IS THE UNIVERSE A VAST, CONSCIOUSNESS-CREATED VIRTUAL REALITY SIMULATION?

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ABSTRACT: Two luminaries of 20th century astrophysics were Sir James Jeans and Sir Arthur Eddington. Both took seriously the view that there is more to reality than the physical universe and more to consciousness than simply brain activity. In his Science and the Unseen World (1929) Eddington speculated about a spiritual world and that "conscious is not wholly, nor even primarily a device for receiving sense impressions." Jeans also speculated on the existence of a universal mind and a non-mechanical reality, writing in his The Mysterious Universe (1932) "the universe begins to look more like a great thought than like a great machine."

In his book QED Feynman discusses the situation of photons being partially transmitted and partially reflected by a sheet of glass: reflection amounting to four percent. In other words one out of every 25 photons will be reflected on average, and this holds true even for a "one at a time" flux. The four percent cannot be explained by statistical differences of the photons (they are identical) nor by random variations in the glass. Something is "telling" every 25th photon on average that it should be reflected back instead of being transmitted. Other quantum experiments lead to similar paradoxes. To explain how a single photon in the two-slit experiment can "know" whether there is one slit or two, Hawking and Mlodonow write:

> In the double-slit experiment Feynman's ideas mean the particles take paths that thread through the first slit, back out though the second slit, and then through the first again; paths that visit the restaurant that serves that great curried shrimp, and then circle Jupiter a few times before heading home; even paths that go across the universe and back. This, in Feynman's view, explains how the particle acquires the information about which slits are open.

It is hard to imagine a more absurd physical explanation. We can think of no way to hardwire the behavior of photons in the glass reflection or the two-slit experiments into a physical law. On the other hand, writing a software algorithm that would yield the desired result is really simple.

A digital reality whose laws are software is an idea that has started to gain traction in large part thanks to an influential paper in Philosophical Quarterly by Oxford professor Nick Bostrom. Writing in the New York Times John Tierney had this to say:

> Until I talked to Nick Bostrom, a philosopher at Oxford University it never occurred to me that our universe might be somebody else's hobby. But now it seems quite possible. In fact, if you accept a pretty reasonable assumption of Dr. Bostrom's, it is

almost a mathematical certainty that we are living in someone else's computer simulation.

An alternate view (and more optimistic view) is that there exists a great consciousness whose mind is the hardware, and whose thoughts are the software creating a virtual universe in which we as beings of consciousness live.

It is widely believed among cognitive scientists (and among most other scientists as well) that consciousness must be something that somehow emerges from complex processes in the brain. Both the "something" and the "somehow" are essentially unknown. Together they constitute what has been called the hard problem of consciousness as stated by philosopher and cognitive scientist David Chalmers:

> Why is it that when our cognitive systems engage in visual and auditory information-processing, we have visual or auditory experience: the quality of deep blue, the sensation of middle C?... It is widely agreed that experience arises from a physical basis, but we have no good explanation of why and how it so arises. Why should physical processing give rise to a rich inner life at all? It seems objectively unreasonable that it should, and yet it does.

In other words, how does our inner world of thought, emotion and personal identity arise from mere chemistry in the brain? An obvious solution to the hard problem would consist of elevating consciousness to primacy: the buck stops here. In this view consciousness cannot ever be explained because it is the fundamental stuff of reality. The only "explanation" is in the direct experience of consciousness that we all possess, and that experience transcends any possible explanation in terms of something simpler. So what is consciousness? Just look at your thoughts. That's it! That's what it is. Any explanation in terms of other things would only be a step backwards.

However this thinking leads directly to the inverse problem: If consciousness is the fundamental stuff and it is non-physical, how did the physical universe emerge from consciousness? That would be quite a feat of creation: making something entirely new and different. Of course, for a religious believer that poses no problem at all: God is credited with creation of the physical universe of matter and energy. From this perspective there are then two components constituting reality: a consciousness which is what it is (whatever that is), and a universe made of matter and energy.

