Article

Science & Spirituality: A Perfect Standoff

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Abstract

The scientific basis for spirituality is discussed in the context of a recent book by Amanda Gefter. This book demonstrates why there is an impasse in the reconciliation of science with spirituality. This impasse is about the nature of reality, specifically what we mean by "reality", and about our basic assumptions about the nature of the world, the nature of consciousness, and the nature of the ultimate reality underlying both the world and consciousness, which is summed up with the slogan "Nothing is ultimately real".

Key Words: science, spirituality, world, consciousness, reality, ultimate reality.

In her paradigm-shattering recent book, as it surveys the landscape of modern physics, Amanda Gefter [1] draws the astounding conclusion that "Nothing is ultimately real". By "ultimate reality", Gefter refers to what is invariant and the same for all observers. She relentlessly demonstrates that modern physics conclusively shows that everything in the world, including the world itself, is "radically observer-dependent", and therefore cannot ultimately be real. This is what she finally has to say about the nature of the world:

"My father's definition of nothing had made it possible to cross that ontological divide between nothing and something, and the radical observer-dependence of every ingredient of reality down to reality itself made it possible to cross back. We had found the universe's secret: physics isn't the machinery behind the workings of the world; physics is the machinery behind the illusion that there is a world."

Gefter demonstrates that the only "thing" that is ultimately real is the "primordial nothingness", which is infinite, unbounded and undifferentiated. An observable world only appears within this primordial nothingness when a boundary arises within its midst and encodes information. She correctly identifies the observer of that world as a frame of reference, specifically the central point of view of that reference frame, but also shows that even this reference frame is not ultimately real, since the reference frame can only arise together with the observable world perceived in that frame of reference. That observable world is always defined in terms of the information encoded on a boundary that surrounds the observer at the central point of view of that reference frame.

Gefter describes that the origin of the observer's world can only arise when a boundary arises that limits observations in the observer's frame of reference:

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"My father's definition of nothing as an infinite, unbounded homogeneous state carried two implications: nothing has no outside, and nothing will never change. At first that had seemed like a nonstarter—if it can't change, how could the universe ever be born?"

"The origin has to come from inside the nothing. Given some internal reference frame with a boundary, a universe is born, its history unfurling from present to past. A top-down universe that exists only relative to its reference frame. Beyond the bounds of the frame, there's nothing."

"One thing was clear: the key to existence was a boundary. From the beginning I had worried that light cones alone wouldn't be enough. Given infinite time, any given light cone would engulf the entire H-state, turning the something back to nothing again. It seemed you needed something more permanent—something like the kind of perpetual boundary dark energy provides. Then again, maybe it was enough to say that no observer can measure himself. Maybe Gödelian incompleteness and the impossibility of self-measurement keep the nothing at bay, the world always carved in half, observer and observed."

"Now I was beginning to understand what information really was: asymmetry. To register a bit of information , you need two distinguishable states: black or white, spin up or spin down, 0 or 1. You need two-ness."

"My father's H-state was a state with no differentiation whatsoever. A state of perfect symmetry. That meant it had zero information, which made sense, considering it was nothing. So how do you get information from the H-state, turning nothing into something? You put a boundary on it. The boundary breaks the symmetry, creating information. But the boundary is observer-dependent, and so is the information it creates."

She concludes that both the observable world, which arises in terms of the information encoded on a boundary that arises in a reference frame, and the observer of that world, which arises at the central point of view of that reference frame, are illusions. The only "thing" that is ultimately real and is not an illusion is the "primordial nothingness", within which the surrounding boundary and the central point of view both arise.

This is what Gefter says about the reality of the observer's frame of reference:

"The message was clear: having a finite frame of reference creates the illusion of a world, but even the reference frame itself is an illusion."

If we call the observer at the central point of view a "focal point of consciousness", we conclude that both this differentiated focal point of consciousness and the observable world it perceives, as defined in terms of the information encoded on the boundary surrounding the focal point, are ultimately unreal. The only "thing" that is ultimately real is the "primordial nothingness", which is infinite, unbounded and undifferentiated.

Is it possible that an observable world and the consciousness that observes that world are both illusions? It is common in neuroscience [2] to assume that the world is real, while the consciousness that perceives that world is understood to be something of an illusion, but can both the perceivable world and the perceiving consciousness be illusions?

How can "nothing" be ultimately real? Doesn't the "primordial nothingness" have to have some inherent attributes of both a perceivable world, which arises within itself in terms of the information encoded on a boundary, and the focal point of perceiving consciousness, which arises at the central point of view of that boundary? How can we understand these attributes? Does it make any sense to understand this ultimate reality as pure nothingness?

The purposes of this article are to review the scientific evidence for the conclusions that Gefter draws, and also to argue for the inherent nature of the "primordial nothingness" beyond what Gefter describes as infinite, unbounded and undifferentiated. The bottom line of this investigation is that the "primordial nothingness" must have the nature of an "empty space of potentiality" that is the source of all physical energy and information characterizing any world, but is also a "void of undifferentiated consciousness" that is the source of all differentiated points of consciousness perceiving any world. At the end of the article, the basic reason for an impasse between science and spirituality is discussed.

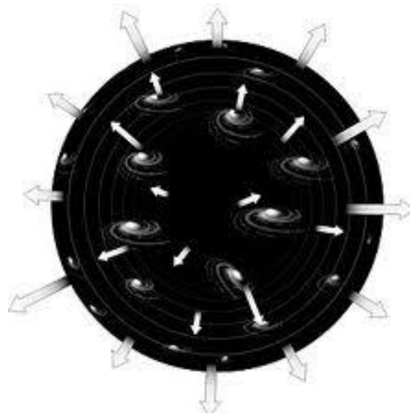
This impasse boils down to a fundamental disagreement in what we mean by "reality". For science, "reality" is a perceivable world. For spirituality, "reality" is the source of any possible perceivable world and the source of the perceiving consciousness of that world.

The Gefter argument is based on two recent discoveries in modern physics [3]. The first discovery is the nature of dark energy and a cosmic horizon, and the second discovery is the holographic principle. The discovery of dark energy is based on recent astronomical observations within the framework of relativity theory. The discovery of the holographic principle is based on the internal mathematical consistency in the way quantum theory is unified with relativity theory, which is essentially how space-time geometry is quantized.

Astronomical observations show that the farther we look out in space, the faster galaxies are moving away from us, as though everything in the universe repels everything else. This repulsive force is called the force of dark energy, which is understood as a kind of anti-gravity. In relativity theory, dark energy is understood as a cosmological constant.

The solutions to Einstein's equations with a positive cosmological constant describe an exponentially expanding space, which is called de Sitter space. The only way this kind of an exponentially expanding space can be understood is in terms of the expansion of space that expands at an accelerated rate relative to the central point of an observer. The farther out in space the observer looks, the faster space expands away from the observer.

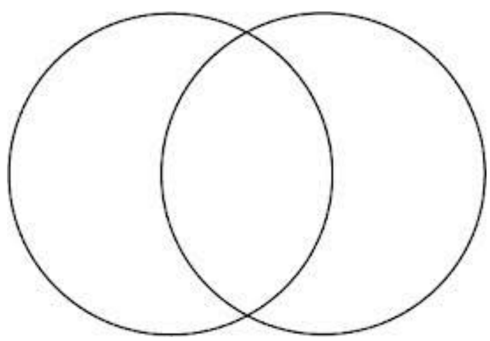
The exponential expansion of space results in a cosmic horizon surrounding the observer at the central point of view. At the observer's cosmic horizon things appear to move away from the observer at the speed of light, and since nothing can travel faster than the speed of light, the cosmic horizon is as far out in space as the observer can see things in space. The observer's cosmic horizon is therefore a bounding surface of space fundamentally limiting the observer's observations of things in space [3].



Expansion of space image from scienceblogs.com

A critical aspect of the cosmic horizon is its observer-dependence. In an exponentially expanding space with a positive cosmological constant, every observer is surrounded by its own cosmic horizon limiting its observations of things in space. Every observer is at the central point of view of its own observation-limiting, surrounding cosmic horizon.

Although the cosmic horizons of different observers can overlap with each other, the observer-dependence of the cosmic horizon tells us that every observer has its own cosmic horizon. By different observers, we can only refer to the differing focal points of consciousness that arise at the central point of view of different cosmic horizons.



The observation-limiting nature of the cosmic horizon implies symmetry breaking. The symmetry broken with a cosmic horizon is the symmetry of empty space, which is what we usually mean by Poincare symmetry. Poincare symmetry is the symmetry of empty, unbounded Minkowski space-time geometry, and that symmetry is broken when an observation-limiting cosmic horizon arises surrounding the observer at the central point of view. A positive cosmological constant breaks the symmetry of empty space by constructing a boundary in space surrounding the observer at the central point of view.

This symmetry breaking has profound implications in the way quantum theory is unified with relativity theory. In the sense of quantum field theory [4], we understand all particle excitations from the vacuum state in terms of irreducible representations of the Poincare symmetry group. The big problem is once we have a positive cosmological constant and every observer is surrounded by its own observation-limiting cosmic horizon, Poincare symmetry is broken and different observers no longer agree on the nature of the vacuum state. Since the observer's cosmic horizon is observer-dependent, different observers no longer agree on either the vacuum state or the spectrum of particle excitations.

The nature of this problem is called horizon complementarity [3]. Whenever an event horizon arises that limits the observations of an external accelerated observer, those observations no longer agree with the observations of a freely falling observer that falls freely through the event horizon. The external accelerated observer and the freely falling observer no longer agree on the nature of the vacuum state or the spectrum of particle excitations. The event horizon breaks the symmetry of empty space from the perspective of the external accelerated observer, and so those observations do not agree with those of the freely falling observer. The external accelerated observer observes thermal particles of Hawking radiation [3], while the freely falling observer does not observe them.

