Essay

How Is the World Created from Nothing?

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Abstract

An answer is given to the question: how is the world created from nothing? This answer is based on recent discoveries of modern physics, including dark energy, the holographic principle, and non-commutative geometry. This answer not only solves the mystery of how the world is created, but also solves the mystery of the origin of consciousness.

Key Words: Creation, world, void, consciousness.

There has recently [1] been in great deal of interest in how the world is created from nothing. An answer to this profound metaphysical question has recently been discovered, and is explained in the book by Amanda Gefter [2], a book that has been praised by many well-known theoretical physicists. This answer is based on the recent discoveries of dark energy, the holographic principle, non-commutative geometry, and what Gefter has called the one-world-per-observer paradigm. In a way, physicists who do not embrace this worldview are reminiscent of classical physicists of a century ago who could not understand the world in terms of quantum theory and relativity theory.

The answer is outlined in a few paragraphs. Whenever dark energy is expended, which in the sense of relativity theory is understood as the exponential expansion of space that arises with a cosmological constant [2], an observer-dependent cosmic horizon arises that surrounds the observer at the central point of view of that particular frame of reference.

The force of dark energy is like a repulsive force of anti-gravity [2] that gives rise to the exponential expansion of space. Space appears to expand away from the central point of view of the observer at an accelerated rate. The farther out in space the observer looks, the faster space appears to expand away from the observer. At the cosmic horizon, space appears to expand away from the observer at the speed of light, and so things at the cosmic horizon appear to move away from the observer at the speed of light. Since nothing can travel faster that the speed of light, the cosmic horizon is as far out in space as the observer can see things in space.

Whenever dark energy is expended, an observer-dependent cosmic horizon surrounds the observer at the central point of view. The cosmic horizon limits the observer's observations of things in space due to the limitation of the speed of light and the exponential expansion of space, which is unlimited. The limitation of the speed of light is like the maximal rate of information transfer in a computer network. There is no good explanation for the expansion of space except that it is a part of relativity theory.

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How can space appear to expand? The answer is the curvature of space-time geometry. Relativity theory describes geometrical curvature in terms of the space-time metric, which is a measure of the curvature of space-time geometry. Space appears to contract with the attractive force of gravity, while space appears to expand with the repulsive force of dark energy. This apparent contraction or expansion of space over the course of time occurs relative to the point of view of an observer, and is the nature of the curvature of space-time geometry in relativity theory [2].

This apparent contraction or expansion of space is like the distortion of images that appear on a computer screen in a computer animation. This is actually a very good analogy since the bounding surface of a cosmic horizon acts as a holographic screen that projects the images of things to the central point of view of an observer.

The holographic principle [3] tells us all bits of information that define all the observable things an observer can observe in the space bounded by a cosmic horizon are encoded on the horizon, which acts as a holographic screen. The screen encodes n bits of information in a pixelated way, with one bit of information per pixel. These n bits of information are typically defined by the n eigenvalues of an nxn matrix [2], where $n=A/4\ell^2$, A is the screen area, and $\ell^2=\hbar G/c^3$ is the Planck area. This result is a natural consequence of defining n position coordinates on the screen with n non-commuting variables [2].

If position on the screen is parameterized in terms of an (x, y) coordinate system, like latitude and longitude on the surface of a sphere, these n non-commuting variables define n position coordinates on the screen, which no longer are points but pixels [4]. If these n non-commuting variables obey an uncertainty relation of the form $\Delta x\Delta y\geq\ell^2$, the pixel size is ℓ^2 and the n bits of information are defined by the n eigenvalues of an nxn matrix.

In the sense of a Hilbert space defined by the n non-commuting variables, every observer has its own world [2] defined on its own observer-dependent cosmic horizon that acts as a holographic screen. In the sense of a consensual reality shared by many observers, many observer-dependent worlds can share information to the degree their respective horizons overlap [2]. Information is shared whenever screens overlap in the sense of a Venn diagram. This is like the kind of information sharing that occurs in an interactive computer network. In much the same way, the expenditure of dark energy is like the flow of energy through a computer network that energizes the network of screens [2].

It is still possible to understand the unification of the laws of physics in such a radically observer-dependent holographic world. The only fundamental things in that world are the way bits of information are encoded on the bounding surface of the observer's horizon and the way energy flows through that world, so where do the laws of physics come from? The answer is the laws of physics can only arise as a thermodynamic average in the sense of the second law of thermodynamics [5].

