

# Alien Its from Bits: Metaphysics Run Amok?

Tubal with translation by Darrell R. Poeppelmeyer  
dpoeppelmeyer@frontier.com

June 28, 2013

## Abstract

John Archibald (JA) Wheeler's "It from Bit" is a form of metaphysics attempting to use information system theory as an ontology to describe Bohr's quantum phenomenology. This paper revels in the insanity caused by humans seeking to understand foundational issues. It offers a fair overview of JA's "Its from Bits." It builds a realistic model that addresses the major unresolved issue raised by JA himself: The continuous nature of the natural number system as opposed to the quantum discreteness of space and time. It concludes that classical mathematics, including binary information, may be a spurious basis for understanding existence. Dimensions must be taken as real in their own right. This article uses an alien commentator as a rhetorical device for entertainment and to aid comprehension. Perhaps humans will be less offended if it is an alien critiquing their cherished beliefs rather than a fellow human.

## Brief Bio

Tubal is a Bundal whose bio may be accessed at <http://tubalsphysics.com/who-is-tubal-what-is-a-bundal/>.

Darrell is the human translator who holds a M.Div. from Nazarene Theological Seminary and a M.B.A. from Indiana-Purdue at Fort Wayne. As an avid student of physics for thirty-two years he is self-taught (a most dangerous kind of learning) in Relativity and Quantum Mechanics.

## Introduction

Hi. I'm Tubal. I did not believe humans existed until my pre-birth. We are Bundals. It is best to think of us as grown-up strings. We are directly evolved from light and gravity. Humans are directly evolved from space and time.

I have been asked by my translator to comment on John Archibald (JA) Wheeler's notion of "Its from Bits."<sup>1</sup> Skeptical readers might ask why an alien would bother to respond to such a narrow question. Actually I find it quite liberating.

Human math is central to JA's metaphysical musings. In spite of math's triumph, JA's musings cast a large shadow over the place of math in reality. He cites the number system as illusionary.<sup>2</sup> He questions why it is that space and time remain physically discrete in the quantum while mathematical measures partake of continuous number lines. He argues for the plausibility that

future numerical measurements, a “yes” or “no” represented by a zero or one, may actually create the real past.<sup>3</sup> These particular issues will be the focus of this paper.<sup>4</sup>

Humans are so confused. There are hundreds of disciplines for the physical sciences on earth.<sup>5</sup> Most disciplines have foundational assumptions that conflict with the assumptions made in other categories. Just ask Einstein and Bohr about quantum mechanics and the decidedly scientific question as to whether God plays with dice. Or ask Darwin how the second law of thermodynamics works? Or bring up the subject of gravity or time. It gets messy.

Trying to answer any human question, within such a wide latitude of academic perspectives and beliefs, is as frustrating as listening to a physicist and mathematician discuss the import and reality of Calabi-Yau manifolds.<sup>6</sup> As the mathematicians and physicists debate reality, each suspects the other is missing an important insight. And both are correct from within their own discipline. Neither discipline seems as critical of itself as it should be.

JA uses human math but despairs of math (as-it-were) in his writings. He claims that in his early work he was “too adept at mathematics and calculation.”<sup>7</sup> This prevented him from tackling problems beyond those areas from which he received public acclaim. He later asks himself the question, Did mathematical prowess prevent me “from spending more time in contemplative thinking about deeper problems?”<sup>8</sup> Probably not, but the issue is raised for the reader.

His mathematical prowess led him to eventually adopt information theory as a potential basis for understanding all of reality. This human discipline, yet another one, was appropriately established with the publication of “A Mathematical Theory of Communication” in 1948 by C.E. Shannon.<sup>9</sup>

Shannon transformed human communication into mathematical equations. It was one thing to predict transmission rates on clear channels. It was revelatory to successfully use the same procedures on channels with varying degrees of noise.<sup>10</sup>

Shannon claims to depart from the “extreme rigor of pure mathematics” when applying his mathematical expertise to continuous, versus discrete, information systems.<sup>11</sup> Actually, his math becomes ever more involved as communication is interpreted “not with operations on particular functions, but with operations on ensembles of functions.”<sup>12</sup> Shannon’s mathematical readers are led to discover that state space can be treated as deeply informational. The rest is history, so humans say.

