Article

The Experiential Basis of Wave-Particle Duality and The Uncertainty Principle

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ABSTRACT

In this article, physical reality as a whole is defined, thereby revealing the actual nature of physical reality to be that of a boundary created by a relation, as that boundary is apprehended from one side of the relation that brings it into existence. The reason we can't pin down a specific physical reality, i.e., completely define any physical reality, is because in doing so we are trying to pin down what is effectively a miniature rainbow, trying to pin down that which is actually only the product of a relation, trying to pin down something that, in the final analysis, is not at all or in any way what is actually there, but only seems to be what is actually there. However, while we cannot ever pin down any specific physical reality for the reasons mentioned above, we can pin down the nature of physical reality as a whole. We cannot get to the end of a rainbow, because rainbows only appear to have an end. However, we can understand the true nature of the rainbow and understand how it is created and why it appears as it does. In the same way, although we cannot pin down any specific physical reality, we can understand the nature of physical reality as a whole, how physical reality is created and why physical reality appears as it does, if we are able to understand what it is that the phenomena of wave-particle duality and uncertainty are actually telling us about the nature of physical reality.

Key Words: wave-particle duality, Uncertainty Principle, physical reality, relation, boundary.

1. Introduction

The purpose of this paper is to present a model of experience that explains the basis of both wave-particle duality and the uncertainty principle. This model will demonstrate that wave-particle duality and the uncertainty principle both exist as unavoidable consequences of the process that must occur in order for there to exist any experience of physical reality. Understanding the experiential mechanism underlying the existence of these phenomena will serve to clarify what these phenomena tell us about the nature of experiential reality in general, and physical reality in particular.

Wave-particle duality refers to the duality of experience that is encountered when attempts are made to observe the fundamental character of the smallest components of physical reality, e.g., an electron or photon. When observed, these components can be experienced to exist as either a particle or a wave, but never both at once. Furthermore, the characteristic that is experienced is

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determined by the experimental setup being used to observe them, indicating that the experiencer is somehow responsible, at least in part, for the nature of the observed experiential reality.

The uncertainty principle, stated in a most general way, refers to the fact that *t*he more precisely one property of something is measured the less precisely the opposite or complementary property of that same something can be simultaneously measured. For example, the more precisely one measures the position of an electron the less precisely one is able to simultaneously measure its momentum.

Prior to the discovery of wave-particle duality, material and energetic stuff was thought to exist in either a defined wave state or a defined particle state, but not both, since these are mutually exclusive states of being. That is, if something existed in one state then it could not, by definition, exist in the other state. For example, if you are hot then you are also not cold, if you are up, then you are also not down. Likewise, it was assumed that if something was a wave, then it was not particulate, and vice versa. As it turns out however, if quantum realities are looked at in different ways then they can appear to be what before they were not.

It is non-sensical that something can be experienced to exist in two mutually exclusive states depending upon the method used to experience it. This would be as if when you stuck your hand in a bowl of water with palm upturned it felt hot, then removed it from the water and quickly stuck the same hand back in the same bowl of water with palm downturned and then felt it to be cold. If such experiences occurred in everyday sensory perception we would have the same apparent something, in this case the bowl of water, existing in opposite and mutually exclusive experiential states depending upon our direction of approach and interaction. Of course, this experiential variability and duality does not occur in everyday sensory perception, which is precisely what makes its occurrence at the quantum level literally non-sensical, i.e., not in accord with sensory experience.

Wave-particle duality and the uncertainty principle are both fundamental components of quantum mechanics. Although wave-particle duality was discovered approximately 100 years ago, its basis has remained unknown.[i] Likewise, the basis of the uncertainty principle, now over 80 years old, remains obscure.[ii] Because the basis of these phenomena remains hidden, what quantum mechanics says about the nature of physical reality itself remains hidden.

The basis of these phenomena has, until now, remained unknown because these phenomena have generally been examined as physical phenomena rather than as experiential phenomena. That is, the answer to the riddle these phenomena present has been sought in some physical mechanism, when in actuality the underlying mechanism is purely experiential, which is to say, a function of the way in which physical experience is created, a function of what is referred to herein as the *experiential process*.

A wave is a physical phenomenon, a particle is a physical phenomenon, but wave-particle duality as a whole is an experiential phenomenon, as is the uncertainty principle. What this means is that the phenomena of wave-particle duality and uncertainty do not present themselves owing to the nature of what is actually and directly there, but rather present themselves owing to the nature of the experiential process, i.e., as an unavoidable result of the way in which our experience of

physical reality comes to exist. What this means is that we do not need to know what it is that is there in order to understand these phenomena. Rather, all we need to know in order to understand these phenomena is the mechanism by which physical experience is produced. This is because these phenomena, as will be described, have as their most proximal basis the limitations inherent in the mechanism responsible for the creation of physical experience, which is to say, the limitations inherent in the experiential process.

All physical reality exists as an experience of that reality. We know nothing of physical reality other than that which has been experienced as such. That is, something is only a physical reality in as much as it exists as an experience, as an experiential reality. So more fundamental than the physical reality itself is the mechanism by which the physical reality comes to exist as an experiential reality. If we seek to understand the basis of wave-particle duality and the uncertainty principle in physical terms, i.e., in terms of some physical mechanism, we will be forever thwarted, because these phenomena have as their basis the process by which physical reality comes to exist as an experiential reality, and so have as their basis a process that must itself be non-physical, being the process that gives rise to or creates physical experience. Put another way, the phenomena of wave-particle duality and uncertainty do not exist as a function of some characteristic or attribute of whatever it is that is actually and directly there, but rather these phenomena exist as a function of the process whereby experience is derived from whatever it is that is actually and directly there. Therefore, in order to understand why the phenomena of wave-particle duality and uncertainty exist, we must first understand how the experience of physical reality is created.

2. Experiential Mechanics I: The Experiential Process

In order to understand the experiential basis of both wave-particle duality and the uncertainty principle we must first understand what the creation of any physical experience most fundamentally involves. What the creation of any physical experience most fundamentally involves is an interaction. This factor is constant. Where there is no interaction there is no experience, physical or otherwise.

What is it that interacts to form physical experience? Whatever it is that exists prior to physical experience, in the absence of physical experience, or underlying physical experience. I call whatever it is that exists prior to, in the absence of, or underlying physical experience, *pre-physical reality*.

Having defined these parameters, it can now be said that the creation of physical experience most fundamentally involves some interaction occurring within pre-physical reality. As an interaction is a form of relationship, it can then be said that the creation of physical experience most fundamentally involves some relationship occurring within pre-physical reality, which is to say, some relation pre-physical reality forms with itself, and out of which relation is produced a physical experience.

In order describe how pre-physical reality forms a relationship with itself, and in so doing creates physical experience, we must make one assumption regarding the nature of pre-physical reality,

one assumption regarding the state of what it is that is there prior to, in the absence of, and underlying physical experience. That assumption is that pre-physical reality exists in a state of *differentiation*.[1] Differentiation means that there exists relative difference in the context of an underlying unity. Your body is a differentiated reality. The thumb is different from the index finger, but they are also inseparable parts of the whole that is you. Because they are in this way different, and yet of the same essential nature, they are able to interact, to form a relationship, without altering their underlying unity, as occurs when the tip of one of these fingers touches the other.

Thus, in assuming that pre-physical reality is differentiated we are saying that whatever it is that exists prior to, in the absence of, or underlying physical experience can be considered as an indivisible whole, and that it is also not everywhere arranged in the same way. As an analogy, the difference between the thumb and index finger is not in what is there, for both are composed of the same essential energies and molecules, as it were. Rather, the difference between the thumb and index finger is a function of the differences in how what is there is arranged in relation to itself. Likewise, it is differences of arrangement in what exists as pre-physical reality that make possible the relationships that produce physical experience. Put another way, it is the differentiation of pre-physical reality that allows the experiential process to function, and as a result produce physical experience.

We will now examine how the differentiation of pre-physical reality allows pre-physical reality to form a relationship with itself, and in so doing produce physical experience. To get a better idea of how a differentiated reality can form a relation with itself, consider again your thumb and index finger. There is no real line between the thumb and index finger where one stops and the other starts. They are different aspects of the same whole that is your hand. Now touch the tip of the fingers to each other. Where they meet there is now a boundary that defines each in relation to the other. They are whole, undivided, and yet because they are different they can form this new relationship. This type of relationship, which can occur between differentiations of pre-physical reality, will be referred to as an *impactive interaction* or *impactive relationship*.

Because what exists where the thumb and index finger are can not occupy the same area of space simultaneously, where they meet they impact each other, each trying to push the other out of that space. In the same way, when differentiations of pre-physical reality meet and can not occupy the same space, as is occurring in the meeting of the thumb and index finger, they impact each other, resulting in the creation of a boundary that defines each in relation to the other. As will be shown, such impactive interactions between differentiations of pre-physical reality are the basic mechanism underlying the creation of any physical experience, and so are also the basic mechanism underlying the creation of our experience of physical reality as a whole.

As already stated, the entire process, whereby physical experience is produced as a result of impactive relations occurring within pre-physical reality, will be referred to as the experiential process. In general, the experiential process involves differentiations of pre-physical reality

[1] A detailed examination of the differentiation of pre-physical reality that occurs prior to the creation or emergence of physical experience was presented in Part 1of my book, "Unified Reality Theory: The Evolution of Existence Into Experience," pps. 15-73.

coming in relation to each other, resulting in the creation of a boundary that defines these differentiations in relation to each other. The way the experiential process produces a physical experience is diagramed in **figure 1**.

