# The Quantum Mechanical Frame of Reference

## Part 2: The Third Logical Type

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Abstract: In Part 1 the properties of QBism are shown to be natural consequences of taking quantum mechanics at face value, as does Everett in his *Relative State Formulation* (1957). In Part 2 supporting evidence is presented. Parmenides' (Palmer, 2012) notion that the physical world is static and unchanging is vividly confirmed in the new physics. This means the time evolution of the physical world perceived by observers only occurs at the level of appearances as noted by Davies (2002). In order to generate this appearance of time evolution, a moving frame of reference is required: this is the only possible explanation of the enactment of the dynamics of physics in a static universe.

Such a frame of reference can only be a fundamental property of the unitary system as a whole, of different logical type to the quantum state. Thus an ontological category in addition to physical existence is required to complete the science. At this level of logical type, all multiply instantiated copies of an inside view constitute a single entity. Thus the superposition proposed in Part 1 is inevitably effected; and the nature of physical reality on the inside view is as described in QBism.

# 1 Logical Type

> Spacetime is sometimes referred to as the 'block universe' because within it the whole of physical reality – past present and future – is laid out once and for all, frozen in a single four-dimensional block. (Deutsch, 1997, p. 268)

Thus there cannot be any such thing as the passage of time: that is inherent in the space-time defined by relativity. The same applies to quantum theory. The wave function of the universe defines the change of the configuration of matter and energy with the progression of time, but time does not progress. As stated by Barbour: “The quantum universe just is. It is static.” (1999, p. 256). So the appearance of the passage of time, and events happening, is a paradox.

To resolve this, a phenomenon is required that is contextual to physical reality, in the same sense that a movie projector is contextual to the frames of the movie film. Logical type (Russell, 1908) serves ideally to illustrate the relationship. The frames of a movie film are of a first, primitive, logical type, compared to the movie itself, the set of all the frames, which is of a second logical type. The movie projector is of a third logical type, operational on the set of all possible movies: the set of all possible sets of frames. It is an iterator mechanism that applies to all sequences of frames; it is necessarily contextual to any given sequence.

Here it is proposed that the presence of the same three logical types, as fundamental operational principles of physical reality, is an unavoidable conclusion. On this view the events and moments along the world-line of an observer are of the first logical type; the world-line itself, the sequence of moments, is of the second.[1] For such a sequence to be encountered, there is necessarily a third logical type in operation, a phenomenon that is to the moments as the film gate of the movie projector is to the frames of the movie film. The frame of reference must be repeatedly moved from one event, at one moment, to the next. This explains the appearance of the passage of time and events taking place.

This movement of the frame of reference also explains the appearance of collapse described by Everett in a static universe. A computer metaphor is ideal here. The frame of reference central to Everett's formulation is the inside view, the state of the memory defined as the record of observations. The process he describes is the addition of the observation to the record. Such a change cannot happen in a static universe. However, exactly this effectively occurs in the transition of the frame of reference from one state to the next; and in the reality of the updated definition of the inside view, the events observed have determinately happened. Collapse effectively occurs. This is the time evolution of the quantum mechanical frame of reference.

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1 Naturally, this is different to the logical type distinction in Part 1 in which a simultaneous superposition of frames was addressed as of second logical type.

# 2 The Now

The moving frame of reference also naturally resolves the problem of the Now. As recorded by Carnap (1963, pp. 37–38) this worried Einstein seriously. As Mermin explains, there seems to be nothing in physics that singles out the present moment:

> The issue for Einstein was not the famous revelation of relativity that whether or not two events in two different places happen at the same time can depend on your frame of reference. It was simply that physics seems to offer no way to identify the Now even at a single event in a single place, although a local present moment — Now — is evident to each and every one of us as undeniably real. How can there be no place in physics for something as obvious as that?
>
> My Now — my current state of affairs — is a special event for me while it is happening. I can tell my Now from earlier events, which I only remember, and from later events which I can only anticipate or imagine. The status of an event as my Now is transitory: it becomes a memory as subsequent Nows emerge.
>
> Yet clear, evident and banal as this is to us all, there is no Now in the usual physical description of space and time. Physicists represent all the events experienced by a single person as a line in four-dimensional space-time, called that person's 'world-line'. There is nothing about any point on my world-line that singles it out as my Now. (2014)

Each event along the world-line defines a coordinate, a specific point in space-time, the fundamental constituent of coordinate frames of reference. In the relativistic system, this frame of reference is the primitive logical type, analogous to a frame of the movie. The status of an event becomes a special event, the Now, as the moving frame of reference arrives at this reference frame in space-time. This moving frame of reference is a third-logical-type phenomenon, logically analogous to the film gate of the projector in which frames are illuminated in sequence.

