosophical Essays* in which he remarks regarding "Dirac's ingenious Quantum Theory of the electron" that:

> In the phenomenon of the creation and annihilation of electron pairs we have in fact to do with new fundamental features of atomicity, which are intimately connected with the non-classical aspects … and which have demanded a still far more reaching renunciation of explanation in terms of a pictorial representation.[2]

In other words at the 'non-classical' quantum level, which resides so to speak at the atomic and beneath the atomic levels of reality, the behavior of the 'stuff' of reality seems so odd that we must simply forgo coherent "pictorial representation". This was written at the end of the nineteen thirties, the following, however, is from a recent (2009) work *Quantum Reality: Theory and Practice*:

> The problem is that the small scale laws describe a way of behaving that, judged by the standards of everyday experience, is utterly bizarre. It is very difficult to see how all the business going on at the atomic scale can lead to the regular, reliable world we spend our lives in.[3]

So in terms of a fundamental gut understanding of the relationship of the 'classical', or everyday level of reality that we seem to inhabit, and the quantum realm which appears to underpin it, it would seem that not much has changed. In another recent work *Quantum Physics at the Crossroads* physicists Guido Bacciagaluppi and Antony Valentini refer to the Genesis story of the Tower of Babel in which God sets out and succeeds in confounding the language of the builders and they write that:

> Anyone who has taken part in a debate on the interpretation of quantum theory will recognise how fitting is the above quote from the book of Genesis, according to which the builders of the Tower of Babel found that they could no longer understand one another's speech. For when it comes to the interpretation of quantum theory, even the most clear-thinking and capable physicists are often unable to understand each other.[4]

As physicists Bryce DeWitt and Neill Graham have pointed out, the quantum revolution did not just demand an extraordinary rethink of the scientific conception of what the material world amounted to, it also had dramatic metaphysical implications:

> No development of modern science has had more profound impact on human thinking than the advent of quantum theory. Wrenched out of centuries-old thought patterns, physicists of a century ago found themselves compelled to embrace a new metaphysics. The distress which this reorientation caused continues to the present day. Basically physicists have suffered a severe loss: their hold on reality.[5]

Indeed the late physicist and Buddhist philosopher Victor Mansfield referred to modern quantum experimentation as 'experimental metaphysics.'[6] In the course of this chapter it will become clear why this characterization is appropriate.

The observation by DeWitt and Graham suggests that the dramatic meta-physical implication of quantum theory is actually one in which 'reality' itself is called into question because of the apparent dramatic disjunction between the quantum level of reality and the appearance of the 'classical' everyday world. Furthermore, a profoundly disturbing aspect of the quantum situation which emerged very quickly in the early years of quantum exploration was the fact that it appeared to be the case that the subjectivities of experimenters were in some way entangled with the nature of reality revealed by experiments. Founding father Werner Heisenberg wrote regarding this situation:

> This again emphasizes a subjective element in the description of atomic events, since the measuring device has been constructed by the observer, and we have to remember that what we observe is not nature in itself, but nature exposed to our method of questioning.[7]

For those not acquainted with the phenomenon in question here it must be indicated that in the early experiments one fundamentally disconcerting aspect of the situation was the fact that 'reality' could be made to 'reveal' itself in apparently contradictory ways, a 'matter-wave' or a particle, depending upon choices made by the experimenters. It appeared, therefore, that the very subjectivities of the experimenters determined the nature of reality as it manifested within experience. There appeared, and still appears, to be two sorts of 'reality', a 'veiled reality', to use a term employed by physicist-philosopher Bernard d'Espagnat, that 'exists' prior to experimental questioning and an second type of 'reality' which is an experiential reality that manifests in different, apparently contradictory ways depending on the mode of the experimental question. Heisenberg wrote of the situation:

> In classical physics science started from the belief – or should one say from the illusion? – that we could describe the world or at least parts of the world without any reference to ourselves.[8]

Bohr, of course, famously attempted to plaster over the apparent cracks in the scientific requirement for an 'objective' 'reality' by declaring that quantum reality was a matter of the 'complementary' nature of the quantum realm; the 'stuff' of reality was, according to him, a kind of 'stuff' which could be one thing or another depending on how one examined it.

Today, however, Bohr's plaster cover is wearing thin. Bernard d'Espagnat writes concerning Bohr's notion of 'complementarity' that:

> …reality cannot be totally described by one such picture, and a … description requires in fact a *duality* of mutually contradictory (but "complementary") pictures. Now we must ask: Is the thus completed conception still compatible with realism? Clearly the answer is no. … If the best we can do to describe to reality is to resort at the same time to two mutually contradictory pictures, the quite obviously we cannot claim that we have described "reality as it really is." In fact … the type of reality that contemporary physics describes … is merely an "effective" of "empirical" reality…[9]

Baggott, at the end of his quest to find 'reality' in his book *A Beginner's Guide to Reality*, tells us that:

> There is simply nothing we can point to, hang our hats on and say *this is real*.[10]

This conclusion results from various modes of investigation culminating in the most dramatic – quantum theory. However, in an apparent volte face, in his more recent book *The Quantum Story* Baggott seems to have revised his opinion somewhat on the matter of 'reality' as he now tells us that Heisenberg's assertion that the results of quantum exploration can only reveal 'nature exposed to our method of questioning' rather than nature as it objectively is in itself :

> …does not mean that quantum particles are not real. What this does mean is that we can ascribe to them only an *empirical* reality. This is a reality that depends on our method of questioning…[11]

A view which reiterates that of d'Espagnat. It would seem, then, that Baggott's more recent view is that quantum 'particles' have *only* an empirical 'reality'. This view, at first sight, seems to contradict the conclusion reached by quantum physicist H. Dieter Zeh who, in his paper '*There are no Quantum Jumps, nor are there Particles!*', writes that:

> …there does not seem to be any reasonable motivation (other than traditionalism) for introducing concepts like particles, quantum jumps, … or classical properties on a fundamental level.[12]

So again it seems that we are thrown into difficulty concerning what we really mean by the term 'real'. Quantum theory really does seem to have thrown the concept of reality into a kind of indeterminate state.

However, there is a more subtle way of conceiving of the quantum-classical situation which is suggested by the observations provided so far. Zeh tells us that we must abandon the notion of the reality of 'particles' 'on a *fundamental* level', Baggott, on the other hand, suggests that we must consider that the 'particles' which appear to come into existence when reality is questioned by a 'particle-producing' method must be considered to have a different, non-fundamental, or *empirical* level of reality. It would seem, then, that we may have to adjust our notions of 'reality' in order to take account of two types, the first being a fundamental quantum reality within which there are no particles to be found, and the second being a less fundamental empirical reality wherein particles appear to exist. Remarkably this division of reality into a two tier system corresponds precisely to a metaphysical division of reality made by central Buddhist Mahayana (Great Vehicle) philosophical systems:

> The seeming and the ultimate-
> These are asserted as the two realities.
> The ultimate is not the sphere of cognition.
> It is said that cognition is the seeming.[13]

In this assertion the 'seeming' corresponds to Baggott's 'empirical' level of reality whilst the 'ultimate' corresponds to the fundamental-quantum level. Furthermore, it is significant that there is an implication that the act of cognition, which as we shall see can be considered to be a quantum-measurement, is a central feature of the realm of the 'seeming' or 'empirical.'

Before pursuing this intriguing connection further, however, it is worthwhile looking a little further into the ambiguous nature of our current notion of 'reality' because we need to be aware just how dire the philosophical situation is within the realm of quantum theory. According to the physicists who carried out the subtle experiments which tested and

demonstrated the quantum violation of the Leggett inequality, an inequality derived from the basis of necessary features of a nonlocal conception of 'reality' which allows instantaneous quantum interconnections between distant objects:

> We believe that our results lend strong support to the view that any future extension of quantum theory that is in agreement with experiments must abandon certain features of realistic descriptions.[14]

However, one of the experimenters, Anton Zeilinger, adds a quantum of caution into the speculation:

> Quantum mechanics is very fundamental. Probably even more fundamental than we appreciate. But giving up on realism altogether is certainly wrong. Going back to Einstein, to give up on realism about the moon, that's ridiculous. But on the quantum level we do have to give up on realism.[15]

The reference here is to a question Einstein once posed to a young colleague Abraham Pais as to whether the moon existed when no one was looking at it, a question prompted by the phenomenon of the 'collapse of the wavefunction' which suggests that, at least at the quantum level, prior to an observation being made entities do not fully exist but only have a potential existence as a mathematical probability. If seems that at the quantum level there is only a potentiality for existence rather than 'real' existence or fully fledged 'reality'. The point that Einstein was making was that if this turned out to 'really' be the case at the quantum level then surely it must also apply at the everyday, 'macroscopic', level, including the moon, which does, indeed seem ridiculous.

Professor Zeilinger is somewhat elusive on the issue of the relationship between 'observation' and 'existence' or 'reality'. In his essay '*Why the quantum? "It from bit"? A participatory universe? Three far-reaching challenges from John Archibald Wheeler and their relation to experiment'*, written for a collection of essays published in honor of the work of the great twentieth century physicist John Wheeler, Zeilinger wrote of Wheeler's:

> …realization that the implications of quantum physics are so far-reaching that they require a completely novel approach in our view of reality and in the way we see our role in the universe. This distinguishes him from many others who in one way or another tried to save pre-quantum viewpoints, particularly the obviously wrong notion of a reality independent of us.[16]

An observation which one would have thought clearly suggests that there can be no 'reality' which is completely cut off and 'independent' from sentient observation of some sort. However, in his recent book, he gravely warns his readers that:

> It is dangerous – and not supported by the physics of the quantum measurement process – to claim, as is sometimes claimed, that it is the mind of the observer that influences the quantum state.[17]

This is certainly a stern admonishment; one might have thought that some scientific mafia had hired a hit-man in order to eliminate such, according to Zeilinger wrong, thinking. And yet, according to Wheeler's understanding of the quantum evidence:

> Directly opposite to the concept of universe as machine built on law is the vision of *a world self-synthesized.* On this view, the notes struck out on a piano by the

> observer participants of all times and all places, bits though they are in and by themselves, constitute the great wide world of space and time and things.[18]

This quote from Wheeler can be found in the collection of essays previously referred to, *Science and Ultimate Reality: Quantum Theory, Cosmology and Complexity*, which was the result of a project 'developed in honour of the ninetieth birthday of renowned theoretical physicist John Archibald Wheeler'[19].

Given this evaluation of Wheeler's work one would have thought that his thoughts on these issues would have counted for something, and yet, whilst Zeilinger applauds Wheeler's 'far-reaching' views in his essay for the appreciative volume, in his more recent book *Dance of the Photons* he appears to directly undermine central aspects of Wheeler's perspective. Indeed there seems to a dramatic amount of confusion surrounding the issue of how we can now, in a quantum age, conceive of 'reality' in a consistent manner. If we take a look at Zeilinger's remark about the 'reality' of the moon (above), it is clear that he regards moon-size objects as being weighty enough to warrant the attribution of realism, whilst 'on the quantum level we do have to give up on realism.' Baggott, however, immediately after quoting Zeilinger's attribution of reality to the moon based on massiveness, immediately asks 'What does this mean?' Indeed!

The following observation from Roger Penrose is clearly cogent in this context:

> Undoubtedly the world is strange and unfamiliar at the quantum level, but it is not unreal. How, indeed, can real objects be constructed from unreal constituents?[20]

As we have seen, it appears that quantum 'particles' might be thought to have aspects of both reality and unreality, and this is a paradoxical viewpoint which leads us in the direction of some dramatic claims about the nature of reality made by Buddhist metaphysicians, claims which moves towards providing an answer to Penrose's quandary:

> Everything is real and not real,
> Both real and not real,
> Neither real nor not real.
> This is the Lord Buddha's teaching.[21]

Which is an apparently inconsistent viewpoint concerning the metaphysical structure of reality advanced by the extraordinary second century CE Buddhist philosopher Nagarjuna, the founder of the remarkable *Madhyamaka*, or Middle Way, metaphysical analysis we shall investigate later. The resolution of the apparent paradox will become clear as we explore the relationship between the implications of quantum theory and the Buddhist doctrine of the 'two truths' in greater detail. In fact we will discover that an appreciation of the Buddhist perspective throws significant light onto quantum conundrums.

Returning to Zeilinger's quandary; if we have to 'give up on realism' at the quantum level, which as he says is 'very fundamental, probably even more fundamental than we appreciate', then how can we coherently claim that the objects which are, as Penrose puts it, 'constructed from unreal constituents' suddenly become real when they club together in large conglomerations of some sort, where does the reality ingredient come from? Baggott tells us that this kind of 'reality' is 'only an *empirical* reality', but one could equally ask 'what does *this* mean?' Does it mean that it isn't a *real* 'reality?'

Such a conclusion might be in order, after all the chapter title in Zeilinger' book that this discussion takes place under is 'The Persistent Illusion', an appellation taken from a quote from Einstein who, Baggott reminds us, said that 'Reality is merely an illusion, albeit a very persistent one,' which is another observation which maps us directly into the 'two truths' philosophy of Buddhist metaphysics:

> These phenomena are like bubbles of foam …
> Like illusions, like lightening in the sky,
> Like water-moons; like mirages.[22]

This observation refers to the 'seeming' or 'empirical' level of 'reality.' According to all phases of Buddhist thought all phenomena are insubstantial and illusion-like, a view which has now been dramatically validated by quantum physics. Thus the assertion by the Buddhist philosopher Asvaghosa that:

> Phenomena as they appear and resound
> Are neither established nor real …
> Since they keep changing in all possible and various manners
> Just like appearances in magical illusions. [23]

Is confirmed by quantum gravity theorist Lee Smolin:

> How something is, or what its state is, is an illusion. It may be a useful illusion for some purposes, but if we want to think fundamentally we must not lose sight of the essential fact that 'is' is an illusion.[24]

So what *is* reality?!

The comments made by d'Espagnat in the preface to his book Veiled Reality are relevant in this context. Our fundamental ideas concerning the world, he tells us, must seriously take account of quantum physics, especially in view of the "mismatch between it and commonsense views of the world, "a mismatch which "creates dissatisfaction." D'Espagnat then goes on to describe the strange situation he found regarding the ontological implications of the theory which he was confronted with at the beginning of his career:

> I have not, as yet, the strange perplexity I felt when, as a beginner, I studied texts on quantum physics and, later, read articles on its foundations. These documents appropriately described the relevant facts and the theoretical formulism. But they were quite unclear – I thought – as to the actual meaning their authors attributed to the formulas they wrote down. … Were they supposed to describe the very *things* the experiments bore on? At some places the argument only seemed to go through by virtue of an axiom that correct prediction of what is *observed* is all we may expect … But at other places … the same authors would unabashedly express themselves as if the probabilities and other items they juggled with *did* refer to events "as they really happen."[25]

In other words an evasive ambiguity reigned, and in large measure is still prominent in discussions and publications.

When we consider the situation within western scientific and philosophical thought on the issue of quantum and everyday 'reality', it quickly becomes clear that the situation is desperate. Despite the fact that there are a considerable number of works attempting to bring

some kind of coherence to the implications of the quantum 'revolution' for our understanding of reality, some of which have been quoted above, the extent of the disarray in the various presentations is really horrifying, if that is one expects some kind of rigor of metaphysical terminology. In fact, as we shall see, it seems to be the case that, perhaps unconsciously, such a lack of rigor seems to be gratefully embraced in order to avoid drawing quite obvious conclusions which we will come to later.

