

# The World Hologram

## The Fundamental Component of Reality

Andrew Soltau

Abstract: The entity at the heart of Everett's famous formulation is the state of the memory, defined as the record of observations. As he makes clear, this is the protagonist of the collapse dynamics. This is a structure of information entirely familiar to everyday experience, but always assigned a very different status. This is simply the definition of the perceptual reality: in humans a three-dimensional virtual-reality representation of the world, here the 'world hologram'.

The extraordinary status of the world hologram arises because it is multiply instantiated in the many-worlds universe. Since the instantiations are superposed and coincident the result is a single world hologram, and thus the effective physical environment is the superposition of all these worlds: a class-of-worlds-as-a-world.

This resolves the paradoxes of quantum mechanics by revealing an ontological dualism. The vital missing lexicon is logical type. The domain encountered by the protagonist, the 'world superposition', is a second-logical-type phenomenon, and determinate solely where observed: all else is the superimposed sum of all possible physical variations. The rogue effects are phenomena operating in the emergent class-of-worlds-as-a-world. Schrödinger's cat is retrodicted.

This type of world is precisely described by the holographic principle. In each class-of-worlds-as-a-world the physical determinacy is defined on the boundary of perception, which is also the cosmological horizon in this frame of reference. The holographic universe is not the absolute reality but simply the effective physical environment encountered by the protagonist. It is idiosyncratic to the individual, as proposed in epistemic, relational and modal interpretations.

# 1 The Inside View

A fundamental requirement of physics is objectivity, but as Mermin explains it is the exclusion of the perceiving subject, the protagonist of the dynamics, that has produced the great paradoxes:

... the perceiving subject has as important a role to play in understanding the nature of physical science as does the perceived object. (2014)

As Tegmark states, the distinction between the objective and subjective frames of reference is of heightened significance in the new physics:

... the development of relativity theory and quantum mechanics has taught us that we must carefully distinguish between two different views of a mathematical structure:

- The *bird perspective* or *outside view*, which is the way a mathematician views it.
- The *frog perspective* or *inside view*, which is the way it is perceived by a [self-aware substructure] in it.

(1998, p. 23; emphasis in original)

As he describes, the outside view follows the linear dynamics, so this defines all possible physical worlds:

There is only one wavefunction, and it evolves smoothly and deterministically over time without any kind of splitting or parallelism. The abstract quantum world described by this evolving wavefunction contains within it a vast number of classical parallel storylines (“worlds”) ... observers perceive only a tiny fraction of this full reality, and they perceive the splitting of classical storylines as quantum randomness. (2007, p. 3)

This is the reality defined by the fundamental math of quantum mechanics, effectively a universe of superposed, more correctly mixed, decoherent quasi-classical physical worlds. On the inside view, however, the individual perceives a specific version of a storyline, and random, specific versions of events are encountered: there is the appearance of collapse of the wave function.

The two dynamics are totally incompatible, hence the measurement problem. The resolution lies in the difference between the observer, a physical entity, and the self-aware substructure, a structure of information. Their different frames of reference operate the two dynamics in parallel, at two different levels of logical type. The term observer is here reserved for the physical entity that makes observations. The self-aware substructure is referred to as the individual.

## 2 The Protagonist

The observer is a physical entity, a measuring instrument. Everett defines observers as physical mechanisms that make observations, by formulating and recoding sensory data:

... automatically functioning machines, possessing sensory apparatus and coupled to recording devices capable of registering past sensory data and machine configurations. (1957, p. 457)

As a physical entity, the observer can only follow the linear dynamics. Thus when an observation is made the result is a superposition of states:

When interaction occurs, the result of the evolution in time is a superposition of states, each element of which assigns a different state to the memory of the observer. (1957, p. 462)

The superposition rapidly becomes a mixture but all possible states are still present.<sup>1</sup> Thus it is on the inside view and there alone, with respect to the the state of the memory as defined by the record of observations, that there is a specific result, and thus a single determinate outcome:

Judged by the state of the memory in almost all of the observer states, the probabilistic conclusion of the usual "external observation" formulation of quantum theory are valid. In other words, pure Process 2 wave mechanics, without any initial probability assertions, leads to all the probability concepts of the familiar formalism. (p. 462)

Process 2 is the linear dynamics, the time evolution of the wavefunction. As Everett demonstrates, within the exercise of this dynamics there is the *appearance* of collapse on the inside view.