The holographic principle tells us entropy is defined on the bounding surface in terms of bits of information. The second law requires that as energy flows through the bounding surface, some entropy must flow with the energy, and this implies Einstein's field equations for the space-time

metric [5] in the bounded space as a thermodynamic equation of state. Einstein's field equations in the bounded space are dual [2] to the holographic description of non-commuting variables defined on the bounding surface, but only in the sense of a thermodynamic average.

It is instructive to briefly review how this holographic mechanism comes into effect [5]. The second law of thermodynamics relates the flow of energy, ΔE, through the bounding surface to the flow of entropy, ΔS, and absolute temperature, T, as $\Delta E=T\Delta S$. Entropy is defined on a holographic screen [3] in terms of the number of bits of information encoded on the screen, $n=A/4\ell^2$, which gives entropy in terms of screen area as $S=kA/4\ell^2$. If the screen is a spherical surface of radius R, the holographic principle [3] also specifies the temperature of the screen, as observed by a distant observer, as $kT=\hbar c/2\pi R$.

As energy flows through the screen, say under the influence of a thermal gradient, some entropy must flow with the energy. Since entropy is defined in terms of screen area, the screen area must change as energy flows. This implies that the geometry of the bounded space must change as energy flows through the bounding surface. This simple thermodynamic relationship, $\Delta E=T\Delta S$, then implies Einstein's field equations for the space-time metric in the bounded space as a thermodynamic equation of state [5].

For a spherical cosmic horizon, the screen area is $A=4\pi R^2$, where the horizon radius, R, is determined in relativity theory [3] in terms of a cosmological constant, Λ, as $R^2/\ell^2=3/\Lambda$, which gives $S=3\pi k/\Lambda$. The idea of inflationary cosmology [2] then gives a natural explanation for the normal flow of thermal energy through the observer's world in terms of an instability in the cosmological constant, which is understood as a phase transition from a meta-stable false vacuum state to an eventual stable true vacuum state [2].

Inflationary cosmology [2] tells us that at the time of the big bang event that creates the observer's world, the cosmological constant has a value of about $\Lambda=1$, which gives the horizon temperature as about 10^{32} degrees Kelvin. Astronomical observations, based on the rate at which distant galaxies accelerate away from us, indicate a current value of about $\Lambda=10^{-123}$. As the cosmological constant decreases in value, the radius of the cosmic horizon inflates in size and the horizon cools in temperature. The normal flow of thermal energy through the observer's world is understood in terms of this thermal gradient that develops due to an instability in the value of the cosmological constant [2].

This instability in the value of the cosmological constant is understood as a transition from meta-stable false vacuum state to a more stable vacuum state. The most stable vacuum state, the true vacuum state, which has eternal stability, is defined by $\Lambda=0$. As the cosmological constant decreases in value to its eventual final value of zero, the cosmic horizon inflates in size to infinity and its temperature cools to absolute zero [2].

This scientific argument tells us the flow of energy through the observer's world arises with the expenditure of dark energy, which gives rise to the bounding surface of a cosmic horizon surrounding the observer at the central point of view, while the encoding of bits of information on the horizon arises in a non-commutative geometry [4], which implies Einstein's field equations for the space-time metric in the bounded space. If the Kaluza-Klein mechanism and

super-symmetry are invoked, all the usual quantum fields of the standard model are then generated from Einstein's field equations [2]. The final result is called 11-dimensional super-gravity, which is understood as a low energy limit.

This also explains the nature of elementary particles, like the electron and photon. The correct way to understand elementary particles is as localized (in space and time) and quantized (in terms of energy and momentum) excitations of field energy. In quantum theory this is usually visualized as a field wave-packet. The standard interpretation of quantum theory tells us this wave-packet only specifies the quantum probability with which the particle can be measured at some point in space and at some moment in time.

Unification of the laws of physics (the Kaluza-Klein mechanism) tells us all quantum fields are components of the space-time metric in extra compactified dimensions. All field equations, like Maxwell's equations for electromagnetism and Dirac's equation for the electron, arise from Einstein's field equations for the space-time metric through the Kaluza-Klein mechanism and super-symmetry.