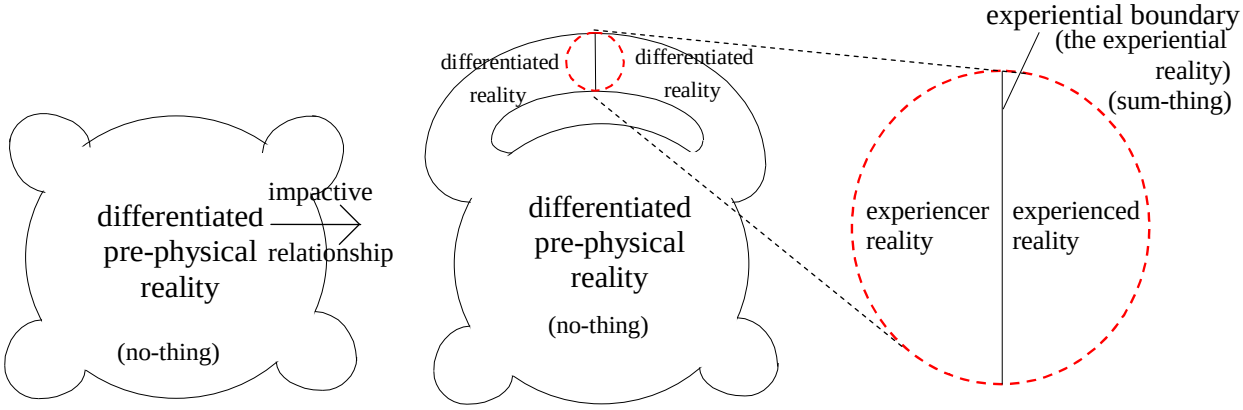

Figure 1 The Experiential Process Modeled as Differentiations of Pre-Physical Reality Forming Relations With Each Other.
These drawings illustrate how differentiations of pre-physical reality can impact each other, resulting in the creation of a boundary whereby the differentiations involved become defined in relation to each other. *(Left)* The undivided circle represents pre-physical reality, where there exists differentiation, denoted by the extensions, but no division. *(Center)* This drawing shows two differentiations of pre-physical reality as they form an impactive relation, giving rise to a boundary that defines each in relation to the other. *(Right)* This drawing is a close up of the impactive relationship, showing the relation between the experiencer, the experienced reality, as well as the boundary that arises as a result or product of that relation.

In figure 1 it can be seen that as differentiations of pre-physical reality impact each other, an experiencer-experienced relationship is established between the differentiations of pre-physical reality involved in the relation. That is, the experiencer and the experienced reality consist of the two differentiations of pre-physical reality that have become defined in relation to each other as a result of their impactive interaction or relation. The boundary or line that defines the relation of each to the other will be called the *experiential boundary*. The experiential boundary is created as a result or product of an impactive relation and only exists in the context of that relation. As will be shown, *it is the experiential boundary, as that boundary is apprehended from the experiencer side of the impactive relation, that is itself what is perceived as the physical experience*. And while the immediate purpose of this paper to explain the basis of both wave-particle duality and the uncertainty principle, the larger purpose in explaining the basis of these phenomena is to provide evidence that all physical experience, rather than being in any way what is actually and directly there where the physical experience seems to be, is actually the experiential boundary, as that boundary appears from one side of the relation that brings it into existence.

The drawings in figure 1 also depict how a physical something extends from the underlying pre-physical no-thing. As differentiations of pre-physical reality become defined in relation to each

other as a result of their involvement in an impactive relation, the boundary that defines their relationship is literally a sum-thing (i.e., something), since that boundary is the product of the interaction of at least two differentiations that are themselves no-thing, which is to say, not physical things. Here no-thing does not mean no existence, or the absence of existence, rather it means existence that is not perceptible as a physical thing, since whatever exists at the pre-physical level of reality is, by definition, not physical and so not a thing, or at least not a physical thing, regardless of any differentiation occurring at the pre-physical level. In a very real way, the experiential process involves making something out of nothing, i.e., sum-thing out of no-thing, and so the creation of every physical experience is, in a way, analogous to pulling a rabbit out of a hat. However, as is the case with all magic tricks, underlying the apparent magic is an actual mechanism, and it is that mechanism which we are now in the process of describing.

Having defined the experiential process along with its components, we are now in a position to describe how the phenomenon of wave-particle duality is created as a result of that process. Once that has been accomplished, that same process will be used to describe the phenomenon of uncertainty.

3. Experiential Mechanics II: How the Experiential Process Creates Complementary Wave and Particle Experiences

As one differentiation of pre-physical reality forms an impactive relation with another differentiation of pre-physical reality, bringing into existence an experiential boundary that defines these differentiations in relation to each other as experiencer and experienced reality, there are only two fundamental ways that these differentiations of pre-physical reality can become defined in relation to each other. Those two fundamental ways are that the differentiation of pre-physical reality that ultimately becomes or functions as the experiencer pole in any impactive relation can either 1) *penetrate* or 2) *be penetrated by* the differentiation of pre-physical reality that ultimately becomes or functions as the experienced pole in that same impactive relation. Each of these two fundamental types of impactive relationships that can exist with respect to the experiencer pole, i.e., penetrating and penetrated, corresponds to opposite and so complementary forms of the experiential boundary with respect to the experiencer pole.

Specifically, an impactive relation where the experiencer is penetrated by the experienced reality results in the creation of a particle experience. Conversely, an impactive interaction where the experiencer penetrates the experienced reality results in the creation of a wave experience. These two fundamental impactive relationships and the complementary wave and particle experiences they produce are diagrammed in **figure 2**.

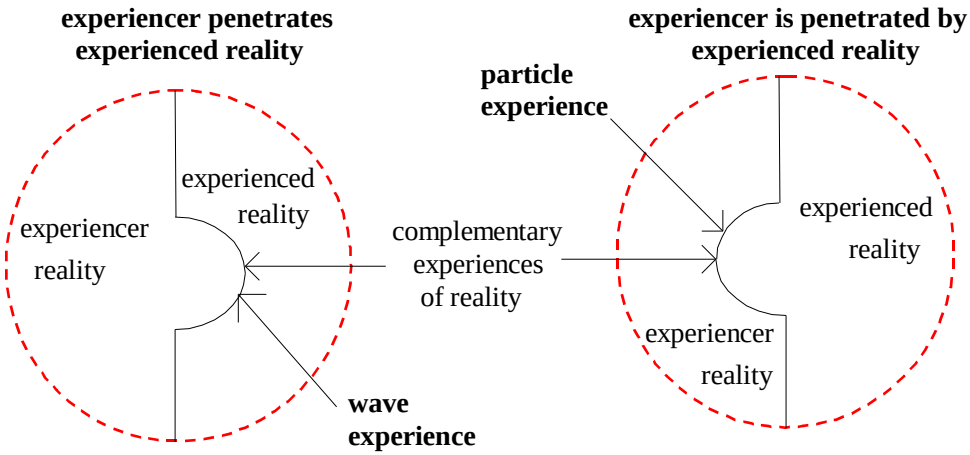

Figure 2 How the Two Fundamental Impactive Relations Produce Complementary Wave and Particle Forms.
These drawings are close ups of two different impactive relations and depict the complementary forms the experiential boundary can assume when differentiations of pre-physical reality become involved impactive relations and become defined in relation to each other as experiencer and experienced poles. *(Left)* If the impactive relation results in the differentiation of pre-physical reality that has become defined as the experiencer penetrating the differentiation of pre-physical reality that has become defined as the experienced reality, then the experiencer will apprehend or experience the boundary that defines that relation as a wave. *(Right)* Conversely, if the impactive relation results in the differentiation of pre-physical reality that has become defined as the experiencer being penetrated by the differentiation of pre-physical reality that has become defined as the experienced reality, then the experiencer will apprehend or experience that boundary as a particle.

What figure 2 shows is that the physical experiences of both wave and particle are not other than the experiential boundary as it is apprehended from the experiencer pole of the impactive relationship that brings it into existence. Therefore, the form that the physical experience takes as wave or particle is not a result or function of what is there as the experienced reality, but rather is a function of the relation between the two differentiations of pre-physical reality involved in the impactive relation. Put another way, whether something appears as a wave or particle says far more about the nature of the relation that's creating the specific physical experience than it does about the actual nature of what's there.

In summary, the form of the experience as either wave or particle is a function of the form of the experiential boundary itself, relative to the experiencer, as it either projects into the experiencer, existing then as the experience of a particle-form, or as it projects into the experienced reality, existing then as the experience of a wave-form.

Physical experience is the product of an impactive relationship. The most basic or fundamental impactive relationship has only two possible fundamental configurations, which are complementary, creating two possible fundamental physical experiences, which are also

complementary. For this reason, we are bound to experience physical reality as existing most fundamentally in either a wave form or a particle form, not because either a wave or a particle is what is actually there directly as the experienced reality, but rather owing to the mechanics of the process by which physical experience is created.

What evidence can be presented that the penetration of the experiencer pole by the experienced pole creates a particle experience, while the penetration of the experienced pole by the experiencer pole creates a wave experience? If we impact something that is softer than ourselves we penetrate it, and we see a wave-form originate from that point of penetration. Conversely, if we impact something that is harder than ourselves it penetrates us, and what we experience is particulate. For example, stick your finger in a cup of water and you will see a wave-form appear as you penetrate the experienced reality. Freeze that cup of water and then try to stick your finger in again. Now you will experience a particulate reality because the experienced reality is penetrating you, the experiencer. These complementary relationships are fundamental to the creation of any physical experience.

Again, the physical experience itself, e.g., wave or particle, is not what is there directly. Rather, the physical experience is the experiential boundary as apprehended from only one side of the impactive relation that brings it into existence. The character or form of the physical experience as either a wave or particle is a function of the relationship that exists between the two areas of differentiated pre-physical reality that are impacting each other, and in so doing creating an experiential boundary while at the same time becoming defined in relation to each other as experiencer and experienced poles of reality.

Thus, the physical experience does not exist independent of either the experienced reality or the experiencer, since the physical experience is the form that arises out of the relationship between the two, as that form is apprehended from what becomes defined as the experiencer side of the impactive relation occurring within differentiated pre-physical reality.

Before we relate this same experiential process to the uncertainty principle, we will first examine some related issues that will serve to both clarify this process and provide further evidence that the experiential process, as is being described herein, is the source of wave-particle duality.

4. Why Wave-Particle Duality Reveals Itself In The Quantum Realm

If all physical experience is the product of an impactive relationship, why then do we not experience the phenomenon of wave-particle duality as a part of our everyday experience of physical reality? Why was it not until scientists were examining very tiny things, subatomic things, that the phenomenon of wave-particle duality presented itself? These questions will now be answered, and in so doing evidence will be provided that wave-particle duality is indeed an inescapable result of the fact that physical experience is created as the product of impactive relationships involving differentiations of pre-physical reality.