CONSCIOUSNESS ONLY

But there is an even simpler view: that some transcendent consciousness has created not a physical reality, but a virtual reality based on its abilities to act like a vast mental computer. At first glance this might appear to be a trivialization of consciousness as a mere computer. But that is too literal. Think instead of an unbounded intelligence capable of unlimited concentration, able to dream up and keep in mind every detail of an entire universe governed by the laws and logic of that intelligence. The data storage and computation for such a Herculean simulation may be only a tiny part of the super abilities of such a consciousness if its potential is unbounded, or even infinite. Creating a simulation of a universe may be just one "project" among many for such an intelligence.

Put aside your laptop and imagine instead a consciousness that can unwaveringly hold in its thoughts the detailed structure of the entire universe, down to the last atom, and indeed even down to the last quark and all other subatomic particles. And not only the structure, but the nanosecond by nanosecond – and even shorter timescale – dynamical behavior of each particle as governed by the laws of nature that this consciousness has also created in its thoughts.

This hypothesis could hardly be seriously imagined, say, even fifty years ago. But the amazing and rapidly expanding capabilities of today's computers clearly suggest where digital simulations can lead. It may be necessary to extrapolate computational capabilities by perhaps a hundred orders of magnitude or more, but the advantage of this view is that there is in the end only one thing constituting all of reality: consciousness, the very thing that we all are most familiar with. Nothing else would need to exist but that as the source of a realistic but simulated universe. All that remains is for the creative consciousness to enter into the apparently real lifeforms that evolution would provide. This way the great consciousness would be able to experience things like, for example, life as a human on planet earth… or life as a dinosaur on the ancient earth… or life in another solar system. This might be the way a vast consciousness comes to know itself, and perhaps even to evolve itself. Each one of us would be such a projection of consciousness into a virtual universe. In this view we, as consciousness, are real; matter, as physical stuff, is a simulation.

What evidence is there that might support such a reality? Consider a very simple observation: reflection of light off a pane of glass. Say that you are in a dark room looking through a window into a garden on a sunny afternoon. If the glass is clean enough you won't even see the window, just the garden. Now imagine looking out the same window at night. If there are no lights in the garden, and if you are standing in a well lit room, what you will see is a fairly faint reflection of yourself in the window and the lit room you are standing in. That is the case because a typical plate of glass

reflects about four percent of the incident light off the front surface. There is in principle a reflection off the back surface as well, but this requires specially prepared glass to see. Reflection off the surface of a lake is another example of front surface only reflection given by Feynman. We concern ourselves only with the front surface reflection.

This simple observation of this phenomenon known as partial reflection has profound implications. But first consider another observation: a stream of water flowing from a faucet. If you turn down the flow slowly it will finally stop being a stream and become a series of drops. Now – in a properly equipped laboratory with a laser – do the same with a stream of light. Turn it down, down, down until at a low enough level what emerges from the laser will be individual photons of light. The human eye is not quite sensitive enough to see an individual photon, but a single photon is easily seen by electronic detectors.

TELLING PHOTONS WHAT TO DO: THE REFLECTED FOUR

Now point the laser at a spot on the surface of a pane of glass and let a detector count the photons that are reflected off the front surface. In any sequence of 100 photons there will be four reflected photons counted on average.

Feynman discusses this at length in his book *QED: The Strange Theory of Light and Matter*. He writes:

> Try as we might to invent a reasonable theory that can explain how a photon "makes up its mind" whether to go through glass or bounce back, it is impossible to predict which way a given photon will go.

> I am not going to explain how the photons actually "decide" whether to bounce back or go through; that is not known. (Probably the question has no meaning.)

But what makes some of the photons reflect at all? What is it that is different for those "reflected four" photons than for the others? The answer is: no difference whatsoever.

The experiment can be done in such a way that a photon is long gone before the next one comes along, so the photons are not conveying information to each other in any understandable sense. And all the photons can be made to hit precisely the same spot on the glass, so it is not a matter of some photons having a different impact point than others. So what tells any given photon that it has the honor of being one of the "reflected four?"

This curious behavior of photons is one of the starting points of an important field of physics known as quantum electrodynamics (QED) which has proven to be one of the most stringently tested theories in science. As one of the founders of QED, Nobel

laureate Richard Feynman, wrote about QED: "It is, therefore, I would say, the jewel of physics – our proudest possession."