For the external accelerated observer the event horizon is a "real" surface in space that has a temperature and radiates away "real" particles of Hawking radiation as thermal radiation, while for the freely falling observer there are no particles of Hawking radiation and the event horizon is only an imaginary surface in space. Although the particles of Hawking radiation appear "real" for the external accelerated observer, they do not even exist for the freely falling observer, nor does the event horizon have a temperature.

If we define "real" as what is invariant and the same for all observers, then clearly, the thermal particles of Hawking radiation are not real, since the freely falling observer does not observe them. The particles of Hawking radiation only appear to be "real" and to exist for the external accelerated observer. The external accelerated observer and freely falling observer do not agree on the nature of the "reality" that they observe, but since they can never communicate with each other or share information, there is no real disagreement. This inability to ever communicate with each other is called horizon complementarity.

This strange state of affairs has profound implications when we try to define what is ultimately real. The nature of ultimate reality is about the ultimate nature of existence. The bizarre conclusion of modern physics is that nothing observable is invariant and the same for all observers, and so "Nothing is ultimately real", which is to say "Nothing ultimately exists". The problem we face is in understanding this "nothingness" as the ultimate nature of existence. The solution to this problem is in understanding ultimate reality not as "something" that we can observe, but as the observing consciousness. If we understand the observing consciousness as "nothingness", then the problem is solved. We understand that ultimately only consciousness exists. To say this in a different way, the consciousness of the observer continues to exist even if the observer observes nothing. Ultimate reality is fundamentally about the ultimate nature of the observer's existence.

Horizon complementarity refers to the absolute impossibility of the external accelerated observer and the freely falling observer ever being able to share information with each other and compare their radically different observations. Since these two observers can never share any information about their radically different observations, there is no real disagreement in the sense of quantum complementarity. This is analogous to the situation in the double slit experiment [3], where there is no real disagreement when one observer measures a particle-like property while another observer measures a wave-like property.

The situation with a positive cosmological constant and an observer-dependent cosmic horizon is different that other event horizons, such as the event horizon of a black hole, since different cosmic horizons can overlap with each other in the sense of a Venn diagram, and therefore it is possible that different observers can share information with each other to the degree their cosmic horizons overlap. Even so, the observer-dependent nature of each observer's cosmic horizon implies that there are observations that differ among differing observers, and those differing observations need not agree. There will always be some information that the different observers do not share with each other.

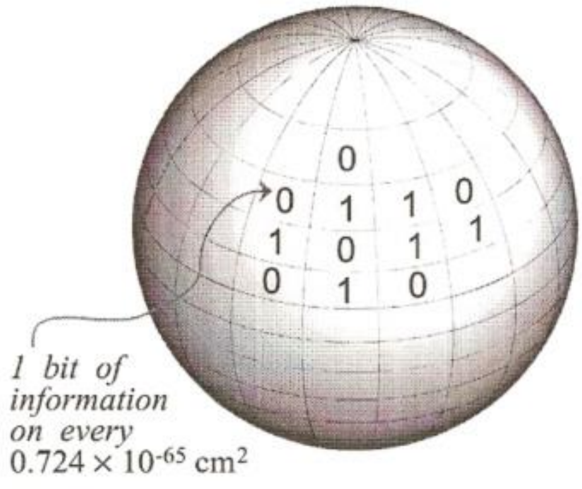
As we look out across the observable universe, observers on the other side of the universe are looking back at us, but since our cosmic horizons only overlap to a limited degree, they do not see the same observable universe as we see. Is the observable universe we see any more real than the observable universe they see? If we define what is ultimately real as what is invariant and the same for all observers, then both our observations and their observations are ultimately unreal, since they are not the same. What appears to exist for us is not the same as what appears to exist for them. This isn't just the case for observers on the opposite side of the universe. This is also the case for observers that are apparently standing right next to each other. Since their central points of view are not exactly the same focal point, their cosmic horizons can only overlap to a limited extent.

The nature of the observer-dependent cosmic horizon can only take us so far in terms of understanding "ultimate reality" in the sense of what is invariant and is the same for all observers. To go further, it is necessary to discuss the holographic principle [5].

The holographic principle is usually expressed as the covariant entropy bound. The idea of entropy arises from the idea of a bit of information that can encode information in a binary code of 1's and 0's. The amount of entropy that characterizes any region of space is the number of yes/no questions about that region of space that can be answered yes or no, like the question: is a particle located at this position in space at this moment of time?

The covariant entropy bound tells us there are a finite number of yes/no questions that can be asked about any finite region of space, which is what we expect when space-time geometry is quantized. In a quantized space-time geometry, there are a finite number of possible quantized position coordinates in any finite region of space that a particle can occupy at any possible quantized moment of time.

What is unexpected is that the total entropy of any region of space is not proportional to the three dimensional volume of that space, but to the two dimensional surface area of a bounding surface that bounds that region of space [6]. If this bounding surface of space is a spherical surface of radius R, then the surface area is $A=4\pi R^2$. The number of bits of information, n, that characterizes any finite region of space is specified in terms of the surface area, A, and the Planck area, $\ell^2=\hbar G/c^3$, as $n=A/4\ell^2$.

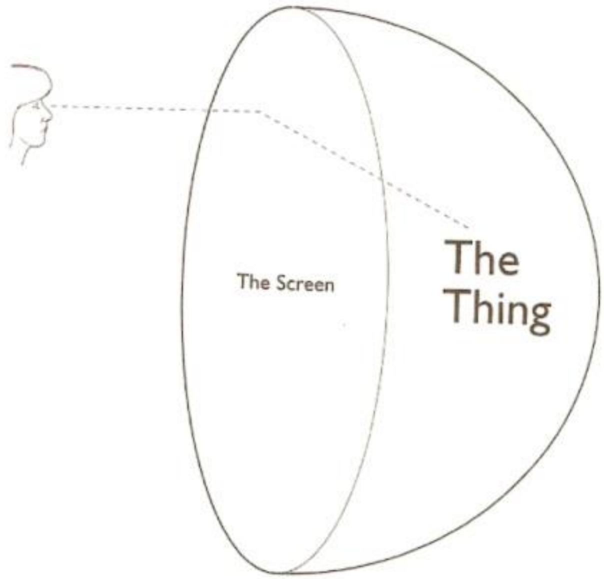


Covariant entropy bound image from 'tHooft

The reason this result is so unexpected is because particles occupy positions in space at moments of time. How then are we to interpret this result that all the bits of information that answer all the yes/no questions: "is a particle located at this position in space at this moment of time?" are encoded on the two dimensional bounding surface of that finite region of three dimensional space? The answer to this question is called a duality [3].

The holographic principle is the most fundamental duality known about in physics. This is like the wave-particle duality of quantum theory, but defined at the fundamental level of quantized space-time geometry. When space-time geometry is quantized, there are a finite number of possible quantized position coordinates available for a particle to occupy in any finite region of space at any possible quantized moment of time. The strange way quantum theory is unified with relativity theory does not allow this quantized space-time geometry to be defined in that region of space. The space-time geometry is only definable on the bounding surface of that space, which is the covariant entropy bound.

The holographic principle is a duality that relates the bits of information encoded on a two dimensional bounding surface of space to the particles that appear to occupy position coordinates in three dimensional space at moments of time. The only way to interpret this duality is that when we observe a particle at a position in space at some moment of time, that observation is like the projection of an image of the particle from a two dimensional surrounding screen to the central point of view of an observer [7].



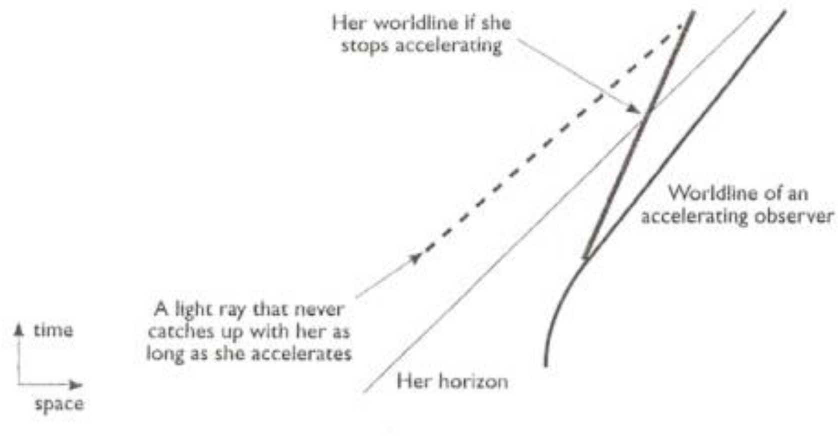
Holographic principle image from Smolin

To make sense of this interpretation, we have to understand the bounding surface of space as a holographic screen, and the projection of the image of something like a particle to the central point of view of the observer as a screen output, just like the kind of images we observe on a computer screen with each screen output. In the same sense, an animated sequence of screen outputs corresponds to a sequence of quantized moments of time.

Since bits of information are encoded on the screen in a pixelated way, with one bit of information encoded per pixel on the screen, this gives rise to a finite number of possible quantized position coordinates in space that a particle can occupy at any possible moment of time. The observed motion of the particle then occurs over an animated sequence of screen outputs. The observation of the particle and its motion are specified by the way in which bits of information are encoded on the screen over a sequence of screen outputs.