For instance, according to Penrose, writing in his massive tome *The Road to Reality*:

> If we are to believe that any one thing in the quantum formulism is 'actually' real, for a quantum system, then I think that it has to be the wavefunction …[26]

But in a more recent work by the physicist Giovanni Vignale, *The Beautiful Invisible*, we read that, according to Vignale:

> …whether quantum mechanics admits an objective reality or not, we cannot hope to find that reality itself in the wave function. A wave function is, at its very best, a convenient representation of the underlying reality…[27]

Of course, one might want to say that these two positions really aren't as different as they appear; Penrose surely knows that the wavefunction is not the actual reality but, as Vignale says, is only a 'convenient representation'. But even if this were true there is still some divergence between the two approaches. The important issue, however, is the fact that we are already faced with a seemingly paradoxical situation of the classical-quantum relationship, resorting to imprecise and confused terminology is hardly likely to improve the situation.

Indeed Vignale considers that all the theories of physics, both classical and quantum are not fully 'objective' or fully 'realistic', precisely because they are 'convenient representations':

> …the older theories based upon particles, waves, vortices, celestial spheres and so on, are not any more realistic than the quantum theory: they just seem more realistic, because they are based on more familiar concepts. Those familiar concepts, when carefully analysed, turn out to be abstractions, limits, idealizations of a reality that is never completely described.[28]

This is an observation which shows us how quantum theory has brought to the fore the crucial issue of the relationship between conceptual systems of description and the phenomena which are supposed to be described by those descriptions, a consideration which was central in the earlier philosophical musing of the trailblazing early twentieth century quantum physicists. Thus Werner Heisenberg wrote in his book *Physics and Philosophy*, shortly before his remark that physics can only reveal 'nature exposed to our method of questioning':

> The concepts of classical physics are just a refinement of the concepts of daily life and are an essential part of the language which forms the basis of all natural science. Our actual situation in science is such that we do use the classical concepts for the description of the experiments, and it was the problem for Quantum Theory to find theoretical interpretation of the experiments on this basis. There is no use in discussing what could be done if we are other beings than we are. At this point we have to realize, as Weizacker has put it, that "Nature is earlier than man, but man is earlier than natural science." The first part of the sentence justifies classical physics,

> with its ideal of complete objectivity. The second part tells us why we cannot escape the paradox of Quantum Theory, namely the necessity of using classical concepts.[29]

Here we see quite clearly then that at the very outset of the quantum demolition of the appearance of the 'classical' world of apparent materiality the notion that the conceptual apparatus that we use in order to investigate the world necessarily depends upon the kind of 'beings' that we happen to be became significant. As various philosophers have indicated, Berkeley and Kant being well known in this context, any scientific knowledge that we might think we have established cannot give direct access to the 'stuff' of reality as it is in its own being so to speak.

More recently Nobel Prize winning physicist Frank Wilczek has expressed this in his book *The Lightness of Being* as follows:

> To begin, we build our world-models from strange raw materials: signal-processing tools "designed" by evolution to filter a universe swarming with information into a very few streams of incoming data.[30]

The 'signal-processing tools' referred to by Wilczek are, of course, the sense faculties and minds of sentient beings. And in this process it is reasonable to suppose that the sense organs themselves may be considered to have a 'filtering' effect which operates prior to the actual application of conceptual structures of thought and language. Thus in Wilczek's observation we can distinguish this two stage process: firstly the fundamental operation of the 'signal-processing tools' of the sense organs which provide the 'raw materials' for the construction of 'world-models' and, secondly, the conceptual activity through which scientists construct the actual world-models, or physical theories, that make up the picture of 'reality' provided by science. In this model of the epistemological model we are at two removes from real 'reality'.

The latter process of the moulding of world, or reality, models, which unavoidably contains the impact of the conceptual baggage carried by the employment of pre-quantum 'classical' modes of conceptual application, became an important concern for the early quantum theorists. Niels Bohr, in his discussion with Einstein concerning the status of quantum theory, for instance, wrote:

> …I entered more directly on questions of terminology. In this connection I warned especially against such phrases, often found in the physical literature, such as "disturbing of phenomena by measurements." Such phrases, which may serve to remind of the apparent paradoxes of Quantum Theory, are at the same time apt to cause confusion, since words like "phenomena" and "observations," just as "attributes" and "measurements," are used in a way hardly compatible with common language and practical definition.[31]

Thus the advent of the breakthrough to the quantum level of 'reality' brought to fore the necessity for an examination of the nature of the relationships between conceptual thought, language and reality. But, reading some of this early, as well as current, discussions concerning the implications of quantum theory it might seem as if 'classical' descriptions were straightforward, unambiguous, perhaps bordering on some kind 'objective' presentation of reality, precisely because of their familiarity to the way that we ordinarily experience the world.

The significant physicist John Bell described the classical and quantum viewpoints as follows:

> Theoretical physicists live in a classical world, looking out on to a quantum mechanical world. The latter we describe only subjectively, in terms of procedures and results in our classical domain. … The classical world of course is described quite directly - "as it is." … nobody knows where the boundary between the classical and the quantum domain is situated.

In this depiction it appears as if the 'classical' domain is quite straightforward, whereas, in reality, even the classical vision of 'reality' must be mediated by sense faculties and conceptual frameworks. Furthermore, as Bell points out, the question as to exactly where a boundary between quantum and classical realms might be seems to be unanswerable.

In this context it is worth considering Vignale's discussion of the nature of the fundamental concepts of the Newtonian 'classical' worldview: velocity, acceleration, mass and force. According to Vignale all these fundamental concepts are the result of a conceptual process which is of the same nature as that which underlies the notion of a mathematical 'limit', a view which clearly follows from the fact that the concepts of 'velocity' and 'acceleration' are defined precisely by using the mathematical concept of a 'limit'. In this mathematical process for deriving an instantaneous velocity (or speed if we ignore direction of motion) the distance-time graph of an object moving with variable velocity can be used in order to derive an 'abstract' value which is called the 'instantaneous velocity' by taking a sequence of chords, for which the slope values can be computed easily, between end points which approach each other along the curve describing the motion of the moving object. The instantaneous velocity is the 'limit' value at the point where the points coincide and thereby the sequence of chords transform to become the tangent. Because the points are identical the chord value, which requires two points, cannot be calculated, but there is a mathematical formula, derived from the limiting process of the chord points approaching each other, which provides a value for the tangent. The point here is that the value which is used in order to calculate the tangent value, strictly speaking, does not 'exist' but is implied by a mathematically imaginative process. Indeed at the head of this chapter, which is entitled 'Limits', Vignale quotes Newton's justification for using such an imaginative process for calculating a value which is then treated as being 'real':

> It may be objected that there is no such thing as an ultimate proportion of vanishing quantities, inasmuch as before vanishing the proportion is not ultimate, and after vanishing it does not exist at all … But the answer is easy … the ultimate ratio of vanishing quantities is to be understood not as the ratio of quantities before they vanish or after they have vanished, but the ratio with which they vanish.[32]

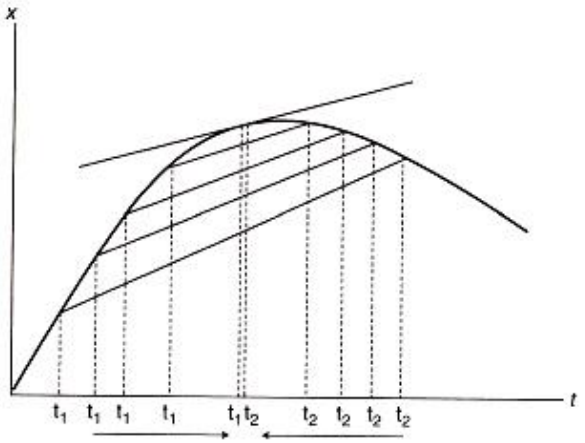


FIG. 7 Velocity as a limit. As the length of the time interval $t_1 - t_2$ tends to zero, the slope of the line that connects the corresponding points on the graph of position versus time tends to a limiting value. In the limit in which t_1 and t_2 coincide, this line becomes the tangent to the curve.

Figure 1

Vignale's appreciation of the nature of the concept of velocity prompts him to comment that:

> Scientific theories, like works of art, live in tangential realities that are conjured up by a limiting process. Starting from familiar concepts we dive into a fantastic space, navigate it according to certain rules, and re-emerge on the level of reality with a new concept, a new figure of thought – velocity in this case.[33]

The remaining question is, however, does the concept of 'velocity', in this case, re-emerge fully 'on the level of reality', or does it actually remain a 'figure of thought' within a 'fantastic space'. Or, perhaps, does it hover between the two? This is a question we shall return to after a brief examination of the early Buddhist employment of the conceptual limiting process in the quest for reality.

The Buddhist metaphysical conceptual analysis of the nature of reality has always been founded upon the basis of a rigorous employment of scrupulously coherent conceptual analysis, which is in turn based upon an empirical observation of experience in a manner appropriate to the time, although one major difference between the empirical attitude of Western science and philosophy during the age of science and that of Buddhism was the Buddhist development of rigorous techniques of meditation in order to explore the structure and nature of consciousness. The fact that much of the Buddhist metaphysical discoveries actually prefigure quantum discoveries is astonishing and clearly holds witness to the effectiveness of the modes of conceptual analysis employed and may indicate that the inclusion of the direct meditational investigation of the nature of consciousness within the realm of the 'empirical' may have been advantageous.

The early Buddhist philosophers were adamant that ultimate constituents of reality, by which they meant the ultimately really real entities which underpin all phenomena (assuming they exist), must be irreducible and therefore could not be reduced into parts. And, remarkably, an

understanding of the reasoning behind and the repercussions from this simple basic requirement supplies a solid basis for understanding the importance of the Buddhist notion of the two truths. It also provides an approach for our further understanding of the metaphysical structure of reality and our understanding of the central quantum-classical conundrum. Metaphysics here is assumed to embrace ontology – what there is (or appears to be) in 'reality', and epistemology – the investigation of how knowledge is gained. As we shall see quantum physics indicates that these two are intertwined.

The work of the seventh century (C.E.) Indian Buddhist philosopher Dharmakirti, who was given the appellation 'the Lord of Reason', provides an excellent starting point for our examination of Buddhist metaphysical analysis. It is important to be aware, however, that Buddhist analysis proceeds, as we shall see, through a series of levels, each one more refined than the previous. In this system it is possible for entities which are considered to be 'ultimate' from the viewpoint of a lower level to lose such a lofty status in 'higher' levels of analysis. The analysis which we begin with here, following Dharmakirti's 'sliding scale of analysis'[34] is that of the Sautrantika or 'External Realist' school of Buddhist philosophy which asserts the existence of ultimately simple self-existent particles which 'club together' in various way to create the apparent phenomena of the everyday world.

From this perspective the objects of everyday world with which are familiar cannot be considered to be 'ultimate' precisely because they can be decomposed into the constituent particles which are 'ultimate' precisely because they cannot be so decomposed:

> Dharmakirti notes that a term such as "water jug" is simply a linguistic convention employed as a convenient means to indirectly express multiple infinitesimal particles that, due to their proximity, causally support each other such that they together perform functions that are of interest to us. When we are thirsty, certainly it is easier to say, "Bring the water jug," than it is to say, "Bring some mutually supporting infinitesimal particles that, through that causal support, serve the functions associated with the concept 'water jug.'"[35]

Such a consideration may seem to be going into the realms of absurdity and indeed from the perspective everyday life, pursued without concern of anything beyond everyday survival, it is. But Buddhist philosophy was conducted with the aim to accomplish complete enlightenment as to the ultimate nature of reality on all levels of experience, and knowing the ultimate causal elements of reality was, clearly, a necessity in this concern. The point here is that if it were to be the case that the only causally effective and constitutive elements within the phenomenon of a water jug were to be such infinitesimal particles, and we consider only causally effective and constitutive elements to be ultimately 'real', then, from an ultimate point of view, the water jug is not ultimately 'real'.

It is intriguing to contrast this approach with the kind of laxity of conceptual use which is often found within Western philosophy. This tendency is beautifully illustrated by a story recounted by the 'philosopher' Ian Hacking. A friend of his was conducting an experiment which was designed to measure a fractional electric charge on subatomic entities, entities which we now know are not *ultimately* 'real' because they do not exist as 'particles' when unobserved. They only have, according to d'Espagnat and Baggott, a derivative, empirical

'reality'. The experiment required changing the charge on a tiny niobium ball. Hacking asked his friend how this was done:

> 'Well at that stage,' said my friend, 'we spray it with positrons to increase the charge or with electrons to decrease the charge.' From that day forth I've been a scientific realist. *So far as I am concerned, if you can spray them then they are real*.[36]

This account is shocking because of the remarkable disregard for ontological precision; such an attitude displays a maverick lack of concern for discovering the real reality of 'reality' on the part of Hacking, who is, after all, a professional, although Western, academic philosopher specialising in the philosophy of science. From the perspective of the precision of Buddhist philosophy to call Hacking's observation 'philosophical' is simply laughable as it shows no concern with really getting to the true nature of the reality of reality, but seems content to allocate *ultimate* reality with anything that appears to function as derivative *empirical* reality. We are hardly likely to get the bottom of the nature of quantum reality with such a lax and imprecise approach.

This shows us the importance of the notion of the Buddhist doctrine of the 'two truths', or the two levels of manifestation of reality. The Buddhist philosopher Vasubandhu (400-480 CE), an important forerunner for Dharmakirti, divided 'reality' into kinds, one provisional and the other ultimate, the following is Vasubandhu's presentation of the two truths – the 'seeming' or 'relative', and the 'absolute' or 'ultimate':

> Things which, when destroyed or mentally dissected,
> Can no longer be identified by the mind,
> Such as pots or water, are relative;
> All else besides is ultimately existent.[37]

This view clearly roughly corresponds to an 'atomic' presentation of the two truths. The seemingly solid entities that sentient beings experience as the 'truth' or mode of apprehension of the everyday world can be broken down into increasingly small particles. The ultimate truth, or ultimate level of reality, is found when there is a 'particle' which can no longer be divided, if such things 'exist' ultimately. If they do not … well then we arrive at the quantum level, or 'emptiness' which is the Buddhist equivalent.

It is useful to recall in this context that at the end of the nineteenth century many physicists did not consider atoms to be 'real' entities and thought that matter was actually continuously solid:

> Planck was conservative in his views and, in the early part of his career, did not even believe in the existence of atoms … Planck felt that it would soon be proved that matter was continuous in the sense that it was not ultimately composed of fundamental 'building blocks', but could be infinitely divided up and still retain its essence.[38]

A few years later the famous experiment organised by Ernest Rutherford's investigation of the behaviour of high velocity alpha particles (composed of two protons and two neutrons). The particles were fired at thin gold foil and the scattering of the alpha particles was monitored. The results were surprising. Some of the alpha particles were deflected through large angles but most passed through, something that could not happen if a continuous or

packed atomic model of the ultimate nature of matter were correct. The fact that the majority had passed straight through clearly suggested that the greater part of the atom was composed of empty space. The particles that had been deflected back must have met something that had given them an appreciable kick. The conclusion that Rutherford came to was that the positively charged alpha particles had been deflected by the positive charge of a central nucleus of the gold atoms. The electrons, therefore, must be orbiting the nucleus like planets and most of the atom was empty space, in fact matter is 99.999999999 percent, or there about, empty space.

