Article

The Metaphysical Connection of Consciousness to the Physical World

James Kowall*

Abstract

There is a long metaphysical tradition that equates the nature of being to consciousness itself, but then has difficulty connecting consciousness to the physical world. This metaphysical connection is explored in terms of recent developments in modern physics, including the holographic principle, dark energy, non-commutative geometry, and unification mechanisms. In the sense of non-dual metaphysics, the ultimate nature of being is argued to be undifferentiated consciousness. It is also argued that this ultimate nature of all being, which is One Being, can only be identified as the void.

Keywords: Consciousness, void, existence, reality.

Genesis:
In the beginning God created the heaven and the earth
And the earth was without form and void
And darkness was upon the face of the deep
And the Spirit of God moved upon the face of the waters
And God said "Let there be light", and there was light
And God saw the light, that it was good
And God divided the light from the darkness

Tao-Te-Ching
The Tao that can be told is not the eternal Tao
The name that can be named is not the eternal name
The nameless is the beginning of heaven and earth
The named is the mother of ten thousand things
Ever desireless one can see the mystery
Ever desiring one can see the manifestations
These two spring from the same source but differ in name
This appears as darkness
Darkness within darkness
The gate to all mystery

Metaphysics is concerned with the nature of being, which is to say existence. Modern physics is concerned with the nature of the physical world, which is to say matter and energy apparently existing within some kind of space-time geometry. There is a big puzzle in the connection between metaphysics and modern physics in that all the matter and energy in the physical world (that apparently exists within some kind of space-time geometry) is composed of observable

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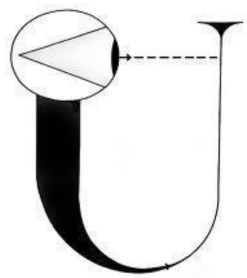
things (like fundamental particles), while there is a long philosophical tradition that equates the nature of being to consciousness itself, which is to say the observer of the observable things.
The big conundrum is about whether consciousness itself (the observer of the observable things) can arise from some complicated configuration of the observable things (like a human brain). Is it possible that consciousness arises from the things it observes? The simple answer is no. Almost all serious philosophers that have considered this puzzle have come to the conclusion that it is not possible, which begs the question: where does consciousness come from?



Wheeler's Universal Observer (image from cosmoquest.org)

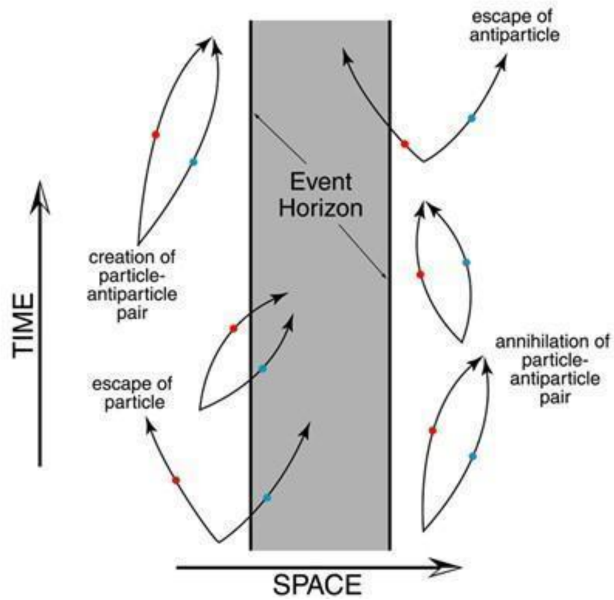
Remarkably, modern physics suggests an answer that is completely consistent with the long history of non-dual metaphysics, as conceptually explored in Plato's Allegory of the Cave, in the Tao-Te-Ching, in Hinduism (such as in the Vedas and the Bhagavad-Gita) and in Zen Buddhism (such as in the Gateless Gate paradoxes). This scientific answer is also consistent with what contemporary truth-realized beings have to say about the nature of consciousness and reality.

The scientific answer to this question about the nature of consciousness is really about what is ultimately real. Is the physical world the ultimate nature of reality, or is there an ultimate (most fundamental) state of reality that is beyond the physical world? Until recent discoveries in physics, many physicists held the position that the physical world is the ultimate nature of reality, the "be all and end all of reality", but that position is no longer tenable.

The basic difficulty with this position goes back to the problem of the unification of quantum theory with relativity theory, which is basically the problem of fundamental particles existing in some kind of space-time geometry. Relativity theory tells us there is no such thing as an absolute or fundamental space-time geometry, and so with unification, there can be no such thing as fundamental particles. Change the space-time geometry (as observed from the point of view of an accelerating observer) and the symmetries inherent in that space-time geometry also change. Since all so-called fundamental particles reflect the symmetries of the space-time geometry, there really are no such things as fundamental particles.

The ultimate example of this dilemma is an event horizon, which always arises from the point of view of an accelerating observer. The observer's horizon fundamentally limits the observer's ability to observe things (like particles) in space. As Hawking realized with the discovery of Hawking radiation from the horizon of a black hole, an accelerating observer (for example that accelerates away from the black hole horizon in a rocket ship) does not observe the same set of particles that a freely falling observer observes (that freely falls through the black hole horizon).

The basic problem is the event horizon of the black hole breaks the symmetry of empty space, and so radically alters what these two observers call fundamental particles. For the freely falling observer, particles of Hawking radiation do not exist.