This problem troubled Einstein greatly. It seems to mean his theory is incomplete. In fact, however, that is not the problem. The problem is the false presupposition that the physical is all there is. There is no such thing as the Now in physics because physics only defines the world-line; and the moving frame of reference is an utterly different kind of thing. The reference frames along the world-line, each at a specific moment along the time dimension, are the first-logical-type elements of the system, while the experience of the change of status of an event, as the moving frame of reference arrives at this moment, is a phenomenon of a higher logical type, logically identical to the action of the projector on the frames of the movie film. The moving frame of reference moves along the world-line, making each event in turn, each moment, into the Now, the current state of events for this observer. This also explains the appearance of the passage of time, as described in the next section.

The same distinction clears up the longstanding debate between tensed and tenseless time. McTaggart's (1908) B series is the series of primitive-logical-type events, each at a specific moment in time, laid out in sequence in space-time. Tense is irrelevant; in other words, all possible moments exist in the static space-time layout of relativity, and none is a special event. Events, at specific moments, exist in firm and fixed relations to other events, at other moments. The A series, on the other hand, implicitly addresses the moving frame of reference, a phenomenon of the third logical type. Tense is determined by the position of the moving frame of reference along the series of moments. This confers on each moment the status of a special event, as it arrives at that position along the continuum.

These two series are not incompatible, pace McTaggart, and neither is right or wrong; they are the same thing from different views, different types of frame of reference: first and third logical type respectively. The B series is the moments in time seen from the perspective of a specific point in time. The A series is the moments in time seen from the perspective of the moving frame of reference. Conflating the different types of frame of reference leads to classic errors of logical type, leading to paradox and nonsense results as Russell (1908) demonstrated.

The Now is simply the moment being experienced, in the moving frame of reference, as it passes along through space-time. This is evident from what we know. As Mermin states:

> My Now — my current state of affairs — is a special event for me while it is happening. I can tell my Now from earlier events, which I only remember, and from later events which I can only anticipate or imagine. The status of an event as my Now is transitory: it becomes a memory as subsequent Nows emerge. (2014)

It seems the moving frame of reference is specifically retrodicted. However, such a phenomenon cannot be enacted in physical reality. Thus it lies outside the science of physics as currently formulated: the ontology is based based exclusively on what can be explained in terms of physical reality per se. It appears another category of ontology is required in order to complete the science and make sense of the new physics.

# 4 The C Word

As is directly evident to perception, the experiencing consciousness supervenes on the moving frame of reference. Here it is proposed that these are simply the subjective and the objective aspects of the same thing: the third-logical-type phenomenon of the universe. This has already been proposed indirectly in relation to both relativity and quantum mechanics.

In relativity there is no question of the static nature of the universe. As Deutsch emphasises:

> *Nothing* can move from one moment to another. To exist at all at a particular moment means to exist there for ever. (1997, p. 263; emphasis in original)

Weyl, however, states that consciousness does move in exactly this way:

> The objective world simply is, it does not happen. Only to the gaze of my consciousness, crawling up the life-line of my body, does the world fleetingly come to life. (1949, p. 116)

This inherently assumes the third logical type: the frame of reference of consciousness passes through space-time, crawling along the world-line of the body at lightspeed. Moments are experienced in sequence. In experience, proper time is enacted.

Such a concept is directly in contravention to the current worldview. Deutsch's statement begins by specifically excluding consciousness as the explanation:

> It is often said that … our consciousness is sweeping forwards through the moments. But our consciousness does not, and could not, do that. … *Nothing* can move … (ibid)

If consciousness is just a property of the brain, a view widely held across scientific disciplines, a property of the physical, this is inevitably correct. It is this view, however, that is specifically repudiated by Chalmers' in-depth analysis (1996).

Here it is essential to note that, as Chalmers explains, the word consciousness tends to be used indiscriminately for two entirely different classes of phenomena. The first, which he calls psychological consciousness, includes cognitive abilities and functions; Block (1995) calls this access consciousness, meaning the accessing of information in the neural system in order to generate the contents of awareness: the sensory information experienced and added to the record of observations. This is well understood. The second, called phenomenal consciousness by both Block and Chalmers, is awareness itself, conscious experiencing. The word consciousness will here refer exclusively to this phenomenal consciousness.