Then he goes on to say: "I would like to again impress you with the vast range of phenomena that the theory of quantum electrodynamics describes: It's easier to say it backwards: the theory describes *all* the phenomena of the physical world except the gravitational effect…and radioactive phenomena."

In one important test of QED, the agreement between the theoretical value of a number and the measurement of that number is so accurate that it is like measuring the distance between New York and San Francisco to the thickness of a human hair.

This is very impressive. There are highly sophisticated mathematical tools that can calculate QED phenomena to enormous precision. But how much do we actually understand? Returning to the simple four percent reflection experiment, how do we explain that?

Feynman was brutally honest about our understanding of QED and quantum laws in general. He wrote: "You see, my physics students don't understand it either. That is because *I* do not understand it. Nobody does."

And that goes for the partial reflection experiment as well.

Something has to keep track of how many photons are being reflected and how many are being transmitted. And that something has to have the means and authority to tell a photon which of the two possibilities it has to actualize.

THE FAMOUS TWO-SLIT EXPERIMENT

A similar experiment is easily done in a science lab with a laser and a screen with two narrow slits. Have the laser beam be wide enough to shine on both slits, then cover up one of the slits. As light from the laser passes through the open slit, a pattern will appear on the wall behind the slit. This pattern is due to spreading out of light, a process called diffraction and in this case specifically single-slit diffraction.

Now if you open the second slit, light going through each slit will still undergo diffraction, but in addition light from both slits will interfere with each other. This yields a double-slit interference pattern that is quite different from the single-slit interference pattern.

These experiments are easily explained by picturing light as a wave. With a bit of geometry you can show how and where the peaks and troughs of the waves will reinforce or cancel yielding the patterns on the wall.

In the double-slit interference experiment, assume that the laser beam has been turned down so low that only one photon at a time reaches the two open slits. It is natural to assume that an individual photon can only go through one of the slits or the

other. If that is the case, then if we let a pattern accumulate on the wall it should be a single-slit pattern because each photon can only go through one or the other.

Wrong!

So long as both slits are open a double-slit pattern is what builds up even though the photons were passing through one at a time with each photon long gone before the next one comes along. How is this possible? The conventional explanation is that each photon somehow "knew" that even though it went through slit A, slit B was also in the open position. Or alternatively, even though it went through slit B, it "knew" that slit A was also open.

How would a photon acquire such information. The answer given by Richard Feymann is stunning. It goes by the name of path integral formulation or sum over histories.

In quantum mechanics the photon has no definite position from the time it is emitted to when it finally strikes the wall. Discussing this Hawking and Mlodinow have this to say in their book *The Grand Design*:

> Feynman realized one does not have to interpret that to mean that particles take *no* path as they travel between source and screen. It could mean instead that particles take *every* possible path connecting those points…. The situation at both slits matters because, rather than following a single definite path, particles take every path and they take them all *simultaneously*. That sounds like science fiction, but it isn't…. In the double-slit experiment Feynman's ideas mean the particles take paths that thread through the first slit, back out though the second slit, and then through the first again; paths that visit the restaurant that serves that great curried shrimp, and then circle Jupiter a few times before heading home; even paths that go across the universe and back. This, in Feynman's view, explains how the particle acquires the information about which slits are open….

Feynman's path integral formulation may yield the correct answer mathematically, but it is hard to imagine a more absurd physical explanation. A photon traversing the entire Universe in every conceivable way in zero time! Most physicists are content with getting the correct answer and putting the bizarre Feynman model out of mind as a description of reality. But honestly, if non-scientists were to propose a solution for some phenomenon half as absurd as Feynman's, they would be roundly ridiculed by scientists.

Perhaps it is time to reconsider the very nature of physical reality. Could it be that the universe and every thing in it is not material stuff governed by rigid physical laws, but rather some kind of virtual reality? This would be consistent with what Heisenberg wrote: "But the atoms or elementary particles themselves are not real; they form a world of potentialities or possibilities rather than one of things or facts."