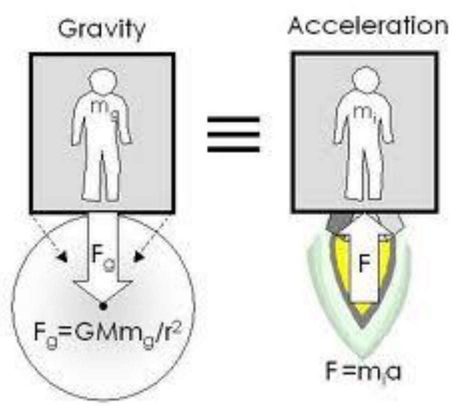
In reality, the particle is no more real than an animated image projected from the screen to the point of view of the observer. How are we to understand the nature of the observer? The observer is only a focal point of consciousness that arises in relation to the screen.

How does the screen arise? A holographic screen can only be understood as an event horizon that arises from the point of view of an accelerated observer. Examples of how event horizons arise are black hole horizons that arise from the perspective of external accelerated observers due to the force of gravity, cosmic horizons that arise from the perspective of observers at the central point of view due to the force of dark energy, and Rindler horizons that arise from the point of view of accelerated observers following accelerated world-lines through space-time geometry [7].



Rindler horizon image from Smolin

In all of these cases, the event horizon arises because the observer is in an accelerated frame of reference. An accelerated frame of reference is like a rocket-ship that accelerates through space due to the force of its thrusters. In the same sense that a rocket-ship must expend energy through the force of its thrusters as it accelerates through space, energy must be expended whenever an observer enters into an accelerated frame of reference [7].



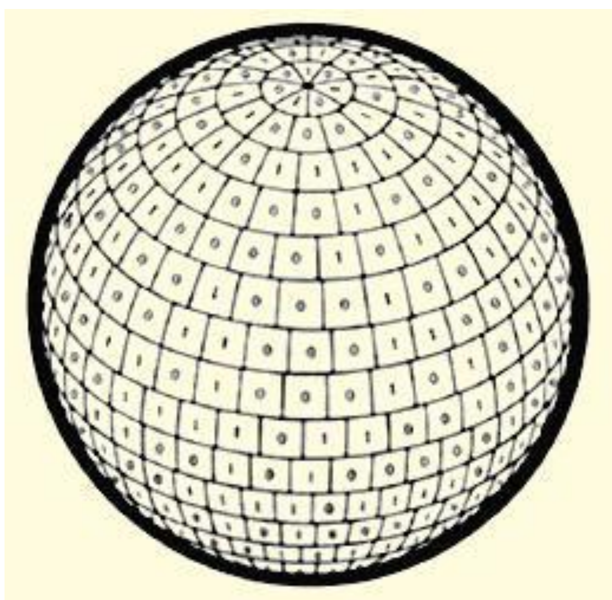
Principle of equivalence image from mysearch.org

The principle of equivalence tells us that the force of gravity experience by an observer is equivalent to an observer's accelerated frame of reference. There is no possible way that an observer can ever distinguish between the force of gravity and an acceleration as long as we understand the observer to be a focal point of consciousness.

The way the fundamental forces of electromagnetism and the strong and weak nuclear forces are unified with gravity demonstrates that all the fundamental gauge forces are equivalent to an observer's accelerated frame of reference. We understand unification in terms of the Kaluza-Klein mechanism [3] and extra compactified dimensions of space. This tells us that gravity corresponds to accelerations through the usual three extended dimensions of space, while the other gauge forces correspond to accelerations through the extra six compactified dimensions of space. Similarly, we understand the force of dark energy as the exponential expansion of space, where space itself does the accelerating. In this sense, all the fundamental forces are equivalent to an observer's accelerated frame of reference.

The observer's event horizon only arises if the observer enters into an accelerated frame of reference. In order for the observer's horizon to arise, energy must be expended. For a cosmic horizon to arise surrounding the observer at the central point of view, dark energy must be expended. We understand the expenditure of dark energy as the exponential expansion of space, which always expands relative to the observer's central point of view.

The holographic principle tells us the observer's horizon is a bounding surface of space that acts as a holographic screen and encodes bits of information. Everything the observer can observe in the space bounded by the screen is like the projection of images from the screen to the observer's central point of view. Those images are animated like the frames of a movie over a sequence of events that arise on the observer's accelerated world-line, where each event is a screen output that projects images to the observer's central point of view. The covariant entropy bound [5] tells us how information is encoded on the screen.



Horizon information image from eskola.hfd.hr

It's worth a brief digression to review the origin of the covariant entropy bound. This fundamental principle is a direct consequence of a more fundamental understanding of quantum uncertainty [3]. This discussion will also allow us to understand the origin of the covariant bound in terms of a non-commutative geometry, which gives us a fundamental way to understand how space-time geometry is quantized.

The uncertainty principle is fundamental to the formulation of quantum theory. If we want to measure the position of a particle in space, we usually shine light at the particle and observe the pattern of scattered radiation. We think of light as a wave, but quantum theory tells us each quantum of light acts like a particle called a photon. When a photon interacts with another particle in a scattering event, momentum is exchanged. The photon has an intrinsic wavelength related to its momentum as $p=h/\lambda$. This wavelength limits the degree to which we can localize the particle's position in space. If we want to localize the particle within a distance interval $\Delta x=\lambda$, an amount of momentum at least as large as $\Delta p=h/\Delta x$ must be exchanged in the scattering event, which is the uncertainty principle.

Quantum uncertainty tells us that something very odd occurs in the vicinity of an event horizon, like that of a black hole. The horizon of a black hole is a bounding surface of space that limits observations in space due to the limitation of the speed of light. The event horizon is a surface that demarcates where the force of gravity is so strong that even light cannot escape away from the black hole. For an external accelerated observer, no signal that originates within the event horizon can ever cross the horizon due to the force of gravity and reach the external observer.

Relativity theory tells us that the radius of the event horizon is directly related to the amount of mass stored inside the black hole as $R=2GM/c^2$. If enough mass and energy is concentrated in a small enough region of space, a black hole is forced to form due to the force of gravity, which is so strong at the event horizon that even light cannot escape.

This result tells us something very odd occurs in our description of how we measure the location of a particle by scattering electromagnetic radiation off the particle. The photon's energy is related to its wave frequency as $E=hf$, which is the same as $E=hc/\lambda$ since the speed of light is given by $c=\lambda f$. This means if we want to localize the particle's position within a smaller distance scale $\Delta x=\lambda$, we must use higher energy photons. Eventually, as we measure distances at smaller and smaller distance scales, we concentrate so much energy into such a small region of space that a black hole is forced to form. If we equate this amount of energy with the mass of the black hole, $E=Mc^2$, and look for the smallest possible black hole radius as $R=\ell$, this determines the radius of the smallest possible black hole that can form as $\ell=2hG/\lambda c^3$. If the wavelength at which a black hole is forced to form is related to the smallest possible black hole radius as $\lambda=4\pi\ell$, we then determine the smallest possible distance scale in terms of the Planck length as $\ell^2=hG/2\pi c^3$.

This is a very odd result. We measure the location of the particle by scattering radiation off the particle, but at a very high energy level and very small distance scale a black hole is forced to form with a radius $R=\ell$. This smallest possible distance scale is the Planck length. As we shine higher energy photons with a smaller wavelength at this black hole, we only concentrate more energy within the black hole, which means the black hole gains a larger mass and its radius increases. The photons that we can measure that scatter off the surface of the black hole have a wavelength that is approximately related to the radius of the event horizon as $\lambda=4\pi R$, which is about the maximal circumference of the horizon.

The reason we cannot measure any photons with a wavelength less than the maximal circumference of the horizon is because those photons are gravitationally bound inside the event horizon of the black hole, and so they cannot escape away from the black hole. In order to escape, the photon must have a wavelength larger than this circumference. If the wavelength is less than this circumference, the photon is bound inside the black hole.

This result also allows us to determine the temperature of the event horizon. When we say that photons scatter off the surface of the event horizon, what we really mean is the horizon absorbs those photons like a black body, and then radiates away photons as thermal black body radiation. The energy of a radiated photon is given by $E=hc/\lambda$, and the wavelength of a radiated photon is about equal to the maximal circumference of the event horizon, which is $2\pi R$. If we equate this energy with the average thermal energy, $E=kT$, of the thermal black body radiation, we determine the absolute temperature of the horizon. Hawking [3] found that the horizon temperature is given by $kT=\hbar c/2\pi R$.

This simple calculation tells us that the Planck length is the smallest possible distance scale that we can ever measure. If we try to measure something smaller than a Planck length, we force a Planck-size black hole to form, and that black hole only becomes larger as we attempt to probe smaller distance scales. As we shine higher energy photons with a smaller wavelength at the black hole, those photons are bound inside the black hole. We thus create a more massive black hole with a larger radius that can only radiate smaller energy photons with a larger wavelength back to us. The distance scale at which the black hole is forced to form, $R=\ell$, is the smallest possible distance scale that we can ever measure. If we try to measure anything smaller than this distance scale, that thing appears to become larger since we have forced a black hole to form [3].

Quantum uncertainty specifies the smallest energy photon radiated back to an external observer from the surface of the horizon has a wavelength about equal to the maximal circumference of the horizon, $\lambda=2\pi R$. This wavelength corresponds to a photon that is just barely gravitationally bound to the black hole. As observed by the external observer, the event horizon demarcates a boundary in space where the force of gravity is so strong that even light cannot escape. Only a photon that is just barely bound to the black hole can escape away. Just like for any other bound state, the wavelength of this barely bound photon is constrained to fit into the circumference of a periodic orbit, where the orbital radius is the horizon radius.