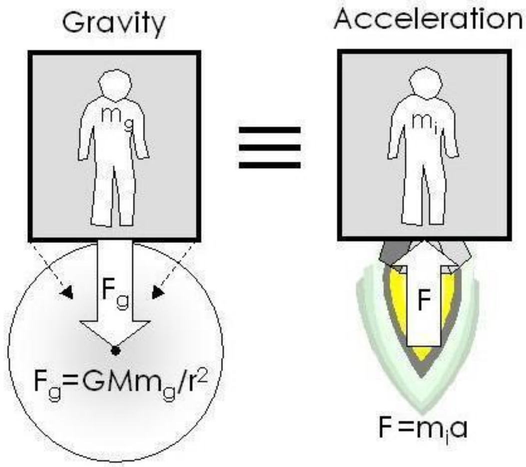


Hawking Radiation (image from universetoday.com)

How can particles of Hawking radiation (radiated away from the event horizon of a black hole) exist for the accelerating observer but not for the freely falling observer? How can any particles be fundamental if the particles that appear to exist for an observer can change (go in and out of existence) based on the observer's point of view (whether that point of view is accelerated or not). If neither space-time geometry nor particles are really fundamental, then what is?

We might guess that only the consciousness of the observer itself is really fundamental, and that so-called fundamental particles (like the observer's space-time geometry) can change based on the observer's frame of reference (whether the observer's point of view is accelerated or not). Although this is a good guess, it's not quite the right answer. There must be something more fundamental than the point of view of the observer that explains whether or not that point of view is accelerated. The basic problem is acceleration implies the expenditure of energy, and that energy has to come from someplace. There must be some kind of a mechanism inherent in the generation of the energy that gives rise to the observer's accelerated frame of reference (the observer’s accelerated point of view). If that energy is not expended (i.e., the acceleration mechanism is not put into effect), then the observer's frame of reference is freely falling.

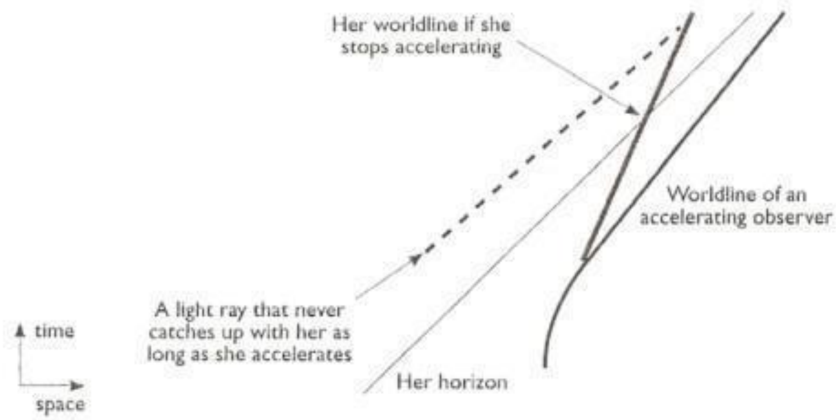
At the root of this problem is the underlying foundation of relativity theory. Relativity theory is fundamentally based on the principle of equivalence. The exertion of any force (which requires the expenditure of energy) is equivalent to an observer's accelerated frame of reference. For example, the force of gravity on the surface of a massive planet is equivalent to the acceleration of a rocket ship through empty space. An observer on the surface of the planet observes exactly the same kind of accelerated motion of objects that fall through space as an observer in the accelerating rocket ship, and so there is no possible way to distinguish between these two scenarios based only on the accelerated motion of objects. As an object accelerates through space, it gains kinetic energy. We usually think that gravitational potential energy is converted into kinetic energy as the object accelerates under the influence of gravity, but where does the energy come from in the accelerating rocket ship? The answer is the energy comes from the energy expended as the thrusters of the rocket ship force it forward through space.



Principle of Equivalence (image from mysearch.org)

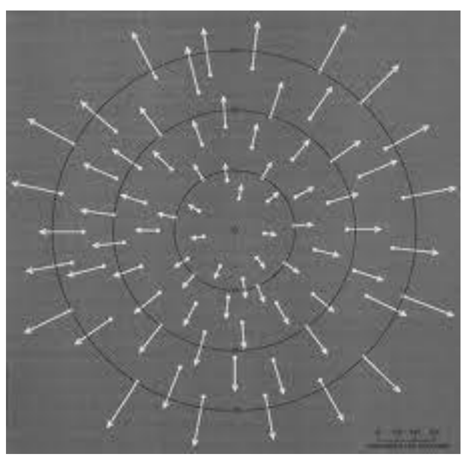
This means that before we can discuss an observer's accelerated frame of reference, we have to discuss the expenditure of energy (or the mechanism that generates this accelerated motion). The consciousness of the observer cannot really be fundamental because there is the issue of whether or not the observer's point of view is accelerated (whether or not energy is expended). The observer is only in an accelerated frame of reference if energy is expended. Where does this energy come from? The strange answer is the energy comes from the same place that the observer's point of view comes from. The irony of this answer is that this most fundamental of all places (the most fundamental of all things) can only be described as the void (nothingness).

Closely related to the issue of the principle of equivalence is the issue of the generation of an event horizon. Although the event horizon of a black hole seems like a special case, it turns out event horizons arise for all accelerated observers. The observer's event horizon always limits the ability of the observer to see things in space. An event horizon (that limits the observer's ability to see things in space) always arises for any observer in an accelerated frame of reference (an accelerated point of view). In the most generic case, this is called a Rindler horizon. In line with the idea that the observer’s accelerated frame of reference is only an accelerated point of view, we say the observer’s horizon arises as the observer follows an accelerated world-line.