Although we do not experience wave-particle duality as part of our normal sensory experience, all sensory experience does have a duality, or a complementarity. Through our senses we

experience soft or hard, hot or cold, light or dark, quiet or loud, etc.. The difference between these sensory dualities and experimentally produced wave-particle duality is that in normal sensory experience the experiential character of a given object remains the same regardless of approach. For example, no matter how you examine a rock it behaves like a rock, i.e., hard and particulate. Conversely, what an electron seems to be, i.e., wave-like or particle-like, changes with approach or method of experimental interaction.

In order to understand the difference between sensory experience and experimental experience we first need to relate differentiated pre-physical reality to the concept of a continuum. To do so we will consider a length of string as a continuum that represents the continuum of differentiated pre-physical reality. Like differentiated pre-physical reality, a string is whole, continuous, and yet it has different areas. When the string-continuum is folded back on itself this creates a relationship between two different areas of the string-continuum. The relationship created by folding the string-continuum back upon itself is analogous to the impactive relationship differentiations of pre-physical reality form with each other as part of the experiential process (see figures 1 and 2).

Thus, the experiential process can also be depicted as a *reality continuum* folding back on itself, impacting itself, forming a relationship with itself, becoming defined in relation to itself, as diagrammed in **figure 3**. Modeling the experiential process in this way will allow us to see the sameness of process that is responsible for physical experiential duality in general, while also allowing us to understand the differences within that process that are responsible for the difference in the way sensory and experimental dualities manifest as physical experiences.

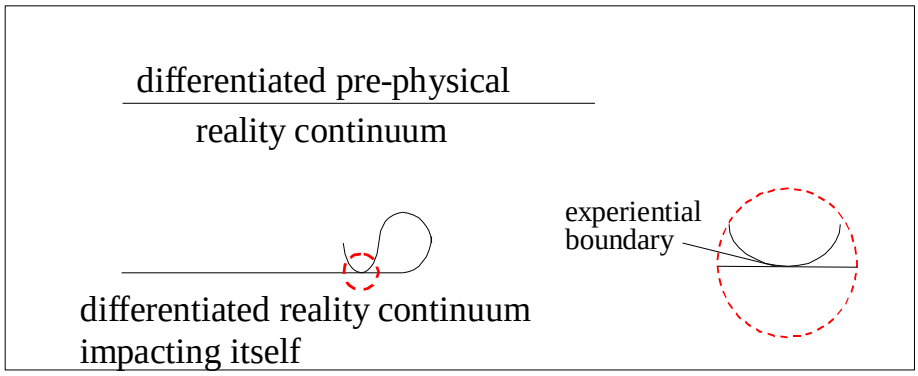

Figure 3 The Experiential Process Modeled as a Reality Continuum Forming an Impactive Relation with Itself.
In this drawing, differentiated pre-physical reality is depicted as a continuum, and physical experience is again represented by the boundary that is created when that continuum becomes defined in relation to itself through an impactive relation, which impactive relation is depicted as the reality continuum folding back on itself. The creation of both sensory and experimental experience can be depicted as resulting from relations of this reality continuum with itself, and depicting the creation of these two sorts of physical experience in this way will provide us with a basis for understanding

the difference between how sensory duality is created and how experimental duality is created.

Organic physical sensors, e.g., the retina and the eardrum, are what they are, and as such their position along the reality continuum is not variable.[2] That is, individual organic physical sensors occupy a stable or non-variable position at some point along the reality continuum because organic physical sensors represent relatively stable differentiations of pre-physical reality. Conversely, experimental sensors can be made of this or that, or set up like this or that, and as this or that experimental sensors represent variable differentiations of pre-physical reality, which then have variable positions along the reality continuum.

It is this stable or non-variable positioning of organic physical sensors at some point along the reality continuum, versus the variable positioning of experimental sensors at some point along the reality continuum, that distinguishes sensory experience from experimental experience. In sensory experience we have organic physical sensors that occupy stable or non-variable positions along the reality continuum impactively interacting with variable differentiations of the reality continuum to produce a physical experience. Conversely, in experimental experience we have experimental sensors that occupy variable positions along the reality continuum impactively interacting with a stable or non-variable differentiations of the reality continuum to produce a physical experience.

It is this difference between the stability and variability of the experiencer differentiation in relation to the differentiation being experienced that is responsible for the difference between the experiential duality manifested in sensory experience, where the experiential process consistently produces only one of two complementary physical experiences, and the experiential duality manifested in experimental experience, where the experiential process can produce one or the other complementary physical experiences, depending on the experimental setup. These differences and their experiential consequences are diagrammed in **figure 4**.

[2] Organic physical sensors are here referred to as "physical" not because they are themselves physical, as that is only their appearance, but because they help to create physical experience by providing a means through which differentiations of pre-physical reality can become involved in impactive relations.

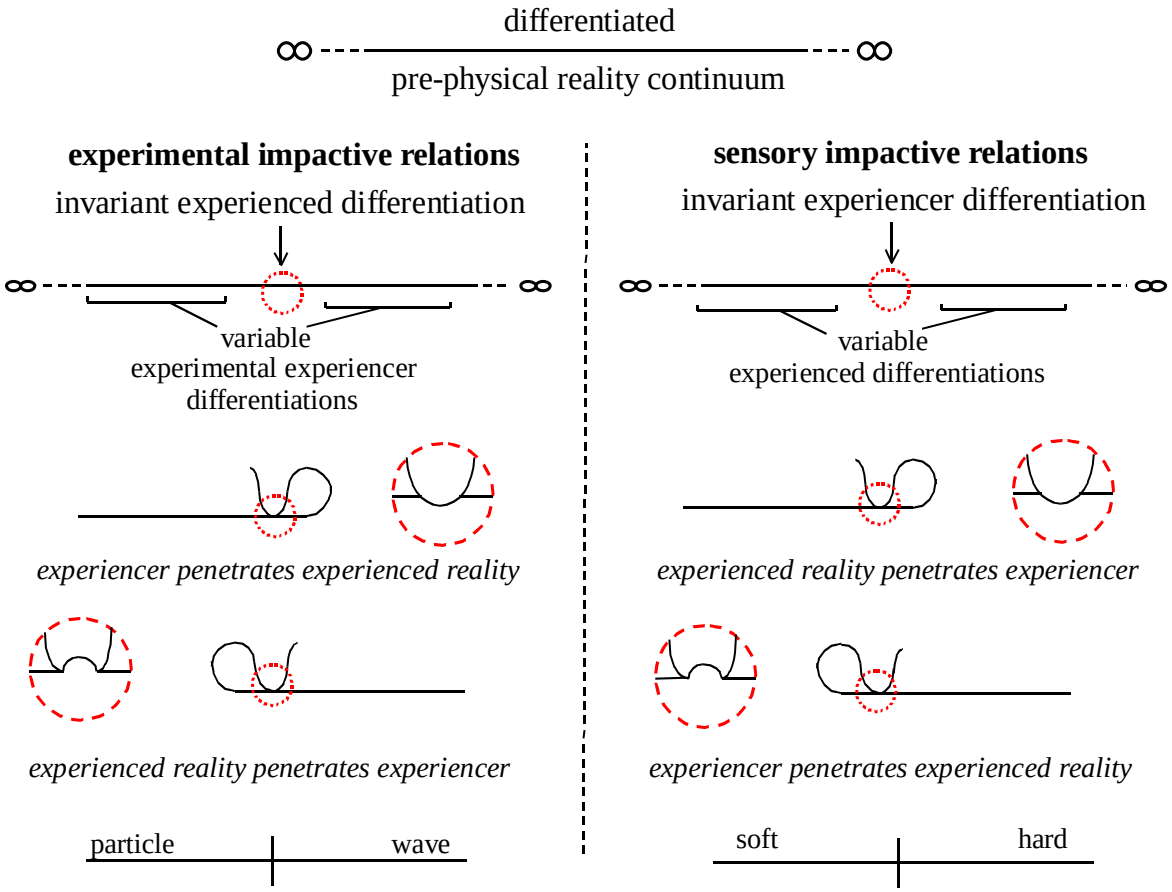

Figure 4 The Difference in How the Experiential Process Produces Experimental Experiential Dualities and Sensory Experiential Dualities.
This drawing depicts the differences between the impactive relationships involved in creating experimental experience and everyday sensory experience when the experiential process is modeled as impactive relations occurring between different areas of a reality continuum. *(Left)* In experimental experience the position of the experimental sensor (experiencer) along the reality continuum is variable. For this reason different experimental sensors can occupy positions on either side of the continuum with respect to the differentiation of pre-physical reality they are designed to interact with. *(Right)* In contrast, in everyday sensory experience our organic sensors are the mechanisms of interaction, and those mechanisms always occupy the same position along the reality continuum. So in experimental experience, variable experiencer areas interact with stable experienced areas, while in normal sensory experience the exact opposite is the case, in that non-variable experiencer areas interact with variable experienced areas. It is for this reason that experimental interactions can produce complementary wave and particle experiences through interaction with the same differentiation of pre-physical reality, while sensory interactions with the same differentiation of pre-physical reality produce a consistent experience, although these

experiences always represent one pole of an experiential duality, such as hard-soft, hot-cold, etc..

With respect to the reality continuum, in the case of a relatively stable and centrally located experiencer, as is the case in the creation of sensory experience, the experiencer's impactive relation with the reality continuum on one side will produce an experiential boundary that, from the perspective of the experiencer, has a form that is opposite or complementary to the form as it would appear to the experiencer, if that same experiencer were to be involved in an impactive relation with the other side of the reality continuum. It is for this reason that organic physical sensors always produce experience in the form of complementary, yet individually occurring physical experiences, e.g., hot or cold, hard or soft, loud or quite, etc.. Put another way, sensory physical experiences always come in complementary pairs not as a function of what's there, but as a function of the way physical experience is created as the product of an impactive relation occurring between what's there. That is, the unavoidable and pervasive complementarity of sensory physical experience corresponds to the complementary forms assumed by the experiential boundary, relative to the experiencer, as a relatively central and stable experiencer forms impactive relationships with differentiations of pre-physical reality positioned on opposite sides of the reality continuum, relative to its own central position along that continuum.

For the relatively stable experiencer, the experience of physical reality will be consistent, since the experiencer's relationship with differentiations of pre-physical reality along the reality continuum will also be consistent. That is, what is experienced as soft will upon reexperience remain soft, and what is experienced as hard will upon reexperience remain hard. (This assumes that the differentiation of pre-physical reality that is defined in the particular impactive relation as the experienced reality does not undergo some alteration between impactive interactions that changes its position along the reality continuum with respect to the experiencer, such as would be the case if water was frozen between impactive interactions.)