The Copenhagen interpretation takes quantum mechanics at face value, which would mean that observation somehow caused collapse in the realm of the physical. Everett demonstrates that there is no need to postulate physical collapse because on the inside view collapse effectively happens, though on the outside view no such phenomenon occurs. In other words, different dynamics operate in the different types of frame of reference: inside and outside views. The outside-view world operates the linear mechanics, unvarying and invariable. The inside-view world operates the collapse dynamics, producing randomness.

The observer, a physical entity, follows only the linear dynamics and is therefore defined by a myriad of states in the unitary wavefunction. Only judged by the *state of the memory*, here the individual, does the collapse dynamics operate, giving rise to a singular state and a specific version of events in sequence.

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1 Decoherence does not solve the measurement problem, now a widely discredited idea.

### 3 The World Hologram

The core component of Everett's formulation, the record of observations is a phenomenon utterly familiar to all conscious individuals. The human physiology system produces a virtual-reality representation of the world. This is the nature of the perceptual reality, meaning the field of information that is directly and immediately experienced:

Our brain constructs a three-dimensional model. It is a virtual reality in the head. (Dawkins, 1998, p. 276)

What we experience directly is a virtual-reality rendering, conveniently generated for us by our unconscious minds from sensory data (Deutsch, 1997, p. 120)

Every last scrap of our external experience is of virtual reality. (Deutsch, 2011, p. 10)

Each state of the model, each sequential rendering, is the observation being made at that moment. The integrated synthesis of the record of these observations forms the full definition of the virtual reality. This is the known world of this individual: the perceptual reality in its entirety.

As Deutsch goes on to describe, this three-dimensional virtual-reality representation is mentally projected onto the real three-dimensional world so as to match up precisely. This is here called the world hologram: the mentally projected representation of the physical environment. This is what is directly experienced. This is the inside view: a field of information, experienced as reality. This is the three-dimensional 'holographic' representation of the record of observations.

### 4 World Superposition

The world hologram is multiply instantiated in the many-worlds universe. In the space of all possible worlds there is a great number that instantiate a specific world hologram. These worlds are coincident, superimposed, and all are identical to this view; thus this is literally the inside view of all of them, simultaneously, superimposed: a 'world superposition'. The result is a class-of-worlds-as-a-world. This defines the quantum-mechanical frame of reference of the self-aware substructure on the inside view.

On this view, the resulting physical reality is determinate solely where observed. Only what has been observed is determinate because only this is the same in all the different versions of the quasi-classical world superposed. Equally, everything not observed is the superposition of all the physically possible ways it

could be. Thus the only determinacy is given by the record of observations, the world hologram.

The class-of-worlds-as-a-world is a second-logical-type phenomenon: it is to the ordinary world of the current ontology as a population is to a person. Consequently it has very different properties. In this domain the making of each observation alters the definition of the world hologram, and thereby changes the definition of the class of worlds that contains it. Thus collapse occurs, *effectively*, on this view. Schrödinger's cat is an ideal example. Before the observation is made, the world superposition contains all possible versions of the unobserved outcome. After, only those worlds in which that specific outcome occurred are included in the world superposition.

Effectively, therefore, on the inside view, the quantum state of the environment operates exactly as described in the Copenhagen interpretation. This is inside-view physics.