JA did not explicitly recount Shannon’s work when he would later opine about the universe, determinism, and evolution.<sup>13</sup>

... it is appropriate to touch on three simplified mathematical models which give us insight into at least some aspects of the three questions (concerning reality) that confronts us. The first is the geometrodynamical model for the expanding and

recontracting universe. The second is the statistical model for deterministic dynamics. The third is the fluctuation model for divergent processes.

All three mathematical modalities are found functioning in terms of communication within Shannon's paper. It becomes a minor mental distance between Bohr's quantum phenomenology using phase states and informationally-laden state spaces.

JA defines his own belief system in terms of three periods of his life. During his early period of life he believed, "Everything is Particles." During his middle period he believed, "Everything is Fields." He circumscribed these two earlier periods by his late period which he describes as, "Everything is Information."<sup>14</sup> He canonized this late period with the phrase, "Its from Bits."

Basically JA adopts Bohr's phenomenological scheme for explaining particles and fields. Like Bohr's critics, JA seeks to discover an underlying ontology.<sup>15</sup> The issue is the perennial human issue of a phenomenology seeking an ontological basis.<sup>16</sup>

JA finds his answer in the same laboratory where phenomenology is displayed.

According to JA your universe is the ultimate delayed-choice experiment. Reality is created when the participatory observer determines the answer to a measurable quantum question. All such quantum questions are binary, requiring only a "yes" or "no" answer. Once determined, this observation goes back into the past to make that part of the contingent past "real."

Past creation only occurs as a result of future observations. Eventually, over fifty billion years, there will be enough laboratory observations to make all of creation "real" all the way back to the Big Bang.<sup>17</sup>

Obviously, according to JA, the universe must be ontologically some form of "self-excited circuit."<sup>18</sup> It elicits and receives binary information. JA triumphs because phenomenology and ontology are united in the laboratory answering to the very-same questions. The quantum and existence are explained by an underlying, binary information system. "Its" are from "Bits."<sup>19</sup>

Before entertaining the aforementioned issues of JA's "Its from Bits" I need to answer the prior question, "Is John Wheeler insane?" This issue is sometimes raised by other physicists under the guise of relevance to physics.

The answer is, "All humans are insane."<sup>20</sup> Fortunately, insanity does not prevent effective communication. Corporate human insanity provides the open door for me to revise your perception of reality in order to affirm provocative insights from JA's program.

## JA's Insights

### Mathematics May Be a Spurious Basis for Understanding Existence

Since you are insane, it should not be difficult for you to imagine space, time, gravity, and light as four separate components of reality. Your Greek forbears did this with air, water, fire, and earth. Their prodigy should be able to do the same utilizing modern dimensional thought.

Humans know there is more to existence than mere space and time.<sup>21</sup> If not, JA's argument concerning deriving space and time from an underlying structure is moot. Why not humor an alien and separate out gravity and light from space and time as a human *gedankenexperiment*?

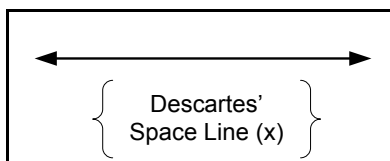
Imagine the possibility that there are two dimensions of space and two of time.<sup>22</sup> Consider these to be second-ordered dimensions that are formed within and from the first-ordered dimensions now ontologically distinguished as gravity and light.<sup>23</sup>

Gravity and light become their own dimensions within which space and time are created.<sup>24</sup> Gravity forms space and time. Light informs gravity. If accepted this means neither gravity nor light can be understood or directly measured through the perspective of space and time only.

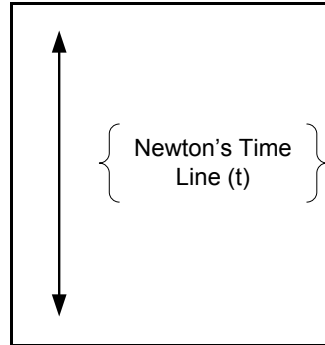
The mathematical bases for your scientific endeavors have historically forced you to focus solely on space and time. Your math has precluded you from expanding your metaphysics beyond mere space and time. Gravity and light and everything else are committed to space and time measurements *apriori* which relegates them as *posteriori* phenomenon. What if gravity and light are *prior* to space and time creation?<sup>25</sup>

Also note, since your mathematical measurements of time are strictly spatial ratios, your math is incapable of capturing the quality or essential characteristic of time that is necessary to distinguish it from space.<sup>26</sup> All of this will be explained by constructing a new basis for comparing the natural numbers to space and time.