In the case of a relatively variable and peripherally located experiencer, as is the case in experimental experience, when the experiencer comes from one side of the continuum and forms an impactive relation with a more centrally located differentiation of pre-physical reality, such an impactive relation will produce an experiential boundary that, relative to the experiencer, has a form that is complementary to the form that would be produced if an experiencer from the other side of the reality continuum were to form an impactive relation with the same centrally located differentiation of pre-physical reality. For this reason, a variable experiencer, as can be made to occur in experimental experience, also experiences physical reality in the form of complementary, yet individual experiences, such as wave and particle or position and momentum, corresponding to the complementary forms assumed by the experiential boundary relative to the variable experiencer.

However, unlike what occurs in the creation of sensory experience, the variable experiencer in experimental experience is able to produce physical experiences through inconsistent impactive relations with the same differentiations of pre-physical reality, since the variable experiencer's approach to a particular differentiation of pre-physical reality is itself not consistent, as it is able to approach first from one side and then from the opposite side of the reality continuum. That is, it is the oppositeness of approach afforded by experimental experience that produces

complementary experimental experiences, such as wave and particle, when forming an impactive relation with the same differentiation of pre-physical reality. Thus, what is experienced as particle can, upon re-experience, behave as wave, and what is experienced as wave can, upon re-experience, behave as particle. (This assumes that the differentiation of pre-physical reality that is defined in the particular impactive relation as the experiencer does undergo some alteration between impactive interactions that changes its position along the reality continuum with respect to the relatively centrally located experienced reality, such that it is now approaching and forming an impactive relation with the experienced reality from the opposite side of the reality continuum.)

The stable and so relatively central position of our individual organic sensors along the reality continuum functionally divides the reality continuum into opposite ends. And it is this functional division of the reality continuum into opposite ends that is the basis of the way we experience physical reality in the form of experiential opposites, such as hot/cold, soft/hard, light/dark, etc.. This is why what we experience as physical reality has far more to do with the way that physical experience is created than it does with the nature of what is actually and directly there where the physical experience seems to be. Consider a bowl of water that is below skin temperature. If you put your hand in it, you will experience cold. Now consider that same bowl of water heated to above skin temperature. If you put your hand in it, you will experience warmth. So while it seems to us that physical experience informs us about what's there, all it really does is inform us about the relation between what's here and there.

In contrast, in experimental experience it is the stable and so relatively central position along the reality continuum of the differentiations of pre-physical reality to be experienced that functionally divides the reality continuum into opposite ends. And it is this functional division of the reality continuum into opposite ends by the stable and centrally located experienced area in experimental experience that is the basis of experimentally produced wave-particle duality. Put another way, the relation of the centrally located experienced differentiation to the experiencer differentiations at opposite ends of the realty continuum creates opposite and so complementary physical experiences, of which wave and particle are the most fundamental sort.

Understanding the differences between sensory and experimental experience, as well as how the experiential duality inherent in each is created, we now are able to answer the question regarding why the phenomenon of wave-particle duality presents itself in experience at the quantum level, but not at the level of everyday sensory experience. That answer is presented in the following paragraphs.

When examining differentiations of pre-physical reality not amenable to our organic senses, as is the case in examining reality at the quantum level, experimental devices must be used as intermediaries in the formation of the impactive relation that provides us with the physical experience, which physical experience in these cases is called an experimental result, and is here called an experimental experience. When experimental devices are used to create a physical experience, the observer is not bound to one approach to the differentiation of pre-physical reality that they are attempting to observe. Thus, when experimental devices are used to form an impactive relationship with a differentiation of pre-physical reality, an observer can construct a device that approaches that differentiation from one side of the reality continuum, and they can

construct another device that approaches that differentiation from the opposite side of the reality continuum, and so create, as a product or result of those two different impactive relations, complementary experimental experiences. Specifically, in terms of the creation of wave-particle duality, an observer can construct one device that approaches the differentiation of pre-physical reality that will become defined as the experienced reality from the side of the reality continuum where it, as experiencer, penetrates the experienced reality, and the observer can construct another device that approaches the differentiation of pre-physical reality that will become defined as the experienced reality from the other side of the reality continuum where it, as experiencer, is penetrated by the experienced reality, and so create, as a product of those two different impactive relations, complementary wave and particle experiences, respectively. In this way, wave and particle experiences, or any pair of complementary physical experiences, can be experimentally produced through opposing impactive relations with the same differentiation of pre-physical reality.

By contrast, in sensory experience it is our organic physical sensors that are themselves the devices that form impactive relations with differentiations of pre-physical reality. Because these organic physical sensors, which themselves are not other than differentiations of pre-physical reality, function as relatively invariant differentiations, their position along the reality continuum is also relatively invariant with respect to the differentiations of pre-physical reality those sensors have evolved to form impactive relations with in order to produce their particular physical experience. Therefore, when we form an impactive relationship with (e.g., touch) a particular differentiation of pre-physical reality, say a differentiation that we ultimately experience as a rock, the relationship between the differentiation of pre-physical reality where we experience the rock to be and the differentiation of pre-physical reality where our organic sensor is, is itself invariant, and so produces a consistent and invariant physical experience. And so it is that we consistently create the same physical experience as a product of the same impactive relation, and so consistently experience what is there as a rock, as hard and particulate, when what is actually and directly there is neither hard nor particulate, as these physical characteristics are products of the experiential process, and have no existence whatsoever outside the context of the functioning of that process.

5. Why the Wave and Particle Experiences Cannot Be Created Simultaneously by a Single Observer

Having described how complementary wave and particle experiences are created as products of the experiential process, we will now explain why only one or the other of these physical experiences presents itself in any experimental situation. And really, if you have understood what has been explained up to this point regarding the nature of physical experience, the reason for this mutual exclusivity of simultaneous experience becomes (almost) self-evident. That is, once one understands what physical experience really is, i.e., a boundary that is created when two differentiations of pre-physical reality form an impactive relation, as that boundary is apprehended from only the experiencer side of that relation, it makes perfect sense that it would be impossible for a single observer to simultaneously create the experience of both wave and particle, because to do would require that a single observer or experimental device be

simultaneously involved in what are mutually exclusive relations with the same underlying differentiation of pre-physical reality.

Put more succinctly, in order for an observer to simultaneously create the experience of both wave and particle through interaction with the same differentiation of pre-physical reality, that observer would have to be in the impossible position of being involved simultaneously in what are mutually exclusive relations. Allow me to elaborate. As long as you are on someone's left, you are precluded from being on their right, i.e., it is not possible to be on their right as long as you are involved in a relation with them that places you on their left. As long as you are facing North, you are precluded from facing South, i.e., it is not possible to face South as long as you are involved in the geographic relation in which you face North. These are examples of mutually exclusive relations, meaning that if you are involved in one then you are not involved in the other.

Likewise, if you, as an observer, are in an impactive relation with a differentiation of pre-physical reality that is penetrating you, (and thereby producing a particle experience) then you, as an observer, are by definition not in an impactive relation with that same differentiation of pre-physical reality as you penetrate it (in which case what would be produced is a wave experience). These too are mutually exclusive relations. Therefore, as it is not possible for someone to simultaneously face both North and South, as these represent mutually exclusive relations, it is not possible for a single observer to be simultaneously involved in mutually exclusive impactive relations with the same differentiation of pre-physical reality in a way that would produce both a wave and particle experience. These mutually exclusive relationships and experiences were shown in figure 2**.**

In the final analysis, the phenomenon of wave-particle duality has as its basis the limitations inherent in the experiential process, which includes the limitation inherent in physical experience itself as something that is other than what is actually and directly there. Wave and particle forms cannot be brought into simultaneous existence by an observer interacting with a single or individual differentiation of pre-physical reality because what is experienced as physical reality is not what is actually and directly there where the physical experience seems to be. Rather, physical experience is the product of an impactive relation occurring between whatever it is that is actually and directly there, which here has been termed differentiated pre-physical reality, as the product of that relation is apprehended from only one side of that relation.

Having explained how the phenomenon of wave particle duality is produced by the experiential process, i.e., as a result of the way physical experience is created, we are now in a position to explain how the phenomenon of uncertainty is produced a result of that same process.

6. The Experiential Basis of the Uncertainty Principle

6.1 Background

Heisenberg's uncertainty principle, published in 1927, also called the indeterminacy principle, states that it is impossible to specify simultaneously the precise position and momentum of a

particle, such as an electron or photon. The theory further states that a more accurate determination of one quantity will result in a less precise measurement of the other. This principle is one of the foundations of quantum mechanics. What the uncertainty principle implies with regards to what quantum theory says about the nature of reality is still a topic of great debate.[iii]

In essence, the uncertainty principle refers to the fact that measuring precisely one aspect of a material phenomenon prevents the simultaneous precise measure of the complementary aspect of that same material phenomenon. That is, if you know just how fast something is going, you can not say exactly where it is, and conversely, if you know just where it is, you can not say exactly how fast it is going.

If this sounds a bit like the phenomenon of wave-particle duality, where the observation of one physical characteristic precludes the simultaneous observation of the complementary physical characteristic, that is because, as shall be described, uncertainty has as its basis the same inherent limitation of process as that which produces the phenomenon of wave-particle duality.