To date this has been a complete mystery. There is no trace of it in the brain, and apparently no possible explanation of the phenomenon. As stated Fodor:

> Nobody has the slightest idea how anything material could be conscious. So much for our philosophy of consciousness. (1992)

As demonstrated in logical analysis by Chalmers (1996) and Bitbol (2008), this phenomenal consciousness can only be a fundamental property of the universe as a whole. As Chalmers states, the phenomenon of conscious experiencing cannot be a property of physical reality; it is necessarily:

> ... a fundamental feature of the world, alongside mass, charge, and space-time. (1995, p. 216)

In other words, it is property of the unitary system, on a par with space-time: thus contextual to all sequences of moments. It is thus in the correct logical position to

move the frame of reference of experience from moment to moment in time. Lockwood puts forward an ideal metaphor for the operation of this consciousness, quoting first Eddington and then Jeans:

> … events do not happen; they are just there and we come across them … In this case our consciousness is like that of a fly caught in a dusting-mop which is being drawn over the surface of the picture; the whole picture is there, but the fly can only experience the one instant of time with which it is in immediate contact (2005, p. 54)

Just as the frame of reference moves across the canvas, the frame of reference of the experiencing consciousness passes along the world-line of the observer.

The logical type of the quantum jump gives the same result. As Deutsch explains in some detail (1997, ch. 11) every possible physical state of the world exists 'already', each one a snapshot of one version of the whole four-dimensional world. He refers to this as the quantum concept of time.[2] The essence is that "... other times are just special cases of other universes" (1997, p. 278). In other words, all possible quantum states exist 'already'. This is clearly evident once relativity and quantum theory are combined in the Wheeler-DeWitt equation; as stated by Barbour, this represents:

> … a time-independent Schrödinger equation for one fixed energy, the solution of which simply gives, once and for all, relative probabilities for each possible static relative configuration of the complete universe. Each such configuration is identified with a possible instant of experienced time. These instants are not embedded in any kind of external or internal time and, if experienced, exist in their own right. (1994, abstract)

In other words, there is nothing that changes, and no possibility of movement from one instant to another. Furthermore, there is no context in which these instants are arrayed in sequence, and no explanation of how one might follow another in the experience of reality, as is constantly witnessed as the experience of change.

Everett's formulation lays the ground work to resolve all these problems. There is only the appearance of collapse, as he clearly states; thus there is only the appearance of instant after instant. The mechanism is essentially an information process. The addition of each observation to the record of observations results in a redefinition of the world hologram; and as a consequence, the quantum mechanical frame of reference is redefined, resulting in a different quantum state effective. This is the dynamics of the inside view.

However, an explanatory principle is required to complete the full picture because even just this information process cannot actually happen in a static universe. A

2 He states: "This understanding first emerged from early research on quantum gravity in the 1960s, in particular from the work of Bryce DeWitt, but to the best of my knowledge it was not stated in general terms until 1983, by Don Page and William Wooters." (1997, p. 278).

moving frame of reference, contextual to the instants, is required. Even to give the appearance of collapse and events happening, the frame of reference must move from one instant, in which this observation has not been made, and the outcome is indeterminate, to one in which it has, and the outcome is determinate recorded history. Such a frame of reference can only be a property of the unitary system as a whole.

Known to each conscious individual as the experience of change, the making of observations can only be the experience of the frame of reference moving, from one instant to the next. As Everett states, it is in experience that the fulfilment of the dynamics of the new physics is explained:

> … we shall deduce the probabilistic assertions of Process 1 as subjective appearances to such observers, thus placing the theory in correspondence with experience. (1973, p. 9)

Given the objective nature of physical reality fundamental to the current worldview, it has been naturally assumed that these appearances are caused by the enactment of the dynamics in physical reality. It is this presupposition, however, that makes the central point of his formulation incomprehensible; as shown by Barrett's (1999) thorough analysis, there is simply no way to make sense of his theory on this basis. Only on the inside view, in experience, does the indeterminacy of the world collapse to a specific determinacy, as the moving frame of reference passes from instant to instant. Decoherence can be no help here as an explanation is still required of how the frame of reference moves from one point in time, in which it has not yet taken place, to the next, in which it has.