Accelerating Observer's Horizon (image from Smolin)

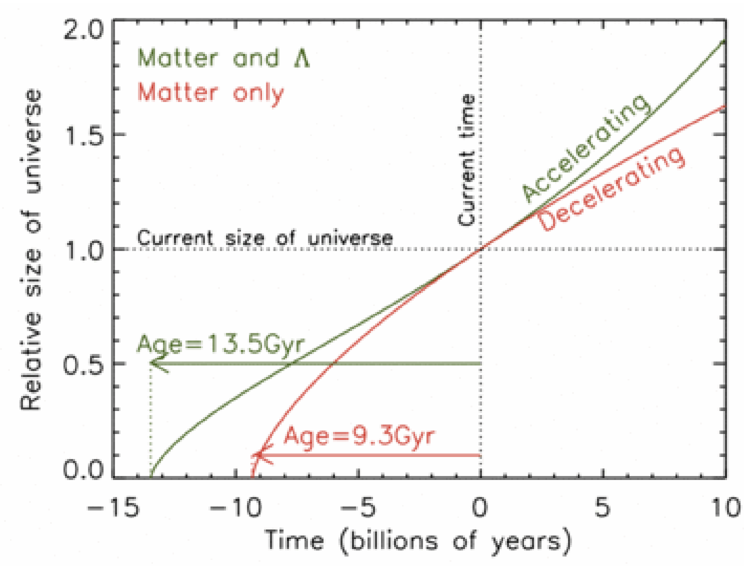
This brings us back to the question of where does the energy come from that gives rise to the observer's accelerated frame of reference? Although the answer seems exceedingly strange, it can be summarized with only a few concepts. This answer is at the heart of all theories of the big bang creation event. The energy must come from the same place that the observer comes from, which is the void. The nature of this energy is called dark energy, which is understood in relativity theory as the exponential (accelerated) expansion of space, which always expands relative to the central point of view of an observer. Dark energy is the creative energy that puts the "bang" in the big bang event. If space does not expand (if dark energy is not expended), then only the void exists, which is like an empty space of potentiality. If space does expand (if dark energy is expended), then an observer's world is created, and the observer of that world is always present to observe that world at the central point of view of that world.



Accelerated Expansion of Space (image from Susskind)

In order to explore this scientific answer further, we have to begin somewhere. The only logical starting point (metaphysically speaking) is the void. What is the void? This is where metaphysics is pushed to its limits. In the sense of non-dual metaphysics (the concept of One Being), the nature of the void is undifferentiated consciousness. In the ultimate state of being, there is only undifferentiated consciousness. The other way the void can be described is as an empty space of potentiality. This is the potentiality not only to create a physical world, but also to observe that world. If this potentiality is not expressed, only the ultimate nature of being (the void) exists.

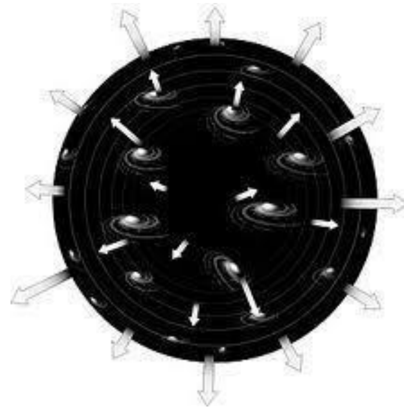
How does the void express this potentiality? Modern physics has recently discovered the answer, which is called dark energy. Dark energy is the creative energy that gives rise to the big bang creation event.



Accelerated Expansion of the Universe (image from scholarpedia.org)

Although a lot of dark energy was used up in the big bang event, astronomical observations indicate there is still a lot of dark energy left in the universe. These are observations of the rate with which distant galaxies accelerate away from us. If the only kind of force operative over galactic distance scales was the force of gravity, the expansion of the universe should be slowing down, since gravity is an attractive force, but that is not what is observed. The expansion of the universe is speeding up, as though all the galaxies were repelling each other. This repulsive force (like a force of anti-gravity) is called the force of dark energy. Its current observed value in terms of the cosmological constant is $\Lambda=10^{-123}$.

In relativity theory the force of dark energy is called a cosmological constant Λ, which gives rise to the exponential expansion of space that always expands relative to the central point of view of an observer. With the exponential expansion of space (the expression of dark energy) the farther out in space the observer looks, the faster space appears to expand away from the observer. Due to the limitation of the speed of light (which simply says nothing can travel faster than the speed of light), the observer is always surrounded by a cosmic horizon that limits the observer's ability to see things in space. This limitation of the speed of light is really not that mysterious, since it is like the maximal rate of information transfer in a computer network. At the observer's cosmic horizon, space appears to expand away from the observer at the speed of light, and so this is as far out in space as the observer can see things in space.



Exponential Expansion of Space (image from scienceblogs.com)

How can space appear to expand? The answer is the curvature of space-time geometry as formulated by Einstein's field equations for the space-time metric. The space-time metric is the field that measures the curvature of space-time geometry. Einstein's field equations directly relate a change in the metric (a change in the curvature of space-time geometry) in a region of space to changes in the energy content of that region of space.

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = 8\pi G T_{\mu\nu} - \Lambda g_{\mu\nu}$$

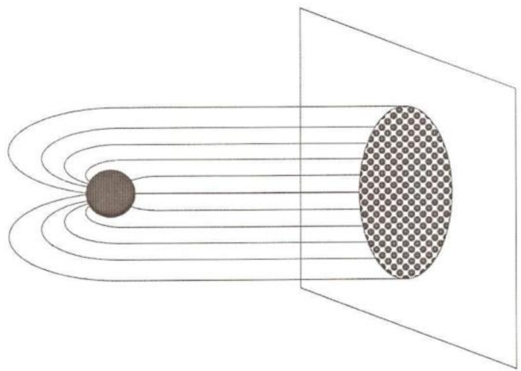
Einstein's Field Equations for the Space-time Metric

With the attractive force of gravity, space appears to contract. This gravitational contraction of space is like the kind of length contraction (and time dilation) that occurs with uniform (constant) motion in special relativity, but with gravity it is generalized to accelerated motion. Relativity theory tells us the gravitational contraction of space always occurs relative to point of view of an observer, like the observations of a distant observer that are limited by the event horizon of a black hole. At the event horizon of a black hole the contraction of space (the attractive force of gravity) is so strong that even light cannot escape away from the black hole (cross outside the boundary of the black hole horizon) and reach the point of view of a distant observer.