It required experiments of this kind to convince Planck and others of the atomic makeup of matter. Buddhist philosophers, however, pondering the issue hundreds of years before such spectacular experiments could be conceived of, came to similar conclusions by employing spectacular razor sharp analysis. The reasoning by which Buddhist philosophers argued for the conclusion that there must be some kind of momentary atomic internal structure of matter (which goes beyond the atomic conclusions of Rutherford who conceived of continuously existing elements within atoms) is remarkable, although completely obvious and perspicacious when comprehended. Here is Vasubandhu's reasoning:

> The change that these conditioned phenomena undergo over time is reasonable only if they are subject to a form of disintegration in which they arise and pass away with each moment; this phenomena is not reasonable if entities remained in an unchanging state.[39]

In other words, if material entities were solidly continuous, with no internal structure, they simply could not deteriorate over time in the manner that they actually do. This is an example of the power of what might appear to be, on some occasions, quite simple modes of reasoning employed within Buddhist philosophy. In this case the reasoning is simply that if the material 'stuff' of reality was internally continuous, with no fluctuations of internal structure, then there is absolutely no reason why any material object should deteriorate.

Buddhist philosophy was, and is, founded on the principle that there must be rigorous internal coherence to the structure of reality and also to the structure of conceptual thinking and analysis concerning reality; it abhors ad-hoc, incoherent explanations. And it expected ultimate constituents to be non-complex; complex entities were considered to be clearly reducible down to more simple constituents. Consider the situation in which someone takes a soft material object, putty perhaps, and breaks it into two pieces; if the matter of this piece of putty had actually been continuous, and for Buddhist philosophers this would entail that every part of the lump of putty was exactly, absolutely and without deviation the same in constitution – any deviation would be inexplicable without internal structure – then the breaking of the lump of putty in the particular place where it did would be inexplicable, no, actually more than this – impossible. If we really think what the notion of continuity of matter really entails then we cannot fail to see that it would clearly mean that all material objects would be necessarily unbreakable!

This is our first example of the fact that Buddhist philosophy requires that we are completely clear of all the rigorous implications of the concepts we work with and we must not allow conceptual boundaries to ebb and flow with our whim, as when we might be tempted to declare:

So far as I am concerned, if you can !!!!!!! them then they are real.

Where the '*!!!!!!!*' can be replaced with some process or function of the derived 'empirical' appearance of 'reality'. Another example of the lack of conceptual coherence which allows conceptual boundaries to be determined by personal whim, which seems to have become allowed in Western philosophy, is supplied by the 'philosopher' Daniel Dennett's proposal that mind or consciousness can arise from elements of reality which are completely and absolutely devoid and antithetical to the qualities of mind and consciousness:

> An impersonal, unreflective, robotic, mindless little scrap of molecular machinery is the ultimate basis of all the agency, and hence meaning, and hence consciousness, in the universe.[40]

This view is considered to be incoherent within Buddhist philosophy simply because:

> Well then, deep darkness can arise from tongues of flame,
> And anything could issue forth from anything.'[41]

In other words if we allow elements which are defined to be completely and absolutely antithetical to some quality to suddenly magically generate that very quality then our entire conceptual framework becomes compromised. The emphasis here is on the fact that the principles involved are *absolutely* unconnected and antithetical as the Cartesian definitions of matter and mind or consciousness clearly are. The essential point is that according to the procedures of Buddhist conceptual analysis the boundaries and necessary implications of concepts must be rigorously respected in order to avoid conceptual incoherence, and the employment of this procedure leads, as we shall see, to intriguing results.

Returning to the issue of the inference of the internal structure of matter; Vasubandhu suggests that as it is the case all material objects do gradually disintegrate over time then there must be some form of internal atomic-like structure which facilitates this deterioration. Furthermore the fact of deterioration must apply to any material object however small, and furthermore takes place over time, the internal structure is likely to be that of momentary pulses of coming into existence and passing out of existence.

We have previously taken account of Vignale's presentation of the derivation of the 'tangential realities' of classical physics, velocity, acceleration and so on, through a 'limiting process'. The Buddhist analysis of the nature of ultimate entities presented by Dharmakirti also uses a limiting process (which we will come to eventually), which is based upon two fundamental and related epistemological presuppositions; it is to these that we shall now turn our attention.

According to Dharmakirti 1) only ultimately real particular entities are causally efficient, and 2) only perceptible particular entities are real, Dharmakirti expresses this:

> Except for being a cause, there is nothing else that could constitute an entity's being an apprehended object. Among the causes of awareness, that cause in whose image that awareness arises is called the apprehended object of that awareness.[42]

The term 'awareness' here does not mean a generalised field of potential or actual cognition; it refers to a specific momentary sensory awareness which is generated by the operation of a causal matrix of sensory awareness generating factors, hence the phrase 'among the causes of

awareness'. The essential factors for the generation of a specific awareness are: a preceding moment of consciousness, the presence of an appropriate sense faculty and the presence of the appropriate object which is apprehended. The 'apprehended object' is, unsurprisingly, the 'objective cause' and it is clear from Dharmakirti's formulation that he considers that the fact that it is an effective cause in the first-order non-interpreted phase of perception is the crucial element in making it a 'real' object, thus the activity of primary 'raw' perception and the notion of 'real' reality is closely entwined. We shall see later that this entanglement is now shown to be a central feature of the 'epiontic' quantum paradigm.

It is important to keep in mind that in our discussion we are in search of the ultimate nature of reality and in this quest we may need to leave behind the appearances of the everyday world, however persuasive the appearance may be. We must also bear in mind that the analysis being carried out is from the point of view of 'External Realism' which assumes, or treats ultimate particulars as being the foundational elements of reality and draws the necessary conclusions. At a later point this presupposition may be updated or transcended, but the lessons learned will still have significance. In Dharmakirti's analysis the notion of causal efficiency relates to the process of perception so the assertion is that only ultimately real and existent ultimate entities are the ultimate causes of perceptions:

> Thus in a basic sense, "perception" (*pratyaksha*) simply refers to cognition with … an image, and since the image is a mental event that occurs prior to any judgement or interpretation, the usage of the term "image" is similar to that of "sense datum" in Euroamerican philosophy.[43]

The notion here, then, is clearly that the ultimate causal agents in the case of any perception are the ultimate particulars that make up the extended 'classical' object that seems to be the content of the perception. In other words the fact that these particulars happen to have clubbed together in the particular manner that they have, say, to produce the functioning entity which appears as a water jug, adds nothing to the objective causal nexus which 'causes' the perception. Dunne here refers to the multitude of 'sense data' which must occur in this model of perception prior to any conceptual judgements as 'mental events', but it is better to conceive of them as a multitude of raw sensory impacts occurring within the layer of sensory awareness beneath the mentality which then subsequently imposes a conceptual form over the riot of incoming data, so the subsequent conceptual interpretation is a kind of 'illusion':

> In conceptual illusion, the problem lies not with the mechanism of perception, but with the subsequent interpretation – the perceptual judgement – of the pre-interpretive image in the sensory cognition.[44]

The entire process of perception, therefore, is one in which the conceptual faculty of the mind throws a conceptual interpretive network over the incoming veridical raw sensory data 'signals' streaming into the psycho-physical organism.

A useful analogy is that of putting a hand into hot water. According to the atomic-molecular viewpoint the 'objective' causal origin of the sensation of hotness is the multitudinous impacts of the fast moving water molecules upon the molecules of the hand. The person's hand, however, does not feel each individual molecular impact. This does not detract from the fact, however, that if we are looking for the 'ultimate' material causes of the phenomenon of 'hotness' in a world where atoms are the ultimate constituents of reality

then they are it, anything else only has an 'empirical', derived, or to use the Buddhist terminology, 'conventional' or 'seeming' reality. Many Western philosophers seem to want to defuse this obvious situation with appeals to 'emergence' or 'supervenience'. From the Buddhist perspective, however, this is nothing more than delusion which leads to philosophical confusion.

A significant reason for taking Dharmakirti's viewpoint to heart is that gives us a direct image which indicates the significance of the 'two truths'. In the case of the hand in hot water, for instance, from the perspective of the way that the hotness is actually experienced there is a degree of illusion in the sense that the ultimate causes, which are the fast moving molecules, are not perceived. This, of course, does not detract from the impact of the experience of hotness, which might be very painful, but the ultimate causes of the sensation are not directly perceived; so in this case the 'hotness' of the 'water' is an 'empirical' manifestation which is generated from a more 'ultimate' level of reality.

An important aspect of this perspective is that it rules out the notion that the so called 'supervenient' or 'emergent' properties are as 'real' as the foundational level of reality which gives rise to the phenomena in question. For Dharmakirti the way in which the world is experienced through the networks of conceptual interpretation creates an illusionary experiential realm floating within the bare particular momentary flashes of fleeting existence which create the sensory inputs for sentient organisms. This view prefigures some modern quantum perspectives, quantum physicist Erich Joos, for instance, tells us the appearance of the classical world from out of the quantum realm is a 'delusion.'[45]

According to Dharmakirti perception is a causal process and the elements of reality ultimately responsible for this process are the 'external' ultimately real particulars or point-particles which give rise to the multitudinous raw sense-data streaming through the sensory channels of sentient beings. These streams of sense-data are subsequently given conceptual form by 'higher' levels of mentality. The aspects of mentality which give the 'raw' data a stable form amidst the cacophony of sense data are higher level concepts which, according to Dharmakirti, are unchangeable (whereas point-particles are momentary). This leads Dharmakirti into conceptual difficulties regarding the nature and function of concepts, since one of his epistemological presuppositions is that unchanging entities cannot be perceived. This means that concepts cannot function on the basis of anything actually existing 'externally' in the world amongst the 'real' world of particulars; they must be applied by an internal mechanism which is generated by a mental focusing guided by the perceiver's intentionality driven by needs and interests. The details need not detain us, the point is that the result of this model of the process of perception results in a two tier system in which the *ultimate* reality of the bare particulars and the *seeming* or *empirical* world mediated by conceptual networks appear to be radically disjoint, even though the latter arises on the basis of the former.

However, in the illusory (from the point of view of *ultimate* reality) realm of conceptuality there are still 'correct' conceptual perceptions and 'mistaken' conceptual perceptions. Correct conceptual perceptions are those which organize the realm of the bare point-instant particulars in a fashion in accord with our requirement of surviving as viable organisms in an apparent material and social world. For example, if someone is thirsty then a perception of a

pool of water is 'correct' if it really is a perception of a conglomeration of momentary point-particles of 'water' flashing in and out of existence; these really will be point-particles of existence which really can slake a thirst. However, if we think a mirage of water indicates thirst quenching point-particles then we will be disappointed. There are degrees of illusion within the illusion; we can say that as we navigate our way through the unseen realm of the ultimate nature of reality there are empirically correct conceptual perceptions which mediate to us a coherent derived 'reality' within the illusion. This is the 'seeming' or 'conventional' reality (*samvrtisatya*) as opposed to 'ultimate' reality (*paramarthasatya*).

The reasoning employed by Dharmakirti to show the necessity of the momentary nature of the 'real' point particles of ultimate reality is worth examining as it illustrates core aspects of Buddhist analysis. One such central principle is that if an entity is ascribed some property or quality as part of its essential nature then that entity must conform to that property or quality completely and without deviation. This is a result of the application of the refusal to allow conceptual boundaries to slip and slide in order to accommodate a preferred position (such a requirement is not undermined by the notion of a 'sliding scale of analysis', the point is we must be rigorous in the analysis of any particular perspective adopted for analysis). The analysis also employs a kind of 'limiting' process that we previously considered in the construction of 'classical' quantities such as velocity, although in this case the conceptual limiting process leads to a radical *deconstruction* of the 'classical' realm of apparent 'reality'.

We have seen that Dharmakirti asserts that ultimately 'real' entities are those that are causally efficient (Dharmakirti's analysis is principally in the context of perception, but the principle can be extended to all causal situations – only the ultimate constituents can be causally efficient). 'Real' existence then means causal efficiency or potency, and such causal efficiency requires that the causally efficient entity must change because in order to take part in the causal process a change must occur. For instance, suppose that at one moment just prior to the causal interaction our entity in unrelated to the other factors in the immanent causal interaction and then at the moment of the interaction our entity enters into relationship. This in itself means that the entity changes; before the interaction our imagined entity is unrelated and then it enters into relationship, thus its nature has changed. Furthermore this change cannot be separated from the entity's essential nature because it is implicated in the causal efficiency which is the essential nature. Dunne, in his excellent work *Foundations of Dharmakirti's Philosophy*, explains this issue as follows:

> …if an entity cannot change, then if it is not currently producing an effect, it will never produce an effect. It could not produce an effect because an unchanging entity that is not currently in the state of producing an effect cannot change from the state of not acting as a cause into the state of acting as a cause. Alternatively, if an unchanging entity were to produce effects, it would have to produce all of its effects simultaneously in every moment, since it could never leave the causal state. Hence, if an unchanging entity were to produce a perceptual image as an effect in one's mind, then one would necessarily perceive that entity continuously for eternity.[46]

The reason that an unchanging effects-producing entity must produce all of its effects every moment for eternity is that, if it were to produce each effect in sequence, it would be changing!

This is a beautiful example of the crystalline precision of the type of reasoning employed within Buddhist metaphysical conceptual investigation which employs strict application of conceptual boundaries. But there is more to come. Is it possible for such an effect-producing and thereby 'real' entity to last for more than one moment? Well such an entity has changeability as part of its essential nature so that it cannot stop changing even for a single moment, and this means that the moment is arises it must be changing, which means at the very moment of it coming into being it must change and thereby become something else, which means it has ceased to be the entity which arose, that entity, therefore, has ceased. All 'real' phenomena, then, arise and pass away momentarily. Thus the Buddhist philosopher Shantarakshita declared that 'the momentary thing represents its own annihilation'. [47] The early Western Buddhist scholar Stcherbatsky, in the first of his classic two volume work *Buddhist Logic* comments that this view is:

> … remarkable in the highest degree. It shows us clearly the kind of reality we have to deal with in Buddhist Logic. It is evidently not the empirical object that can be called its own annihilation. Nobody will deny that when a jar has been broken to pieces by a stroke of the hammer it has ceased to exist. But beyond this obvious empirical change there is … another, never beginning and never stopping, infinitely graduated, constant change, a running transcendental ultimate reality.[48]

Thus it appears that, beginning from a quite commonsense kind of notion that there are ultimate 'externally real' particles which are the ultimate source of all our perceptions, along with some minimalist and fairly straightforward notions of how such effective agents of the production of perception must exist and function, i.e. as ultimately simple entities which must change in order to produce an effect and so on, the Dharmakirtian metaphysical analysis has, through a kind of 'limiting' process, reduced such 'externally real' entities to nothing more that evanescent flickering moments of causal potentiality, a kind of seething background 'transcendental' (in the Kantian sense – not immediately available for inspection because prior to sense perception) ultimate reality' within which the 'empirical' appearances of our everyday world are etched out by some magic of the perceptual and conceptual apparatus of our psychophysical being.

The kind of transcendental world arrived at by the Dharmakirtian conceptual analysis is not metaphysically far removed from the world revealed by quantum physics. This, for instance, is the first paragraph in the preface for a recent work on quantum physics, *Quantum Reality: Theory and Philosophy:*

> The world is not what it seems. Behind the apparent solidity of everyday objects lies a seething shadow world of potentiality. This world defies easy description, as its form is so different to our everyday experience. Yet our common or garden world of solid tables, cricket balls, stars, and galaxies somehow arises from what transpires beneath. We do not know how this comes about.[49]

It seems then that the Buddhist philosophers (for Dharmakirti was systemizing fundamental insights of the Buddhist philosophical tradition) had penetrated to some fundamental quantum insights about the nature of reality over a thousand years ago, insights only recently discovered experimentally by quantum physicists. Furthermore, it seems that these insights were the result of fairly simple observations (the disintegration of material objects) and rigorous conceptual and logical analysis.