Given consciousness as the subjective attribute of a fundamental property of the universe, we have both an explanation of the experience of the passage of time, as described by Weyl, and the experience of the making of observations, as described by Everett, all against the backdrop of a static physical universe. We also have the explanation of the longstanding puzzle of why no trace of the experiencing conciousness can be found in the brain. It is not there. It is an attribute of the unitary system as a whole, of different logical type to anything in physical reality. The brain produces that which gets experienced, the product of access consciousness, but awareness itself is an utterly different kind of phenomenon.

As Davies states: “... it appears that the flow of time is subjective, not objective.” (2002). This, however, does not mean that the apparent passage of time, and events taking place, are illusory. It means that the frame of reference of experience passes from moment to moment, and from instant to instant, and thus events are encountered, and the dynamics of physics effectively enacted, in experience. This is the universe in dynamic operation.

# 5 Identification

Given this third-logical-type phenomenon, necessarily contextual to all physical situations, it follows that effectively, there is only one instance of a specific inside view.

As a system property of the universe, the frame of reference of the experiencing consciousness is not localised to a specific world. As stated by Bitbol, in and of itself: "... it is point-of-view-less, just as it is placeless and timeless." (1990, p. 8). It is quintessentially non-local. Since it is therefore present at all possible places and times, this would imply that it must necessarily embrace and include all possible static frames of reference, all possible moments and events, all at once. Each relativistic frame of reference is a spatio-temporal point of view, and in principle it must have all possible points of view. On the inside view, however, within the context of the frame of reference of a conscious observer, there is only that specific frame of reference. As Bitbol explains, referring to the experiencing consciousness as Mind:

> Indeed, as soon as (abstract) Mind identifies itself with a point of view, it can but identify itself to a *particular* one. … the point of view Mind adopts, when adopted, is not one among others; it is *the* point of view, self-referred to as *my* point of view. (ibid; emphasis in original)

Although on the outside view, consciousness experiences all possible versions of the inside view, on the inside view of each possible version there is only that point of view. Just as reflected light takes on the pattern of information defined by the objects it illuminates, the ubiquitous phenomenon of conscious experiencing becomes the experiencing of the sensory data of the inside view of the individual.

This is what gives the illusion that consciousness is personal and localised. Because the world hologram is formulated with respect to the familiar location 'in here', this point of view is identified as the location of consciousness. Thus, identified completely with the world hologram of a specific individual, the consciousness becomes the experiencing consciousness of this individual. This explains the nature of a conscious individual: there is a self-awareness, an 'I' 'in here' at the familiar location within the body-mind. This is what is called awareness. Taken all together this provides the elusive definition of a conscious individual.

This also explains our difficulties in comprehending consciousness. On introspection, it is clear that experiencing is going on 'in here', where the world hologram is being formulated. This is the central point of the conscious 'I'. This, however, is not the kind of phenomenon it seems so obviously to be: a phenomenon generated by the brain. It is the experiencing of the world hologram (generated by access consciousness in the brain) by a fundamental property of the universe (phenomenal consciousness).

This provides a further explanation of why all possible instances of a specific inside view are effectively one single instance. From the perspective of the non-local

consciousness phenomenon, identification with a specific inside view is identification with all the 'identical copies' simultaneously. From this perspective, there is no such thing as an identical copy: all 'copies' are one single instance of this structure of information. Since this structure of information exists simultaneously in multiple versions of a quasi-classical world, the effective physical environment of this inside view is the superposed sum of all of them. As shown in Part 1 this produces centred worlds in which the principles of QBism apply: determinacy and probability are defined only what what is experienced and observed.

# 6 Ontology and Dualism

Western dualism once held that mind and matter are two ontologically separate categories, an idea now considered mythical nonsense. As stated by Ryle in his debunking of this myth:

> A myth is, of course, not a fairy story. It is the presentation of facts belonging to one category in the idioms appropriate to another. To explode a myth is accordingly not to deny the facts but to re-allocate them. (1949, p. 8)

The myth of the duality of mind and body is exploded by allocating the facts about the capabilities of the mind to the computing power of the brain. However, the original principle behind the myth is sound nonetheless. Consciousness and matter are ontologically separate categories; and the explanatory principle is clear. The duality is of logical type.

The quantum state is fundamental and primary: on both outside and inside views, the system is completely defined by the quantum state. This is the obvious ontology. The moving frame of reference is also necessarily fundamental, being a property of the universe as a whole, alongside mass, charge and space-time. Therefore there two ontologically separate, fundamental categories. Duality is required.