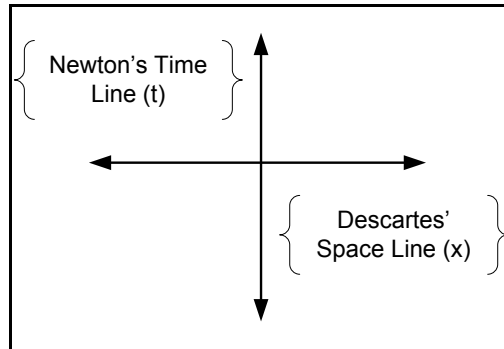
First let me review standard human models. Here is a classical space line used in Euclidean physics.



Here is a classical time line used in Euclidean physics.



Combine the two and humans have the beginnings of a classical, Euclidean, orthogonal coordinate system to measure time and space. All that is needed is a Galilean ball and ramp.



Note that both lines imply infinity. Both are composed of zero-dimensional points that create one-dimensional lines and two-dimensional planes.

Gödel's incompleteness theorem should warn you not to be amazed when this axiomatic geometry evolves through modern precepts of non-Euclidean space so that every point eventually represents a  $\Psi$ -function. This is equivalent to an entire universe potentially existing within each point. If your geometries start with zero dimensions which then produce multiple dimensions (Euclid's postulates) then do not be surprised when something always seems to mathematically emerge from nothing. Do not be surprised when everything can potentially exist within one point.

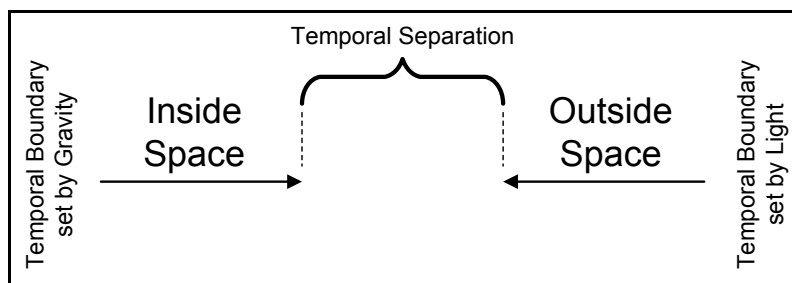
The intersection of the above two classical lines occurs at a point. Is this point a part of space or a part of time? Its quality must be defined by both. Do not be surprised when this axiomatic geometry evolves through modern precepts of non-Euclidean space so that space and time are mathematically indistinguishable and partake of and eventually create a Minkowski-inspired, hyperspace mentality.<sup>27</sup>

Both classical lines extend to infinity. Do not be surprised when such axiomatic geometry evolves through modern precepts of non-Euclidean space so that your equations are inundated with too easily discarded infinities.

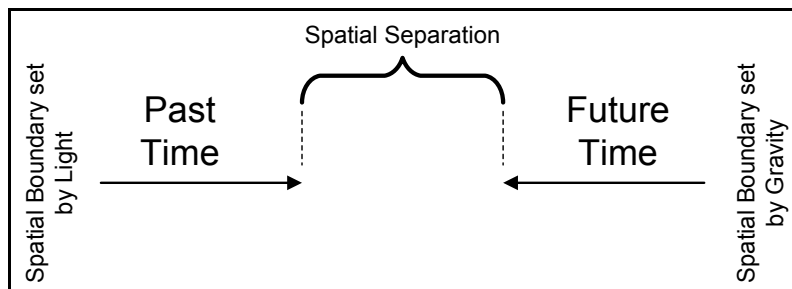
Your whole system is imaginary and cries for reform. JA stated it well when he said: “The continuum of natural numbers, Weyl taught us, is an illusion. It is an idealization. It is a dream.”<sup>28</sup>

Let us try a different model. Look at my revision done in a way to communicate to humans.