Figure 2 presents the situation in a simple form. From our everyday world of experience, which itself resides within the 'classical domain' we can use the kind of limiting process described by Vignale to construct the 'tangential realities that are conjured up by a limiting process' that describe the regularities and apparent solidities of the world we appear to unambiguously inhabit. Up until the end of the nineteenth century these procedures actually produced a kind of 'solidified' and mechanistic vision of reality, even Kant's version of the 'transcendental' 'noumenal reality' which he suggested must lie beyond the scope of the senses had a fundamentally clunky feel to it. It is precisely the fact that we are so familiar with the 'classical' feel that the senses feed to us that the quantum realm seems so shocking. Furthermore, because we live in a culture wherein our conceptual history is solidly based within a tradition that assents to the appearances of the 'classical' world as being fully 'real', quantum revelations seem completely outlandish. When the quantum revolution occurred, it took place via the classical concepts of nineteenth century physics which is why the early quantum physicists were forced to consider the nature of classical concepts in a quantum context.

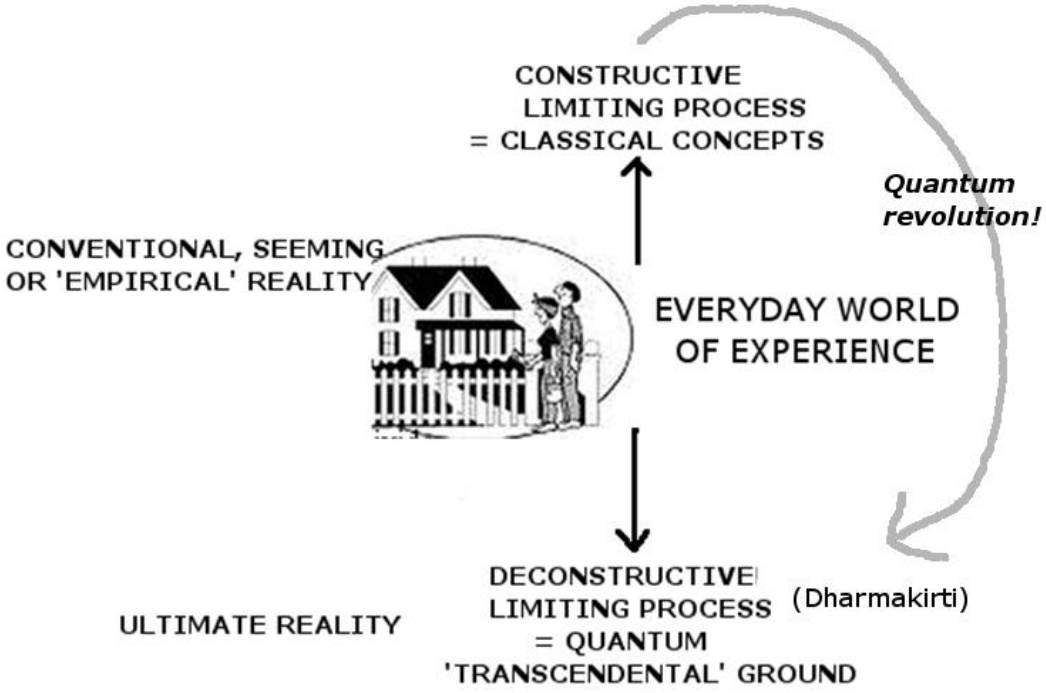


Figure 2

The Buddhist worldview, however, had, through a thorough conceptual analysis of the situation based on simple empirical observations, developed techniques of thought and description quite capable of comprehending the situation. The doctrine of the 'two truths', the ultimate truth of the 'emptiness' of all phenomena, and the deceptive nature of 'conventional' truths, or appearances, had been explicitly fundamental to Buddhist thought since the time of the great Buddhist Madhyamaka philosopher Nagarjuna, and was implicit in the original teachings of the Buddha as written down in the Pali cannon.

The notion of the 'empty' and insubstantial nature of all phenomena, including the apparently material word, is contained within the early suttas. The following from the *Phena Sutta*, contains the seeds of later Mahayana metaphysical presentation of the ultimate nature of reality as 'emptiness' (*shunyata*):

> Form is like a glob of foam; feeling, a bubble; perception, a mirage; [mental formations], a banana tree; consciousness, a magic trick …. However you observe them, appropriately examine them, they're empty, void to whoever sees them appropriately. Beginning with the body as taught by the One with profound discernment: when abandoned by three things — life, warmth, & consciousness — form is rejected, cast aside. When bereft of these it lies thrown away, senseless, a meal for others. That's the way it goes: it's a magic trick, an idiot's babbling. … No substance here is found.[50]

According to this teaching all phenomena, the 'form' and substance of the material world, the 'mental formations' through which our experience is organized and all the phenomena associated with consciousness are 'empty' of any core substantiality, and inner stability. In this sutta the Buddha does not hold back any metaphorical punches as he presses home the point that all phenomena are 'empty, void, without substance':

> Monks, suppose that a large glob of foam were floating down this Ganges River, and a man with good eyesight were to see it, observe it, & appropriately examine it. To him — seeing it, observing it, & appropriately examining it — it would appear empty, void, without substance: for what substance would there be in a glob of foam?

Furthermore, according to these first teachings attributed to the Buddha, he clearly indicated the 'existence', although the existence spoken of here is not the same kind of existence as the phenomena of the 'empirical' world, of a deeper realm 'beyond' and yet at the same time within the realm of ordinary everyday experience. In the *Udana* the Buddha expressed the realm of the unconditioned, the nondual ground from within which the illusion of duality arises, in inspirational language:

> There is that dimension where there is neither earth, nor water, nor fire, nor wind; neither dimension of the infinitude of space, nor dimension of the infinitude of consciousness, nor dimension of nothingness, nor dimension of neither perception nor non-perception; neither this world, nor the next world, nor sun, nor moon. And there, I say, there is neither coming, nor going, nor staying; neither passing away nor arising: unestablished, unevolving, without support.[51]

The terms 'dimension of the infinitude of space, nor dimension of the infinitude of consciousness, nor dimension of nothingness' and so on refer to states of unified consciousness which can be experience through meditation. In another passage we read:

> There is, monks, an unborn, an unbecome, an unmade, unfabricated. If there were not that unborn, unbecome, unmade, unfabricated, there would not be the case that emancipation from the born, become, made, fabricated would be discerned. But precisely because there is an unborn, unbecome, unmade, unfabricated, emancipation from the born, become, made, fabricated is discerned.[52]

Here we find perhaps the earliest description of the ultimate realm which lies behind the conditioned realm of ordinary 'empirical' experience. It is remarkable that these observations

made two and half thousand years ago by the Buddha seem to have anticipated quantum discoveries.

Figure 3 shows an experimental setup to demonstrate what Jonathan Allday, in his recent book *Quantum Reality: Theory and Philosophy*, calls the "contextual" nature of quantum reality. It consists of a Mach-Zehnder interferometer. Light can be thought of, roughly speaking, as being made up of miniscule 'particles' of wave-like energy, these 'particles' are called photons. Because each 'particle' (the inverted commas are used to indicate that photons are not like little miniature balls of solid 'matter', they are more like fragments of immaterial yet energetic 'indeterminate stuff') has a wave nature it consists of peaks and troughs with a wavelength, represented by the Greek symbol λ, between each successive peak and each successive trough as shown in figure 4. This means that when photons come together and 'interfere' with each other they can do so with peaks matching with peaks and troughs matching troughs as in figure 5 A and B, or with peaks and troughs overlaying each other as in figure 5 B and C. In the former case the wave is amplified and in the latter case the wave movement is cancelled out. Because of this it is possible to get an interference pattern when a beam is split and then brought back together (figure 6).

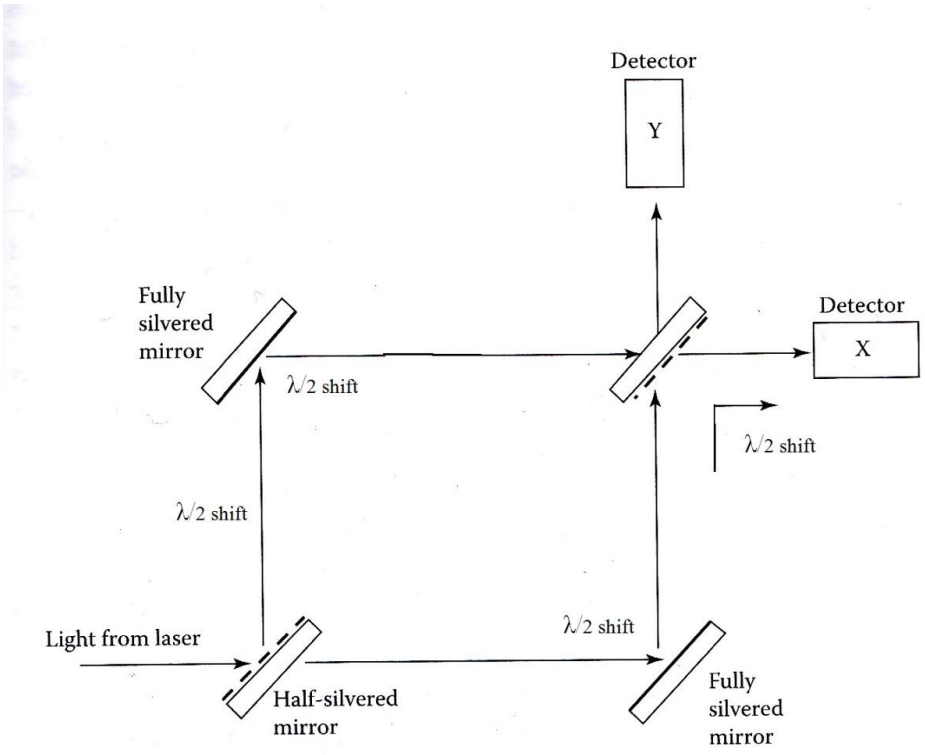


Figure 3

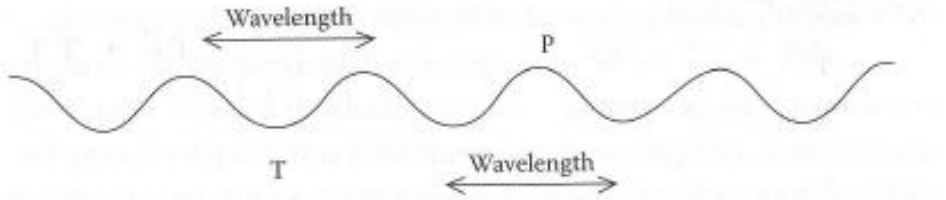


Figure 4

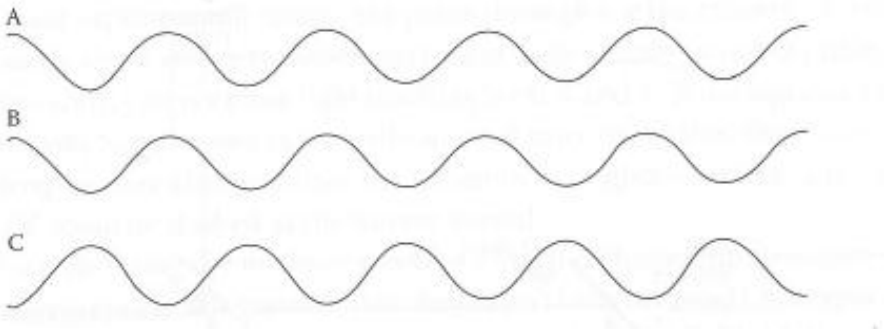


Figure 5

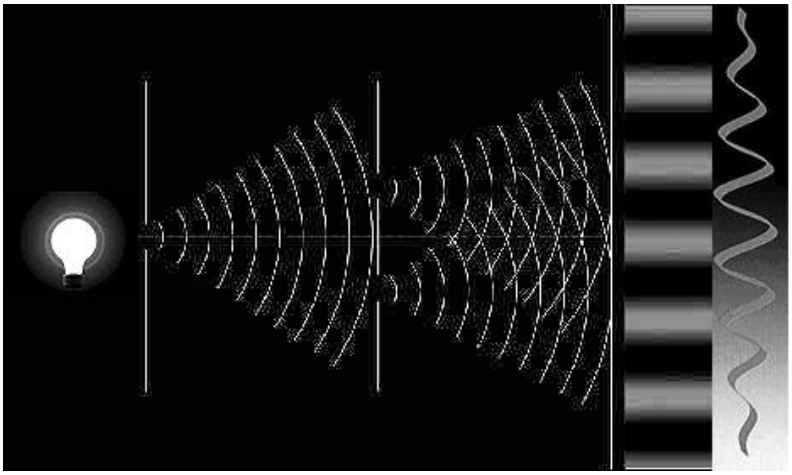


Figure 6

In the experiment carried out with the Mach-Zehnder interferometer photons are sent into the apparatus from the left. The apparatus is set up so that the lengths of the two paths through the apparatus are exactly equal. At the first half-silvered mirror they are either transmitted or reflected with a 50-50 probability; the actual behaviour of any one photon appears to be random but the overall distribution over a large number of photons is 50-50. Furthermore

there is nothing intrinsic to any photon which makes it a transmitted type or reflected type, they are all the same.

When a photon is reflected from the front surface of a mirror there is a λ/2 shift in the phase of the waveform, which means that peaks move to the places troughs were and troughs move to where the peaks were. These phases shifts are shown on the figure, note that the shift which occurs at the X-detector applies only to the photons which come from the bottom mirror and are reflected into the X detector. This means that the photons arriving at the X-detector are in phase because they have all undergone two half wavelength shifts so are all back in phase with each other. Photons heading for the Y-detector, however, are out of phase by half a wavelength so they cancel out and therefore no photons are registered at the Y-detector. Furthermore the photons that arrive at the X-detector amplify each other so the same intensity of light or the same number of photons as went in on the bottom left arrives at the X-detector.

When the length of the paths is different the intensity of light, or number of photons, varies between the two detectors according to the difference in length. If the difference in length between the two paths is λ/2 then the situation changes such that the photons heading for the Y-detector are now in phase so all the photons arrive at the Y-detector and none arrive at the X-detector. If the difference between the paths is λ/4 then the photons heading for both detectors will be a mixture which is out of phase by λ/4, in this case 50 percent of photons arrive at the X-detector and 50 percent arrive at the Y-detector.

The quantum fun begins when photons are sent through the apparatus one at a time. The explanation offered for the behavior described above involves, as we have seen, the phenomenon of interference which is supposed to take place between different photons, two in phase photons amplifying and λ/2 out of phase photons canceling each other out. But, even here there are problems when we consider the explanation in terms of individual photons. Is it really the case that amplified photons can double the number of photons whilst out of phase photons actually destroy each other? When photons are sent through one at a time and we count the photons arriving at the detectors we find exactly the same situation occurs, when the paths are exactly equal all the photons arrive at the X-photon and none at the Y-photon. This poses an extraordinary quantum conundrum, as Allday says:

> If the photon is genuinely a small particle of light, then how can the different paths have any effect on *one single photon?*[53]

The emphasis is Allday's.

In order to see the problem let's consider a photon travelling around the bottom path. First consider the situation shown in figure 7 in which the apparatus pertaining to the upper path has been removed. Remember that we are sending photons into the apparatus one at a time so that the top path should be irrelevant, photons traveling along the bottom path should not be influenced at all by anything pertaining to the top path; the presence or absence of the upper left mirror should have no bearing on the behaviour of bottom path photons. In the figure 7 apparatus the mirror has been removed and all is as it should be, the 50 percent of the photons transmitted along the bottom path divides at the top right half-silvered mirror into two paths having 25 percent of the original number. We can do this experiment by sending a large

number of photons through one at a time and counting the number arriving at the X and Y detectors.