This perspective also lays to rest the more extreme versions of anthropocentrism, where a conscious observer is required to bring the universe into existence. The physical universe is fundamental, and exists with or without concious observers. However, this gives rise to only the potential for conscious observers in the usual sense of the term. Leaving aside consciousness, observers, meaning physical entities possessing sensory apparatus and memory, as described by Everett, are defined in the quasi-classical worlds of the no-collapse universe. Each contains a perceptual reality, a world hologram; but nothing happens. To produce worlds that happen, the third-logical-type phenomenon of the universe has to interact with the first-logical-type components, the events in a quasi-classical physical world. The result is the ongoing reality experienced by each conscious individual, the four-dimensional, space-time, matter and energy 'movie' defined by the quantum mechanical frame of reference.

# 7 The Individual

In the light of these concepts, it is possible to define the conscious individual with precision. The standard identity for human observers is of course the physical body including the mind: the computational capability that gives rise to the cognitive and conceptual functions of the physical system. This is simply correct on the outside view. On the inside view, however, the body-mind, like the rest of the world, is determinate only where observed and recorded in memory. The person on the inside view, here the individual, is thus a very different kind of entity to the physical body-mind on the outside view. As stated in Part 1, the distinction between the two is inherent in Everett's formulation though not explicitly stated. The physical body-mind is what Everett defines as the observer. The different inside views, different versions of the world hologram, are what he refers to as the different experiences within the superposition following the making of an observation. It is these experiences that form the basis of many-minds theories. However, it is not the mind but the world hologram that is the protagonist in each of the many worlds.

Naturally, the world hologram resides in a body-mind, one that gives rise to it and instantiates it. On the inside view, however, only where defined by the record of observations is this body-mind determinate, just as with everything else in the world. In the multiple instantiations of the record of observations, every possible version of the physical body that instantiates this inside view is included in the effective superposition. Since all possible variations of the body are included, every possible variation of attributes of the body not observed are included. When all are effectively superposed, these attributes are indeterminate. Thus only what is observed is determinate, even with respect to the body of the observer. As with the rest of the world, this does not of course mean that the body is not really there. There is a superfluity of physicality, not a deficit. The inside view is simply the view of the effective superposition of a vast number of bodies, all of which instantiate this specific world hologram. Thus the true identity of the individual on the inside view is simply that much of the body-mind which is observed, as recorded in the record of observations. These observations of oneself, external and internal, are the observations of machine configuration, the state of the physical observer system, in Everett's (1957, p. 457) statement quoted in Part 1. The integrated synthesis of these observations is known to the individual as the self-concept avatar: the three-dimensional, virtual-reality representation of the body-mind at the centre of the world hologram.

At first brush such a definition may seem unrealistically minimal to account for the nature of a conscious individual. However, this is the full definition of the operational identity. As Everett states, referring to the physical observer as the machine:

> … the actions of the machine at a given instant can be regarded as a function of the memory contents only, and all relevant experience of the machine is contained in the memory (1957, p. 457)

In other words, every aspect of the decision-making capability of the observer is contained in the memory, defined as the record of observations. All the attributes of character are included: values, beliefs, expectations, criteria and algorithms for decisions are all defined in memory; and this memory is rendered in the form of the world hologram, the virtual reality representation of the real physical world, as borne out by modern analysis. As Deutsch states, all the operational knowledge of the individual is encoded in the world hologram:

> … every last scrap of our knowledge — including our knowledge of the non-physical worlds of logic, mathematics and philosophy, and of imagination, fiction, art and fantasy — is encoded in the form of programs for the rendering of those worlds on our brain's own virtual-reality generator. (1997, p. 121)

While all the information generated by observations is part of the world hologram, one might argue that the programs that produce the world hologram are defined in the neural network of the brain. Attributes of these programs may well be defined by the DNA. However, on the inside view, the DNA, along with all the information and programs in the neural system, are indeterminate except where observed in operation because every possible version is instantiated in the quasi-classical worlds effectively superposed. Thus the only programs that are determinately defined on the inside view are those defined in the world hologram, along with the rest of the determinate character and psychology. This comprises the full definition of the functional identity. Just as the world hologram is the sole definition of the determinacy of the physical world, the self-concept avatar is the sole definition of the determinacy of the body-mind; and this is the complete definition of the functional identity.