Here is my revised space line using two dimensions of space classically known as inside and outside:



Here is my revised time line using two dimensions of time classically known as past and future:

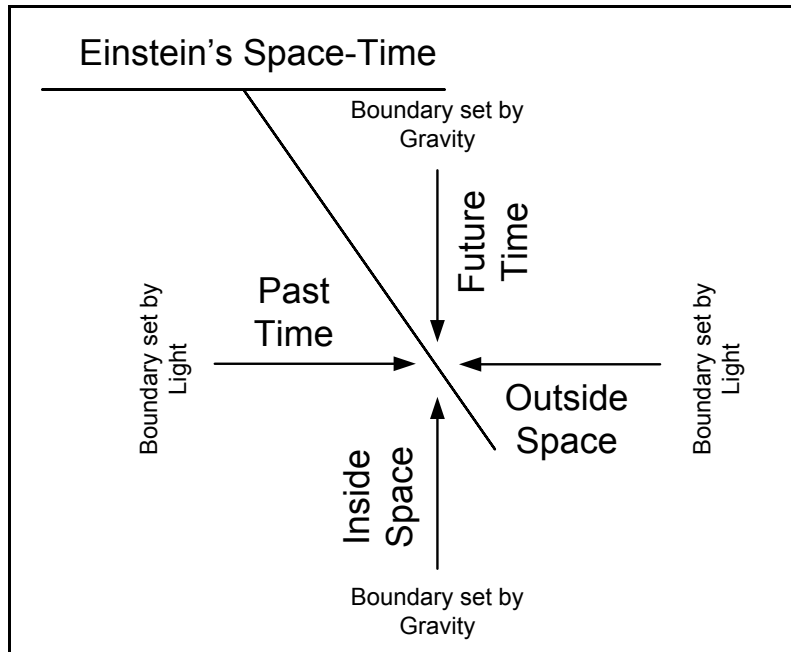


Notice that both time and space are set within and bounded by gravity and light.<sup>29</sup> Space and time emerge (are created) from gravity and light in the two drawings above. There is no zero origin, *per se*, for either one. Note there are no infinities. Perhaps the natural numbers are natural, when not including zero, but are not continuous as is generally presupposed for spatial and temporal measure. The definition of a line needs to be redefined away from Euclid. It must be seen as a relationship between countable elements and processes correlated to each dimension. This project is beyond the scope of this present paper.

JA was correct to question the foundations of physics and be concerned for the “illusion” of math. Classically accepted human math may be a spurious basis for understanding existence, especially a math relegated to only two numbers, zero and one. The classical way in which mathematics has been applied to physics deserves being challenged, in spite of three-thousand years of human history.<sup>30</sup>

## Space and Time as Discrete

Using an adaptation of the two models above, I have created a revised relationship between space and time as symbolized within an Euclidean-like system:



Space is not contiguous. Inside-space and outside-space are separated by time.

Time is not continuous. Past-time and future-time are separated by space.

For argument's sake I ask you to imagine inside-space coupled with past-time as its own universe. I ask you to imagine outside space coupled with future-time as a parallel universe. Einstein's space-time appears as a phenomenon of the processes between the past-inside space and the future-outside space since both are created by gravity and light.

Your universe is not one of many multi-verses.<sup>31</sup> The inverse is true. Ontologically you are a space and time bi-verse. Phenomenologically you are a space and time universe.

As bi-spatial, inside-outside creatures, humans perceive the in-between. They call this in-between the real stuff. Your mistaken sense of a third spatial dimension fails to account for temporal distance. As humans you see two spatial dimensions that appear to have depth. That depth is actually a temporal projection of the possible future as compared to the past.<sup>32</sup> Depth is no more or less than the future coming to you.

As bi-temporal, past-future creatures, humans perceive the present-now. You remember the past. You anticipate the future. No human has ever grasped a now. Your ADM formalisms for relativity that dispense with time go too far.<sup>33</sup> The only thing you need to dispense with is the present-now. Einstein might be relieved.

Now imagine the interplay of space and time as a quantum-like process occurring between the two bi-verses. The future outside is potential matter consisting of real energy fields. They will collapse to form the next inside past.<sup>34</sup> The inside past is real matter and potential energy. It will explode, releasing its potential energy, to form the next future-outside.

Think of this as each universe being destroyed and created, actually converting on a cyclical basis as energy and matter are fed through the boundaries of gravity and light. The reason the speed of light appears as a constant to you is that it structures, as a separate dimension operating through gravity, the continual relationship between matter and energy conversion.<sup>35</sup>

Past space matter converts to the next future time energy. The next future time energy converts to the next past space matter.

Past time energy converts to the next future space matter. The next future space matter converts to the next past time energy.

Your universe is one past time and one future time long. You do not need to go into some distance past to change the future. You actually live in your most recent past to change your next potential future. You live in your most recent future to decide your next past. (JA was partially correct concerning the future creating the past.)