And might the sole basis of this virtual reality be consciousness? Is consciousness the only thing that actually exists?

LAWS OF NATURE AS SOFTWARE

In both the glass reflection and the two-slit experiments, what is there that tells photons what to do? Brian Whitworth, a professor of information processing and technology, puts it this way:

> One of the mysteries of our world is how every photon of light, every electron and quark, and indeed every point of space itself, seems to just "know" what to do at each moment. The mystery is that these tiniest parts of the universe have no mechanisms or structures by which to make such decisions. Yet if the world is a virtual reality, this problem disappears.

We can think of no way to hardwire the behavior of photons in the glass reflection or the two-slit experiments into a physical law, or explain things in terms of particles coming in touch with each other. In the case of the two-slit experiment, we need to assume, following Feynman, that a photon instantaneously traverses every possible path through the entire universe in order to "explain" the behavior of one little laboratory photon. What kind of bizarre information is being shared between particles in the glass reflection experiment and how would that conceivably be possible?

On the other hand, writing a bit of software – an algorithm – that would yield the desired result is really simple. For example, in the case of the four percent reflection, every time a photon is emitted from the laser, let a random number generator select a number between one and 100. Then specify that if the number turns out to be 25, 50, 75 or 100 the photon that triggered the random number will become one of the "reflected four."

That does the trick that no hardwiring – that we can imagine – can do. And likely many other incomprehensible aspects of quantum physics could be understood if we replace the notion that the laws of nature are hardwired with the possibility that they are software algorithms.

The other thing we glean from quantum physics is that the world is not made of solid continuous stuff. It's not just that what we perceive as solid, continuous matter is not solid and continuous at all thanks to everything being made of atoms. Even atoms themselves are insubstantial. Prior to any observation the only "thing" there is, is the insubstantial wave function. As University of California, Santa Cruz, physicists Rosenblum and Kuttner forthrightly state in their book *Quantum Enigma*:

> In quantum theory there is no atom in addition to the wavefunction of the atom. This is so critical that we say it again in other words. The atom's wavefunction

and the atom are the same thing; the wavefunction of the atom is a synonym for
the atom.

The difference between how we picture reality as solid and continuous and how
quantum physics tells us it is, is profound.

A GREAT VIRTUAL REALITY CREATED BY CONSCIOUSNESS

A digital reality whose laws are software is an idea that has started to gain traction in
large part thanks to an influential paper in *Philosophical Quarterly* by Oxford professor
Nick Bostrom.

> Writing in the *New York Times* John Tierney had this to say about Bostrom:

>> Until I talked to Nick Bostrom, a philosopher at Oxford University it never
>> occurred to me that our universe might be somebody else's hobby. I hadn't
>> imagined that the omniscient, omnipotent creator of the heavens and earth could
>> be an advanced version of a guy who spends his weekends building model
>> railroads or overseeing video-game worlds like the Sims.

>> But now it seems quite possible. In fact, if you accept a pretty reasonable
>> assumption of Dr. Bostrom's, it is almost a mathematical certainty that we are
>> living in someone else's computer simulation.

Tierney's article was mischievously titled: Our Lives, Controlled From Some Guy's
Couch. And he states: "It's unsettling to think of the world being run by a futuristic
computer geek." I wholeheartedly agree, but it is possible to recast this somewhat
frivolous interpretation of the meaning of it all into something profound.

One of the biggest and most puzzling scientific questions today is: what is the
nature of consciousness and its origin? It is taken as a given that consciousness
somehow arises out of the physical matter and processes in the brain. In this view the
physical stuff of particles and energies is real and consciousness is essentially an illusion
created by the physical. *Science has steadfastly refused to take seriously the possibility that it may
be the other way around: that consciousness is real whereas the physical is an illusion.* This view,
known as idealism in philosophy, has seemed like mumbo-jumbo unworthy of
scientific consideration. Recall Dr. Johnson's refutation of idealism to Boswell.