Relativity theory tells us the radius of the event horizon is determined by the mass of the black hole as $R=2GM/c^2$. The Planck length is the smallest possible distance scale, and corresponds to the smallest possible mass, which is called the Planck mass. It is a simple matter to determine the radius of a Planck size black hole by equating the energy $E=hc/\lambda$ of the smallest energy photon gravitationally bound to the black hole, with a wavelength $\lambda=2\pi R$, with $E=Mc^2$, and setting $\ell=R/\sqrt{2}$, this gives the Planck length as $\ell^2=\hbar G/c^3$.

In terms of the holographic principle, the energy of the smallest energy photon radiated away from the surface of the black hole horizon corresponds to the thermal energy of a fundamental bit of information encoded on the surface of the horizon. An easy way to estimate how many bits of information are encoded on the horizon is to calculate how much the radius of the horizon changes as the smallest energy photon with wavelength $\lambda=2\pi R$ is radiated away and the mass of the black hole decreases. This change in radius is given as $\Delta R=2G\Delta M/c^2$. If we equate $\Delta M=\Delta E/c^2=h/c\lambda=\hbar/cR$, we find $R\Delta R=2G\hbar/c^3=2\ell^2$. Since $A=4\pi R^2$ and $\Delta A=8\pi R\Delta R$, this tells us as the smallest energy photon is radiated away, the surface area of the horizon decreases by about a Planck area. Since the smallest energy photon corresponds to a single bit of information, this tells us each Planck area encodes about one bit of information, which is the covariant entropy bound, $n=A/4\ell^2$.

In the sense of thermodynamics, this smallest possible bit of information is the smallest possible degree of freedom, and carries an amount of thermal energy E=kT. Fundamentally, this thermal energy arises as a bit of information encoded in a binary code of 1's and 0's tends to flip back and forth, just like a switch that tends to flip back and forth between the on and the off positions due to its thermal energy. This thermal energy represents the kinetic energy of each of the bits of information. If we equate the thermal energy of each bit of information with the energy carried by the smallest energy photon radiated away from the horizon, we find $kT=hc/2\pi R$.

This thermal radiation leads to an infamous paradox. If the surrounding space is cold enough, the black hole will radiate away thermal radiation and decrease in mass until the black hole evaporates away and disappears. What happens to all the information for all the things that fell into the black hole? Does all that information disappear as the black hole evaporates away or does it come out with the Hawking radiation? How can all the information for the things that fell into the black hole come out with the Hawking radiation since no signal that originates inside the black hole can ever cross the horizon?

The answer to this puzzle is called horizon complementarity. From the perspective of an external observer, nothing ever really fell into the black hole in the first place. As things appear to fall into the black hole, those things appear to stop right at the event horizon due to gravitational infrared Doppler shifting, which is a kind of time dilation. For the external observer, it takes an infinite amount of time for anything to cross the event horizon and fall into the black hole. From that external perspective, those things stop right at the horizon and all the information becomes scrambled. That scrambled information is then radiated back to the external observer as Hawking radiation, and so no information is ever lost as the black hole evaporates away.

But things appear to be very different for a freely falling observer that falls right through the event horizon. The horizon only appears to exist for the external observer. For the freely falling observer the event horizon is just an imaginary surface in space and does not really exist. For the freely falling observer there is no event horizon and there are no particles of Hawking radiation.

For the external observer the event horizon is a real surface in space that appears to have a temperature and to radiate away a form of thermal radiation called Hawking radiation towards the external observer, but for the freely falling observer there is no event horizon and there are no thermal particles of Hawking radiation. For the freely falling observer these things simply do not exist. They only appear to exist from the accelerated perspective of the external observer.

How can what appears to exist be so radically different for the external observer and for the freely falling observer? The principle of equivalence gives the answer, and is called horizon complementarity. The external observer is in an accelerated frame of reference. That acceleration is equivalent to the force of gravity that the external observer perceives to arise from the black hole. That force of gravity is equivalent to the external observer's accelerated frame of reference. Only in that accelerated frame of reference does the external observer perceive the event horizon of the black hole and the associated particles of Hawking radiation radiated away from the horizon towards the external observer. In the freely falling frame of reference of the freely falling observer, there is no force of gravity, there is no event horizon, and there are no particles of Hawking radiation.

There is no real paradox here because it is impossible for the external observer to compare its observations with the observations of the freely falling observer. The absolute impossibility of ever comparing their radically different observations is called horizon complementarity. As long as it remains absolutely impossible for different observers to compare their radically different observations about what appears to exist, there is no real disagreement in those observations.

A non-commutative geometry [8] is a way of mathematically formalizing this smallest possible distance scale. The easiest example to consider is the event horizon of a black hole. The event horizon is a spherical surface of radius R. Just like with quantum theory, a non-commutative geometry is characterized by an uncertainty relationship, but this relation is not between positions in space and momenta through space of particles. This uncertainty relation is between the position coordinates of space. In a non-commutative geometry, there is always some uncertainty in the position coordinates of space. That uncertainty is what we mean by a quantized space-time geometry.

A non-commutative geometry solves the problem of the smallest possible distance scale by specifying all possible positions in space defined by a coordinate system have inherent uncertainty. If we consider the event horizon of a black hole, that two dimensional spherical surface can be parameterized in terms of an x-y coordinate system labeled by points on the surface as (x, y). On the surface of a sphere, these coordinates are like latitude and longitude. A non-commutative geometry specifies there is some inherent uncertainty in our ability to define the (x, y) points. This uncertainty relation is usually expressed as $\Delta x \Delta y \geq \ell^2$. The more accurately we know about the x-coordinate, the less accurately we know about the y-coordinate. It is as though the (x, y) point on the surface of the sphere becomes fuzzy and gets smeared out into an area element of size ℓ^2. This area element acts like a pixel on the surface of the sphere and encodes a bit of information [8].

Information is encoded in a non-commutative geometry because the position coordinates on the surface are smeared out into pixels. Mathematically, this corresponds to position coordinates represented by non-commuting variables. This parameterization is in terms of matrices. If two positions coordinates are defined on the surface, the parameterization is as a 2x2 matrix. Information is encoded in terms of the two eigenvalues of the matrix. Each eigenvalue of the matrix localizes a position on the surface, but the coordinate is smeared out into a pixel of size ℓ^2. Two position coordinates are defined in a rotationally invariant way in a non-commutative geometry since the 2x2 matrix is an SU(2) matrix.

An SU(2) matrix encodes information in a binary code, just like a spin ½ variable that can only point up or down. The spin ½ variable is like an on/off switch that encodes information in a binary code of 1's and 0's. If there are n position coordinates defined on the bounding surface, the parameterization is as an nxn matrix. The n bits of information are defined in terms of the n eigenvalues of the nxn matrix. An SU(n) matrix can be decomposed into SU(2) matrices, and so the information for the n position coordinates can be decomposed into n bits of information.

This is the natural way information becomes encoded on a bounding surface of space in a non-commutative geometry. If the pixel size is $4\ell^2$, then a surface with area A can encode a total of $n=A/4\ell^2$ bits of information. Each pixel on the screen encodes a quantized bit of information, but that information is entangled due to the nature of matrices.

In a non-commutative geometry position coordinates on a bounding surface of space are represented by non-commuting variables, typically by Dirac operators [8]. Non-commuting position coordinates on the bounding surface gives rise to an uncertainty relation of the form $\Delta x \Delta y \geq \ell^2$, just as non-commuting operators for position and momentum variables of particles give rise to an uncertainty relation of the form $\Delta x \Delta p \geq h$.

The holographic principle is a duality translating between the way information is encoded on a bounding surface of space that acts as a holographic screen and the behavior of the particles observed in the space bounded by that surface. This translation is only possible because position coordinates on the bounding surface are smeared out into pixels when represented by non-commuting operators, and each pixel encodes a bit of information. The observation of particles is like a projection of images from the screen to the central point of view of the observer of the screen. The observed motion of particles corresponds to the animation of these images over a sequence of screen outputs.

In the language of quantum theory, the observer's holographic screen gives rise to a Hilbert space of observable values. Everything the observer can possibly observe in the space bounded by the screen is defined in terms of how information is encoded on the screen. A non-commutative geometry tells us the n bits of information encoded on the screen are defined in terms of the n eigenvalues of an SU(n) matrix. This SU(n) matrix defines the Hilbert space. These n bits of information are entangled with each other due to the nature of matrices. The SU(n) matrix, and therefore the Hilbert space, is defined on the bounding surface. In mathematical language, the bounding surface is the base space, while the Hilbert space is a kind of fibre bundle space that sits on top of the base space.

What are we to make of space-time geometry? Space-time geometry is a holographic projection from the bounding surface to the central point of view of the observer. The bounding surface acts as a holographic screen, and with each screen output the observer makes observations of things in the space bounded by the screen. Each observation of something is a quantum state reduction that reduces the quantum state of the screen to an actual observable state. An observable state is defined by an actual configuration state of information defined on the screen, while the quantum state of the screen is defined as a sum over all possible ways information can become encoded on the screen, which is a sum over all possible configuration states of information.

With the observation of things in space, not only are those things defined, but space-time geometry is also defined. Space-time geometry is defined with each screen output that reduces the quantum state of the screen to an actual configuration state of information.

This result tells us why it is impossible to understand the unification of quantum theory with relativity theory in terms of a quantum field theory, or anything similar to quantum field theory, like string theory. The Hilbert space that corresponds to any quantum field theory is a kind of fibre bundle space that sits on top of a space defined in a space-time geometry, like Minkowski space. With any quantum field theory, the base space is always a space defined in a space-time geometry. At each point in this space, the quantum field φ(x, t) acts like a harmonic oscillator [4], and has its own Hilbert space of excited states from the ground state.