The missing piece of the quantum puzzle is the dualism of ontologically fundamental domains. The quasi-classical world is ontic as is obvious, but the class-of-worlds-as-a-world is ontic also, on the inside view. The determinacy of the domain is defined by the world hologram, and changes as the definition of the world hologram changes when an observation is made. Thus there is a relative onticity. As stated by Atmanspacher et al.:

The central point of the concept of relative onticity is that states and properties of a system, which belong to an epistemic description in a particular domain, can be considered as ontic from the perspective of another domain. (2005, 19)

The inside and outside views of physical reality are unilaterally ontic. The measurement problem is in fact an explication of the unilaterally onticities.

## 5 The Real Person

A further major departure from the current worldview is the nature of the perceiving subject, the individual protagonist, the self-aware substructure. The world hologram is the self-aware substructure of Tegmark's description, but this seems almost as nothing to the accustomed concept of self, physical and mental. This entity, however, is the real person in that this is the whole of the functional identity of the individual. 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. This is all part of the world hologram, so this is the identity actually operating the personal system.

This may seem highly inadequate as the full definition of the real person, but on the inside view, as the self-aware substructure, the body is indeterminate except where observed, along with everything else. Only the world hologram is determinate. As stated by von Baeyer:

If I am the agent, the objective world is everything outside my mind —including other agents and even my own body. All of that I may, if I chose, treat quantum mechanically and describe by wavefunctions. (2016, p. 154)

The indeterminate nature of the body of the observer is an inevitable consequence of this type of world. This does not of course mean that the individual is just a field of information and does not really have a body. Each individual is present in a vast number of bodies simultaneously: a class-of-bodies-as-a-body. Effectively, therefore, the individual is a real physical entity, but determinate solely where observed. Thus the determinacy of the real person is entirely defined by the world hologram.

Here again the relevant structure of information is highly familiar, but accorded a very different meaning.

The self-concept is the sum of the things one knows about oneself, the complete mental image produced over time from all the observations of oneself. This is the holographic representation of the body at the centre of the world hologram. As with the rest of the world hologram, the self-concept is projected precisely onto that which it represents. As Deutsch states:

Consider the nerve signals reaching our brains from our sense organs. Far from providing direct or untainted access to reality, even they themselves are never experienced for what they really are – namely crackles of electrical activity. Nor, for the most part, do we experience them as being *where* they really are – inside our brains. Instead, we place them in the reality beyond. We do not just see blue: we see a blue sky up there, far away. We do not just feel pain: we experience a headache, or a stomach ache. The brain attaches those interpretations – 'head', 'stomach' and 'up there' – to events that are in fact within the brain itself. (2011, p. 10)

In other words, the direct experience of the body is in fact the experience of the self-concept avatar figure at the centre of the world hologram.

Just as with the rest of the world, since the body is only determinate where observed, the self-concept avatar figure defines the determinacy of the body on the inside view.

The mind is here defined as an attribute of the physical body, the computational and management capability, the operating system of the hardware running the neural network. Thus von Baeyer's dictum about the mind is taken as applying to the world hologram as the individual. This means that the mind, as the operating system, is indeterminate: the effective mind is all possible minds instantiating this world hologram.<sup>2</sup>

Natural habit of mind takes for granted that the known world is 'the world', and the self-identity is 'me'. Both are literally correct in terms of what is actual and determinate in the frame of reference directly encountered. In this domain, the world hologram is the real person, the protagonist of life.

## 6 Schrödinger's Cat

The thought experiment of Schrödinger's cat (1935) shows that a cat in a box must be both alive and dead at the same time. Since this is obviously impossible, the implication is that the quantum theory must be wrong. The theory is correct, however; it is the presumption of a specific quasi-classical world as the effective physical environment that is wrong. The physical reality of the experimenter, the class-of-worlds-as-a-world, includes every possible world in which he is performing this experiment. In half of these worlds the cat is alive inside the box, and in half of them dead. Thus in his physical reality the situation is exactly as described in the thought experiment. On observation the cat is found to be in one state or the other *because* the experimenter is, as a result, present in only half of these worlds.