Although it is commonly taught in undergraduate physics courses that uncertainty results from the measurement of a particle's position affecting its momentum, and vice versa, this way of explaining uncertainty is inconsistent, as it must assume that a measurable and determinable position and momentum exist prior to their being observed. If you can understand that physical reality is a product of the experiential process, and that specifically it is the experiential boundary as apprehended from one side of the impactive relation that creates it, then you can understand that measuring position can not affect momentum, because momentum, or any physical characteristic, is not an inherent attribute of what's actually and directly there as the experienced reality. Rather, momentum, or any physical characteristic, is something that is superimposed upon what's there by the experiential process, causing what is actually and directly there to seem or appear to have the physical characteristic of momentum, or position, or particle, or wave, or hardness, or softness, etc. etc., much in the way that a reflection is superimposed upon the surface of water, causing what is there as water to seem to be or appear as something else, as something other than what is actually and directly there. Therefore, measuring position cannot affect momentum, not because until momentum is observed what is actually and directly there has no defined nor determinable physical characteristic called momentum, but because what is actually and directly there simply does not possess the physical characteristic of momentum, any more than water possesses the character of that which is reflected on its surface. The inconsistency inherent in explaining the basis of the uncertainty principle in terms of some mechanical interaction at the physical level was pointed out to Heisenberg by Neils Bohr.[iv]

Here we need to keep in mind that in forming a physical experience we are not interacting with a defined reality. Rather, in forming a physical experience we are interacting with a differentiation of pre-physical reality that becomes defined in relation to us as an experienced reality while we are simultaneously defined in relation to it as the experiencer. But we are not the experiencers of the experienced reality. That is, the experienced reality is not what we perceive as the physical experience. Rather, what we perceive as the physical experience is the boundary that is created where differentiations of pre-physical reality impact each other and becomes defined in relation to each other. Specifically, we are the experiencers of the experiential boundary, as that

boundary is apprehended from our side, i.e., the experiencer side, of the impactive relation that brings it into being.

Heisenburg himself ultimately felt that uncertainty was the product of some limitation inherent in nature, and in this he was very close to the truth. That is, uncertainty is the result of a limitation, but the limitation is not one inherent in nature itself, i.e., not a property of what's actually and directly there, rather, the limitation is one inherent in the way nature, i.e., what's actually and directly there, produces physical experience through relation to itself. And it is in this context that uncertainty will now be described as being the result of a limitation inherent in the experiential process, which is to say, a limitation inherent in the way physical experience is created.

6.2 The Difference Between Wave-particle Duality and Uncertainty

In uncertainty, as in wave-particle duality, we are dealing with complementary physical experiences, such as position and momentum. However, in uncertainty, unlike wave-particle duality, the situation is one of not being able to fully experience, i.e., fully define, opposite or complementary physical experiences, such as position and momentum. Thus, there is a slight difference between the experiential exclusivity found in wave-particle duality and that found in uncertainty, in that in wave-particle duality the creation and experience of one physical characteristic completely precludes the simultaneous creation and experience of the opposite or complementary physical characteristic, whereas in uncertainty, although there can be this *complete preclusion of the simultaneous creation of opposing or complementary physical experiences*, as occurs when one fully defines any one physical characteristic, such as position or momentum, and so can make no statement whatsoever regarding its opposite or complementary physical characteristic, it is possible to simultaneously create the experience of physical opposites, such as position and momentum. However, to reiterate, this simultaneous creation of physical opposites or complements can only occur if neither physical characteristic is itself fully defined, which is to say, is by itself not a complete or whole physical experience, such as occurs when position is partially defined and momentum is also partially defined.

Initially the fact that physical opposites can be simultaneously even partially experienced as the result of any single impactive relation, such as occurs when the position and momentum of some quantum reality are both partially defined, seems to go against or be counter to what has been described as the experiential process, since the physical experience itself has been said to be the experiential boundary as it is apprehended from only one side of the impactive relation that creates it. If this is indeed the case, which it is, then how can two opposing or complementary physical experiences be created at once, even partially, since this would seem to necessitate, according to the model of experience being presented here, the involvement of the experiencer simultaneously in mutually exclusive relations, which is, for reasons already described, simply not possible?

According to the model of experience being presented here, each impactive relation creates a single experiential boundary, and physical experience is that single boundary as apprehended from what becomes defined as the experiencer side of the impactive relation. So how can that

single boundary be apprehended simultaneously, even partially, from one side of the relation, as opposite or complementary physical experiences, such as position and momentum? How can a single experiential boundary, as apprehended from only one side, present the experiencer with opposite or complementary physical experiences? Put another way, if the complementary experiences of wave and particle are mutually exclusive, as a function of the limitations inherent in the experiential process, why are other complementary physical experiences, such as position and momentum, not completely mutually exclusive, but only partially so?

As will be described, the answers to these questions derive naturally from the experiential process as already described, with only a slight variation with regard to experimental impactive relations that create physical experiences other than wave and particle. In fact, the elegance of the way uncertainty is accounted for so naturally and effortlessly within this model of experience provides additional evidence of its veracity or accuracy. Put another way, the slight difference between the complete experiential exclusivity of wave-particle duality and the partial experiential exclusivity of uncertainty, rather than disproving the model of experience being presented herein, provides further proof of its overall veracity, both with regard what it says about the nature of physical experience, as well as what it says about the way in which physical experience is created.

6.3 Uncertainty as an Experiential Phenomenon

In explaining the experiential basis of the uncertainty principle, there is no need for a modified explanation regarding why completely defining one physical characteristic, such as position, precludes any degree or amount of simultaneous definition of the opposite physical characteristic, which in this example would be momentum, as this is the same mechanism and limitation as was described that makes impossible the simultaneous creation of wave and particle experiences in the context of a single impactive relation. That is, just as being involved in an impactive relation that creates a particle experience makes impossible being simultaneously involved in an impactive relation with the same differentiation of pre-physical reality that would create a wave experience, so to does creating the complete, i.e., fully defined, position experience make it impossible to simultaneously be in the relation needed to create the opposite or complementary experience, which in this example would again be the experience of momentum.

However, what does need a modified explanation is how it is even possible, in the context of the experiential process as described herein, to create opposing or complementary physical experiences or characteristics as the result of a single impactive relation. Either the model is wrong or there is something else going on regarding the impactive relations that create physical experiences other than wave and particle. And as you may have guessed, I am going to go with the latter explanation, i.e., that there has to be something else going on, some difference between the impactive relations that create the experiences of wave and particle and the impactive relations that create all other experimentally produced physical experiences, such as position and momentum. And once that difference has been identified and explained, the phenomenon of uncertainty will be shown to not only fit neatly into the model of experience already described, but will reinforce the idea of physical experience as being the product of a relation.

The difference between the experimental impactive relations that create the experience of wave and particle, and the experimental impactive relations that create all other experimentally produced physical experiences or characteristics, such as position and momentum, is in what will be called the level of relation at which the impactive relation that creates the experimental experience in question occurs. That is, the difference is not in the nature of the relation itself, as it is always an impactive relation that produces the experiential boundary, which when apprehended from the experiencer side of the relation becomes the physical experience. Rather, the difference is in the level of relation at which the impactive relation occurs.

The impactive relation that creates wave or particle is, as an impactive relation, unique. This impactive relation is unique because it is the most fundamental impactive relation, the first relation that creates what is apprehended as a physical experience. What this means is that it is not proceeded by, nor does it rest upon, the existence of any prior impactive relations. The experiences of wave and particle are the most fundamental physical experiences possible because wave and particle are products of the most basic impactive relations differentiations of pre-physical reality can form with each other.

On the other hand, experimental impactive relations other than those that create the wave and particle physical experiences will be called second level impactive relations, meaning that they are impactive relations that contain within themselves at least one other already present impactive relation. Specifically, experimental impactive relations other than those that create the wave and particle physical experiences contain within themselves, at the very least, the fundamental impactive relation that creates a particle or wave experience.

Why must this be so? Why must experimental impactive relations other than those that create the wave and particle physical experiences contain within themselves, at the very least, the fundamental impactive relation that creates a particle or wave experience? Because, in the absence of already having brought into being one or the other physical reality, i.e., wave or particle, there is literally no-thing, no physical reality, to define or characterize any further. Thus, the impactive relation that creates wave or particle is implicit in the impactive relations that produce physical characteristics or properties other than wave and particle. And it is within this framework that the uncertainty relations arise as products of the experiential process.

In a first level experimental impactive relation, i.e., one that creates wave or particle, two differentiations of pre-physical reality impact each other and produce either a wave or a particle experience. In a second level or higher experimental impactive relation, i.e., one that creates any other physical characteristic such as position or momentum, it is also two differentiations of pre-physical reality that impact each other in order to create the particular physical experience. However, the difference between the first level and second level or higher impactive relations is that in the second level or higher impactive relations, the differentiation of pre-physical reality that the experiencer is involved with in an impactive relation is itself already involved in the first level impactive relation that creates a wave or particle experience. Conversely, in the first level impactive relation that creates a wave or particle experience, the differentiation of pre-physical reality that the experiencer is involved with in that impactive relation is not itself already involved in any other impactive relation.

The difference between these two levels of impactive relation, i.e., first level and second level, is shown in **figures 5 and 6** below, both in terms of what has been depicted and described as the impactive relation of the reality continuum to itself, as well as in terms of what has been depicted and described as the impactive relation of differentiations of pre-physical reality with each other, as these are themselves two ways of depicting and describing the same process.

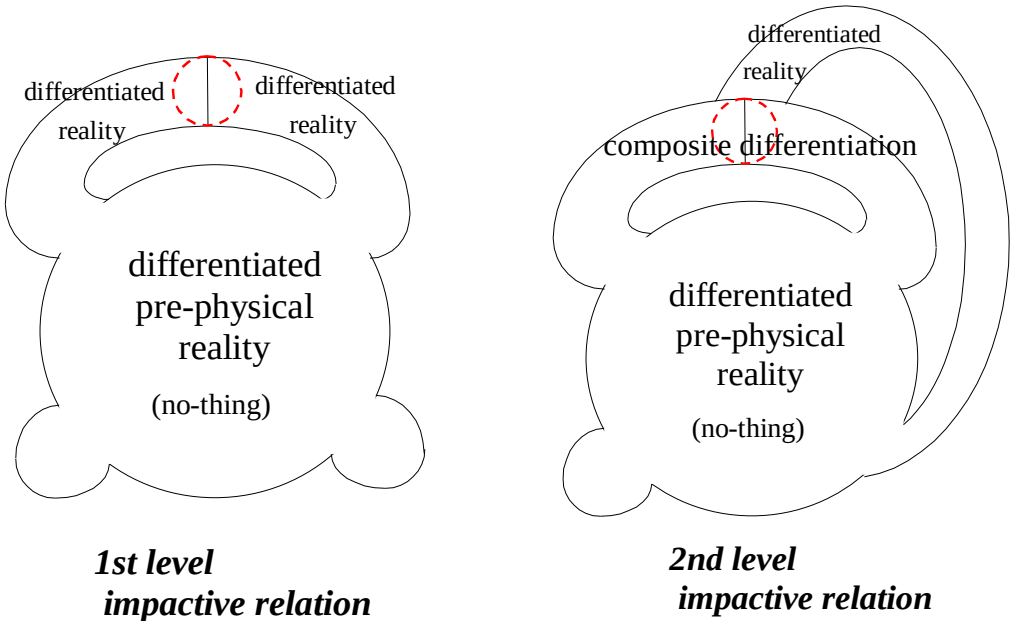

Figure 5 The Difference Between First and Second Level Impactive Relations When Depicted as Relations Occurring Between Differentiations of Pre-physical Reality.
In the drawing on the left, a first level impactive relation is depicted. In the drawing on the right a second level impactive relation is depicted. What these drawings show is that in a first level impactive relation, which is the sort that creates either a wave or particle experience, the differentiations of pre-physical reality that are impacting each other are not themselves involved in any other impactive relation, whereas in the second level impactive relation, which is the sort that creates physical characteristics other than wave or particle, such as position and momentum, one of the differentiations of pre-physical reality that is involved in this second level impactive relation is a *composite differentiation* of pre-physical reality, i.e., one composed of differentiations that are already involved in a first level impactive relation.