Samuel Johnson (1709-1784), a literary giant of the 18th century and the second
most quoted person in the English language (after Shakespeare) one day was discussing
the idealist views of reality proposed by philosopher George Berkeley with his
biographer, James Boswell, who recorded the following:

> After we came out of the church, we stood talking for some time together of
> Bishop Berkeley's ingenious sophistry to prove the nonexistence of matter, and
> that every thing in the universe is merely ideal. I observed, that though we are

satisfied his doctrine is not true, it is impossible to refute it. I never shall forget the
alacrity with which Johnson answered, striking his foot with mighty force against
a large stone, till he rebounded from it – "I refute it *thusly*."

THE UNIVERSE AS A GREAT THOUGHT.

Two luminaries of 20th century astrophysics were Sir James Jeans and Sir Arthur
Eddington. Both took seriously the view that there is more to reality than the physical
universe and more to consciousness than simply brain activity. In his *Science and the
Unseen World* (1929) Eddington speculated about a spiritual world and that "conscious is
not wholly, nor even primarily a device for receiving sense impressions." Jeans also
speculated on the existence of a universal mind and a non-mechanical reality, writing
in his *The Mysterious Universe* (1932)

> … the universe begins to look more like a great thought than like a great
> machine. Mind no longer appears as an accidental intruder into the realm on
> matter; we are beginning to suspect that we ought rather to hail it as the creator
> and governor of the realm of matter….

The possibility that we are immersed in a virtual reality simulation shows how it would
be possible for a consciousness as real and primary, physical as illusion and secondary,
view to be the right one.

Let's postulate that ultimately there is one "thing" and nothing else: a vast
unbounded consciousness (or non-physical mind) beyond space and time, a
consciousness that can think, imagine, reason, calculate and compute. Picture this
consciousness acting as a self-programming computer, a computer so vast and
powerful that it can store and manipulate "bytes of consciousness" and process
"software thoughts" sufficient to model the laws of nature and the behavior of every
single particle in the universe subject to those laws. In computer terminology the
computational substrate, the platform, is consciousness itself. Consciousness is the
hardware. Its thoughts are the software. The scale is beyond imagination; an amazing
computer that has no processing or storage limits and thereby can create a simulated
reality which models the entire universe. In fact, that simulation *would be* the universe.

In this view we ourselves are projections of this consciousness into this virtual
world. We and all other life forms interact with this universe in a way that is analogous
to playing a video game. By attaching our projected real consciousness to a particular
avatar (in the video game sense, not the Hindu god sense) we become a "real material"
person in a totally realistic virtual world… even though in fact the only thing that is
real is the fundamental consciousness along with its projections – us – into the virtual
reality. But to us playing the game, it seems totally real and we can interact with the

environment and other players as if they were made of matter, even though there is no such thing as matter. We become totally immersed in this virtual world.

What is gained by this view? First off, this obviates the need for there to be anything else but consciousness itself. Real matter would be a figment of the imagination. It would not be necessary. All "data" and every "line of code" would be thoughts. So long as the universe simulation is held in the mind of the fundamental consciousness this creation persists and provides us an arena to play the game of life. And it may even be a way through which the fundamental consciousness evolves itself: through the actions and life lessons of its projections.

If we accept the view that ultimately the only true reality is a universal consciousness, then it does not matter whether we as projection of that consciousness play a game of life by joining our consciousness with what we believe to be genuine physical matter or join a massive, incredibly detailed simulation. Neither is real, but living lives in such an imagined space and time affords both an adventurous experience and even a means for growth of the fundamental consciousness because the lessons we learn are quite real even if the world is not. An airline pilot in training on a simulator learns how to fly in a machine that has no wings and never leaves the ground. He becomes a better pilot by playing the simulation game. The skill gained is real, the aircraft is not.

This view also resolves the origin of space, time and other universes with different laws. You can make up any number of spatial dimensions and time dimensions in your software. You can also specify whatever laws you want a universe to have with software… provided they are consistent with each other in any given universe. The cause of the Big Bang would be the booting up of the simulation. And otherwise inexplicable quantum laws are easily explained by the software. Different universes could just be different subprograms within the fundamental consciousness. No wonder there is such an unreasonable effectiveness of mathematics in the natural sciences, as Wigner wrote in 1960: Reality is digital.