This is closely akin to many minds interpretations; however, the individual on the inside view is not a mind as usually conceptualised. As stated by Page, Everett's theory is more correctly: “... a many-perceptions framework not a many-minds framework.” (2011, p. 4). It is solely the record of perceptions, the world hologram with which each person is immediately familiar, that forms the core component of the many worlds theory. This is the operational entity, defined by the record of observations. This defines the conscious individual; and this is what lies at the heart of the many worlds theory. As Page states: “I regard the basic conscious entities to be the conscious experiences themselves.” (ibid).

This is perhaps the final conceptual leap required to resolve the philosophical difficulties of quantum mechanics. As stated by Barrett:

> … in order to get probabilities out of the many-worlds theory, the first step is to provide an account of the transtemporal identity of observers. (2003)

The key point is that conscious individuals, as the term is usually understood, are in truth beings of three logical types. Each is a world hologram experienced by consciousness. The interaction of conciousness with the components of physical reality

results in the experience of the passage of time and the enactment of the quantum dynamics. Such an individual is transtemporal, changing incrementally with each observation made. Like a computation in action, this is a process of the second logical type. The explanation of the conscious individual requires both the fundamental ontological types, giving rise to the second-logical-type phenomenon experienced as transtemporal reality. Probabilities are as defined in QBism.

# 8 Conclusion

In order to resolve the deepest paradox of the new physics, the experience of the passage of time and events taking place in a static physical universe, a moving frame of reference is required. By definition this can only be of a logical type contextual to the matter, energy and space-time of physical reality on which physics is currently based. As the projector of movies is to the frames, this frame of reference is a phenomenon of the third level of logical type: of the logical type of the set of all possible sets of instants. An additional ontological category is required.

This also dissolves the paradox of the topology of time. There has been great debate about whether time is tensed or tenseless, and both views seem to have unquestionable merit. Both are correct. The two series described by McTaggart are simply descriptions of the system at different levels of logical type. The B series is a static sequence, like the movie film, addressed from the perspective of a specific fixed point along the sequence, of the first, primitive logical type. The A series is the same sequence addressed from the point of view of the moving frame of reference, of the third logical type.

This is certainly a major paradigm shift, but surely this should not be unexpected. If the resolution of the paradoxes of the new physics were not deeply counterintuitive it would likely have been recognised a long time ago. It is unsurprising that this has remained invisible in the established field of physics, since it is an oxymoron in that context. The objective physical environment is taken as the only fundamental. The resolution presented here requires stepping completely outside the science of the physical to include another ontological category. In order to explain how reality actually happens, the third logical type of phenomenon is required, a property of the unitary system as a whole. This gives rise, in effect, to the passage of time and the collapse dynamics: emergent, second-logical-type phenomena.

This understanding also resolves the longstanding puzzle about the peculiar significance of observation in the physics. As stated by Heisenberg:

> We can no longer speak of the behaviour of the particle independently of the process of observation. (1958, p. 15)

The great mystery has been why on Earth observation should be significant to the definition of physical reality. The answer is that the inside view *is* reality: the only

reality that can ever be encountered and measured, and the only reality that actually happens. This reality is the identification, by the third-logical-type phenomenon of the universe, known to us as consciousness, with the world hologram of the individual. It would be very strange if the process of observation were not deeply relevant.

Everett's formulation describes a many-perceptions theory; the many worlds are inside views. The world hologram defines the sole determinacy of the physical world of the individual. Thus probabilities are defined solely by experiences, and the world is idiosyncratic to the individual, as in QBism; and problems of measurement and locality do not arise as shown in Part 1.

# Appendices

Related subjects are addressed where these concepts integrate with established principles, in effect providing the enactment of the dynamics.

## The Specious Present

James states that in experience, i.e. on the inside view, the only present is the specious present: "… the short duration of which we are immediately and incessantly sensible." (1890, p. 631). He quotes Clay, the originator of the term, who points out that it is really part of the very recent past, and that a sequence of events is bundled into a composite experience, e.g.: "All the notes of a bar of a song seem to the listener to be contained in the present." (Clay, quoted by James, 1890, p. 574). Since the events are really in the past, Clay defines the specious present as: "… delusively given as being a time that intervenes between the past and the future." (ibid). This is again a situation in which inside and outside views differ. On the outside view, all this is a straightforward and accurate portrayal of the situation. On the inside view, however, the specious present is the real present moment, a specific instant in the quantum concept of time. It is literally a time that intervenes between the past and the future in the transtemporal reality of the individual: the instant in between the instants of the past, as recorded in the world hologram, and the possible instants of the future to which the moving frame of reference could progress.