In a very similar way, the repulsive force of dark energy gives rise to a cosmic horizon that limits the observations of the observer at the central point of view. With the repulsive force of dark energy, space appears to exponentially expand relative to the central point of view of the observer, and due to the limitation of the speed of light, this limits the observer's ability to see things in space. At the observer's cosmic horizon the expansion of space (the repulsive force of dark energy) is so strong that even light cannot cross inside the boundary of the horizon and reach the central point of view of the observer.

If the only recent discovery of modern physics was that of dark energy, we would only have another puzzle, but about the same time dark energy was discovered (about twenty years ago), the holographic principle was also discovered. The holographic principle is about where all the bits of information that define all the observable things in a region of space are encoded.

The strange answer is that these bits of information are not encoded in space itself, but on a bounding surface of space. This bounding surface of space acts as a holographic screen that projects the images of things into space, just like a conventional piece of holographic film projects holographic images into space. The other analogy is a computer screen. Bits of information encoded on the screen project images into space.



Holographic Projection (image from Susskind)

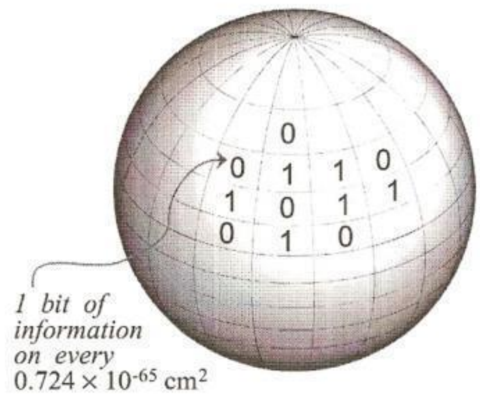
This kind of holographic projection from a screen into space is really no different than the kind of animated space-time geometry projected from a computer screen to the point of view of an observer, except the images appear three dimensional since their nature is holographic. Just like the animated frames of a movie, the projected images are animated over a sequence of screen outputs. With each screen output (which corresponds to an instant of time), the images are projected into space. Since the projected images can become distorted (as they change in size and shape), the projection of images from a screen to an observer over a sequence of screen outputs can give the appearance of the curving (warping) of space-time geometry.

Just like a computer screen, each pixel defined on the screen encodes a bit of information in a binary code of 1's and 0's. In a conventional computer, this encoding of information in a binary code is performed by switches that are either in the on or the off position, but on a holographic screen, the encoding is generically performed by spin variables that are either in the spin up or the spin down position. Since spin variables are mathematically represented by SU(2) matrices, this encoding of information has a purely mathematical representation.

The holographic principle is fundamentally about how the space-time geometry of any bounded region of space is defined (specifically where all the bits of information defining the space-time geometry of that bounded region of space are encoded). The strange answer is that all the bits of information are not encoded in space, but on the bounding surface of that region of space.

Bits of information are encoded in a pixelated way, with each pixel on the screen encoding a single bit of information. The holographic principle tells us the pixel size is about a Planck area $\ell^2=\hbar G/c^3$, given in terms of Planck's constant, the gravitational constant and the speed of light.

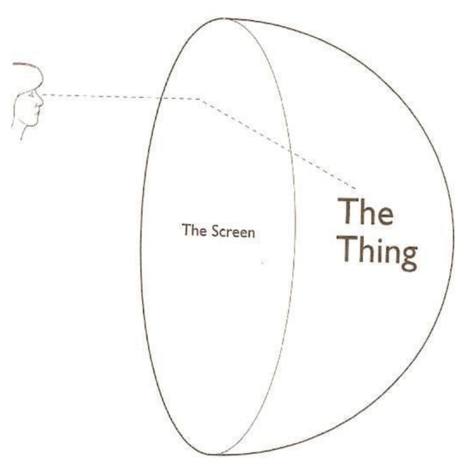
For a bounding surface of space of surface area A, the total number of bits of information encoded is given by $n=A/4\ell^2$.



The Holographic Principle (image from ‘tHooft)

What is a bounding surface of space? The answer is for any region of space, the bounding surface is an event horizon that limits the ability of the observer of that region of space to see things in that region of space. With the expression of dark energy (the exponential expansion of space), the observer at the central point of view has limited ability to see things in space due to the limitation of the observer's cosmic horizon, and so the bounding surface of that region of space is the observer's cosmic horizon.

This is where things start to get weird. The holographic principle tells us the observer's cosmic horizon acts as a holographic screen that encodes all the bits of information that define everything the observer can possibly observe in that region of space. Every observation of something is like the projection of an image of that thing from the observer's holographic screen to the observer's central point of view.



The Observer, the Screen and the Thing (image from Smolin)

Before delving into all the weird implications of the holographic principle, it is worth an examination of how the holographic principle arises in the first place, and secondly, how the holographic principle gives rise to a world that appears (from the point of view of the observer of that world) to be composed of matter and energy (all of which appears to reduce down to some kind of fundamental particles) existing in some kind of space-time geometry.

The first question is: how does the holographic principle arise in the first place? The answer is it can only arise if there is a bounding surface of space that acts as a holographic screen which projects all the images of things in that bounded region of space to the central point of view of an observer. This is the critical role that dark energy (the exponential expansion of space) plays, as the expenditure of dark energy gives rise to a cosmic horizon that acts as the observer's holographic screen. All the bits of information encoded on the observer's holographic screen in effect define everything in the observer's world (in the sense of a Hilbert space). The observer's cosmic horizon is the bounding surface of space that defines the observer's world as it limits the observer's observations of things in space.