In any quantum field theory [4], a Hilbert space sits on top of each point of a space defined in a space-time geometry, which defines every possible observation an observer can make at any point of space and at any moment of time in terms of particle excitations from the vacuum state.

The problem with any QFT formulation is that it violates the covariant entropy bound. Even if space-time geometry is quantized, QFT says the entropy of any region of space is proportional to the volume of that space, while the covariant entropy bound says entropy is proportional to the area of the surface bounding that space. QFT is not consistent with relativity theory for the fundamental reason that all the bits of information that define the observer's observations are defined on an observation-limiting event horizon that arises in the observer's accelerated frame of reference. The observer's Hilbert space is defined on the event horizon. The problem is the event horizon breaks the symmetry of empty space, and so different observers in different frames of reference no longer agree about the nature of the vacuum state or particle excitations.

The holographic principle tells us that the base space is a bounding surface of space. The Hilbert space defined by an SU(n) matrix sits on top of the bounding surface, which acts as a holographic screen. Space-time geometry, like anything the observer can observe, is a projection from the holographic screen to the central point of view of the observer. No quantum field theory can ever fully encompass the holographic principle, since anything like a quantum field theory assumes that the base space is a space defined in a space-time geometry.

What then are we to make of a quantum field theory? The answer is a QFT is only an effective field theory that arises as a thermodynamic average, sort of like the ideal gas law arises as a thermodynamic average in kinetic theory. The field variables are not really fluctuating quantum variables, at least not with a range of validity approaching the Planck scale. This is the case for all the gauge theories, not only including electromagnetism and the nuclear forces, but also gravity [7]. Even Einstein's field equations for the metric arise as a thermodynamic average. The only valid fluctuating quantum variables at the Planck scale are non-commuting variables defined on a bounding surface of space. The bounding surface of space is the base space for the observer's Hilbert space.

The observer's holographic screen is an event horizon that only arises when the observer enters into an accelerated frame of reference. This happens whenever energy is expended, like the cosmic horizon that arises when dark energy is expended. We understand that the observer is only a focal point of consciousness that arises in relation to its holographic screen, like the observer at the central point of view that arises when a cosmic horizon arises. When energy is expended and the screen arises, the observer also arises.

Although it seems as though the observer follows an accelerated world-line through space-time geometry, the correct way to understand this state of affairs is in terms of the holographic screen that arises when energy is expended and the observer enters into an accelerated frame of reference. Space-time geometry, like everything else the observer can observe in its world, is a projection from the holographic screen to the central point of view of the observer. Every event on the observer's accelerated world-line is another screen output. The key thing to understand is the observer and its screen arise together, but they can only arise when energy is expended in an accelerated frame of reference.

The big question we have to answer is: from what do the observer and its screen arise? What is the nature of the ultimate reality from which an observer and its screen arise?

To answer this question we need to investigate how energy is expended. What gives rise to an accelerated frame of reference? We understand the observer to be a focal point of consciousness present at the central point of view of an accelerated frame of reference, while the observer's world is defined by the way information is encoded on the boundary of that reference frame. That boundary is an event horizon that acts as a holographic screen and projects images of the observer's world to the central point of view of the observer. Gefter [1] refers to this as the "one-world-per-observer paradigm".

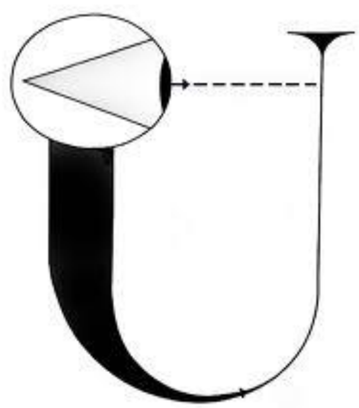


Image of Wheeler's universal observer from cosmoquest.org

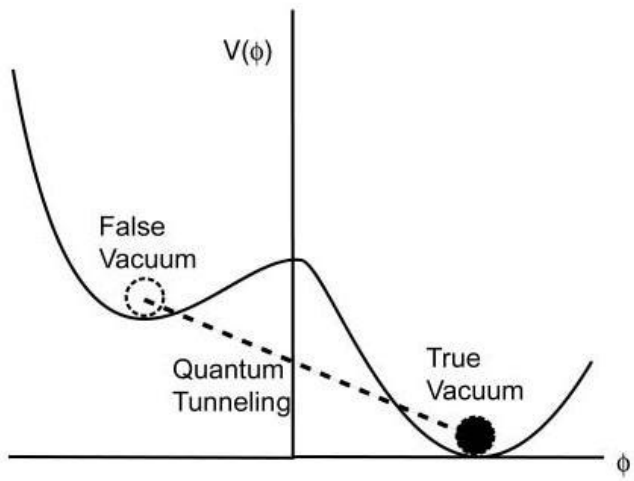
The key idea in the "one-world-per-observer paradigm" is each observer at the central point of view has its own Hilbert space defined on its own holographic screen, which defines everything the observer can possibly observe in its own world. The boundary of that world is the base space for a Hilbert space that represents all possible observations the observer can make in its world. Each observation reduces the quantum state of the screen to an actual configuration state of information defined on the screen, and is like a screen output. Each event on the observer's accelerated world-line through its projected space-time geometry is another screen output.

The holographic principle tells us the boundary is an event horizon that can only arise when the observer enters into an accelerated frame of reference, which requires the expenditure of energy. What is the ultimate source of this energy?

Modern cosmology gives us the answer in terms of dark energy and the exponential expansion of space. Whenever dark energy is expended, space appears to expand at an accelerated rate relative to the observer's central point of view, and a surrounding cosmic horizon arises that limits the observer's observations of things in space.

If we take inflationary cosmology and the big bang theory seriously, we understand that at the moment of creation of the observer's world, that world is about a Planck length in size, but that world then inflates in size because of an instability in dark energy. This instability in dark energy is like a process of burning that burns away the dark energy.

The expenditure of dark energy breaks the symmetry of empty space by constructing an observation-limiting cosmic horizon that surrounds the observer at the central point of view. The instability in dark energy is like a process of burning that burns away the dark energy and "undoes" this broken symmetry. As the dark energy burns away to zero, the cosmic horizon inflates in size to infinity, and the symmetry is restored. We understand that this "undoing" of symmetry breaking is like a phase transition from a false vacuum state to a true vacuum state [9]. As the phase transition occurs, dark energy burns away.



Meta-stable state image from ned.ipac.caltech.edu

This burning away of dark energy explains the normal flow of energy in the observer's world in the sense of the second law of thermodynamics. This is easiest to understand in terms of a cosmological constant Λ. Relativity theory [5] tells us the size of the observer's cosmic horizon is related to the cosmological constant as $R^2/\ell^2=3/\Lambda$. The holographic principle tells us the absolute temperature of the cosmic horizon is related to its radius as $kT=\hbar c/2\pi R$. At the moment of creation, R is about equal to ℓ, Λ is about equal to 1, and the absolute temperature is about equal to 10^{32} degrees Kelvin. As the dark energy burns away, Λ decreases in value, R inflates in size, and the temperature cools. As Λ decreases to zero, R inflates to infinity, and the temperature cools to absolute zero.

This understanding is not only consistent with our understanding of the big bang event, but also with the current measured value of the cosmological constant, based on the rate at which distant galaxies are observed to accelerate away from us. The current measured value of Λ is about 10^{-123}, which corresponds to the size of the observable universe of about 15 billion light years.

The second law of thermodynamics simply says that heat tends to flow from a hotter object to a colder object because the hotter object radiates away more heat, which is thermal radiation. The instability in dark energy explains the second law as dark energy burns away, the observer's world inflates in size and cools in temperature, and heat tends to flow from hotter states of the observer's world to colder states of the observer's world [9].

Second law of thermodynamics image from Penrose

The normal flow of energy through the observer's world simply reflects this normal flow of heat as the dark energy burns away and the observer's world inflates in size and cools. This normal flow of energy naturally arises in a thermal gradient. One of the mysteries of the second law is understanding time's arrow, or how the normal course of time is related to this normal flow of energy. The burning away of dark energy explains this mystery. As far as the holographic principle goes, a thermal gradient is also a temporal gradient. The holographic principle reduces concepts of temperature, the normal flow of energy and the course of time to geometry, and so these concepts are intrinsically related to each other.

What are we to make of the expenditure of other forms of energy besides dark energy? Modern cosmology and physics again give the answer in terms of symmetry breaking. Observations indicate that the total energy of the observable universe is zero. This is possible in relativity theory since the negative potential energy of gravitational attraction can exactly cancel out the total amount of dark energy and any other forms of positive energy that arise from dark energy [9].

How do other forms of energy, like mass energy, arise from dark energy? The answer is symmetry breaking. As dark energy burns away, high energy photons are created, and these photons can create particle-antiparticle pairs, like proton-antiproton pairs. One of the mysteries of cosmology is why there are so many protons in the universe and so few antiprotons. Symmetry breaking gives the answer. At high energies, antiprotons can decay into electrons and protons into positrons, but there is a difference in the decay rates due to a broken symmetry, and so more antiprotons decay than protons. As the universe cools, the protons become stable, and so that is what we are left with. The expenditure of energy that characterizes the fundamental gauge forces, like electromagnetic energy in a living organism, or nuclear energy in a star, all arises from dark energy through a process of symmetry breaking, but all of this positive energy is exactly cancelled out by the negative potential energy of gravitational attraction.