As the field of observation sweeps through space-time, in effect, the time evolution of the world progresses. However, on the inside view, nothing happens until the next observation is made: in between observations, for this brief period of time, the world hologram remains constant. There is no change to the record of observations, and therefore, on the inside view, the physical world remains the same. On the outside view, the song is played, and the ears are responding to the sound waves; and the neural network is integrating a brief sequence of events into the next observation: the

process of access consciousness. However, on the inside view, which version of events will be experienced and observed remains indeterminate up to the point in time where the observation is experienced and added to the record. (For simplicity of discussion it is assumed the experiencing and the addition to memory are coincident in time.) At this point in time, a new observation is added to the world hologram, and the frame of reference jumps to the next instant. On the outside view, the inside view lags behind the real situation. On the inside view, however, the world hologram defines the real situation, the determinacy of the real physical world, for the duration of the instant, the period of time between the making of one observation and the making of the next. This instant corresponds precisely to the definition of the specious present. It is the short duration of time encapsulating a brief range of events, of which one is immediately sensible.

## Enactment of the Linear Dynamics

The enactment of the collapse dynamics is here depicted as a movement of the third-logical-type frame of reference from instant to instant. The enactment of the linear dynamics, which is of course primary, is not so intuitively straightforward. The linear dynamics is the time evolution of the physical, defining, for instance, the change of location of matter and energy in space-time as the time parameter is advanced. However, since time does not pass, there is no explanation of how this takes place. Understanding the third-logical-type phenomenon of the universe as the essence of subjectivity provides a mechanism. Here it is proposed that the experience of the state vector is the experience of the change the vector defines. Just as the experience of velocity is the experience of motion through space in a specific direction, the experience of the quantum state vector is the experience of the time evolution of the system, the change of state of matter and energy with advance of the time parameter.

Nothing happens on the inside view until an observation is made. Thus, for the duration of the specious present, the only experience is of the passage of time. This is what it is like to experience the state vector in action, the wave function functioning. This provides a time base for the unfolding of the dynamics, of which the appearance of collapse is a subsidiary phenomenon, as described by Everett. The enactment of this time base is experienced as movement of the frame of reference through space-time, along the trajectory of proper time, at lightspeed. This is punctuated periodically with the experience of the collapse of the state vector as each observation is made, and a new bundle of sequenced events defines the specious present.

## The Standard von Neumann - Dirac formulation

The linear and collapse dynamics are effectively enacted in the moving frame of reference, at different levels of logical type, cycling as defined by the standard von Neumann - Dirac formulation:

> Process 1: The discontinuous change brought about by the observation of a quantity with eigenstates $\varphi 1$, $\varphi 2$, … in which the state $\psi$ will be changed to the state $\varphi j$ with probability $|(\psi, \varphi j)|$.
>
> Process 2: The continuous, deterministic change of state of an isolated system with time according to a wave equation $\partial\psi/\partial t = U\psi$, where $U$ is a linear operator. (von Neumann, 1932)

The quantum state of the system ψ is that defining the quantum mechanical frame of reference. Process 1 is the change of this frame of reference. Process 2 is the change of the spatio-temporal frame of reference within the context of a specific quantum mechanical frame of reference. The time evolution of the world effectively proceeds as defined by the linear dynamics. This is experienced as the passage of time. On the inside view, no change is experienced for the duration of the specious present; the record of observations remains constant, and thus the quantum mechanical frame of reference remains constant. At the end of this period of time, on the making of an observation, the quantum state of the system is changed to a new value, with probabilities for specific events given by the formula: Process 1, experienced as events happening. Within the new quantum mechanical frame of reference the linear dynamics is experienced as the passage of time, and the cycle continues.

The enactment of the linear dynamics, experienced as the transition through space-time within the context of a specific quantum state, is like the fly being drawn across the canvas in Lockwood's analogy, passing along the sequence of moments in the worldline. The quantum jump to a different instant is like the duster moving to a different canvas, the world defined by a slightly different quantum state. The same overall system engages in change at the the two different levels: Process 2, within a specific frame of reference, and Process 1, from one frame of reference to another. As Everett states, referring to the standard formulation:

> ... we were able to show that all phenomena will *seem* to follow the predictions of this scheme to any observer. (1973, p. 110; emphasis in original)

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