But now consider the situation when we put the top path in again so we are now doing the original experiment by sending the photons into the apparatus, again one at a time, with the top left mirror put back in and the paths are exactly equal in length. In figure 8, with the top path back in, the situation on the bottom path is no different to that in figure 7 and yet the result is radically different. Now all of the 50 percent of the photons on the bottom path get reflected from the top right half-silvered mirror into the Y-detector. How can a single photon traveling around the bottom path 'know' about the presence of the top path and thereby somehow also 'know' that it is supposed to get reflected at the top right half-silvered mirror. As Allday comments:

> Now a wave can do this. It can spread out throughout the experiment (think of the ripples formed when you toss a pebble into a lake) so that parts of the wave travel along each path at the same time. When the two parts of the wave combine at the far side of the experiment, the information about both paths is being compared, which leads to the interference pattern.
>
> A single photon must surely have information about only one path, so how can single photon experiments produce interference patterns.[54]

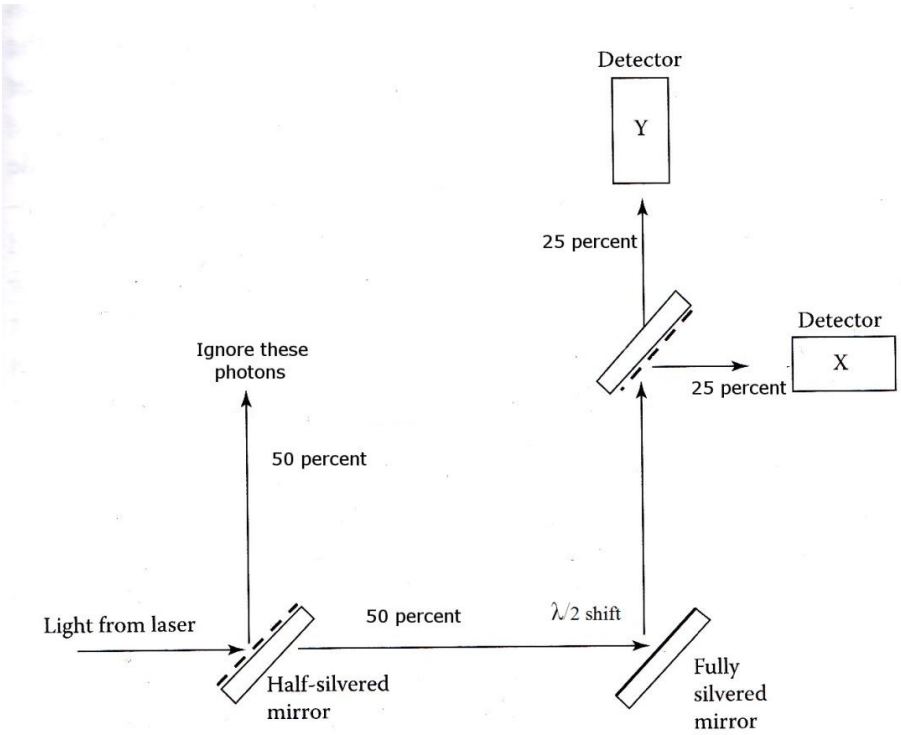


Figure 7 – bottom path – apparatus for top path removed.

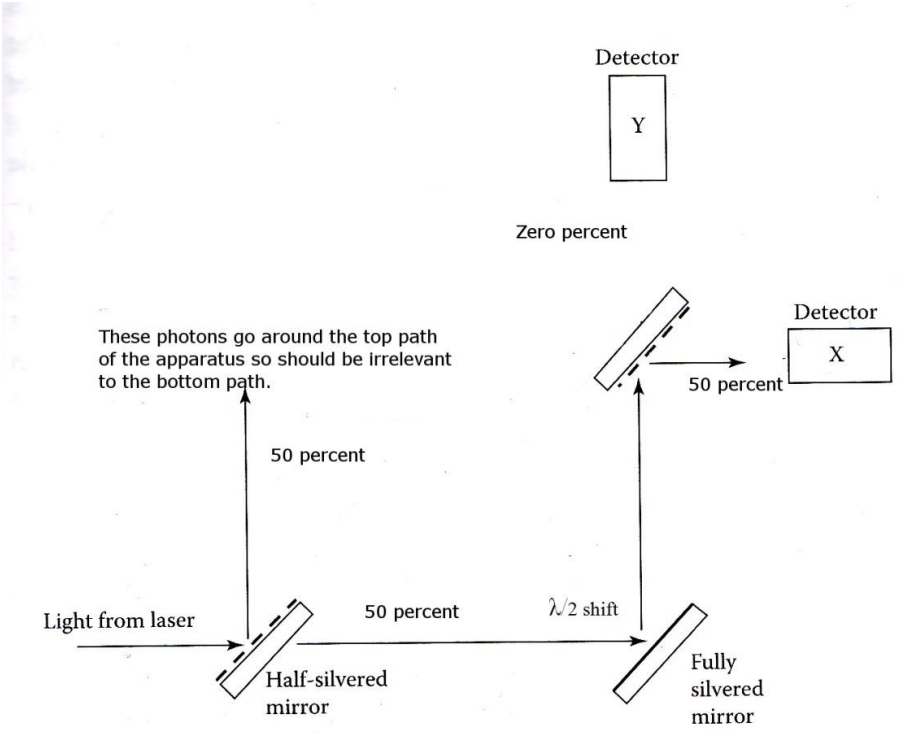


Figure 8 – situation when top path is in place, path lengths equal.

Allday's suggestion that 'a wave can do this' must not be passed over too hastily, as it is so often easy to do when the suggestion has a surface level plausibility, a wave of what? Remember that in the original version, the version in which we seemed to have an explanation, we had lots of photons each with their independent wave-characteristics which interacted at the far side of the experiment. What we are asked to consider here is that an individual photon is in fact a wave of something intelligently immaterial which is able to pick up 'information' regarding the terrain it has traversed.

The next step in the development of the experiment deepens the quantum mystery backwards in time. Figure 9 shows the experiment with the addition of a Pockels cell placed in the top route. The Pockels cell (PC) enables the experimenters to divert the photon out of the path towards the top right half-silvered mirror. If the PC is set to divert photons out of the path then the situation is the same as figure 7 with the top path removed; in this case the interference pattern disappears. When the PC is set to allow the top path to function then the situation is the same as figure 8; in this case the interference pattern reappears.

Pockels cells can be switched between states very rapidly by an electric current and the experiment can be set up so that the PC can be switched to divert or not after the photon has passed through the bottom left half-silvered mirror and is therefore 'traveling' though the interior of the apparatus but would not have yet reached the PC if it were on the top path. In this way we can change between the non-interference or interference experimental setup in mid experimental flow, but before the photon could be past the PC.

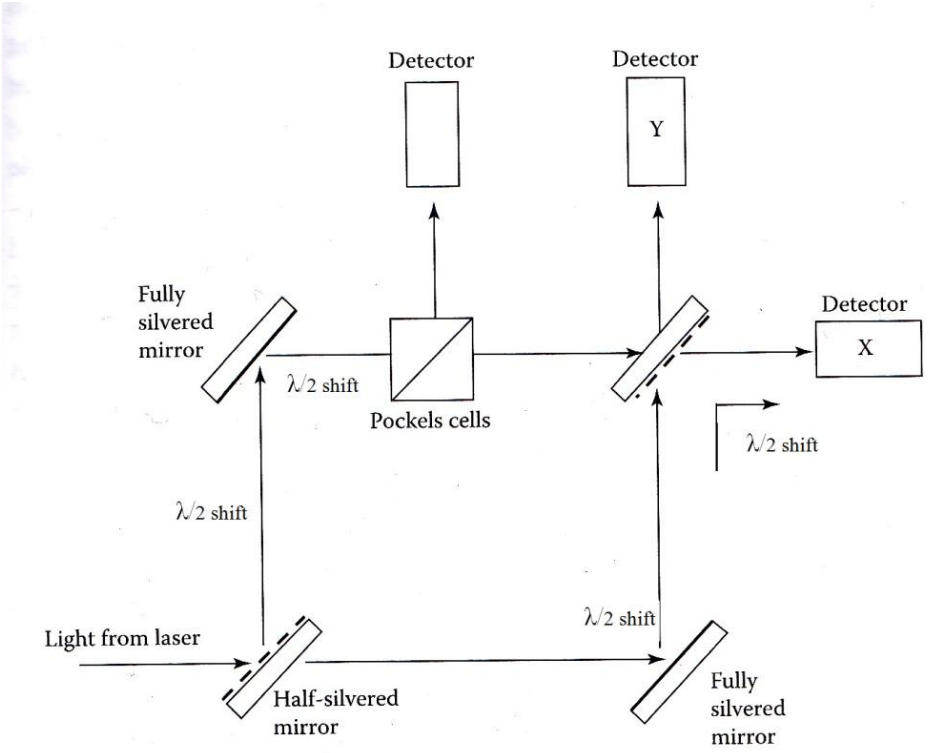


Figure 9

When this experiment is run and analyzed by computer, it turns out that when the PC is set to transmit then the interference pattern is activated and no photons get through to the Y-detector, they all arrive at the X-detector. When the PC is set to divert the results are exactly the same as the experiment carried out with the top path removed (figure 7). Allday comments of this case that:

> In every case the PC was set to divert photons and was switched only *after* they left the mirror. With the PC set to divert we have seen that the photons follow one route or another. But we then switched the PC, destroying our ability to know which path the photons had travelled, and producing an interference pattern. It's hard to believe that changing the setting of the PC can have an influence that travels backwards in time to when the photon reaches the mirror.[55]

Allday leaves the issue of the implied backwards in time influence upon the manifestation of reality, which is implied by this 'delayed choice' experiment, hanging in an indeterminate state, and, although he indicates the quantum situation is somehow connected to "our ability to know which path the photons have taken," he steers clear at this point of raising the controversial issue of the involvement of consciousness in bringing about the transition from quantum indeterminacy to the classical realm of the everyday world.

However, the writing is on the wall, or in this case on the page, for in discussing the more complicated experiment shown in figure 10, an experiment concocted in order to remove the path which gives 'which way' information, i.e. the beam which when blocked (by the opaque screen) allows the experimenter to know exactly how the final 'particles' reached their

destination, further away so to speak from the beams which produce the final interference pattern (or not),he writes as follows:

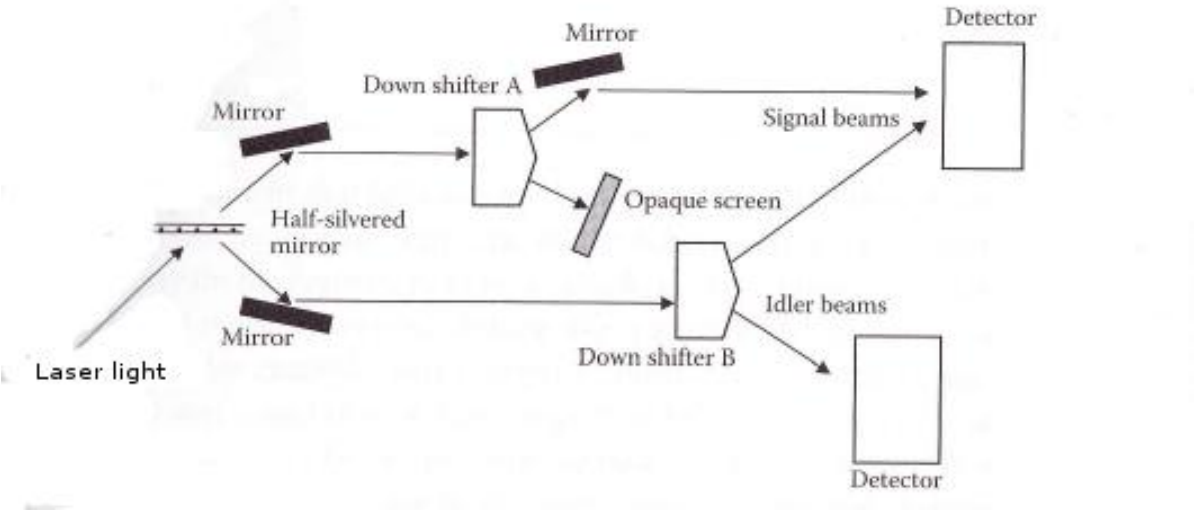


Figure 10

> It seems that the behavior of the photon is being determined by the context of the experiment as a whole- After all if we know that there are no photons coming from down shifter A, why does it matter that the idle route from A is blocked? How is this information conveyed back to the half-silvered mirror so as to determine what happens there?
>
> In the experiment with the pockels cell … we destroyed the interference by changing something directly in the path leading to the pattern. Here we are placing a block in a path that does not lead to the pattern and furthermore can only directly affect the photons that are not involved with the formation of the pattern anyway.[56]

Whilst it is true that "the behavior of the photon is being determined by the context of the experiment as a whole" it is also true that the behavior is also determined by the state of the experimenter's knowledge concerning the experimental setup. It is quite clear that the state of the experimenter's (or experimenters') consciousness (consciousnesses) is/are involved.

Some physicists are not so timid in this respect; quantum physicist Wojciech H. Zurek for instance asserts that:

> …while the ultimate evidence for the choice of one alternative resides in our elusive "consciousness," there is every indication that the choice occurs much before consciousness ever gets involved[57].

In this observation the term 'alternative' can be taken to refer to the different possible manifestations of the underlying quantum 'reality'. The point is that, whilst there is no evidence that *individual* consciousnesses are directly involved, the evidence does indicate

that consciousness is involved at a deep level of the process. As quantum physicists Bruce Rosenblum and Fred Kuttner, in their book *Quantum Enigma: physics encounters consciousness,* conclude that

> …physics' encounter with consciousness, demonstrated for the small, applies to everything. And that 'everything' can include the entire Universe.[58]

It is worth noting in this context that John Wheeler proposed a 'delayed choice' thought experiment of cosmic proportions. In this thought experiment a beam of light which originates in a distant quasar is bent around the two sides of an intervening galaxy on its way to earth, when it reaches earth the split beam is used in a conventional split beam experiment The new feature that this imaginary cosmic scale setup incorporates is a 'delayed-choice', as to the measurement of particle or wave aspect, which appears to act backward in time. The decision as to whether to measure the light as particle or wave is made on earth but the light might have been travelling across the universe for millions or billions of years. So the question that this cosmic scale 'delayed choice' experiment poses is what state, particle or wave, the photons have prior to their observation on Earth. The experiment has been interpreted as suggesting that the light must be influenced in some manner backwards in time across 'billions of years.'[59]

A 'delayed choice' choice on this cosmic scale suggests the process of the universe might be a closed self-manifesting loop with consciousness acting as a central ingredient:

> Physics gives rise to observer-participancy; observer-participancy gives rise to information; information gives rise to physics.[60]

The physicist Freeman J. Dyson indicates the remarkable and radical nature of this view-point:

> Wheeler would make all physical law dependent on the participation of observers. He has us creating physical laws by our existence.[61]

So Wheeler notion's that the universe might be 'self-synthesized' through the agency of consciousness (see previous quote), a view which he illustrated with his self perceiving universe graphic (figure 11) and is also shared by Stephen Hawking and Leonard Mlodinow in their recent book *The Grand Design*[62], is based on a variety of the delayed choice experiment described by Allday. Allday, however, more conservatively concludes that 'quantum theory is going to be a *contextual* theory', although he does mention in passing the 'parallel worlds' interpretation in which each possibility is supposed to be manifested in different 'worlds' or 'universes'.