How does the observer's cosmic horizon encode all the bits of information that define everything the observer can possibly observe in its world? The answer has to do with the quantization of space-time geometry. This is what the unification of quantum theory with relativity theory is all about. The most generic way to understand unification is with a non-commutative geometry. Although the holographic principle was initially discovered in string theory (now generalized to M-theory), string theory is a special case of non-commutative geometry. All examples of the holographic principle occur in some kind of non-commutative geometry. The other way to state this is: if non-commutative geometry is applied to a bounding surface of space, the holographic principle is automatically in effect. Non-commutative geometry is manifestly holographic. This basically says the space-time geometry of any bounded region of space is a direct consequence of how bits of information are encoded on the bounding surface of that region of space.

How does this happen? The basic problem is that position coordinates on the bounding surface of space can always be parameterized in terms of some (x, y) coordinate system, like latitude and longitude on the surface of a sphere. In a commutative geometry, there are an infinite number of (x, y) position coordinates, since the geometry of the bounding surface is a two dimensional continuum and is infinitely divisible. The quantization of space-time geometry turns this infinitely divisible continuum into a finite number of position coordinates on the surface.

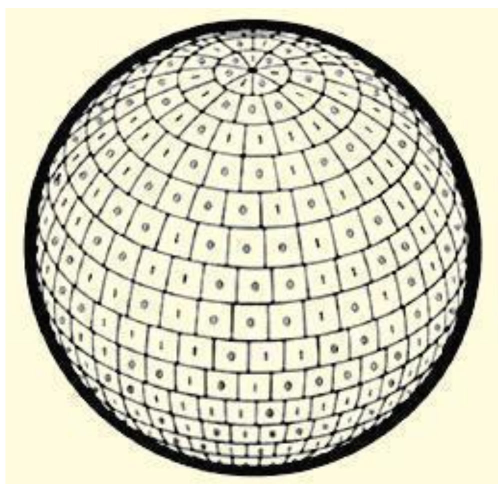
The way non-commutative geometry performs this trick (in the most generic case) is to require an uncertainty relation between the x and y position coordinates: $\Delta x \Delta y \geq \ell^2$. This is analogous to the uncertainty relation between the position, x, and the momentum, p, of a particle in ordinary quantum theory: $\Delta p \Delta x \geq \hbar$, except in non-commutative geometry the uncertainty relation is between the position coordinates of space itself, not the dynamical variables of particles defined in a space-time geometry. Non-commutative geometry is fundamentally about how space-time geometry is quantized (not how the dynamical variables of particles are quantized), which turns the (x, y) position coordinates defined on the bounding surface into non-commuting variables.

Whenever non-commutative geometry is applied to a bounding surface of space (like a cosmic horizon), there are no longer an infinite number of position coordinates defined on the surface, but rather a finite number of non-commuting variables, which give rise to pixels. In effect, each quantized position coordinate is smeared out into an area element (pixel) of size ℓ^2. The total number of pixels defined on the bounding surface (with an area A) is given as $n=A/4\ell^2$. The number of pixels corresponds to the number of non-commuting variables that define the non-commutative geometry.

In the most generic case of non-commutative geometry, these n non-commuting variables give rise to n bits of information defined by the n eigenvalues of an SU(n) matrix, and so the n pixels defined on the bounding surface encode n bits of information. Since an SU(n) matrix can always be decomposed into SU(2) matrices, and since SU(2) matrices encode bits of information in a binary code (like spin variables that are either spin up or spin down), the SU(n) matrix thus encodes n bits of information in a binary code, which is the nature of horizon entropy.

$$S_{\mathrm{BH}} = \frac{kA}{4\ell_{\mathrm{P}}^2}$$

Horizon Entropy



Horizon Information (image from eskola.hfd.hr)

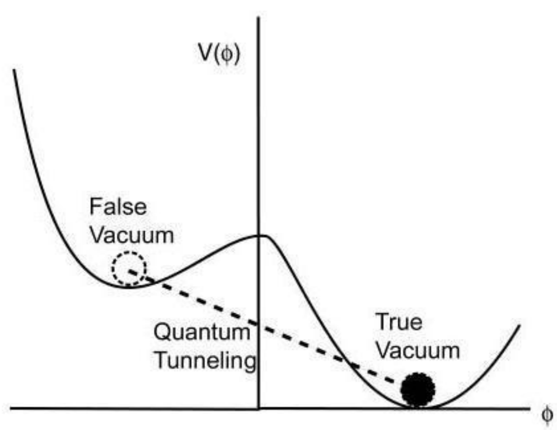
To recap, the holographic principle is a direct consequence of two effects. The first effect is the exponential expansion of space that gives rise to a cosmic horizon that arises relative to the central point of view of an observer. The second effect is the mechanism of non-commutative geometry that turns the bounding surface of space into a holographic screen that encodes n bits of information. These n bits of information encoded on the observer's holographic screen in turn give rise to the images of things in space projected from the screen to the observer.

To be clear about things, these two effects are only mechanisms. The first mechanism is the exponential expansion of space that gives rise to the observer's cosmic horizon, and the second mechanism is non-commutative geometry that turns the observer's horizon into a holographic screen. These are both geometrical mechanisms. The weird thing about these two mechanisms is that they give rise to an observer and its observable world.

If the expansion of space and the holographic principle are only generic mechanisms, then what about a Theory of Everything? At the deepest level of reality, isn't there a fundamental theory that explains everything? The simple answer is no. At the deepest level of reality there is only potentiality that gives rise to geometrical mechanisms.

This is the potentiality of the void to create a world for itself and to observe that world from the central point of view of that world. The void (as an empty space of potentiality) expresses this potentiality through the exponential expansion of space (that gives rise to the observer's cosmic horizon) and non-commutative geometry (that turns the observer's horizon into a holographic screen that projects images of things to the observer's central point of view). At the deepest level of reality there is only this potentiality of the void to express these geometrical mechanisms.