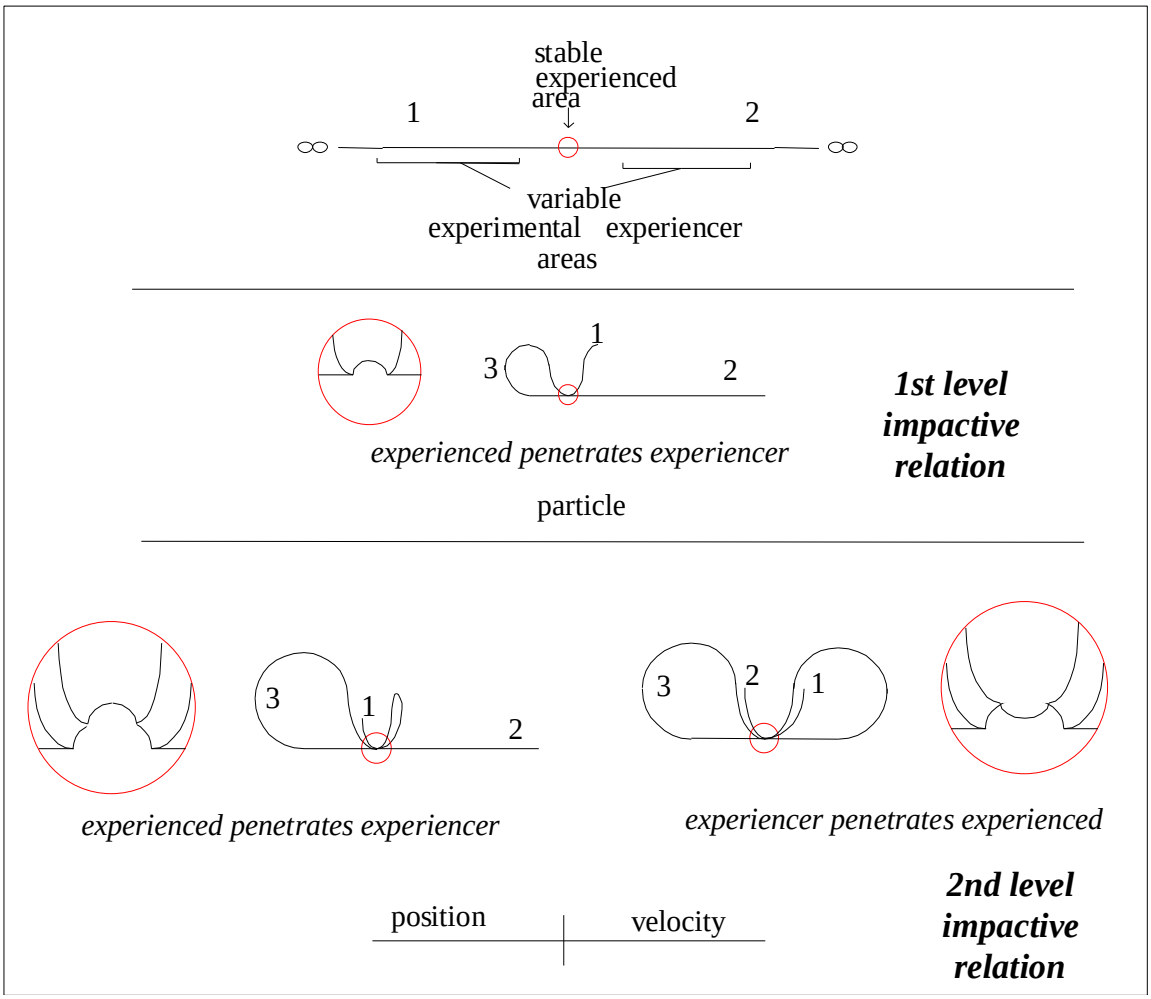

Figure 6 The Difference Between First and Second Order Experimental Impactive Relations When Depicted as Relations of the Reality Continuum to Itself.
The drawing at the top shows the differentiated reality continuum with the variable experiencer areas to the left and right of the centrally located experienced area labeled as 1 and 2, respectively. The drawing in the center shows a first level experimental impactive relation creating a particle experience, as area #1 forms an impactive relation with the centrally located experienced area. The drawing at the bottom shows two different, complementary, and mutually exclusive second level impactive relations, each having the same first level impactive relation as its basis. What these drawings also show is that the first level impactive relation creates a new third area of the reality continuum with respect to the composite differentiation of pre-physical reality that makes up the first level impactive relation. And as will be described, it is when a variable experiencer differentiation coming from this third area forms an impactive relation with the composite differentiation of pre-physical reality that makes up the first level impactive relation that complementary and partial physical experiences are created, such as occurs when both the position and momentum of something are each only partially known, and specifically only known to the extent that the other is unknown.

What the drawings above show is that, in a second level experimental impactive relation, what the experiencer area is forming an impactive relation with are the two differentiations of pre-physical reality that are themselves already involved in a first order impactive relation defining what is there as some sort of physical reality, either wave or particle. The two differentiations of pre-physical reality that are themselves already involved in a first order impactive relation function in the second order impactive relation as a single unit, or as an individual differentiation of pre-physical reality, and thus make up what is called a *composite differentiation*.

Having described and depicted in a general way the second level impactive relations that create the physical characteristics subject to the uncertainty principle, we are now in a position to describe and depict these relations as they create simultaneously opposite and complementary physical experiences, but only partially so. Once these relations are understood the experiential basis of the uncertainty principle will be evident.

In any second level experimental impactive relation there are three mutually exclusive relations possible. Two of these three possible relations have experiential results that are like those created by the mutually exclusive relations that create the mutually exclusive experiences of wave and particle, i.e., they create only one or the other of the possible complementary physical experiences, such as when the position of something is fully known, allowing no knowledge of momentum, or vice versa. However, the third possible relation has an experiential result that is unlike that created by the mutually exclusive relations that create the mutually exclusive experiences of wave and particle, in that this third relation creates both possible complementary physical experiences at once, although only partially, such as when both the position and momentum of something are each partially known, but only to the extent that the other remains unknown. It is then this third sort of second level experimental impactive relation that produces the uncertainty relations or phenomenon.

The three basic second level experimental impactive relations that are possible, as well as their respective experiential outcomes, are shown in **figures 7 and 8**, depicted once again both in terms of differentiations of pre-physical reality forming impactive relations with each other as well in terms of the reality continuum forming impactive relations with itself.