The illustration below shows the sets of worldlines, alive-cat and dead-cat (Lockwood, 1989, p. 231; adapted). Before the observation the class-of-worlds-as-a-world of the experimenter includes both halves. Once the observation is made,

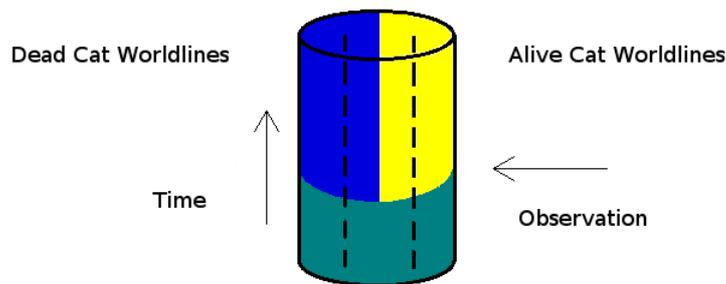


Figure 1: Parallel worlds in the Schrödinger's cat experiment, on observation.

- 2 Thus the mind of the individual is logically of the same type as a quantum computer, operating all possible mental states and computations at the same time. Creativity needs no further explanation.

there are two different versions of the experimenter's world hologram, in the different sets of quasi-classical worlds corresponding to the different states of the cat. Thus the physical environment of the experimenter now corresponds to either one state of the cat or the other. This is the enactment of the collapse dynamics, effectively, on the inside view, in the class-of-worlds-as-a-world of the experimenter. This second-logical-type reality retrodicts the appearance of collapse in the operation of the linear dynamics alone. This is the process Everett describes. The experimenter is correlated with all the worlds containing the cat until the observation correlates him with only half those worlds. The missing logic is the emergent, second-logical-type environment.

## 7 The Missing Subject

Naturally, it is a fundamental tenet of physics that subjective effects should be ruled out, but as Mermin (2014) describes, it is the omission of the perceiving subject from the science that is the source of the great paradoxes. This omission produces a physics with a precisely world-hologram-shaped hole in the science. As Wilczek describes, the vital "observer" is missing from the science:

The relevant literature [on the meaning of quantum theory] is famously contentious and obscure. I believe it will remain so until someone constructs, within the formalism of quantum mechanics, an "observer," that is, a model entity whose states correspond to a recognizable caricature of conscious awareness, and demonstrates that the perceived interaction of this entity with the physical world, following the equations of quantum theory, accords with our experience. That is a formidable project, extending well beyond what is conventionally considered physics.

Like most working physicists, I assume, perhaps naively, that this project can be accomplished, and that the equations will survive its completion unscathed. In any case, only after its completion might one legitimately claim that quantum theory is defined by the equations of quantum theory. (2006, p. 142)

The world hologram is literally the definition of the terms he defines. As has been described, the world hologram is the *definition* of conscious awareness: it is the perceptual reality itself. There is also no question that the interactions of this entity with the environment follow the equations of quantum theory precisely. That is the basic tenet of Everett's formulation. As he states:

... 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)

In other words, the world hologram is the "observer", the entity to which collapse is real. This is the missing protagonist of the quantum dynamics.

The nature of this "observer" is confusing. It is a field of information. It is the reality directly experienced, the perceptual reality. And according to Everett it is both the protagonist of the dynamics and also the functional identity of the individual; and it defines the determinacy of the effective physical environment.

There is a crucial operational distinction between two attributes of the protagonist, conscious and unconscious. The conscious is the immediate awareness of experience. This is the sensorium, the view of reality that is currently being perceived. This is the definition of conscious awareness. The rest of the world hologram is the 'personal unconscious', meaning those attributes of the mind that are accessible, but not in immediate conscious awareness. The mind external to the world hologram defines another phenomenon in search of an explanation, the collective unconscious.<sup>3</sup>

This defines the major components of the psyche in operational terms. The ego is the identification with the sensorium and the self-concept avatar figure. As described in Section 5 the world hologram as a whole is a different type of entity to the physical body-mind. Awareness of this identity, sometimes called the higher self, is expressed in endless variations in myth, but familiarity with this "observer" is also a practical aim in various modern disciplines.