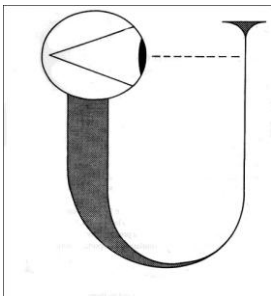


Figure 11

Overall, Allday's discussion seems to want to minimize as much as possible the more spectacular, although clearly implied aspects of quantum theory. Admittedly this might be said to be in line with his decision to discuss quantum 'interpretations' at the end of his book, but, on the other hand, this strategy seems to miss the point that the reader will come to weigh up the various interpretations on the basis of an exposition of the evidence which constantly seeks to undermine the more radical implications.

Allday, whose book *Quantum Reality*, is an absolutely brilliant exposition of the intriguing wonders of quantum theory, is by no means alone in this regard. Indeed there does seem to be a movement amongst certain sections of the scientific and philosophical community to try and undermine the more radical quantum implications, even when the evidence in favor is pretty convincing.

An extreme example of this is provided by the recent popular works of the science writer Marcus Chown, cosmology consultant for the new scientist, whose books are indeed readable, entertaining and certainly give readers some insight into some of the seemingly bizarre aspects of the quantum realm. However, when it comes to the metaphysical implications of quantum theory his books are misleading. In his book *Quantum Theory Cannot Hurt You (QTCHU)*, for instance, he implies that there is nothing strange about the fact that the way things behave at the level of the very small is completely, and by all accounts – even his own – bizarrely, different from the normal world we appear to inhabit:

> The microscopic world of atoms and photons turns out to be nothing like the familiar realm of trees and clouds and people. Since it is a domain millions of times smaller than the realm of familiar objects, why should it be?[63]

Because they are so small, Chown implies, quantum bits and pieces are bound to behave very differently, there's nothing strange about it at all, it's all in fact 'deceptively simple' he claims in the introduction *QTCHU*, so simple in fact that it completely baffled the apparently defective minds of the struggling physicists of the twentieth century:

> … crucial pieces of the theory such as "decoherence" – which explains why atoms but not people can be at two places at once – seem beyond the power of physicists to communicate in any intelligible way. After corresponding with many "experts", and beginning to think that decoherence should be renamed "incoherence" (!), it dawned on me that maybe the experts did not understand it themselves.

But if Chown's 'deceptive simplicity' were to be correct we would need to ask why, then, did just about all the great minds of the founding fathers find it so difficult to comprehend such obvious simplicity regarding the apparent vast difference in the demeanors of quantum and classical 'reality'?

Heisenberg, one of the founding fathers and the inventor of quantum matrix mechanics, lamented after discussing quantum issues with other founding quantum physicists over dinner:

> Can nature possibly be as absurd as it seems to us in these atomic experiments?[64]

The celebrated mathematical physicist Roger Penrose tells the following story:

> I cannot resist quoting a remark that was made to me by Professor Bob Wald, of the University of Chicago, at a dinner party some years ago: If you really believe in quantum physics, then you can't take it seriously.[65]

Quantum physicist Aephraim M. Steinberg, Professor of Physics at Toronto University, writing in 2004, points out that:

> For all of our apparent understanding of quantum mechanics, our ability to calculate remarkable things using this theory, and the regularity with which experiment has borne out these predictions, at the turn of the twenty first century it seems as if there are as many puzzles on the road to a true *understanding* of quantum theory as there were at the start previous century.[66]

It is possible to find many, many such expressions of amazement and incomprehension by highly qualified and respected physicists (Allday's version is above). But it seems now that all is solved by Chown who asserts that:

> Wave-particle duality may sound complicated – but the basics of quantum theory can be explained by matchboxes and trucks…[67]

According to Bill Thomson, a contributor to *The Humanist* magazine:

> Instead of simply rehashing the inadequate explanatory devices used by those who have previously tried to popularize this most abstract science, … sets out on his own journey. Freed from the need to re-present the analogies and metaphors of others, … has relied on his own insights and understandings to come up with a story which has the narrative drive and explanatory force that vitally important topic merits. The first couple of chapters may seem ill-conceived to anyone who already has what they consider a good grasp of topics such as time dilation, coherence and wave functions, but the power of the explanatory model on offer quickly overcomes any initial misgivings.[68]

Now the notion of a wave function is a fundamental aspect of quantum theory so one might wonder why Thompson would so enthusiastically commend a book wherein the chapter dealing with the concept of a wave function is 'ill-conceived'. The answer soon becomes clear; it lies in Chown's "resolute unwillingness to bring God or consciousness into his physics":

> One of the great achievements of this short book … is that it explains the basics of modern physics without the need to resort to anything that could be considered mystical, spiritual or theological. Chown explains decoherence, the process by which the quantum nature of a body is destroyed so that it appears in one state … by defining "observation" in terms of the effect of the outside world. He looks to probability theory, not sentience, to determine why a table stays put but an electron must be uncertain, leaving no space for the mystics to smuggle consciousness, intension or God into the quantum world laid out before us. He therefore does a great service to all of us who seek to counter attempts to base a mystic cosmology around the act of "observation" and its associated observing entity, whether a human being or the God of Berkeley's imagination.[69]

The problem with this 'great service' to all of the various opponents of the view that God or consciousness might be significant in the metaphysical structure of reality is that it requires

not only "ill-conceived" but also a large degree of misrepresentation and massaging of the views of physicists, as well as the "resolutely unwillingness" to consider the views of the large number of highly regarded physicists who would consider that the views promulgated by Chown and his admirers are "known-to-be-false", to use a phrase employed by the significant quantum physicist Henry Stapp. Stapp explicitly directs his criticism to 'philosophers of mind':

> Philosophers of mind appear to have arrived, today, at less-than-satisfactory solutions to the mind-brain and free will problems, and the difficulties seem, at least prima facie, very closely connected with their acceptance of a known-to-be-false understanding of the nature of the physical world, and of the causal role of our conscious thoughts within it.[70]

However, it is the adoption of the "known-to-be-false understanding …. of the causal role of our conscious thoughts within it" which Stapp considers to be the fundamental mistake underlying the view he is taking to task. Stapp considers that the understanding that sentience is a central requirement for decoherence is now incontrovertible. In his book *Mind, Matter and Quantum Mechanics* Stapp writes uncompromisingly that:

> The basic building blocks of quantum theory are, then, a set of intentional actions by agents…[71]

Stapp has patiently and tenaciously, with great clarity and rigor, presented the inescapable conclusions regarding the natural function of human intentionality within the quantum context. In a recent paper he writes that:

> The only objections I know to applying the basic orthodox principles of physics to brain dynamics are, first, the forcefully expressed opinions of some non-physicists that the classical approximation provides an entirely adequate foundation for understanding brain dynamics, in spite of the physics calculations that indicate the opposite; and, second, the opinions of some physicists that the hugely successful orthodox quantum theory, which is intrinsically dualistic, should, for philosophical reasons, be replaced by some theory that re-converts human consciousness into a causally inert witness to the mindless dance of atoms. Neither of these opinions has any rational scientific basis.[72]

The account proposed by Chown, who actually does have a physics background, to all intents and purposes is a 'classical approximation.' This is clearly illustrated by various discussions in his chapter on the nature of reality entitled 'Keeping it Real', which is in a forerunner for his supposedly harmless book on quantum theory, this book is snappily and journalistically entitled *The Never Ending Days of Being Dead*. Here is part of his 'ill conceived' account of the wave function:

> The wave does indeed make contact with reality. It does so through its height … the 'square' of the wave's 'amplitude'. This quantity turns out to be the chance, or probability, that the atom will actually be found at the location if anyone cares to look.[73]

This version is misleading because it implies that the 'atom' exists as a fully manifest 'particle' which is somewhere but we just do not know where. This is false; the wave function squared does not give the probabilities of where a pre-existing particle can be found. It actually gives the probabilities that, when a measurement interaction, *seemingly* involving

human consciousness, is performed at a particular time and in a particular location, the measurement will register the presence of a particle. The particle, however, does not exist prior to the interaction. Rosenblum and Kuttner describe this fact as follows:

> The object was not there before you found it there. Your happening to find it there *caused* it to be there.[74]

A wave function precisely predicts the time evolution of the state of a quantum system of potentialities, a 'state of the system' being the, possibly infinite, collection of possibilities contained within the wave function. But then, as Penrose describes:

> From time to time – whenever we consider that a 'measurement' has occurred – we must discard the quantum state that we have been laboriously evolving, and use it only to compute various probabilities that the state will 'jump' to one or another of a set of *new* possible states.[75]

Stapp describes the wave function as follows:

> The evolving quantum state, although controlled in part by mathematical laws that are direct analogs of the laws that in classical physics govern the motion of 'matter', no longer represents anything substantive. Instead, the evolving quantum state would represent the 'potentialities' and 'probabilities' for actual events. Thus the 'primal stuff' represented by the evolving quantum state would be idealike in character rather than matterlike … quantum theory provides a detailed and explicit example of how an idealike primal stuff can be controlled in part by mathematical rules based in spacetime.[76]

And as we have already seen quantum physicist H. Dieter Zeh writes that there is no 'reasonable motivation … for introducing concepts like particles … on a fundamental level.[77] Chown, however, whilst paying lip service to the fact that the notion of the wave function means that any unobserved 'particles' must be considered to be "smeared out entities like ripples on a pond"[78], subsequently proceeds to describe the quantum situation as if the wave function were a Bohmian[79] like 'pilot-wave' pushing a pre-existing 'particle' around:

> Not only is it impossible to know with absolute certainly where an atom is located, it is impossible to know what it is doing. There is no way, for instance, to know which path an atom will take as it flies through space – only that it will take one path with a particular probability, another path with another probability, and so on.[80]

In *QTCHU* he tells his readers that most physicists favour the view that the wave function is not a "real thing" but is "just a convenient mathematical device for calculating things."[81]

It does seem that Chown's version of quantum theory is 'deceptively' simple. His descriptions seem to be designed in many places to give his readers, who will not have the necessary knowledge to see through the manipulation, a mistaken impression by using 'classical' type language which, although having a limited validity for someone who already knows about quantum theory, will convey completely the wrong metaphysical understanding to an unsuspecting reader.

With regard to the issue of the nature of the 'paths' taken by 'atoms'; the photo (figure 12) shows Professor John Wheeler in mid flow of explaining the 'two truths', or two levels of reality, as discovered by quantum theory: the 'classical' realm and the 'quantum' realm. On

the left of the photo the blackboard drawing shows a 'classical' size object moving between two points. At every point in time it has a definite position and it therefore seems to follow a definite trajectory between the points. In other words it behaves like an everyday object. The section of the blackboard drawing behind Wheeler's head indicates the situation at the quantum level; quantum 'entities' behave in a completely different and counter-intuitive manner; they spread out or 'smear out' over increasingly large areas and fade into a ghostly semi-existence of potentiality, on this level there are no 'atoms' or any other 'particles' taking any kind of 'paths'. Such 'entities' only recover their full entity-ness when they are observed. When unobserved quantum entities really are not 'entities,' they are a 'smeared out' potentiality fields of possible entity experience.

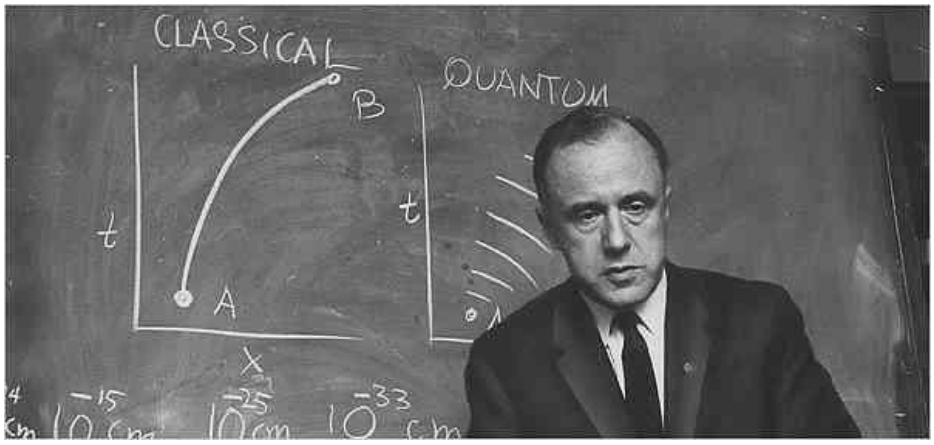


Figure12. - The 'two truths' according to John Wheeler

Professor Stapp, who is one of the few physicists still around who discussed such 'experimental metaphysical' issues with some of the 'founding fathers' of quantum theory, says that the central distinguishing feature between these two physical 'truths' is that on the 'classical' level motions are 'apparently independent of our human observations of them.'[82] The important word in this observation is '*apparently*', a word we could equally replace with 'seemingly', so the 'classical' level, or 'truth', has been clearly established by physics as a 'seeming' reality. It is a 'seeming' appearance of an independent material world of Newtonian objects, an appearance which, when analyzed from the perspective of quantum theory, is found to emerge from a deeper, more 'ultimate', quantum level through the operation of consciousness, although not necessarily individual consciousness.

Here is Penrose on this issue of decoherence and consciousness in his recent massive tome *The Road to Reality*:

> The issue of environmental decoherence … provides us with a merely stopgap position … 'lost in the environment' does not literally mean that it is *actually* lost, in an objective sense. But for the loss to be subjective, we are again thrown back on the issue 'subjectively perceived – by whom?' which returns us to the consciousness-observer question.[83]

And:

> …almost all the 'conventional' interpretations of quantum mechanics ultimately depend upon the presence of a 'perceiving being'…[84]

And:

> …the behaviour of the seemingly objective world that is actually perceived depends on how one's consciousness threads its way through the myriads of quantum-superposed alternatives. In the absence of an adequate theory of conscious observers, the many-worlds interpretation must necessarily remain incomplete.[85]

And:

> As far as I can make out, the only interpretations that do *not* necessarily depend upon some notion of 'conscious observer' … require some fundamental change in the rules of quantum mechanics…[86]

In his earlier work *Shadows of the Mind* Penrose is quite aware of the powerful nature of the experimental evidence of quantum physics that clearly suggests that:

> At the large end of things, the place where 'the buck stops' is provided by our *conscious perceptions*.[87]

Penrose was forced to reach this conclusion, despite the fact that he clearly said at the time that he deeply disliked the view that the evidence seemed to require.

When one reads reviewers, such as to Bill Thomson (see above), refer to the great service done by writers such as Chown in their 'resolute' stand against 'mystical, spiritual or theological' perspectives encroaching into the quantum domain it is easy to get the image of an embattled group of rational scientists with full command and comprehension of the evidence standing fast against the ravings of mystically crazed, perhaps drug induced, irrational fanatics who are hell bent on promoting a hazy 'mystical' quantum perspective against all the evidence. Nothing, however, could be further from the truth. According to Penrose:

> Quantum theory was not wished upon us by theorists. It was (for the most part) with great reluctance that they found themselves driven to this strange and, in many ways, philosophically unsatisfying view of the world.[88]

And John Wheeler remarked that:

> Quantum Theory appears to many as strange, unwelcome, and forced on physics as it were from outside against its will.[89]

This is an important point to bear in mind because it lends great weight to the discoveries of quantum theory. The remarkable features of quantum functioning were not unearthed by physicists who set out to uncover them; quite the opposite. The American experimental physicist Robert Millikan, for instance, could not accept Einstein's picture of the light photon as both wave and particle and he therefore set out on a series of difficult experiments in order to prove that Einstein was wrong. The physicist and science writer John Gribben writes concerning this:

> … he only succeeded in proving that Einstein was right … In the best traditions of science, it was this experimental confirmation of Einstein's hypothesis (all the more impressive since it was obtained by a skeptic trying to prove the idea wrong) that

> established clearly, by about 1915, that there was something in the idea of light quanta.[90]

Towards the end of his life Millikan commented on this episode:

> I spent ten years of my life testing that 1905 equation of Einstein's and contrary to all my expectations, I was compelled in 1915 to its unambiguous verification in spite of its unreasonableness.[91]

So it is not the case that a deviant group of mad scientists got together sometime at the beginning of the twentieth century and decided that they were bored with the idea of a completely 'material' world, and would therefore like to concoct a more exciting version of reality; a numinous vision within which matter was asserted to be similar to an illusion generated in some strange fashion by the operation of mind or minds. Nor did they go to bed one evening and, because of some strange *Day of the Triffids*[92] like cosmic event, wake up next morning turned into incoherent rabid mystics, somewhat akin to Franz Kafka's unfortunate protagonist in the short story *Metamorphosis*, who went to bed a human being and woke up an insect.