The fact that the total energy of the observable universe exactly adds up to zero tells us something important. Since everything in the world is composed of energy and all of that energy ultimately adds up to zero, this tells us that everything is ultimately nothing.

Everything the observer can possibly observe in its world is like an image projected from its holographic screen to the observer's central point of view. All the bits of information that define the images are encoded on a two dimensional screen, but the projected images appear three dimensional since they're holographic. Those projected images are animated over a sequence of events in the flow of energy, just like the frames of a movie, and each observational event on the observer's world-line is another screen output.

The projected images are best understood in the sense of coherently organized forms of information. These coherently organized forms of information can be understood in the sense of bound states of information that tend to hold together over a sequence of screen outputs. Coherent organization means these forms tend to self-replicate their forms over a sequence of events and hold together as bound states of information. This animation of images over a sequence of events always arises in the flow of energy that characterizes the observer's accelerated world-line.

In relativity theory, we understand an observer's accelerated frame of reference as an accelerated world-line through space-time geometry. The holographic principle turns this understanding inside-out, since space-time geometry is a projection from the observer's screen to the observer's central point of view. The observer only appears to follow an accelerated world-line through the space-time geometry projected from its screen to the central point of view of the observer.

This gives us a natural explanation for the one-world-per-observer paradigm, but how do we understand a consensual reality shared by many observers? Again, the answer is the holographic principle. Each observer's world is defined on its own holographic screen, but those bounding surfaces of space can overlap with each other and share information. Many observers can share a consensual reality together to the degree their holographic screens overlap and share information.

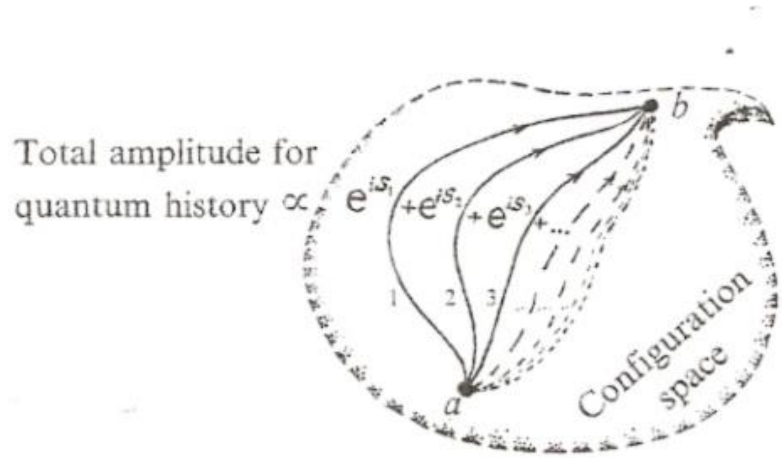
The holographic principle also tells us that energy and information are really the same thing. Information is what energy looks like when observed at an instant of time. Each coherently organized form of information is composed of bits of information, and those forms of information are animated over a sequence of events. Energy is what a form of information looks like when that form is animated over a sequence of events. Information is a static concept while energy is a dynamic concept.

The equivalence of energy and information has a deep connection in quantum theory and in the way quantum theory is unified with relativity theory. When we speak of bits of information encoded on a holographic screen, we're speaking about the quantized bits of information that define everything observable in an observer's world. The observer's holographic screen is characterized by a quantum state describing all possible ways in which bits of information can become encoded on the screen. The quantum state of the screen defines everything the observer can possibly observe in its world. We can think of this quantum state as a sum over all possible configuration states of information, where a configuration state specifies a specific configuration in the way bits of information are encoded on the screen. A screen output must chose a specific configuration state from the quantum state when the observation of anything is observed. In quantum theory, this observational choice is called a quantum state reduction.

Quantum theory tells us that the observation of any observable thing by an observer implies an observer-observation-observable relationship, while an observation implies a choice as the quantum state of potentiality is reduced to an actual configuration state of information. In this sense, each screen output is a choice.

There is something very odd about quantum theory that is usually not discussed. Every quantum state reduction is a choice, which occurs at a decision point on the observer's world-line. At every decision point, the observer has a choice to make about what to observe in its world and which path to follow. Physicists have arbitrarily assumed that all choices are made randomly, in an unbiased way, but this assumption is only made since physicists want the laws of physics to have predictability. If choices are made in a biased way, then the laws of physics lose their predictability, and all bets are off, so to speak.

It's worth a brief review of how choice operates in quantum theory. The quantum state can always be formalized as a sum over all possible paths that connect two points in some configuration space [9]. For example, a configuration space could be space-time geometry, and then a path would be a world-line followed by an observer. In this sum over all paths formulation of the quantum state, we are instructed to sum over all possible paths in the configuration space, and then weight each path with a probability factor called the wave-function, $\psi=\exp(i\theta)$, where the phase angle θ is given in terms of the action S as $\theta=S/\hbar$.



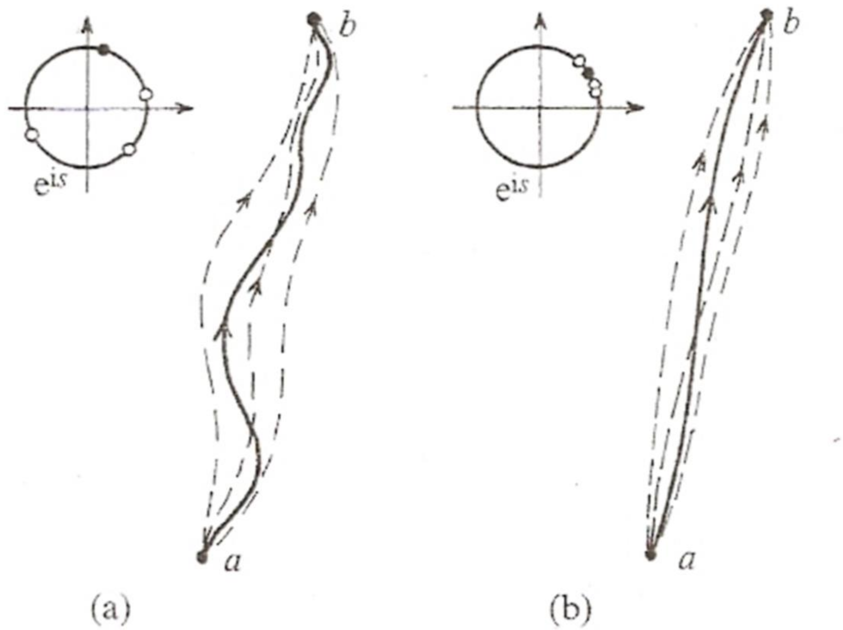
Sum over all paths image from Penrose

The action is specified in terms of the geometrical length of a path that connects two points. For example, for a world-line, the action is specified by the proper-time, $\tau=\int ds$, where $ds^2=g_{\mu\nu}dx^\mu dx^\nu$, and where $g_{\mu\nu}$ is the space-time metric. This is the case if there are 3+1 extended dimensions of space-time, but is also valid when there are extra compactified dimensions, in which case the metric not only represents the force of gravity, but also represents all the gauge forces, like electromagnetism. With a cosmological constant, the metric also represents the force of dark energy. The metric is the natural way to unify all fundamental forces [4].

Laws of physics are always expressed in terms of an action principle. Once we express S, we express the laws of physics, but the laws of physics only enter into the quantum state in terms of a probability factor ψ that gives weight to every possible path in the sum over all paths. The most likely path in the sense of quantum probability is the path of least action. Relativity theory tells us that the path of least action is like the shortest distance between two points in a curved space-time geometry, which is how we understand all of classical physics. The path of least action gives the maximal quantum probability [9], but this maximal likelihood is only meaningful if choices are made in an unbiased way.

What if there is bias in the way choices are made? The all bets are off, and the laws of physics lose their predictability. Physicists don't like that idea, and so they've arbitrarily assumed only random choice is operative, but each of us knows that is not the way the world really works. Each of us is biased to choose what we like and to avoid what we don't like. This ability to choose what we like is the nature of our volition, or free will.

How are these choices made? The only possible answer is choices are made as the focus of attention of consciousness is focused on something. An observer chooses what it observes in its world with its focus of attention on that thing in its world. This makes perfectly good sense, since an observer is a focal point of consciousness. A focal point of consciousness is always at the central point of view of its own world, and that world is always defined on a holographic screen surrounding the central focal point. The observer expresses it volition or free will as it focuses its attention on something in its world.



Principle of least action image from Penrose

There are two mysteries about the nature of consciousness that this explanation helps us understand. The first mystery is about how choices are made, which is the nature of free will. The answer is an observer chooses what it observes in its world as it focuses its attention on things in its world. The observer is always free to shift its focus of attention into a different direction and observe something different, thereby expressing its free will.

The second mystery is about how meaning is given to observations. The holographic principle tells us the observation of anything occurs in a screen output, but the nature of that thing is only a coherently organized form of information defined on the screen in terms of how bits of information are encoded on the screen. These forms of information are composed of bits of information encoded in a binary code of 1's and 0's.

How does a presence of consciousness give meaning to the forms of information it observes? The answer is all meaning is given in an energetic context, and this energetic context implies the expenditure of energy. The expenditure of energy is how a form of information is animated over a sequence of events, and only that animation of form creates the energetic context within which meaning is given to the form.

In emotional terms, or in terms of the animation of a body, the expenditure of energy creates the emotional context in which meaning is given. As is well known from the study of emotions [2], all meaning is given in an emotional context. The expression of emotion is the expenditure of energy that animates the form of a body. Without this emotional expenditure of energy, which animates the form of the observer's body, the observer cannot give meaning to any form of information that it observes.