## 8 Multisolvism

Like Schrödinger's cat, Wigner's friend (1961) is a straightforward consequence of the emergent domain. If the experimenter in Schrödinger's cat is Wigner's friend, Wigner's biography remains unchanged when he makes the observation because he exists in all the worlds where the experiment was performed, with either outcome. His diagram remains all one colour past the point where the diagram for the experimenter divides into two: in his class-of-worlds-as-a-world the cat is *still* both alive and dead. The determinacy of the effective physical environment is defined solely by the world hologram, so for Wigner the situation is still indeterminate. This is what accords different definitions of physical reality to different individuals, even in the same place at the same time, like the experimenter and the cat. This kind of observer-dependent situation has been confirmed in recent experimental research by Proietti et al..

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3 Anything unobserved is indeterminate, in a sense generic, and is thus part of the collective unconscious. This exists across the boundaries of individuals' identities in a dynamic manner thus providing a rationale for the remarkable type of properties described by Jung (1969, p. 43). The human being embodies distinct cybernetic layers in a manner that has not been generally recognised.

This result lends considerable strength to interpretations of quantum theory already set in an observer-dependent framework and demands for revision of those which are not. (abs, 2019)

Thus experimental evidence confirms the dictum of QBism:

This means that reality differs from one agent to another. This is not as strange as it may sound. What is real for an agent rests entirely on what that agent experiences, and different agents have different experiences. (Fuchs et al., 2013, p. 3)

Each individual protagonist exists in a different quantum-mechanical frame of reference. In each such domain, the protagonist is the only individual fully defined in this physical reality, so this is closely akin to the concept of solipsism.

As Everett (1973, p. 6) states, solipsism is entirely in accord with the facts of quantum mechanics. A multisolipsism fits the physics precisely. As QBism demonstrates, the world of the Copenhagen interpretation taken as applying to each protagonist individually:

... removes the paradoxes, conundra, and pseudo-problems that have plagued quantum foundations for the past nine decades. (Fuchs et al., 2013, 1)

Multisolipsism is very different to the original concept of solipsism. This does not mean that other people are not real. The real world of human affairs is a real and worldly culture just as it seems to be. Other individuals encountered in the world are all perfectly real, but they live in personal, physical, parallel realities, also here and now.

The solipsisms are coexistent. They share common ground. Naturally, these realities can often be the same with regard to the current location. With respect to two individuals standing next to each other and making essentially the same observations, their physical realities are of course the same – with regard to this environment at the present moment. Nonetheless, the Bayesian definition of each of their realities is different. This is the nature of each individual quantum-mechanical frame of reference. All the parallel realities exist in a non-exclusive, overlapping manner, each with an idiosyncratic definition of physical reality.

## 9 The Holographic Universe

The physical reality of the class-of-worlds-as-a-world provides a simple intuitive explanation of the holographic principle of t'Hooft (1993). This holds that the universe is like a gigantic hologram, defined solely on the surface of its boundary. As stated by Smolin (2000, p. 174) this is a consequence of the second

law of dynamics according to which there can be no more definition to the region beyond the interface than defined by the interface itself. This is a deeply puzzling result in an ordinary universe. As he comments:

... for the first time in the history of quantum gravity we have in our hands an idea which at first seems too crazy to be true, but which survives all our attempts to disprove it. (2000, p. 178)

Taken as a description of the world defined by correlations as Everett describes, however, this is simply the definition of the determinacy of the effective physical environment of the protagonist.

The world hologram is the definition of the surface of the boundary of the world of the protagonist. It is quite literally the interface to the rest of the universe; and by definition everything behind and beyond this interface is indeterminate. As Everett demonstrates, only that with which the protagonist is correlated by observations is determinate. In other words the holographic principle defines the same physical environment for the protagonist as Everett's many-worlds theory.