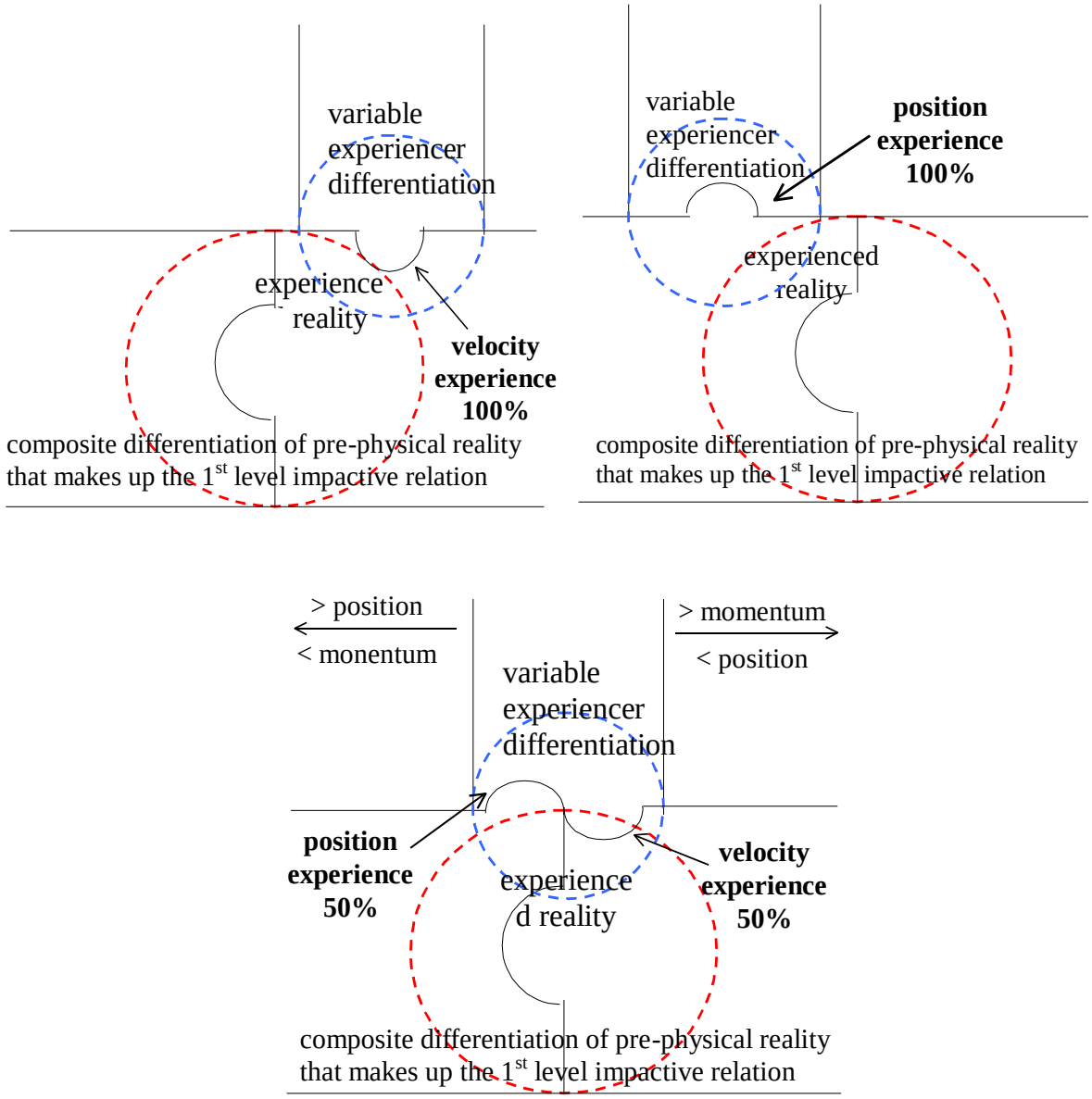

Figure 7 The Three Basic Types of Second Level Experimental Impactive Relations Depicted as Relations Occurring Between Differentiations of Pre-physical Reality.
All three relations depicted above are themselves mutually exclusive of one another with respect to a single impactive relation. The two basic second level experimental impactive relations depicted at the top produce only one or the other of the possible complementary physical experiences, such as position or momentum, while the third, depicted at the bottom, produces both possible complementary physical experiences at once, although each only partially, and each only to the extent that the other is not produced as an experience.

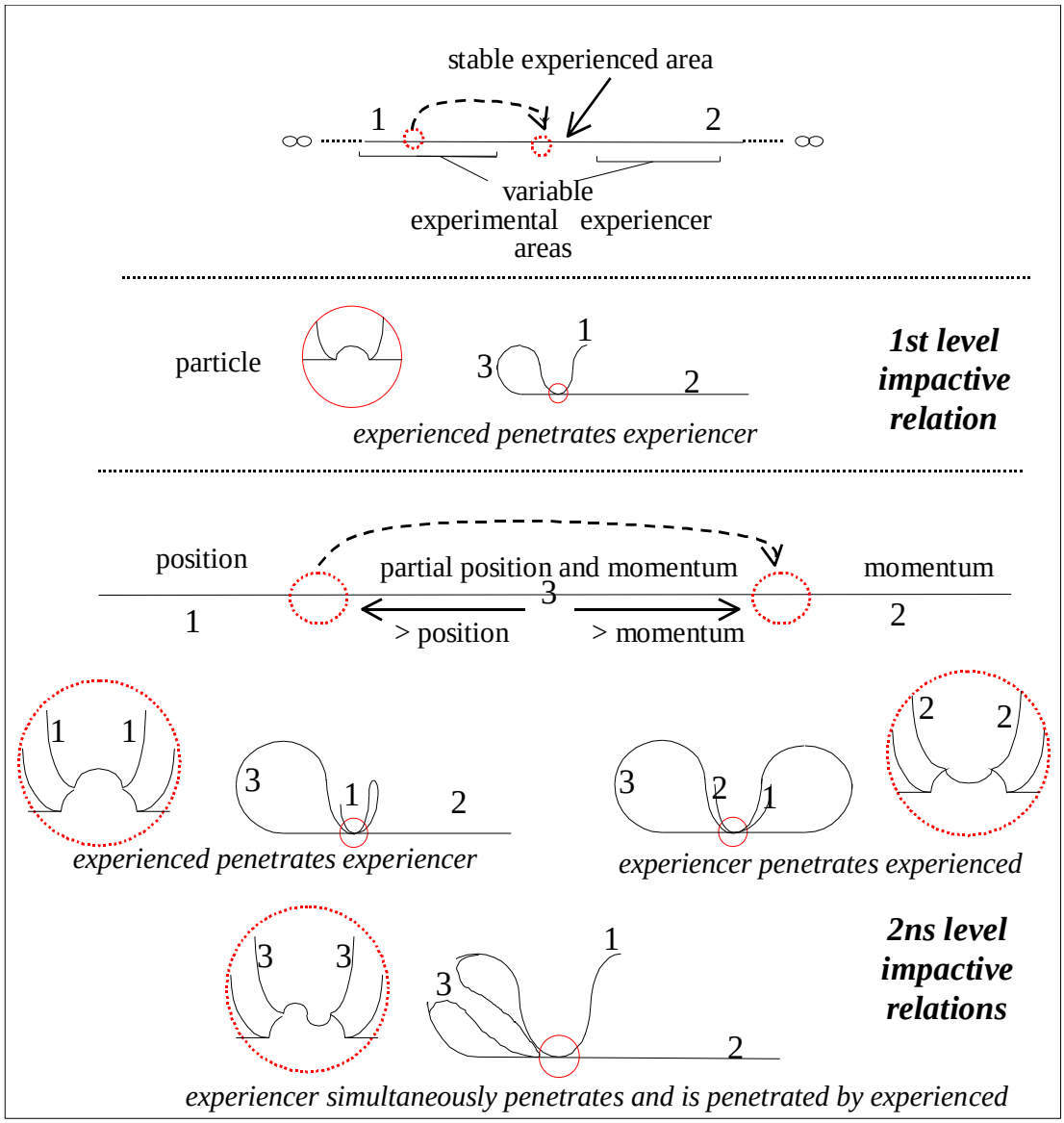

Figure 8 The Three Basic Types of Second Level Experimental Impactive Relations Depicted as Relations of the Reality Continuum to Itself.

Here we see that the first level experimental impactive relation results in the creation of a third area within the reality continuum that lies between the two areas already involved in a relation. It is when a differentiation that lies within this third area impacts the already existent relation that partial complementary physical experiences are created. How much each experience is partially defined depends on where along the continuum within this third area the differentiation that is involved in the second level relation lies, i.e., where it rests between the two areas already impactively interacting. The closer the differentiation within area #3 lies to area #1 the greater will be the definition of position experience and the less the definition of the momentum experience, with the reverse being true the closer the differentiation within area #3 lies to area #2.

From the drawings above, it can be seen that the uncertainty principle, or the uncertainty relations, wherein complementary physical experiences are each partially known to the extent the other remains unknown, are a function of the experiential process occurring at a second level of impactive relation, because this second level of impactive relation represents a *composite impactive relation* that has the potential to present the experiencer with both possible forms of the experiential boundary simultaneously, but each only partially.

Because the two differentiations involved in the first order impactive relation function as an individual differentiation, when another differentiation forms an impactive relation with this composite differentiation, it can either impact that composite differentiation in a way that creates only one or the other possible physical experiences, or it can approach that composite differentiation in a way that simultaneously creates both physical experiences partially, to the extent the other is not created as an experience.

What that this way of explaining the uncertainty principle demonstrates is that, in any impactive relation, be it first or second level, be it non-composite or composite, there is only one experiential boundary created. Further, this way of explaining the uncertainty principle again demonstrates that the physical experience, rather than being some form of what is actually and directly there, is actually the experiential boundary as it is apprehended from the experiencer side of the impactive relation that produces it.

Furthermore, explaining the uncertainty principle within the context of the experiential process shows that the phenomenon of uncertainty, like the phenomenon of wave-particle duality, derives not from some limitation that exists within what's actually and directly there, i.e., it is not produced by some limitation of nature, but rather derives from a limitation that exists within physical experience itself, imposed as a result of the process whereby physical experience is produced or brought into existence as the product of a relation between what is actually and directly there.

7. Conclusions

The key to understanding the phenomena of wave-particle duality and uncertainty is to understand that it is the experiential process itself that creates, entirely out of whole cloth, as it were, what we experience as physical reality. That is, there exists no physical reality whatsoever outside the context of an impactive relationship occurring between differentiations of pre-physical reality. Neither the wave nor the particle, nor any other physical experience, just sits out there waiting for us to come across it and experience it. Rather, physical experience is created, is brought into being, when we, through our organic physical sensors or our experimental apparati, form an impactive relation with whatever it is that is just sitting out there waiting for us to come across it.

And although physical experience cannot get at the nature of what's actually and directly there, being only the product of an impactive relation occurring between what's actually and directly there, physical experience does tell us something about what's going on at the level of pre-

physical reality. Specifically, physical experience tells us that whatever it is that is actually and directly there at the level of pre-physical reality must exist in a state of differentiation, because if it were not differentiated, if it was everywhere arranged the same, then there could be no impactive interactions and thus no creation of anything called a physical experience. That is, if what exists at the level of pre-physical reality were not differentiated, was everywhere arranged the same, then trying to create a physical experience would have the same result as when one creates an etching of a perfectly smooth surface.

Thus, wave-particle duality and uncertainty are, as phenomena, reflective of the limitations inherent in the process whereby physical experience is created, and therefore reflective of the limitations inherent in the nature of physical experience itself as being the product of a relation.

And here it is important to understand precisely what is meant when it is said that physical experience is the product of a relation, as relations create two sorts of products, one of which is of the same nature as that which produces it and one of which bears no relation whatsoever to the nature of that which produces it. That is, it is important to understand the nature of that product that is physical experience as it relates to the nature of what it is that is impactively interacting to create the experiential product.

As stated, physical experience is always the product of a relation, and those relations, as well as their experiential products, have been described in some detail. But what has not yet been stated clearly is that physical experience is the product of a relation where the product is of a completely different nature than that which, through being in relation, creates or produces it. That is, physical experience is not the product of a relation as when two or more edible ingredients are mixed to produce some sort of meal, or as when pieces of string are twisted together to make a rope. In such cases the products of the relations are of the same essential nature as what it is that is involved in the relations that produce the products. Instead, physical experience is the product of a relation as when the tips of two fingers touch and a boundary is produced that defines each in relation to the other, or as when a rubber band is twisted upon itself causing a boundary to be produced where the rubber band comes in relation to itself. In these cases the products of the relations are not of the same nature as what it is that is involved in the relations that produce the products.

What this means is that, even though physical experience is produced as a result of relations occurring between differentiations of pre-physical reality, *the nature of physical experience is completely different than the nature of whatever it is that composes those differentiations*. Put another way, physical experience is the product of a relation occurring between what's there, *but is itself completely devoid of the nature of what's there, completely devoid of the nature of that which is itself interacting to create the physical experience*.