The solution to these two mysteries leads to an odd kind of emotional feedback loop. A presence of consciousness chooses what it observes in its world with its focus of attention on things in that world, but the meaning it gives to those observations always occurs in an emotional context as energy is expended to animate a form of information in that world.

When we speak of an animated form of information in the observer's world, we are speaking about a coherently organized form of information that is displayed on the observer's holographic screen and self-replicated in form over a sequence of events.

Some of these observations are external sensory perceptions of the observer's world, which includes perceptions of the animated form of the observer's body, and some of these observations are internal perceptions that arise in mental imagination, like the perception of memories, emotions, thoughts, and other mentally constructed forms of information. The holographic principle tells us that there is really no difference in the nature of these external and internal perceptions, since all of these animated forms of information are displayed on the observer's holographic screen. The observer is only a focal point of consciousness at the central point of view of its holographic screen.

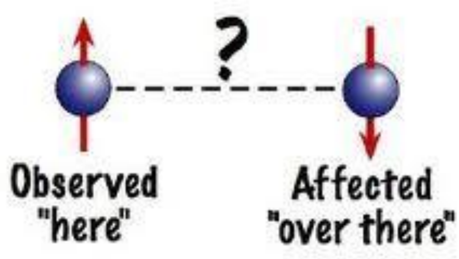
Whether the observed form of information is an external or internal perception, the observer can only give meaning to its perception in an emotional context. This gives rise to an emotional feedback loop that directs the observer's focus of attention on its world.

How can this emotional feedback loop direct the observer's focus of attention? There are two important ways this direction can occur. The first has to do with the alignment of the flow of energy. When the flow of energy comes into alignment, feelings of connection are perceived. When the flow of energy goes out of alignment, feelings if disconnection are perceived. Since feelings of connection feel "good" while feelings of disconnection feel "bad", the observer is naturally biased to choose feelings of connection and to avoid feelings of disconnection. That is how the observer expresses its volition by choosing what it likes and avoiding what it doesn't like. It likes whatever makes it "feel good".

This bias to feel "good" naturally directs the observer's focus of attention on its world in such a way as to keep the flow of energy through its world in alignment, thereby resulting in feelings of connection, which is the normal way in which the emotional feedback loop operates. This is normal since the natural way for energy to flow through that world when choices are made in an unbiased way is for the flow of energy to come into alignment.

This natural alignment in the flow of energy is a direct consequence of the principle of least action. Quantum theory tells us that as long as choices are made in a unbiased way, the motion of all things tends to follow the path of least action, and in the process, the flow of energy through all things tends to come into alignment.

The other way to understand the alignment of the flow of energy is in terms of the alignment of information. Bits of information encoded on a holographic screen are like spin variables that can only point up or down [9], but since the spin variables are entangled with each other like the eigenvalues of a matrix, they naturally tend to align together over the course of time, which is a sequence of screen outputs. The flow of energy through the observer's world tends to come into alignment as the bits of information align together.



Entanglement image from science.nasa.gov

The normal flow of energy can be understood in terms of the alignment of the flow of energy and the principle of least action, or in terms of the alignment of information and the entanglement of information. Entanglement is operative over all of space. Events that apparently occur on opposite sides of the universe are related if the information for those events is entangled. Not as well appreciated is that entanglement is also operative over all of time. Events that apparently occur at the beginning of the universe are related to events now if the information for those events is entangled. In some sense, this means that everything occurs "here and now". In the sense of spirituality, prayer and devotion are a natural way of bringing oneself into alignment and experiencing the "here and now".

As long as a presence of consciousness makes its choices in its world by choosing "good" feelings of connection, the flow of energy through its world tends to remain in alignment, which is the normal way for energy to flow through its world. This kind of biased choice expresses the bias to "feel good", which leads to the "best of all possible worlds".

Problems only arise in the observer's world when the observer becomes biased to choose feelings of disconnection, and the flow of energy goes out of alignment. Since feelings of disconnection feel "bad", why would the observer ever make these kinds of choices? Why would the observer ever express the bias to "feel bad" or choose "bad" feelings?

The answer to this question is called self-identification. Whenever an observer identifies itself with an animated form of information it perceives in its world, it naturally becomes biased to defend the survival of that form. The survival of a form of information is the self-replication of that animated form over a sequence of screen outputs. Self-defensive expressions arise out of self-identification and result in feelings of disconnection. The observer focuses its attention on these self-defensive expressions due to its assumption that its existence depends on the survival of that form. This kind of emotional feedback loop is established because the observer really feels self-limited to the form of its body as it perceives the emotions expressed by its body that defend the survival of its body.

In the sense of the normal flow of energy, every such self-defensive expression is an interference with the normal flow of things, and leads to a "bad" feeling of disconnection as the observer feels self-limited to the form of its body. Once self-identification occurs, the observer feels compelled to defend the survival of its body from all threats posed by other things in the observer's world. At the root of all self-defensive expressions is the fear of non-existence. This fearful feeling of self-limitation to the form of a body is the essence of all concepts of self and other. All concepts of self and other can only arise in an emotional context, and the expression of self-defensive emotions defines that context.

This self-defensive way of expending energy creates the emotional context within which an observer identifies itself with the form of its body and gives meaning to events in its world. The meaning the observer gives to events that arise within this emotional context then directs the observer's focus of attention on its world, which is a self-limited way of perceiving that world, as the observer identifies itself with the form of its body.

In the sense of the principle of least action, this self-defensive way of expending energy is always an interference with the normal flow of things. The normal alignment of the flow of energy and information creates feelings of connection, but this alignment is only possible when choices are made in an emotionally unbiased way. If choices are made in an unbiased way, the flow of energy tends to come into alignment. If choices are made in an emotionally biased way, the flow of energy goes out of alignment. The expression of biased emotions is directly related to biased choices, which are directly related to the bias in the focus of attention of consciousness. This bias arises because the observer identifies itself with an observable form of information. This bias always creates a disturbance in the normal flow of things. Self-defensive expressions express an emotional bias, which is always an interference with the normal flow of energy through the observer's world.

An observer expresses its volition and free will with its focus of attention. The observer is always free to redirect its focus of attention and make different choices. To the extent that bias arises in the way choices are made, that bias is the nature of individual volition. This bias is always emotional in nature, such as the bias to feel "good", or the self-defensive bias to defend the survival of one's body. The expression of an emotional bias is always an interference with the normal flow of energy that animates the behavior of all things.

The principle of least action tells us that when choices are made in an unbiased way, the motion of all things tends to follow the path of least action and the flow of energy tends to come into alignment. This alignment is the natural way for energy to flow through the observer's world. As long as all choices are made in an unbiased way, as long as there is no emotional bias in the way choices are made, the flow of energy tends to come into alignment, which is the natural way for energy to flow through the observer's world and to animate the behavior of all things, including the behavior of the observer's body.

This normal flow of things is what Wei Wu Wei [10] means by "non-doing". Everything one can do in the sense of individual volition is biased and is an interference with the normal flow of things, since biased behavior always expresses an emotional bias. When one is "non-doing", one does nothing in an individual sense, and one no longer expresses any emotional bias. When one is "non-doing", one allows all actions to play out in the normal way, and allows the flow of energy through all things to come into alignment, which is the normal way for energy to flow through all things in the observer's world.

This state of "non-doing" is a kind of "surrender", as one stops fighting for the survival of one's self-identified form. This surrender is the willingness to no longer interfere with the normal flow of things. In this state of non-interference, there is no desire to fight against, control, defend, or hold onto anything. This willingness to surrender is inherently a detachment process as one lets go of things. This willingness to "let go" and enter into a state of non-interference is the only way one can bring oneself into alignment with the normal flow of things and stop identifying oneself with the form of one's body.

What is the real significance of this timeless wisdom of "non-doing"? Wherever we look in the world of frenetic human activity and behavior, we see the fear of non-existence and the insanity of self-identification and self-defense express itself in destructive ways. This insanity is Maya, the illusion of self-identification arising from the emotional intelligence of fear, run amok.

On the other hand, the alignment of the flow of energy that arises in a state of "non-doing" expresses itself in constructive ways. This is the difference between love and hate; creativity and destruction. At the root of hatred and destructive behavior is the irrational fear of non-existence, based on the mistaken self-identification of an observer with an observable form of information it perceives, as though consciousness itself could stop existing.

It is tempting to say events in the world are unpredictable because of the overwhelming complexity of the world, but that is not quite right. We could also say that events in the world are unpredictable because this complexity is not classically determined, but arises in a quantum state, but that is also not quite right. Events in the world are unpredictable because of the emotionally biased nature of choice. Once the observer identifies itself with the form of its body, there is no predicting what the observer will choose with its emotionally biased focus of attention. Self-identification makes the emotional feedback loop biased in unpredictable ways.

The holographic principle tells us that the world an observer perceives is no more real than a virtual reality world displayed on a computer screen. Everything the observer can perceive in its world is no more real than an animated image projected from its screen to the observer's central point of view. This includes the animated form of the observer's body. The observer's self-identification with the animated form of its body only arises due to its emotional sense of being self-limited to the form of that body, which can only arise when the emotional feedback loop directing the focus of attention becomes biased.

The holographic principle also tells us the consensual reality shared by many observers is very much like an interactive computer network generated virtual reality world displayed on multiple computer screens and observed by many observers. Each observer observes its own world on its own holographic screen, but those screens can overlap with each other and share information. Each observer makes choices in its own world with its own focus of attention on that world, but due to sharing of information, the choices of other observers can have an effect on what each observer observes in its own world, which is the interactive nature of the network. The nature of the consensual reality is constructed out of all of these interacting choices.