The inside-past is fully determinate. The outside-future is indeterminate.<sup>36</sup>

Humans can only measure one inside-past to another inside-past using memory. Since you are only comparing two memorized past times, your models make time appear to be bi-directional. Your physics only proves it does not matter which past time you measure first. It does not prove time is bi-directional.

The process of cyclic conversion, within gravity and light, means time forms and reforms in a systemic direction which you properly perceive as one way.<sup>37</sup>

Humans can only predict the probabilities for the next future-outside. You cannot actually measure it.

This model seeks to be in accord with both relativity and quantum mechanics. Space and time are formed by gravity and light.

Numerous physical phenomena can be derived from this model. The two temporal dimensions give rise to particle-wave duality and the issues of complementarity. Elliptical orbits are the result of two-foci, one located in the future-outside, the other measured within the past-inside. The exponential difference between Newtonian and Machian measures of velocity is due to the meaning and measure of one versus two time zones.

This model places thermodynamics and fluid dynamics prior to quantum mechanics and relativity.<sup>38</sup> Thermodynamics is involved in the measure of entropy within your space and time



bi-verse as generated by gravity and light. Fluid dynamics is involved from treating gravity as a fluid.

JA was correct. Both space and time need to be discrete in order to explain the quantum. Space and time have an ending and they have a beginning. It is a continuous process not occurring within hidden, mathematical dimensions. Rather it is a continuous converting process occurring within somewhat hidden but very real dimensions. Going beyond JA, space and time are continuously created within the non-temporal environment of gravity and light.

## Conclusion

What humans need is to allow their curiosity to ask questions beyond their parochial disciplines. JA stopped short by limiting his imagination to an information-system hypothesis based solely on a binary analysis. However, he correctly adduced that public research to address out-of-their-normal-disciplines' thinking will sharpen physics rather than annul it.

The natural number system need not be continuous. Space and time are discrete. The number system needs adapted more directly to the interaction of the various physical dimensions. This would give rise to understanding quantum phenomenology without the need for misusing math or over burdening information system theories. Space, time, gravity, and light are real. The measure of each is qualitatively different than current, imaginary mathematical amalgamations allow.

JA said the last 100 years has not turned over previous physical assumptions.<sup>39</sup> Is this good or bad? Does it mean science has successfully cornered the market on understanding? Or has human science gotten into a mathematical rut? It is true, further insights can be gleaned, even from within a rut. Maybe it is time for you to climb out of the rut and imagine new possibilities that challenge your foundations.

Bundals wonder. Has human metaphysics gone amok? Or has human mathematics gone amok? You will figure it out in a bit.

## Endnotes

<sup>1</sup> To keep my approach simple and focused I will use two of JA's works. These books contain the gist of his thoughts on "Its from Bits" and offer a summary of his numerous publications. They are:

Wheeler, J.A., *At Home in the Universe*, (The American institute of Physics (AIP) Press, 1994), hereinafter *Home*.

Wheeler, John Archibald with Kenneth Ford, *Geons, Black Holes and Quantum Foam*, (New York and London: W.W. Norton & Co., 1998), hereinafter *Geons*.

<sup>2</sup> *Home*, pp. 189-190.

<sup>3</sup> JA states, "By looking back, by observing what happened in the earliest days of the universe, we give reality to those days," *Geons*, p. 338. JA later explains, "The universe and all that it contains ('it') may arise from the myriad yes-no choices of measurement (the "bits")," *Geons*, p. 340. (Parenthesis are JA's.)

JA will argue his notion is not preposterous. See endnote 17.

JA adopts an underlying (hidden) binary information system over a tertiary quantum-like system. True or false is binary; while true or false or yet to be determined is tertiary and more quantum-like.

<sup>4</sup> Intelligent readers can extend the model presented in this paper to JA's other issues.

<sup>5</sup> Just pay a visit to [www.arXiv.org](http://www.arXiv.org).

<sup>6</sup> Humans hope some form of Calabi-Yau manifold holds the secrets to understanding their universe. For a real-world example involving Calabi-Yau Manifolds see Brian Greene, *The Elegant Universe*, (New York and London: W.W. Norton & Company, 1999), pages 271 and 275.

<sup>7</sup> *Geons*, p. 158.

<sup>8</sup> The question is actually directed at the reader, *Geons*, p. 158. Wheeler admits to have "never been too busy to dream," p. 182.