For those having difficulty understanding this idea of the complete uncoupling of the nature of physical experience from the nature of that which is its most proximal basis, I call as a witness Plato and his Allegory of the Cave, (http://classics.mit.edu/Plato/republic.8.vii.html) wherein the same case that is being made here is made in that allegory regarding the relation of the nature of physical reality to the nature of that which it is presumed to represent. Specifically, in that allegory he states that what we perceive as the world of objects bears no relation in nature

whatsoever to the nature of that which is the actual basis of those perceptions. Thus, in his allegory the shadows of which he writes that are cast on the wall of the cave, and which the prisoners take for reality, are not other than physical experience as described herein, whereas that which casts the shadows are what have been referred to here as differentiations of pre-physical reality.

8. Ramifications With Regard to the Nature of Physical Reality Inherent in the Experiential Description of Wave-particle Duality and The Uncertainty Principle

In this article, physical reality as a whole has been defined, thereby revealing the actual nature of physical reality to be that of a boundary created by a relation, as that boundary is apprehended from one side of the relation that brings it into existence. In this way, we have accomplished with regard to physical reality as a whole what it is not possible to accomplish with regard to any specific physical reality.

The reason we can't pin down a specific physical reality, i.e., completely define any physical reality, is because in doing so we are trying to pin down what is effectively a miniature rainbow, trying to pin down that which is actually only the product of a relation, trying to pin down something that, in the final analysis, is not at all or in any way what is actually there, but only seems to be what is actually there. In trying to pin down any physical reality what we really are trying to pin down is something that we ourselves are creating in its entirety by the very act of trying to pin it down, by the very act of trying to define it. We think in examining physical reality we are trying to pin down what's actually there, but this is an illusion, as all we are really doing is grabbing at the reflection that lies on the surface of what is actually there, grabbing at a shadow cast on a wall by what is actually there. In trying to pin down any individual physical reality, what we really are engaged in is the futile quest for the end of the rainbow.

However, while we cannot ever pin down any specific physical reality for the reasons mentioned above, we can pin down the nature of physical reality as a whole. We cannot get to the end of a rainbow, because rainbows only appear to have an end. However, we can understand the true nature of the rainbow, understand how it is created and why it appears as it does. In the same way, although we cannot pin down any specific physical reality, we can understand the nature of physical reality as a whole, how physical reality is created and why physical reality appears as it does, if we are able to understand what it is that the phenomena of wave-particle duality and uncertainty are actually telling us about the nature of physical reality.

But we can only understand what it is that the phenomena of wave-particle duality and uncertainty are actually telling us about the nature of physical reality to the extent that we are able to let go of our conception of physical reality as having any relation in nature whatsoever to the nature of the reality which underlies it and is its basis. This is because the uncertainty principle operates in conceptual experience just as it does in physical experience to limit the degree to which we can apprehend complementary experiences.

The uncertainty principle operates in conceptual experience just as in physical experience because all experience is the product of a relation and so is subject to the same limitations and constraints as those that are found in the creation and perception of physical reality. That is, the limitations upon what can be known imposed by the experiential process apply not just to the creation and perception of physical experience, but they apply to the creation and conception of mental experience as well. And this, I believe, is the reason why what these phenomena have been telling us about the nature of physical reality for the past one hundred years or so has taken so long to hear, and will in all likelihood remain unheard by most for the foreseeable future.

There persists in quantum mechanics the idea that what is actually there is somehow transformed into the physical experience by the act of experience itself, which is to say that the act of experience causes some fundamental transformation in the nature of what's there. This idea is inherent in the notion of the collapse of the wave-function, where it is conceived that prior to experience what is there exists in some sort of probabilistic state, i.e., as a probability wave, that then upon experience "collapses," which is to say transforms, into what we experience as physical reality. However, any attempt to connect the nature of what is actually there to the physical experience itself, no matter how abstract that expression, is a conception of physical reality that precludes conceiving of it as it is, i.e., as completely uncoupled and unrelated in nature to whatever it is that is actually and directly there.

As a result of the limitations inherent in the experiential process, one has to pick between the idea of a flat Earth or a round Earth, and one has to pick between the idea of a Universe where the Earth is at the center and one where the Earth is seen in its actual relation to the heavenly bodies. Likewise, one must choose between the idea of physical reality being in any way whatsoever of the nature of what's actually there, and the idea of physical reality as being nothing more than a shadow of what's actually there. You are free to think anything you want, but what you think is constrained and limited by what you are already thinking, which is to say, by the relations in which you must already be involved in order to create as an experience whatever it is that you are already experiencing as thought or concept.

Thus, it is not possible to hold on to any idea of physical reality as in any way whatsoever being of the nature of what's actually there as its basis, and at the same time comprehend its true nature as completely unlike that which is its basis. And this, I believe, is why the relatively simple explanation that has been presented here regarding how the experiential process creates the phenomena of wave-particle duality and uncertainty has been so long overlooked. Not because the experiential process is something that is difficult to understand, but only because it presents us with an idea regarding the nature of physical reality that is mutually exclusive of the idea that most all of humanity already holds with regard to the nature of physical reality, i.e., that it bears some relation in nature to whatever reality is its source. No one ever came to understand that the Earth was round while at the same time still believing it was flat. No one ever understood that the Earth orbits the Sun while still believing that the Sun orbits the Earth. And no one will ever understand the nature of physical reality as a purely experiential phenomenon, i.e., as a rainbow-like phenomenon, while still conceiving of physical reality as having any relation in nature whatsoever to the underlying reality that is its basis.

The phenomena of wave-particle duality and uncertainty tell us something very definite about the nature of physical reality. And what they tell us is that physical reality is the product of a relation occurring between what's there, a boundary that arises where what is there becomes defined in relation to itself, as that boundary is apprehended from only one side of the relation that creates it or brings it into existence. In this way, what the phenomena of wave-particle duality and uncertainty also tell us is that physical reality not only isn't what's there, but that physical reality bears no relation in nature whatsoever to the nature of what it is that is actually there, no more than the nature of the line that arises where two fingertips meet bears any relation in nature to the fingers themselves.

Thus, wave-particle duality and uncertainty, once understood as experiential phenomena, present *objective evidence* that the nature of physical reality, with respect to the nature of the reality that is its basis, is as has been described by Plato in his cave allegory, as well as has been described by Eastern philosophies, wherein physical reality is maintained to be a sort of illusion that, when its nature is not understood, functions to obscure the nature of what it is that is actually and directly there. As long as you are focused upon the reflection at the surface of the pond, considering that to be reality, then the unrelated reality upon which the reflection rests must remain hidden.

In this way, through what the phenomena of wave-particle duality and uncertainty tell us about the nature of physical reality, Science has itself become like one of the ancient masters, responding to our questions regarding the ultimate nature of reality with only the words "neti, neti," i.e., "not this, not this," not wave, not particle, not any physical experience or reality of any sort. And in this regard Science has not failed to achieve or serve its purpose, but rather, I would contend, has in fact achieved and served its highest purpose.

I am aware that most people do not like to hear that physical reality is a sort of illusion, any more than they would like to hear that their favorite "reality" show is scripted. It makes them feel like sort of a chump, like they've been taken in by a ruse, and so in these circumstances resistance to the presented concept is unavoidable and really quite natural.

However, some of the natural resistance to the idea that physical reality is a sort of illusion can be tempered by making clear what is meant by the use of the term "illusion" in this regard. If one sees a snake and there is really nothing there at all, this is an illusion. But if one sees a rope and thinks it is a snake, this is also an illusion. These two sorts of illusions are not at all the same, as the former has no basis in what is actually there, whereas the other, while not being what is there, does at least have some basis in what's there. The illusion that physical reality presents us with is of the latter sort, in that it presents us with experiences that seem to represent what's actually there, when those physical experiences are in fact of a completely different nature than what is actually and directly there, as the nature of a snake is different from that of a rope, although physical experiences do have some basis in what's there, as the perception of a snake has as its basis the presence or reality of the rope.

And even in the absence of having any idea of the nature of what it is that is actually and directly there as the basis of physical experience, and so of physical reality, we can still know that physical experience is not itself of that nature, if we understand that physical experience is only a

boundary that must arise when what is actually there becomes defined in relation to itself, as that boundary is apprehended from only one side of the relation that creates it.

Would you say that the line that arises where fingertips meet is of the same nature as the fingers themselves, even though it is the relation of the fingers to each other that creates the line? Likewise, relations between differentiations of pre-physical reality create physical experience, but pre-physical reality is not itself in any way physical. Just as one can never know the nature of the fingers by examining only the line that arises where they meet, or the nature of water through the reflection that lies on its surface, one can never know the nature of the reality that underlies physical reality by examining only the boundary that is created when and where that underlying reality meets and impacts itself.

And here at the end one might reasonably ask; if the nature of the reality that is the basis of physical reality, and indeed of all experience, is in no way physical, then what is its nature? What is the nature of the reality that underlies physical reality, and is obscured by the physical reality its own relations produce? That is, what is actually and directly there where physical reality seems to be? Put another way, if what we are seeing is the snake, then what is the nature of the rope? What else is there and how can we ever hope to know or even approach it if our methods of knowing by their very nature obscure as much or more as they illumine?

In response to these imagined queries I will answer with another question: What is it that exists most directly where you are? Every reason that you have for thinking that what exists directly where you are is other than what exists directly everywhere else has its root in some idea of physical reality being more real than it actually is, some idea of physical reality being of a nature that is other than its actual nature, some idea of physical reality possessing a substantiality of which, as the phenomena of wave-particle and uncertainty demonstrate, it is not deserving. And if you can put aside those ideas, for even a short time, then the answer to these questions should become apparent, as your focus will naturally shift from the reflection that lies on the surface to the previously obscured reality that lies below. Ultimately, all you need to do to find out what's actually and directly there is to just stop looking where it's not.

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[i] Englert, Berthold-Georg, Marion Scully, and Herbert Walther. "The Duality in Matter and Light", *Scientific American*, vol. 271 no. 6 (December 1994), 86-92.

[ii] Baggot, Jim *The Meaning of Quantum Theory*, Oxford 1992 p. 30

[iii] Ibid. p. 30

[iv] Ibid. p. 33