Each observer's world also shares in the flow of energy that energizes the entire network of screens. The consensual reality shared by many observers can share information to the degree their screens overlap, but each observer's holographic screen is ultimately defined by a cosmic horizon that arises from the expenditure of dark energy that all the observers share with each other. All observers share in the normal flow of energy, and to the extent their choices are made in an unbiased way, share in the alignment of the flow of energy. Even when choices are made in an emotionally biased way, this interference with the normal flow of things only creates a localized disturbance in the normal flow of energy.

In spite of the complexity of this consensual reality, the nature of this kind of interactive virtual reality world is ultimately no more real than the perception of animated images projected from a digital computer screen to the central point of view of an observer.

This is what Wei Wu Wei [10] says about the unreality of the observer's self-concept:

"There seem to two kinds of searchers: those who seek to make their ego something other than it is, i.e. holy, happy, unselfish (as though you could make a fish unfish), and those who understand that all such attempts are just gesticulation and play-acting, that there is only one thing that can be done, which is to disidentify themselves with their ego, by realizing its unreality, and by becoming aware of their eternal identity with pure being."

Nisargadatta Maharaj [11] says something very similar about the nature of "pure being", which resonates deeply with the holographic principle:

"In pure being consciousness arises; in consciousness the world appears and disappears.
Consciousness is on contact, a reflection against a surface, a state of duality.
The center is a point of void and the witness a point of pure awareness; they know themselves to be as nothing.
But the void is full to the brim.
It is the eternal potential as consciousness is the eternal actual."

The only way to define "ultimate reality" is in terms of what is invariant and the same for all observers. The holographic principle demonstrates the consensual reality shared by many observers is ultimately unreal, since whatever any individual observer observes will never be the same as what all other observers observe. Different observers can only share information to the extent their holographic screens overlap with each other. Different observers will always observe different "things", and so "Nothing is ultimately real".

What is ultimately real? Is the observer real? If the observer isn't real, does the observer have an underlying reality? What is left when the observer's world disappears?

How can the observer's world disappear? The thing to be clear about is the observer's world can only appear from the central point of view of the observer. The observer's world can only appear when the observer expends energy and enters into an accelerated frame of reference, since that is the only way an event horizon can arise that surrounds the observer at the central point of view.

If the observer does not enter into an accelerated frame of reference and expend energy, then no event horizon arises, and the observer has no holographic screen that surrounds itself and defines everything in its world. If no energy is expended, then no information is encoded for the observer's world, and the observer's world must disappear.

What is left when the observer's world disappears? What is the nature of the underlying reality that remains when energy is no longer expended, when information is no longer encoded, and when the observer's world disappears?

There are many names for this underlying reality. It is sometimes called the void, empty space, or non-dual awareness. In the Advaita tradition of Shankara, it can be called Brahmanic consciousness. In physical terms, there is nothing in it, and so it is called the void. Probably the best name for it is undifferentiated consciousness. Since it is the source of consciousness and the source of energy, it is also called the Source.

The hardest thing to understand about the nature of this underlying reality is that the source of consciousness is undifferentiated consciousness. The consciousness that is characteristic of an observer and its world is a differentiated kind of consciousness, which can be called Atmanic consciousness. Differentiation of a point of consciousness from undifferentiated consciousness occurs at a focal point, which is the central point of view of a world holographically defined on a bounding surface of space. The differentiation process is the energetic construction of the boundary. The boundary is an event horizon that can only arise when energy is expended. The relation of a differentiated point of consciousness to the totality of undifferentiated consciousness is the relation of a focal point to the totality of an infinite empty space.

To be clear about things, this infinite empty space is an "empty space of potentiality". The nature of this "space" is not defined by the boundary or by the bounded space that arises inside the boundary. The bounding surface of space is a holographic screen that projects an observable space-time geometry to the central point of view of the observer. This observable space-time geometry is defined by properties like dimensionality and curvature, but these properties arise from the nature of the boundary, which is an event horizon that arises in an accelerated frame of reference. This accelerated reference frame characterizes the nature of the event horizon and the observer's world, but does not in any way characterize the empty space of potentiality within which the boundary arises. This empty space of potentiality cannot be characterized in terms of a dimensionality or any other physical properties. It is the source of all dimensions and physical characteristics.

The empty space of potentiality is the source of all dimensions, the source of all physical properties, the source of all space-time geometries, the source of all reference frames, the source of all energy and the source of all information. The holographic principle explains how all these things arise in an accelerated frame of reference as energy is expended and the boundary of an event horizon arises. This boundary characterizes every aspect of the world bounded by that boundary, including its space-time geometry, but tells us nothing about the nature of the empty space of potentiality within which the boundary arises.

Another way to understand the nature of this empty space of potentiality is as a "void of undifferentiated consciousness". As energy is expended in an accelerated reference frame and the boundary of an event horizon arises, a focal point of consciousness at the central point of view is differentiated from undifferentiated consciousness. The differentiation process is the construction of this boundary within empty space. The construction of the boundary requires the expenditure of energy. Empty space itself is the source of this energy, which we call dark energy and understand as the exponential expansion of space.

The expenditure of this energy is what causes a boundary to arise that surrounds the central focal point. This expenditure of energy is the nature of the differentiation process. Encoding of information for the observer's world only occurs when energy is expended.

The nature of an observer and its world is a constructed reality, which is to say that world is a bounded reality. The boundary can only arise when energy is expended. Information for the observer's world is only encoded on this boundary when energy is expended. The observer's world can only appear when energy is expended and a boundary arises. When energy is no longer expended, there is no longer a boundary, information is no longer encoded, and the observer's world must disappear. Disappearance of the observer's world always occurs relative to the central point of view of the observer.

What happens to the observer's consciousness when the observer's world disappears? What happens to this differentiated focal point of consciousness? The answer is the observer's consciousness is no longer differentiated from undifferentiated consciousness. The differentiated consciousness of the observer rejoins undifferentiated consciousness. This is often described as a dissolution, like a drop of water that dissolves back into the ocean. In the Tao this is referred to as "returning", and in many religions as a "reunion".

This underlying reality of undifferentiated consciousness is what is left when an observer and its world disappear from existence. It is not that the differentiated consciousness of an observer stops existing, but timelessly exists as undifferentiated consciousness. This experience of "timeless being" or "pure being" is often referred to as "truth-realization".

Something remarkable happens after truth-realization that Plato calls "ascension". After truth-realization, an observer observes its world again, but from an ascended level of consciousness, which is like a higher dimension. Ascension is often described in terms of an observer that observes the animated images of its world on a two dimensional screen from a higher dimension outside the screen. It is as though the observer has come out of its world, but it was never really in its world in the first place. There was only an illusion that the observer was a part of that world. That illusion is the nature of self-identification.

The observer is always present a focal point of consciousness at the center of its world, while the animated images of that world are projected from a surrounding holographic screen to the observer. If the observer identifies itself with the form of an image that appears in its world, it seems as though the observer is a part of that world. This illusion comes to an end when the observer ascends to a higher level of consciousness and sees that these images are only displayed on a surrounding screen.

A truth-realized observer can turn its world on and off like a child flicking a light switch. The observer can turn off the expenditure of energy that constructs a boundary on which its world is displayed. When that expenditure of energy is turned off, the observer's world disappears and the observer's consciousness rejoins undifferentiated consciousness.

When energy is no longer expended, the observer is no longer in an accelerated frame of reference, the observer's holographic screen is no longer constructed, the observer's world disappears, and the observer is no longer present for that world. In relativity theory, we call such a non-accelerated frame of reference a freely falling frame of reference.

A truth-realized observer can enter into an "ultimate freely falling frame of reference" at will. This is how Osho [12] describes this "ultimate state of being":

"You fall into an abyss, and the abyss is bottomless: you go on falling.
That is why Buddha has called this nothingness emptiness.
There is no end to it. Once you know it, you also have become endless.
At this point Being is revealed: then you know who you are, what is your real being, what is your authentic existence.
That being is void."

In some sense, the fear of non-being is the emotional barrier separating the self-identified state of being from the ultimate state of being, like a potential barrier separating a false vacuum state from the true vacuum state. In the same sense, the expression of the emotional energy of this fear of non-being is the energy that animates one's self-concept.

The expenditure of energy creates the emotional context within which the observer gives meaning to all the forms of information it perceives in its world. All worldly knowledge is a form of information, but meaning can only be given to knowledge in an emotional context. In the process of expressing self-limiting emotions and identifying itself with a form of information, the observer gives meaning to self-limiting emotional expressions that create the emotional context. The observer expresses emotions as it expends energy, and then gives meaning to its emotional expressions as they create the emotional context. Without that emotional context, all forms of self-knowledge become meaningless, and the observer becomes "knowledgeless". A truth-realized observer "knows nothing" about itself, except for the timeless nature of its existence.

Without the expression of self-limiting emotions, no meaning can be given to the forms of information that create the observer's self-concept. Without the expenditure of energy that constructs a boundary upon which these forms of information are displayed, there is nothing to know. A truth-realized observer "sees everything", since its consciousness is ascended, but "knows nothing", since its consciousness is unbounded. The only true thing a truth-realized observer can ever know about itself is "I Am".

The standoff between science and spirituality is about what is meant by "reality". For science, "reality" is perceivable reality, while for spirituality, "reality" is ultimate reality. This is the difference between somethingness and nothingness; the difference between what is perceivable and the perceiving consciousness; the difference between physical reality and spiritual reality; the difference between the manifested world and the unmanifested source. There is a perfect standoff in this debate because when the term "reality" is used, science and spirituality are talking about different "things".

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