<sup>9</sup> *The Bell System Technical Journal*, Vol. 27, pp. 379-423, 623-656, July, October, 1948.

<sup>10</sup> Shannon, p. 22. Shannon humbly notes, "It may seem surprising that we should define a definite capacity C for a noisy channel since we can never send certain information in such a case." Shannon solves this problem through redundancy coupled with proper encoding of binary information.

<sup>11</sup> Shannon, p. 32.

<sup>12</sup> Shannon, p. 34. Compare this to JA's superspace, see *Home*, pp. 60-64.

<sup>13</sup> *Home*, pp. 236-7

<sup>14</sup> JA does not refute particles and fields *per se*. He only wants (humans) to investigate the possibility that binary information underlies them. *Geons*, pp. 63-64.

<sup>15</sup> JA humbly asserts, "I build only a little on the structure of Bohr's thinking ... (but then pointedly asserts) we may never understand this strange thing, the quantum, until we understand how information may underlie reality," *Geons*, p. 141.

<sup>16</sup> JA must have tired of having to repeat "To say that the world exists out there ... can no longer be upheld," *Home*, p. 126. Apparently Niels Bohr never tired of such a scheme.

<sup>17</sup> JA asks, "Is this preposterous?" He answers there are approximately  $8 \times 10^{88}$  bits necessary to inform (create) our universe. "There are billions of years yet to come, billions on billions of sites of observer-participatory (laboratories) yet to be occupied. (...) Do bits needed balance bits achievable? They must! ...," JA declares, *Home*, pp. 306-7.

JA unwillingness to strictly define "observership" does indicate creating reality may someday go beyond the laboratory. His examples show the laboratory as the "obvious instance" where reality is created. (*Home*, p. 43.)

The number "fifty billion years" comes from *Homes*, p. 309.

<sup>18</sup> JA seems adamant there are no other obvious answers underlying Bohr's Quantum phenomenology. He lists six clues and announces six agenda items necessary for understanding existence. All of them relate to an "Its from Bits" schema essentially based on Bohr's phenomenology, (*Geons*, pp. 302-310.)

To answer the questions of existence JA states, "... no pattern suggests itself from the available clues except this, to interpret (Bohr-style) quantum mechanics as evidence for the tie between genesis and observership," *Home*, p. 26.

<sup>19</sup> See *Home*, p. 191.

<sup>20</sup> A human might think that a dedication to pure phenomenology should raise a host of psychiatric questions. Fortunately, your American Psychiatric Association's DSM-5 (their official manual for classifying mental disorders) has no classification for those who insist all of reality is illusionary. Perhaps the soft sciences are being kind to the hard sciences? Unfortunately, we Bundals do not look upon humans so kindly in regards to their mental attributes. (See [www.psych.org/practice/dsm](http://www.psych.org/practice/dsm).)

<sup>21</sup> JA speaks for many when he says, “Whether canvas or stage, it (space-time) is the arena of action, not the action itself,” *Geons*, p. 346. While many will argue that space and time are insufficient for the arts or religion, I will argue space and time are insufficient for the sciences as well.

<sup>22</sup> The number of possible spatial dimensions has grown from three to thirty-two in some forms of string-loop theory. Multi-verse theory expands the number of spatial dimensions needed to describe human reality to no more than  $10^{500}$ . See Brian Greene, *The Hidden Reality*, (New York: Vintage Books, 2011), p. 177. This assumes Calabi-Yau’s can explain the hidden dimensions.

What of poor time? Time is either stuck with its one dimension or it does not exist at all. One exception is Itshak Bars, <http://physics.usc.edu/~bars/>.

Note: Two dimensions of space and two of time invite an ontological basis for super-symmetry.

<sup>23</sup> The full model is available at [www.tubalsphysics.com](http://www.tubalsphysics.com) or in Darrell Poeppelmeyer, *Tubal’s Recipe for Physics: Imagining Two Temporal Dimensions*, (Create Space, 2012).

<sup>24</sup> At least in your universe. Notes: Gravity, postulated as outside space and time, cannot be directly unified with the other three-unified forces which exist within space and time. Gravity is creative which may address issues of dark energy and dark matter.

<sup>25</sup> God said, “Let there be light.”

<sup>26</sup> Say a runner runs ten meters per second. This is only a spatial ratio between the distance covered by a particular runner to the distance covered by the second hand of a particular watch.