If we take the big bang creation theory seriously (as formulated with inflationary cosmology) we understand that at the moment of creation of the observer's world a great deal of dark energy is expended. That world is initially only about a Planck length in size, but then inflates in size due to an instability in the amount of dark energy. This instability in dark energy is like a process that burns away dark energy. Inflationary cosmology hypothesizes that at the moment of creation the cosmological constant takes on a value of about $\Lambda=1$, but due to an instability in the amount of dark energy, the cosmological constant transitions to a lower value. This transition is like a phase transition from a metastable false vacuum state to a more stable vacuum state of lower energy. The most stable state (the true vacuum with $\Lambda=0$) is a state with zero dark energy.



Metastable State (image from ned.ipac.caltech.edu)

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 consumptive process of burning that burns away dark energy and undoes this broken symmetry. As dark energy burns away to zero, the cosmic horizon inflates in size to infinity, and the symmetry is restored. We understand this undoing of symmetry breaking is like a phase transition from a false vacuum state to a true vacuum state. Dark energy burns away as the phase transition goes forward. This idea is also consistent with the current measured value of the cosmological constant $\Lambda=10^{-123}$ (based on the rate with which distant galaxies are observed to accelerate away from us), which also corresponds to the size of the observable universe of about 15 billion light years.

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

The second law of thermodynamics simply says that heat tends to flow from hotter objects to colder objects because the hotter objects radiate 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.

Second Law of Thermodynamics (image from Penrose)

The normal flow of energy through the observer's world reflects this normal flow of heat as 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. This also explains the mystery of "time's arrow", as the normal course of time is related to the normal flow of energy through the observer's world. As far as the holographic principle goes, a thermal gradient is also a temporal gradient.

The second question was about how the holographic principle gives rise to a world that appears (from the point of view of the observer of that world) to be composed of matter and energy (all of which appears to reduce down to some kind of fundamental particles) and that appears to exist in some kind of space-time geometry. Although this begins to sound like a broken record, the answer is again geometrical mechanisms.

The first step in solving this puzzle is to understand how bits of information encoded on a bounding surface of space give rise to the appearance of a curved space-time geometry in a bounded region of space. This is the problem of how the holographic principle explains the nature of gravity, which is understood as the curvature of space-time geometry.

Although there are many ways to approach this problem, the most generic way is the second law of thermodynamics. The second law is a very general statistical relationship that relates how a change in the number of bits of information (entropy) that define the configuration state of everything in a region of space are related to the thermal flow of energy (heat) through that region of space. This relation is usually written as $\Delta Q=T\Delta S$, where ΔQ is the flow of heat through the region of space, T is the absolute temperature of that region of space, and ΔS is the change in entropy (number of bits of information) that define everything in that region of space.

The flow of heat through that region of space is understood as the random thermal motion (kinetic energy) of those things through space, while the holographic principle tells us all the bits of information (entropy) defining everything in that region of space are encoded on the bounding surface of that region of space as $S=kn$, where the total number of bits of information encoded is given in terms of the surface area A of the bounding surface as $n=A/4\ell^2$. The constant k is called Boltzmann's constant, which converts thermal kinetic energy (heat) into conventional units of absolute temperature (degrees Kelvin).

Remarkably, this simple statistical (thermal) relation between the flow of heat through a region of space and the entropy of that region of space implies Einstein's field equations for the space-time metric in that region of space as a thermodynamic average (as long as things are near thermodynamic equilibrium), which is called a thermodynamic equation of state. The reason is fairly simple. The holographic principle tells us all the bits of information that define everything in a region of space are defined on the bounding surface of that region of space as $S=kn$. As heat flows through that region of space and the heat content of that region changes as $\Delta Q=T\Delta S$, the second law tells us the entropy of that region of space must also change as $\Delta S=k\Delta n$.

Since entropy is given in terms of the surface area of the bounding surface, $n=A/4\ell^2$, as heat flows across the bounding surface, the surface area of the bounding surface must also change. As the bounding surface of space changes, the geometry of the region of space bounded by the bounding surface also changes. This change in the geometry of the bounded region of space is mathematically specified by Einstein's field equations for the space-time metric, which relates a change in the curvature of the space-time geometry of that bounded region of space to a change in the energy content of that bounded region of space.

If this result doesn't knock your socks off, then you're not thinking like a physicist. Before the discovery of the holographic principle, the vast majority of theoretical physicists thought

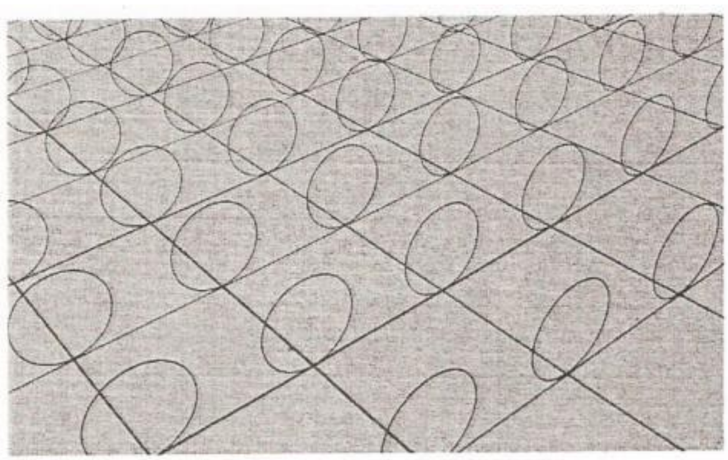
Einstein's field equations for the space-time metric were about as fundamental as physics can ever get. Thanks to the holographic principle, we now know that Einstein's field equations are not really fundamental, but only arise as a thermodynamic average in any bounded region of space (a thermodynamic equation of state that is only valid near thermal equilibrium) from the holographic way bits of information are encoded on the bounding surface of that space.