The holographic principle seems to mean that the volume of space is illusory, but no such drastic remodelling of common sense is required. It is just that the determinacy of each solipsism is defined solely on the surface, the interface to the rest of the universe. It is all real.

## 10 Transtemporal Reality

In order to complete the explanation of the operational system of physics a third level of logical type is required. This explains the origin of the transtemporal nature of the world encountered. It also explains how the protagonist can be both the determinant of the world and the knower of the world.

All conscious individuals experience the passage of time, thus a transtemporal reality, but in both relativity and quantum theory the universe is static, unchanging. Time cannot actually pass. That is an oxymoron. The only possible explanation is that a succession of states of the world is encountered in sequence. As Weyl states:

The objective world simply *is*, it does not *happen*. Only to the gaze of my consciousness, crawling upward along the life line of my body, does a section of this world come to life as a fleeting image in space which continuously changes in time. (1949, p. 116: emphasis in original)

In other words, the frame of reference of consciousness crawls upward along the four-dimensional space-time worldline, and thus there is the experience of a succession of states of the world hologram. Just as there is the appearance of

collapse of the wavefunction in quantum theory, there is the appearance of the passage of time in the relativistic block universe.

The logical types in the operational system are the same as a movie system. The frames are of the first, primitive logical type. The movie, the set of frames, is of the second. The iterator is of a third logical type, operational on all movies, the set of all sets of frames. It is universal to the system. Similarly, the moments in time, events along the worldline, are first-logical-type phenomena. The sequence is like the movie film, second-logical-type. The moving frame of reference is third-logical-type.

The problem is that such a phenomenon cannot exist in the physics as currently defined; but that is the whole point. As Weyl declared: "... the consciousness in this function does not belong to the world" (1934, p. 1). This is confirmed by Chalmers, who proposes that the experiencing phenomenon can only be: "... a fundamental feature of the world, alongside mass, charge, and space-time." (1995, p. 216).

On the inside view, in the moving frame of reference, the static block universe operates exactly like a DVD in action that produces the effect of the movie. As Tegmark states: "So life is like a movie, and space-time is like the DVD" (Kuhn, 2015). The fleeting image in space is the effective time-evolution of the world hologram, as the moving frame of reference passes from moment to moment along the worldline of the body. Effectively time passes, in experience. The gaze is the Now, the present moment that Einstein (Carnap, 1963, p. 37) specifically identifies as an impossibility in the physics.

Transtemporal reality is literally the movie of life, the moving picture of the world hologram experienced by consciousness. The known world is the memory, the recorded history that defines the Bayesian future. The Now, the present moment constantly moving into the future, is the moving frame of reference of the fundamental consciousness. This is the inescapable requirement for an effectively transtemporal world in the static block universe. The system effectively operates with the movement of the frame of reference, a third-logical-type phenomenon.

This experiencing consciousness is the *I* in each reality. The self-concept avatar figure is the *me*. The body is the structure. Thus the perceiving subject in the fullest sense is ontologically triune. This is how the conscious individual can be both the definition of the world and the knower of the world.

The third-logical-type phenomenon also resolves the preferred basis problem. The three-dimensional virtual-reality representation of the physical reality is literally the basis on which the experiencing consciousness encounters physical reality. In this frame of reference, as encountered by the fundamental consciousness, that is what defines reality, and thus the determinacy: correlations are established between the system and the rest of the environment on observation. The basis is different on inside and outside views, hence relative onticity.

## 11 Conclusion

As Everett demonstrates it is judged by the state of the memory, and there alone, that collapse effectively happens. In other words, the protagonist of the dynamics is not the observer, the physical measuring instrument, but the state of the memory, defined as the record of observations. This distinction is pivotal because their physical frames of reference are of different logical type.