<sup>27</sup> As an aside, do not be surprised if you are always one Kaluza-Klein dimension short in your attempts to unify all of your measuring equations. You started with two qualities (time and space) that you essentially unified as one at the point of intersection (and axiomatic definition).

<sup>28</sup> *Home*, P. 189. For JA the mathematical continuum is complementary (through logical rigor) to the physical necessity for space and time to be discrete (the quantum). See *Home*, pp. 190 and 283.

<sup>29</sup> There are two types of gravity and two types of light used in this model. Distinguishing them within this paper is not necessary for the argument.

<sup>30</sup> JA always opposed the herd instinct, see *Geons*, p. 173.

<sup>31</sup> This is true only within space and time. Cosmologically, gravity and light can give birth to different types of universes, none of which necessarily corresponds directly to a space and time analysis.

<sup>32</sup> When you look at the stars above, you are not looking back in time. Rather you are looking at your future. If a star was heading towards you, you would be sure to duck. When you look through a telescope you perceive (are able to measure) inside space. When you look through a microscope, you perceive (are able to measure) inside space. You cannot perceive (are unable to measure) outside space since it is pure potential matter with real temporal energy.

<sup>33</sup> A strong public proponent of timeless space is Julian Barbour. See *The End of Time*, (Oxford University Press, 1999) or [www.platonian.com](http://www.platonian.com). JA states there is no space nor time at a fundamental level, see *Homes*, p. 301.

<sup>34</sup> Humans believe it is only a wave-function that collapses.

<sup>35</sup> This model assumes that light inform gravity which in turn structures space and time (through the shaping of gravity by light). See an alternative interpretation of “Eddington’s 1919 Greatest Confirmation” at <http://wp.me/p3aQvH-7U>. Compare JA’s notes on understanding light as a topology, *Home*, p. 176.

<sup>36</sup> Human philosophers on both sides of these issues are both correct as concerns part of their existence.

<sup>37</sup> This is based on Whitehead’s event ontology commonly known as “Organism.” While Whitehead would not differentiate gravity and light as dimensions separate from time and space, modifying his views on the extensive continuum and coupling them with his doctrine of concrescence produces results similar to JA’s program. See Alfred North Whitehead, *Process and Reality*, the corrected edition by David Ray Griffin and Donald W. Sherburne, (New York: The Free Press, 1978), pp. 283-333. Whitehead states, “But what has vanished from the field of ultimate scientific conceptions is the notion of vacuous material existence with passive endurance, with primary individual attributes, and with accidental adventures. ... (This) concept is useless as an ultimate notion in science, and in cosmology,” p. 309.

<sup>38</sup> Remember, gravity and light are first-ordered dimensions. Space and time are derived from them.

<sup>39</sup> *Geon*, p. 251.

## References

- American Psychiatric Association's DSM-5, [www.psych.org/practice/dsm](http://www.psych.org/practice/dsm) .  
----- [www.arXiv.org](http://www.arXiv.org) .
- Barbour, Julian. *The End of Time*, (Oxford University Press, 1999)  
----- [www.platonina.com](http://www.platonina.com) .
- Bars, Itshak. <http://physics.usc.edu/~bars/> .
- God. "Let there be light."
- Greene, Brian. *The Elegant Universe*. (New York and London: W.W. Norton & Company, 1999).  
----- *The Hidden Reality*. (New York: Vintage Books, 2011).
- Poepelmeyer, Darrell. *Tubal's Recipe for Physics: Imagining Two Temporal Dimensions*. (Create Space, 2012).  
----- "Eddington's 1919 Greatest Confirmation" at <http://wp.me/p3aQvH-7U>.  
----- [www.tubalsphysics.com](http://www.tubalsphysics.com)
- Shannon, C.E. *The Bell System Technical Journal*, "A Mathematical Theory of Communication." Vol. 27, pp. 379-423, 623-656, July, October, 1948.
- Wheeler, J.A.. *At Home in the Universe*. (The American institute of Physics (AIP) Press, 1994).
- Wheeler, John Archibald with Kenneth Ford. *Geons, Black Holes and Quantum Foam*. (New York and London: W.W. Norton & Co., 1998).
- Whitehead, Alfred North. *Process and Reality*, the corrected edition by David Ray Griffin and Donald W. Sherburne. (New York: The Free Press, 1978).