Shockingly, the holographic principle is more fundamental than Einstein's field equations for the space-time metric. Einstein’s field equations are only derivative of the holographic principle as a statistical (thermal) average (near thermal equilibrium). The force of gravity (the curvature of space-time geometry) only arises in a bounded region of space from the holographic way bits of information are encoded on the bounding surface of that region of space.

The holographic principle in turn is only a geometrical mechanism that allows bits of information to become encoded on a bounding surface of space whenever a bounding surface (a cosmic horizon) arises with the expression of dark energy and the exponential expansion of space.

If Einstein's field equations are only derivative of the holographic principle, which in turn is only a geometrical mechanism, then what is really fundamental? The weird answer is nothing is really fundamental. Only the potentiality of the void (the potentiality of the void to express itself with the expression of dark energy and encode bits of information on a bounding surface of space) is really fundamental. This is the potentiality of the void to create a world for itself and observe that world from the central point of view of that world.

What about other forces of nature besides gravity, like the electromagnetic and nuclear forces? What about other quantum fields besides the space-time metric, which comprise the standard model of particle physics? The unification of quantum theory with relativity theory solves this problem in a very straightforward way, again based on geometrical mechanisms. The only known mechanisms of unification are super-symmetry and extra compactified dimensions of space (the Kaluza-Klein mechanism).

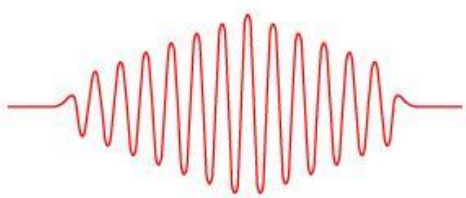


Extra Compactified Dimensions of Space (image from Greene)

If there are six extra compactified dimensions of space, then Einstein's field equations for the space-time metric give rise to the electromagnetic, strong and weak nuclear forces. The quantum fields that describe these forces are extra components of the space-time metric that arise in extra compactified dimensions of space. In other words, the quantum fields for these extra forces represent the curvature of space-time geometry in extra compactified dimensions of space, just like the ordinary components of the space-time metric for the usual four extended dimensions of space-time represent the force of gravity.

If super-symmetry (spatial coordinates that have both commuting and anti-commuting aspects) is applied to Einstein's field equations for the space-time metric (with six extra compactified dimensions of space), then not only are the boson (force particle) quantum fields generated, but also the fermion (matter particle) quantum fields are generated. If the extra compactified dimensions of space are formulated in terms of non-commutative geometry, then not only are the force particle fields and the matter particle fields generated, but also the Higgs (symmetry breaking) fields are generated. By breaking the symmetry of space, the Higgs fields give rise to the mass energy carried by all the matter particle fields.

The final result of unification is called 11-dimensional super-gravity, which includes all the standard quantum fields of the standard model of particles physics (including the electromagnetic and nuclear forces in addition to gravity). Since 11-dimensional super-gravity can only arise as a thermodynamical average (valid near thermal equilibrium), it is only valid as a low energy limit. All so-called fundamental particles are thus understood to be nothing more than localized excitations of field energy, which are called wave-packets. The wave-packet is localized in space and time, which gives rise to the particle quantization of energy and momentum.



Wave-packet

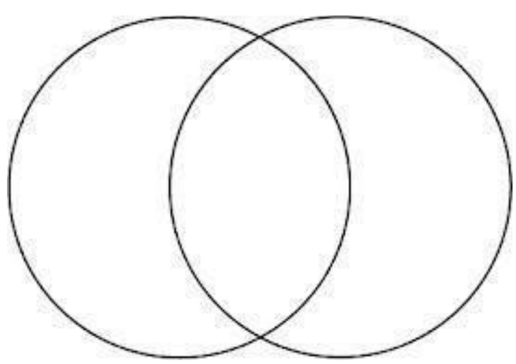
A so-called fundamental particle is thus nothing more than a localized excitation of field energy. These quantum fields all arise from the space-time metric through the unification mechanisms of super-symmetry, extra compactified dimensions of space, and non-commutative geometry. All the quantum fields of the standard model of particle physics are really only extra components of the space-time metric that arise through these geometrical mechanisms. Even the space-time metric only arises (as a thermal average) through the geometrical mechanisms of the expression of dark energy (the exponential expansion of space) and non-commutative geometry. In reality, there are no such things as fundamental particles (or fundamental forces), only the potentiality of the void to express these geometrical mechanisms. This potentiality always arises from the void.

So much for the fool's errand of searching for a Theory of Everything! There is no theory of everything because there is No Theory of Nothing. The potentiality of the void cannot be reduced to a theory, or conceptualized in any other possible way. That is the nature of infinite potentiality. Scientific reductionism simply does not apply to infinite potentiality. Anything is possible as long as it can be expressed in terms of a geometrical mechanism. The expression of this potentiality always requires the expenditure of energy. In emotional terms, the expression of this energy is the expression of desire, which directly leads to the manifestation of desires.

This important point cannot be stressed enough. The physical world is only an expression of the potentiality of the void. Through its geometrical mechanisms, the void has the potentiality to create a world for itself and to observe that world from the central point of view of that world. The nature of this potentiality is undifferentiated consciousness.

If the void is the ultimate nature of reality, the physical world is a lower form of reality, like a virtual reality of images projected from a screen to the central point of view of an observer. This lower form of reality (the projection of images from a screen) only exists when the void expresses its potentiality through geometrical mechanisms. If this potentiality is not expressed, only the void exists. As undifferentiated consciousness, the void exists as One Being. When the void does express its potentiality through these geometrical mechanisms, it creates a world for itself, which it always observes from the central point of view of that world.