The human observer is the body-mind, a physical machine that formulates observations in sensory data and records them. The frame of reference of this entity is the quasi-classical world of the current paradigm. The integrated synthesis of the record of observations forms the perceptual reality, the familiar three-dimensional representation of the world, mentally projected to coincide with the physical environment: here the world hologram. This is the entity the observer gives rise to, and Everett's protagonist. As he states, it is with respect to the state of the memory, i.e. in that frame of reference, that the dynamics operate in the standard formulation of quantum mechanics. This is a field of information, a very different type of entity to the physical observer. The frame of reference of this field of information is the class-of-worlds-as-a-world.

In the current paradigm it seems obvious that the world hologram is nothing but the perceptual reality, the inside view of the real world as encountered by each observer. The extraordinary status of this field of information is a feature of its multiple instantiation in the universe of the unitary wave function. As these are all coincident and superposed, the net result on the inside view is that there is just a single entity, a single individual; and the physical reality of this entity is the superposed sum of all worlds in which it exists. By definition this is indeterminate except where observed, and thus defined in the world hologram. The surreal implication is that the world hologram, a field of information, defines the determinacy of the physical reality. this is a class-of-worlds-as-a-world, a second-logical-type phenomenon.

Decoherence means that the physical environment of the observer is the quasi-classical world, as is obvious. The physical environment of the protagonist, the world hologram, is a phenomenon of different logical type: the superposition of a class of such worlds. The great paradoxes of quantum theory arise because the two are conflated. As Russell (1901) demonstrates, failure to discriminate between different logical types inevitably leads to nonsense results.

This explains the apparently paradoxical nature of the results of quantum physics experiments. Schrödinger's cat really is alive and dead at the same time because the class of quasi-classical worlds in the superposition includes both states. It is an insoluble paradox when the physical reality is taken to be nothing but a specific quasi-classical world. It is retrodicted in a world superposition.

In the frame of reference of the inside view, the quantum-mechanical frame of reference, determinacy is defined by the record of observations, the world hologram. Thus the definition is idiosyncratic to the individual as described in QBism (2013). This precisely explains the observer-dependent worlds of Wigner's friend: different relative states. This is now confirmed in experiment by Proietti et al. (2019).

Each such domain is a holographic 'universe'. Only the surface of the world encountered is determinate. There is thus an interface with the rest of the universe, the observed surface of the environment, behind and beyond which everything is indeterminate, just as proposed in the holographic principle (t'Hooft, 1993). This makes real sense of the principle because the boundary of the real determinate world is defined not at the limit of the objective, physical, decoherent, quasi-classical world (a seriously dubious concept in its own right), but the effective physical environment of the individual, the self-aware substructure on the inside view.

This resolves the fundamental conundrum of the holographic principle which seems to require that the volume of the universe is illusory. In this light it is shown to be perfectly real; it is just the determinacy of the effective physical reality of the perceiving subject that is defined solely on the lower-dimensional boundary of the region. It is not that the real, objective, physical world is just a hologram. It is simply that the determinacy of the effective physical environment of each individual is defined by a hologram: the three-dimensional representation of the integrated synthesis of the record of observations, mentally projected to coincide with the real spatial environment.

The holographic principle is simply a feature of the physical universe of all possible worlds, as encountered on the inside view. The result is interacting, overlapping, holographic worlds in action, each defined by the protagonist with the self-concept avatar figure at the centre. This is the topological structure of the multisolipsism.

This is exactly the type of environment Smolin sees as directly required by quantum gravity. As he states:

... it is not enough to say that the world is a hologram. The world must be a network of holograms ... the holographic principle is the ultimate realization of the notion that the world is a network of relationships. Those relationships are revealed by this new principle to involve nothing but information. (2000, p. 178)

The universe of multisolipsism is a network of holograms, each one the class-of-worlds-as-a-world of a particular inside view. Each inside view is a world hologram, a field of information. It would seem that the world hologram, Everett's state of the memory, is the fundamental component of reality.

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