SECOND LIFE

An Internet-based virtual world called Second Life was launched in 2003. Currently over half a million people have created online versions of themselves – commonly called avatars – to populate this virtual reality. Your avatar can have whatever attributes you want and can interact with other avatars, participate in individual and group activities, own property, earn money by providing services, etc. In short, Second Life aims to create an artificial reality that becomes more and more real as software and hardware and bandwidth grow. Here in the twenty-first century we are creating

and selling gaming toys that may be primitive analogs of our own reality. The Business Report in a recent San Francisco Chronicle reporting on a Game Developer Conference ran the headlines: "Morpheus blurs reality's lines. Illusions feel real with Sony's new device." Virtual reality is well underway.

But is a virtual Universe at all a possibility? Is there any evidence?

Seth Lloyd is a professor of mechanical engineering at MIT. In his book *Programming the Universe*, Lloyd contends that the universe itself is one big quantum computer producing what we see around us, and ourselves, as it runs a cosmic program. Lloyd estimates that we could have the whole universe simulated in a computer in 600 years provided that computational power increases according to Moore's Law.

Now it would not be necessary to simulate the presence and action of every single particle or photon. It's a question of realistic rendering. Take the moon as an example. An object called the moon along with all its characteristics would reside in the data base. But given that the simulation would undoubtedly be intelligently done so as to save effort and minimize rote computation, it would only be necessary to render the moon to whomever happens to be looking at it, and the required rendering would be fine it had the resolution of a television image (or less). There is no need to calculate what is going on for all the atoms and molecules inside the moon. Judiciously chosen rendering is what is done today in movies and games. Even with rendering being custom produced for every observer that still saves many orders of magnitude over calculating everything. And, yes, this would be relevant to the question of whether there is a noise in the forest when a tree falls. The falling of the tree would be recorded in the database, but without anyone to hear a sound, a noise would probably not warrant rendering.

As for evidence for all this, a recent article in the MIT Technology Review (Oct. 10, 2012) entitled "The Measurement That Would Reveal The Universe As A Computer Simulation" states: "The problem with all simulations is that the laws of physics, which appear continuous, have to be superimposed onto a discrete three dimensional lattice which advances in steps of time."

A simulated hence discrete reality has subtle but essential differences from a continuous one , and we may be on the verge of detecting such evidence. One such sign of a simulated reality would be that nothing can exist that is smaller than the computational lattice spacing itself. This would predict not only a cutoff in the high energy particle spectrum of cosmic rays, but, according to Silas Beane at the University of Bonn, also an isotropy in their distribution. Such a cosmic ray cutoff is already known in the GZK cutoff. The anisotropy effect could be detected with current technology.

The laws of quantum physics stubbornly link measurement with consciousness and demonstrate behavior – such as entanglement – that can be readily demonstrated but not explained in terms of hard physical reality. Whereas on the other hand, returning to the QED example above, a software algorithm telling entangled particle, for example, what to do is logically simple and straightforward. Entangled particles far separated in a calculated virtual space have no true spatial separation in the computational realm.

John Bell, the theorist who proposed the famous Bell Inequality believed that quantum mechanics revealed that our worldview is incomplete and, as quoted by Rosenblum and Kuttner: "…that the new way of seeing things will involve an imaginative leap that will astonish us." They go on to state their own view that "along with Bell, we suspect that something beyond ordinary physics awaits discovery."

Also, in this view the universe is not something that was made and simply persists thereafter. It is instead an ongoing process, requiring continual intention. The software needs to keep running. Writing in the fifth century St. Augustine stated:

> If God's power ever ceased to govern creatures their essences would pass away
> and all nature would perish. When a builder puts up a house and departs, his
> work remains in spite of the fact that he is no longer there. But the universe will
> pass away in the twinkling of an eye if God withdraws his ruling hand.

It is exciting to think that there may be a whole new approach possible to unravel the perennial mysteries of what we really are and what this universe is all about. Finally, for the fearless few willing to suspend disbelief, the adventures in virtual reality of physicist Thomas Campbell as discussed in his monograph *My Big TOE* (Theory of Everything) are recommended reading, and I acknowledge thought provoking discussions with him.

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