What about a consensual reality apparently shared by many observers? The answer is many observers can share a consensual reality to the degree their respective holographic screens overlap (in the sense of a Venn diagram) and share information. This is just like the kind of information sharing that occurs in an interactive computer network. Each observer only observes its own holographic screen, but to the degree different screens overlap, different observers can apparently interact and share information. The network of holographic screens can share information to the degree the screens overlap.



Overlapping Bounded Spaces

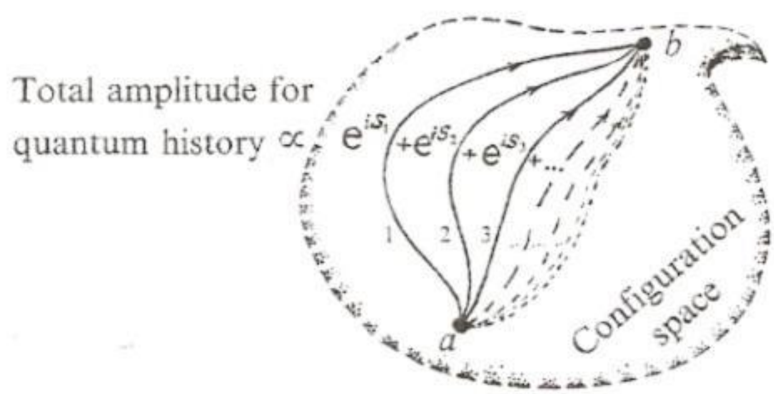
Each holographic screen encodes bits of information in a binary code. This is due to defining n distinct position coordinates (pixels) on a bounding surface of space, which is a consequence of defining n non-commuting variables on the bounding surface. The n bits of information (one per pixel) that arise from this holographic mechanism arise as the n eigenvalues of an SU(n) matrix.

It's worth pointing out out that the holographic principle is completely consistent with quantum theory. In effect, each observer has its own Hilbert space of observable values, with all the bits of information for observables encoded on the observer's holographic screen. In this sense, each observation of something by the observer is like a screen output that projects an image of the thing from the screen to the central point of view of the observer.

How do these screen outputs occur? Truth realized beings describe their own direct experience that each projection of an image is like a reflection of "light" off the screen back to the observer, except this is not ordinary physical light, but the "light of consciousness". It is the observer's own "light of consciousness" that emanates from the observer, reflects off the screen, and projects the images of things back to the observer's point of view. In this sense, the observer's own "light of consciousness" illuminates all the images of its own world.

Just as the observer is a focal point of consciousness (to which images are projected from the observer's holographic screen), the "light of consciousness" (emanating from the observer's point of view and reflecting off the screen) is the observer's focus of attention (which is focused on the observable images). To use a physical analogy, the observer's "light of consciousness" is like the light of a laser that projects images from an ordinary hologram.

The very fact that the observer has the innate ability to focus its attention on things in its world raises the issue of choice. How is this choice expressed? Quantum theory gives a natural answer in terms of a quantum state of potentiality. The quantum state can always be expressed in terms of a sum over all possible paths in some configuration space.



Sum over all Paths (image from Penrose)

The configuration space relevant for the holographic principle are the n non-commuting variables defined on the observer's holographic screen that give rise to the SU(n) matrix that defines the n bits of information encoded on the screen. That is the nature of the observer's Hilbert space.

Since the observer's holographic screen projects all images of the observer's world, each path specified in the sum over all paths is a possible world-line through the observer's projected space-time geometry. The observer's space-time geometry is not only projected from its holographic screen, but is also animated over a sequence of screen outputs. It is the observer itself that follows this world-line through its projected and animated space-time geometry. As a focal point of consciousness, an accelerating observer always follows a world-line.

Each screen output on the observer's world-line is a decision point where the observer chooses to follow some particular path rather than some other possible path. Each possible path of the observer through its projected and animated space-time geometry is a possible world-line. At every decision point (screen output) the observer has a choice to make about what to observe and which path to follow in its world. This choice arises with the observer's focus of attention, which is best understood in the metaphysical sense of the "light of consciousness".

Quantum theory tells us that each observer has its own Hilbert space of observable values for its own world (defined by an SU(n) matrix or the quantization of n non-commuting variables on the observer's holographic screen) that defines everything the observer can possible observe in its own world, but due to information sharing (in the network of overlapping holographic screens) these observations can become correlated with the observations of other observers.

What is meant by other observers? Each observer is only a point of view that arises in relation to its own holographic screen. This point of view can be called a differentiated focal point of consciousness, or individual consciousness. The holographic principle tells us this focal point of consciousness is a point of singularity that arises at the center of the observer's horizon, which is to say the observer is the singularity at the center of its own world. Many apparently distinct observers can share a consensual reality, but ultimately (when these geometrical mechanisms are no longer expressed), only the void (undifferentiated consciousness) exists.

In a metaphysical sense, each observer's differentiated "light of consciousness" (emanating from its own focal point of consciousness or singularity) is the nature of spiritual being, while the undifferentiated consciousness of the void is the ultimate nature of all being (One Being).

Each observer's consciousness has an apparent individual existence, but at the end of the day (when the holographic mechanism is no longer expressed and the observer's world disappears) every observer must return to its ultimate state of being as undifferentiated consciousness.

Ultimately, there is only One Being. The void expresses its potentiality as it creates many worlds, each observed by its own observer at the central point of view, and sharing information to the degree each observer's holographic screen overlaps with the holographic screens of other observers, but at the end of the day (when these holographic mechanisms are no longer expressed) only the void exists as One Being (undifferentiated consciousness). Every observer must eventually return to this ultimate state of being. The divided "light of consciousness" of the observer must ultimately return to the undivided darkness of the void.

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