In this book on quantum theory *Veiled Reality* Bernard d'Espagnat, Professor Emeritus of Physics at the University of Paris-Orsay, also indicates his lack of a-priori point of view and his commitment to the evidence:

> As my interest in conceptual and interpretation problems should make clear I am not one of those who reject realism- even in its so-called naive version any a priori ground. In fact if physics unambiguously proposed a picture of the world obeying the prerequisites of physicalism (alias "physical realism" the doctrine that physics ultimately is a good candidate for describing "reality as it really is" exhaustively and in detail), I would tend to accept physicalism. My point, however, is that it does not…[93]

D'Espagnat's books, *Veiled Reality* and the subsequent *Physics and Philosophy*, are substantial investigations of both the details of the experimental evidence, the mathematical formulism and surrounding philosophical issues and implications, carried out with impeccable disinterest. Indeed if one examines his background one can see no reason why he would want to cook the books, so to speak, towards any a priori conclusion. The startling conclusion he does reach however, is that physics is incapable of ever unveiling the nature of a quantum 'veiled' reality conceived of as existing separately and independently of consciousness, and he suggests that insights into the nature of reality might very well come from other directions amongst which he cites mysticism[94]. In particular he refers to Buddhist philosophy which:

> …rejects the notion of a 'ground of things' and even lays stress on the opposite notion, the one of an 'absence of foundation' or 'emptiness.'[95]

Physicist and Buddhist practitioner Victor Mansfield tells us that:

> We can now demonstrate that 'quantum moons' do not exist when unobserved. Such 'experimental metaphysics' has an extraordinary resonance with the Middle Way Buddhist principle of emptiness…[96]

The Buddhist concept of 'emptiness' is indeed, to alter slightly the terminology employed by d'Espagnat, an 'absence of substantial foundation' which provides, contrary to d'Espagnat's understanding, a 'ground of things'; this 'empty' ground, which Dharmakirti reasoned his way towards, turns out to be closely analogous to a quantum field of potentiality., for as Allday tells us:

> …at the quantum level, the objects we study have no substance to them independent of their properties.[97]

Mansfield has indicated, using a phrase coined by Abner Shimony, that modern quantum physics constitutes an 'experimental metaphysics' precisely because *quantum physics has penetrated the veil of the material world to what lies beyond.* In fact quantum physics has clearly shown the significance of the notion of 'the two truths,' precisely because it turns out that the 'material' world *is an illusion* because it does not exist the way it appears to. Mansfield uses the term 'quantum moons' here in reference to a question that Einstein once posed to a younger colleague as to whether the moon existed when no one was looking at it, a question we shall return to. The point is that it has been shown quite clearly that quantum 'entities' do not 'exist', as we usually mean by the term 'exist', when not being observed. Chown's version of this quantum conclusion, the 'Copenhagen interpretation', is that "the everyday word is created when a classical object observes a quantum object"[98]; and it is idiosyncratic that at this point his notion of 'observation' seems not to involve any requirement for consciousness in any way what so ever.

In his next section however, entitled 'We Never Observe a Quantum Thing, We Observe Ourselves', Chown delves into the realms of very arcane levels of quantum interpretation when he makes a reference to Wojciech H. Zurek's quantum 'epiontic' paradigm; but his treatment of this very recent perspective bears little resemblance to Zurek's insights. The question Chown sets out to answer is that of the quantum-classical divide, or the 'measurement problem', which is posed as follows (to give yet another presentation of the Buddhist 'two truths', or 'two realities'[99] as they appear in modern physics):

> …if [quantum] theory is really deep and fundamental, it should apply to everything in Creation – not just the world of small things like atoms but also the world of big things like footballs? Why then is the microscopic world, which dances to the tune of quantum theory, so different from the everyday world of trees and planets and people.[100]

The answer, Chown tells us is "very subtle." We do not, obviously, see things directly:

> What we observe … is not the quantum object itself but a 'record' that the quantum object leaves on a large number of other atoms.[101]

Already, however, Chown has misrepresented the situation to his advantage and the readers disadvantage, if that is they seriously want to know about the current state of quantum theory. To see the misrepresentation clearly it is useful to restate Zurek's presentation of the quantum-classical conundrum. The following is from Zurek's classic paper 'Decoherence and the Transition from Quantum to Classical – *Revisited*':

> Quantum mechanics works exceedingly well in all practical applications. No example of conflict between its predictions and experiment is known. Without quantum physics, we could not explain the behavior of the solids, the structure

and function of DNA, the color of the stars, the action of lasers, or the properties of superfluids. Yet nearly a century after its inception, the debate about the relation of quantum physics to the familiar physical world continues. Why is a theory that seems to account with precision for everything we can measure is still deemed lacking?

The only "failure" of quantum theory is its inability to provide a natural framework for our prejudices about the workings of the Universe. States of quantum systems evolve according to the deterministic, linear Schrodinger equation

$$i\hbar \frac{d}{dt}|\psi\rangle = H|\psi\rangle \qquad (1)$$

That is, just as in classical mechanics, given the initial state of the system and its Hamiltonian H, one can, at least in principle, compute the state at an arbitrary time. This deterministic evolution of $|\Psi>$ … has been verified in carefully controlled experiments. Moreover, there is no indication of a border between quantum and classical at which Equation (1) would fail (see cartoon on the opener to this article).

There is, however, a very poorly controlled experiment with results so tangible and immediate that it has enormous power to convince: Our perceptions are often difficult to reconcile with the predictions of Equation (1). Why? Given almost any initial condition, the Universe described by $|\Psi>$ evolves into a state containing many alternatives that are never seen to coexist in our world. Moreover, while the ultimate evidence for the choice of one alternative resides in our elusive "consciousness," there is every indication that the choice occurs much before consciousness ever gets involved and that, once made, the choice is irrevocable. Thus, at the root of our unease with quantum theory is the clash between the principle of superposition - the basic tenet of the theory reflected in the linearity of Equation (l) - and everyday classical reality in which this principle appears to be violated.[102]

Here it is made quite clear that issue of decoherence involves the transition between the quantum realm of the Schrodinger equation, the equation from which wave functions, which describe superpositions of 'alternatives', are derived. The term 'superposition' means, crudely speaking, lots of *possibilities for the manifestations* of 'atoms' stacked together; the crucial points being that 'inside' the wave function $|\Psi>$ there are no 'atoms' or any other 'classical' phenomenon, despite the fact that in his cartoon Zurek lists photons, electrons, atoms, this is only an indication of the size of the phenomenon, in actuality there are only potentialities for the manifestation of 'atoms' at the true quantum level within which decoherence operates. Furthermore these potentialities somehow depend on consciousness for activation; as Zurek clearly says "the ultimate evidence for the choice of one alternative resides in our elusive "consciousness,"" None of this is taken account in Chown's account, instead he quotes Zurek, without indication of the source, as waxing lyrical when making the cryptic observation: 'What the observer knows is inseparable from what he is'.[103] If one

probes more deeply into what Zurek means by such cryptic observation we find that, according to Zurek's quantum perspective:

> …quantum states, by their very nature share an epistemological and ontological role – are simultaneously a description of the state, and the 'dream stuff is made of.' One might say that they are *epiontic*. These two aspects may seem contradictory, but at least in the quantum setting, there is a union of these two functions.[104]

This description clearly indicates that the 'classical' realm emerges from the quantum 'dream stuff is made of' through a process which involves an 'epiontic' quantum functioning, which implies some kind of minimalist internal cognitive or perceptual capacity at the quantum level, without this it would be inconsistent to assert a quantum 'epiontic' nature, which indicates that epistemology creates in some fashion ontology.

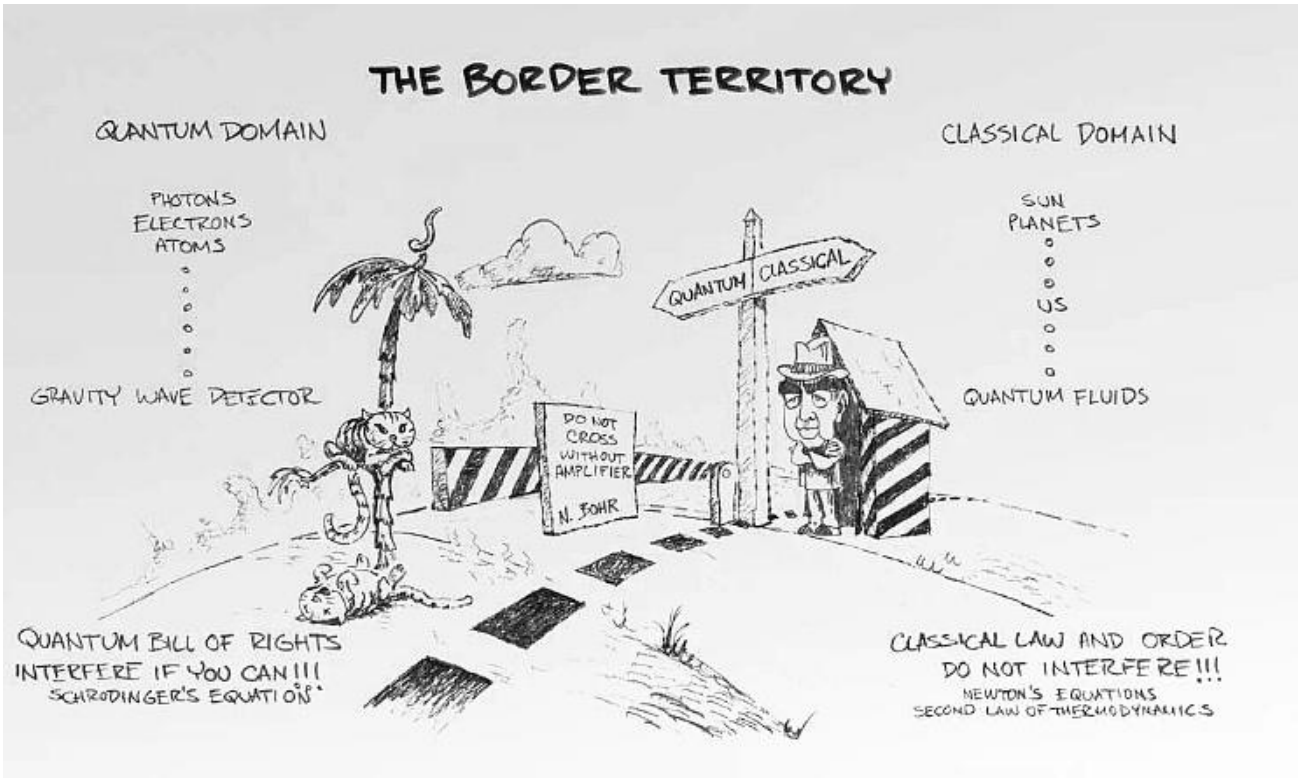


Figure 13 – Zurek's cartoon - the 'two truths': quantum and classical

Zurek calls his new quantum perspective quantum Darwinism, an analogy which he says:

> …focuses on the fact that proliferation of certain information throughout the environment makes its further proliferation more likely.[105]

This is an extraordinary insight which gives us a mechanism, internal to the fundamental quantum field which accounts for the 'emergence' of the 'classical' everyday world. The mechanism is one in which informational quantum states, for Zurek conceives of the

quantum realm as being informational in nature, which have managed, for a reason to be determined shortly, to stabilize themselves as being repeatedly 'registered' through a quantum interaction will become 'fitter', or more able to survive in the future:

> The natural sciences were built on a tacit assumption: Information about the universe can be acquired without changing its state. The ideal of "hard science" was to be objective and to provide a description of reality. Information was regarded as unphysical, ethereal; a mere record of the tangible….Quantum theory has put an end to this Laplacean dream about a mechanical universe. Observers of quantum phenomena can no longer be just passive spectators. Quantum laws make it impossible to gain information without changing the state of the measured object. The dividing line between what is and what is known to be has been blurred forever. While abolishing this boundary, quantum theory has simultaneously deprived the 'conscious observer: Any correlation is a registration; any quantum state is a record of some other quantum state. When correlations are robust enough, or the record is sufficiently indelible, familiar classical "objective reality" emerges from the quantum substrate.[106]

There is a great deal insight into the functioning of reality in this fragment which can be unpacked and elucidated to get to the full scope of it bit by bit (to echo a famous adage coined by Wheeler).

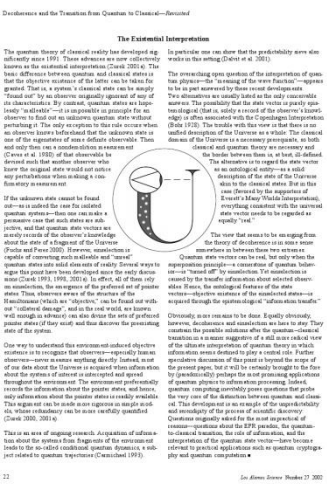
Zurek points out that the 'classical' vision of 'hard science' of a completely 'objective' description of a frame work of reality which is entirely independent of the act of acquiring information is now known to be not possible. Observers are not 'passive spectators', a view which was central to Wheeler's quantum perspective:

> The universe does not 'exist, out there,' independent of all acts of observation. Instead, it is in some strange sense a participatory universe.[107]

As we have seen, one of Wheeler's crucial quantum insights was that the universe was a 'self-synthesized' creation within which the perceptual or cognitive acts of all sentient beings (see quote above). In this view sentient beings become the agents through which the universe 'creates' itself through acts of self-perception. The quantum cosmologist Andre Linde indicates this aspect:

> …without introducing an observer, we have a dead universe, which does not evolve in time. This example demonstrates an unusually important role played by the concept of an observer in quantum cosmology. John Wheeler underscored the complexity of the situation, replacing the word observer by the word participant, and introducing such terms as a 'self-observing universe.'[108]

In order to press home the point that this is the correct and valid context within which to develop and elucidate Zurek's insights it is relevant to point out that his final summing up of his quantum 'epiontic' viewpoint places Wheeler's 'self-perceiving' universe graphic at the center of the page (figure 14). Now such a viewpoint also must bring consciousness to the fore, indeed, speaking in April 2003 to the American Physical Society, Wheeler made the following remarkable; perhaps one might say 'mystical', sequence of remarks:



Decoherence and the Transition from Quantum to Classical—*Revisited*

The Existential Interpretation

The quantum theory of classical reality has developed sufficiently since 1981. These advances are now collectively known as the existential interpretation (Zurek 2001a). The basic difference between quantum and classical states is that the objective existence of the latter can be taken for granted. That is, a system's classical state can be simply "found out" by an observer originally ignorant of any of its characteristics. By contrast, quantum states are hopelessly "unrealistic"—it is impossible in principle for an observer to find out an unknown quantum state without perturbing it. The only exception to this rule occurs when an observer knows beforehand that the unknown state is one of the eigenstates of some definite observable. Then and only then can a nondisturbing measurement (Caves et al. 1982) of that observable be devised such that another observer who knew the original state would not notice any perturbations when asking a question story a measurement.