The holographic principle tells us Einstein's field equations for the space-time metric in the bounded space arise from the statistical laws of thermodynamics as a thermodynamic equation of state due to the encoding of bits of information on the bounding surface of that space. We can therefore say all elementary particles in space are really a form of gravity in extra compactified dimensions that arise from the way bits of information are encoded on the bounding surface of that space.

Gravity is the curvature of space-time geometry. Elementary particles are therefore space-time curvature in extra compactified dimensions of space. That curvature arises holographically from bits of information encoded on the bounding surface, which acts as a holographic screen. This tells us the measurement of the particle at some position in space at some moment in time is like the projection of an image of the particle from a holographic screen to the central point of view of an observer [6]. All bits of information for the particle are encoded on the bounding surface of space, not in space itself.

This projection of images from a holographic screen to an observer is very much like the way a movie is animated on a digital computer screen over a sequence of screen outputs in a computer animation. In much the same way, the expenditure of dark energy that gives rise to the construction of the holographic screen is like the flow of energy through an interactive network of computer screens that gives rise to the computer animation. Each screen in the network is observed by its own observer at the central point of view.

The way the holographic principle is formulated in terms of non-commutative geometry and non-commuting variables defined on the bounding surface of a cosmic horizon insures the total energy of the observer's world is exactly zero [2]. In this sense, everything in that world arises from nothing. The positive energy of dark energy and any other forms of positive energy that arise from dark energy, like mass energy, are exactly cancelled out by the negative potential energy of gravitational attraction.

By its nature, the expenditure of dark energy, the expansion of space, and the creation of an observer-dependent cosmic horizon implies there must be an empty space of potentiality within which this bounding surface of space arises [2]. There must be an all-encompassing empty space with the potential to express energy as the exponential expansion of space. This empty space of potentiality can be called the void or the primordial nothingness. In this sense, everything is created from nothing. An observer's world is only created if this empty space of potentiality expresses dark energy.

This empty space of potentiality cannot be characterized in terms of the laws of physics, a dimensionality, or the curvature of space-time geometry. Only the observer's world can be characterized in this way [2], but that characterization only arises from the way bits of information are encoded on the bounding surface of the observer's world and the way energy flows through the observer's world.

This explanation not only solves the mystery of how everything is created from nothing, it also solves the mystery of how the observer's world is created. It also solves an even greater mystery: how does the observer's consciousness arise?

The answer is found in non-dual wisdom. The primordial nothingness or void is the nature of undifferentiated consciousness [7, 8, 9]. When this empty space of potentiality expresses dark energy with the exponential expansion of space and an observer-dependent cosmic horizon arises that acts as a holographic screen that defines the observer's world, the observer's individual consciousness is differentiated from undifferentiated consciousness. The consciousness present at the central point of view of the observer's world is differentiated from the undifferentiated consciousness of the void when the bounding surface of a cosmic horizon arises in empty space. Mystery solved.

The observer's focal point of consciousness is present at the central point of view of a surrounding holographic screen, which only arises when dark energy is expended. The expenditure of dark energy is the nature of the process that differentiates this focal point of consciousness from undifferentiated consciousness. We understand the expenditure of dark energy as the exponential expansion of space, which expands at an accelerated rate relative to the central point of view of the observer. In the sense of the curvature of space-time geometry, this accelerated expansion of space is the "bending of space".

The undifferentiated consciousness of the void expresses its power with the expenditure of dark energy. As dark energy is expended, the observer's focal point of consciousness is differentiated from undifferentiated consciousness and a cosmic horizon arises that acts as a holographic screen surrounding the observer at the central point of view.

This "bending of space" is the only way the observer's world can be created and the observer's individual consciousness can come into being. When the expenditure of dark energy ultimately comes to an end, as it must since all things ultimately come to an end, the observer's world must disappear and the observer's differentiated focal point of consciousness must return to the void of undifferentiated consciousness.

Ultimately all the observer really is, is this empty space of potentiality. Ultimately all the observer really does is bend space as it expresses its energy.

> Do not try to bend the spoon. That is impossible.
>
> Instead, only try to realize the truth.
>
> What truth?
>
> There is no spoon.
>
> Then you'll see it's not the spoon that bends, it is only yourself.
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> - *The Matrix*

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