If the unknown state cannot be found out—as is indeed the case for isolated quantum systems—then one can make a persuasive case that such states are subjective, and that quantum state vectors are merely records of the observer's knowledge about the state of a fragment of the Universe (Fuchs and Peres 2000). However, nonselection is capable of converting such unrealistic and "unreal" quantum states into solid elements of reality. Several ways to argue this point have been developed since the early discussions (Zurek 1993, 1998, 2001a). In effect, all of them rely on nonselection, the consequence of the preferred set of pointer states. Thus, observers aware of the structure of the Hamiltonian (which are "objective," can be found out without "collateral damage", and in the real world, are known, well enough in advance) can also devise the sets of preferred pointer states (if they exist) and thus discover the preexisting state of the system.

One way to understand this environment-induced objective existence is to recognize that observers—especially human observers—never measure anything directly. Instead, most of our data about the Universe is acquired when information about the systems of interest is intercepted and spread throughout the environment. The environment preferentially records the information about the pointer states, and hence, only information about the pointer states is readily available. This argument can be made more rigorous in simple models, where redundancy can be more carefully quantified (Zurek 2000, 2001a).

This is an area of ongoing research. Acquisition of information about the systems from fragments of the environment leads to the so-called conditional quantum dynamics, a subject related to quantum trajectories (Carmichael 1993).

In particular one can show that the predictability sieve also works in this setting (Tabesh et al. 2001).

The overarching open question of the interpretation of quantum physics—the "meaning of the wave function"—appears to be in part answered by these recent developments. Two alternatives are usually listed as the only conceivable answers. The possibility that the state vector is purely epistemological (that is, solely a record of the observer's knowledge) is often associated with the Copenhagen Interpretation (Bohr 1928). The trouble with this view is that there is no unified description of the Universe as a whole. The classical domains of the Universe is a necessary prerequisite, so both classical and quantum theory are necessary and the border between them is, at best, ill-defined. The alternative is to regard the state vector as an ontological entity—as a solid description of the state of the Universe akin to the classical states. But in this case (favored by the supporters of Everett's Many Worlds Interpretation), everything consistent with the universal state vector needs to be regarded as equally "real."

The view that seems to be emerging from the theory of decoherence is in some sense somewhere in between these two extremes. Quantum state vectors can be real, but only when the superposition principle—a cornerstone of quantum behavior—is "turned off" by nonselection. Yet nonselection is caused by the transfer information about selected observables. Hence, the ontological features of the state vectors—objective existence of the nonselected states—is acquired through the epistemological "information transfer."

Obviously, more remains to be done. Equally obviously, however, decoherence and nonselection are here to stay. They constrain the possible solutions after the quantum–classical transition in a manner suggestive of a still more radical view of the ultimate interpretation of quantum theory in which information seems destined to play a central role. Further speculative discussion of this point is beyond the scope of the present paper, but it will be certainly brought to the fore by (paradoxically) perhaps the most promising applications of quantum physics to information processing. Indeed, quantum computing inevitably poses questions that probe the very core of the distinction between quantum and classical. This development is an example of the unpredictability and serendipity of the process of scientific discovery. Questions originally asked for the most impractical of reasons—questions about the EPR paradox, the quantum-to-classical transition, the role of information, and the interpretation of the quantum state vector—have become relevant to practical applications such as quantum cryptography and quantum computation ■

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Figure 14

The Question is what is the Question?
Is it all a Magic Show?
Is Reality an Illusion?
What is the framework of the Machine?
Darwin's Puzzle: Natural Selection?
Where does Space-Time come from?
Is there any answer except that it comes from consciousness?[109]

However, it is clear that Zurek does not intend to adopt a simplistic notion that somehow individual consciousnesses 'collapse the wavefunction' (i.e. reduce the collection of quantum potential 'alternatives' to one actuality), which is why he states that "quantum theory has simultaneously deprived the 'conscious observer' of a monopoly on acquiring and storing information" and on the previous page he says:

> …one might be tempted to follow Eugene Wigner (1961) and give consciousness the last word in collapsing the state vector. I shall assume the opposite. That is, I shall examine the idea that the higher mental processes all correspond to well-defined, but at present poorly understood, information-processing functions that are being carried out by physical systems, our brains.[110]

At first sight this seems to contradict the previous contention by Wheeler that Space-Time (and Matter) 'comes from consciousness, for here is Zurek talking about repudiating Wigner's notion that consciousness has 'the last word in collapsing the state vector.' But in a situation such as this it is necessary to consider the entire perspective involved and also the details of the proposals that various participants have made, rather than hastily collecting 'sentence-bites' which seem to fit the a-priori bill, as Chown and other of his ilk tend to do. Wigner suggested that the quantum wave function of potentialities was reduced to actuality by the first sentient being on the scene, so to speak. What Zurek is indicating is that, to offer this quote once again because of its importance:

> …while the ultimate evidence for the choice of one alternative resides in our elusive "consciousness," there is every indication that the choice occurs much

> before consciousness ever gets involved and that, once made, the choice is irrevocable.[111]

What does this mean? If we consider the implication of the split-beam experiments outlined above it requires a huge amount of manipulation and explaining-away of the evidence to avoid the conclusion that the state of knowledge or even possible states of knowledge of an experimenter or group of experimenters has a direct determining influence upon the way that the underlying quantum reality manifest within their experience. Furthermore experiment after experiment, at increasingly subtle levels, have reinforced this conclusion, so much so that Zeilinger has emphatically stated that the notion of "a reality independent of us" is "obviously wrong"[112]. However, it is also the case that such experiments indicate some kind of influence due to consciousness operating at a level much deeper and apparently independent of *individual* consciousnesses.

This insight indicates the necessity for adopting the Buddhist notion of the two levels of reality, one at a deeper level than the other. On this view there is a deep fundamental level of the 'epiontic' 'dream stuff' of reality which, being informational in nature must also have a nature which includes the potentiality for awareness and consciousness, and there is a 'higher' level at which the 'epiontic' functioning of the fundamental quantum 'dream stuff' creates informational structures which mediate and focus a fundamental informational minimalist awareness into fully individualized consciousnesses. The brains of sentient beings, on this view, would have to be conceived of as 'classical' structures of apparent materiality through which the deeper level of the quantum informational ground produces fully manifested consciousnesses within an apparently 'material' world. To a large extent Zurek 'epiontic' 'quantum Darwinism' perspective is a restatement and improvement, as it has greater detail of the mechanisms involved, of David Bohm's notion of a nondual 'implicate order' which 'unfold' into an 'explicate order'. According to Bohm:

> If matter and consciousness could in this way be understood together, in terms of the same general notion of order, the way would be opened to comprehending their relationship on the basis of some common ground. Thus we could come to the germ of a new notion of unbroken wholeness, in which consciousness is no longer to be fundamentally separated from matter.[113]

According to Bohm this 'common ground' was the quantum 'implicate order.' Furthermore, the fact that the ground of reality must be of the nature of consciousness is indicated by Bohm in terms of the implicate order:

> … consciousness has to be understood in terms of an order that is closer to the implicate than it is to the explicate. … The question which is arises here, then, is that of whether or not (as was in a certain sense anticipated by Descartes) the actual 'substance' of consciousness can be understood in terms of the notion that the implicate order is also its primary and immediate actuality.[114]

A similar observation is made by d'Espagnat:

> …some data are now available that tend to suggest that, far from being a mere efflorescence from neurons, thought has structures that might be, somehow, directly connect to those of 'the Real.' … They consist of a kind of parallelism between, on the one hand, the structures of thought and, on the other hand, the structures of quantum mechanics…[115]

On this view the brain itself is a manifestation of the functioning of deeper levels of 'implicate' epiontic' functioning (figure 15).

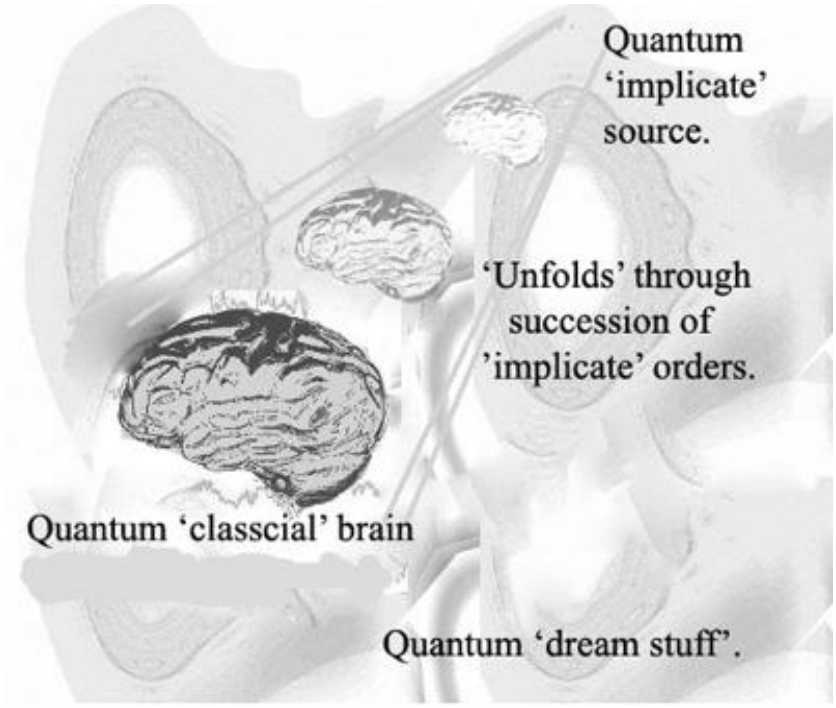

Figure 15

Returning to Zurek's description, the end section of the the quote we are elucidating (see above) states that:

> Any correlation is a registration; any quantum state is a record of some other quantum state. When correlations are robust enough, or the record is sufficiently indelible, familiar classical of "objective reality" emerges from the quantum substrate.

Here Zurek indicates that beneath the upper levels of individuated consciousness, which are mediated and individuated by the brain, the 'epiontic' 'quantum substrate' is somehow constantly 'registering', or 'correlating, or interacting, or exchanging information, and only 'when correlations are robust enough' does a 'classical' reality emerge. Thus the emergence of the classical world depends on the solidification, so to speak, of a natural internal process of self-registration. Wheeler, of course, referred to this epiontic process as a form of internal quantum self-perception, a characterization which is fully justified by Zurek's description of the mechanism of 'einselection' which underlies decoherence from the state of coherent quantum superposition to classical reality:

> …einselection is caused by the transfer information about selected observables. Hence, the ontological features of the state vectors - objective existence of the einselected states - is acquired through the epistemological "information transfer".[116]

A crucial aspect of this process is the way in which there is an appearance of 'objectivity' between observers within the emergence of the classical realm. As Zurek points out if one focuses on the situation of an individual observer 'collapsing' a quantum soup of potentiality into actuality:

> …one can make a persuasive case that such states are subjective, and that quantum state vectors are merely records of the observer's knowledge about the state of a fragment of the universe …. However, einselection is capable of converting such malleable and "unreal" quantum states into solid elements of reality.[117]

So here we have an answer to Penrose's question as to how "unreal" quantum events can produce reality (see above), it is through the process of 'einselection'. But what exactly is 'einselection'. This is where the 'Darwinism' is brought into the quantum realm:

> … the appearance of the classical reality can be viewed as the result of the emergence of the preferred states from within the quantum substrate through the Darwinian paradigm, once the survival of the fittest quantum states and selective proliferation of the information about them throughout the universe are properly taken into account.[118]

The insight that Zurek has given is that 'states that exist are the states that persist' and this is a persistence within a quantum realm which consists of, as Zurek puts it, 'the dream stuff which reality is made of'[119]; and the mechanism that underlies this persistence is 'an objective consequence of the relationship between the state of the observer and the rest of the universe'[120]. In other words the more often a particular quantum state is observed, or 'registered', to be a particular way the more likely it will be to be observed in the same way in the future. Zurek describes his view as follows:

> The main idea of quantum Darwinism is that we almost never do any direct measurement on anything … the environment acts as a witness, or as a communication channel. … It is like a big advertising billboard, which floats multiple copies of the information about our universe all over the place.[121]

In another paper Zurek wrote that:

> In our quantum universe the environment is promoted from a passive role of a reservoir selecting destroying quantum coherence to an active role of an amplifier selectively proliferating information about the system.[122]

In other words there is an internal *amplificatory* tendency within the epiontic functioning of the quantum realm, and the central features within this process that are amplified are the individualized consciousnesses of the sentient beings doing the observations, presumably reaching a pinnacle (excluding undiscovered planets) with the development of the apparent self-awareness of human beings, and the apparent solidity of the 'advertising billboard' of the material world.

It would seem then that the entire epiontic process of the evolution of reality is geared towards the production of ever greater levels of sentient awareness and the material world is an 'advertising billboard' for a realm of solidity amidst the 'unreal' 'dream stuff' of the quantum realm within which individualized consciousness can grow to fruition. And the reason that the apparent solidity of the apparently material universe comes into being is

because the universe is nothing more than an enormous and multitudinous ultimately *immaterial* epiontic information exchange which takes place within the quantum 'dream stuff is made of'. So, although Chown is to a certain extent correct when he writes that:

> The Moon, for instance, is continually impressing itself on its environment because photons - particles of sunlight - are constantly bouncing off its face and flying away into the night. Sooner or later, they impress themselves on everything in the environment from the Earth to the distant stars to the human eye. And it is in these bodies – large collections of atoms - that any weird quantumness of the Moon is lost. Einstein asked: 'Is the Moon there when nobody looks? The answer is yes - because the presence of the Moon is continually being recorded by the Universe itself.[123]

But Chown is missing the essential point of it all in more ways than one. This is because the only reason that the universe is able to 'record' or 'observe' or 'perceive' itself is that it is made of quantum epiontic 'dream stuff'.

How illuminating it is that Chown's 'resolutely' anti-mystical vision of the multitudinous information carrying photons bouncing around from one end of the universe to the other, transferring information from one end to the other and back again, thus keeping the Moon resolutely real, is mystically analogous to the Buddhist Hua-yen metaphysical vision:

> There is a wonderful net which has been hung by some cunning artificer in such a manner that it stretches out indefinitely in all directions. In accordance with the extravagant tastes of deities, the artificer has hung a single glittering jewel at the net's every node, and since the net itself is infinite in dimension, the jewels are infinite in number. There hang the jewels, glittering like stars of the first magnitude, a wonderful sight to behold. If we now arbitrarily select one of these jewels for inspection and look closely at it, we will discover that in its polished surface there are reflected all the other jewels in the net, infinite in number. Not only that, but each of the jewels reflected in this one jewel is also reflecting all the other jewels, so that the process of reflection is infinite.[124]

This is the infinitely creative interdependent realm of quantum Epiontic Mindnature.

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[24] Smolin, Lee (2002) p53
[25] Veiled Reality xvi
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[27] The Beautiful Invisible: creativity, imagination, and theoretical physics – Giovanni Vignale; p214
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[33] The Beautiful Invisible: creativity, imagination, and theoretical physics – Giovanni Vignale; p32
[34] Sara McClintock's term
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[36] Cited in Baggott, Jim (2005) p239
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[56] Quantum Reality: Theory and Philosophy; Allday, Jonathan p26
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[64] Oerter, Robert (2006) p49
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[75] Penrose, Roger (1999) p293
[76] Stapp, Henry (2004) p223
[77] No Quantum Jumps p5
[78] Never-Ending Days p82
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[100] Never-Ending Days p88
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