

# A Meditation on Consciousness:

the physics of intentionality and prayer

by Jon Trevathan

In David Chalmers' paper, "Facing Up to the Problem of Consciousness", Dr. Chalmers wrote:

"Wheeler (1990) has suggested that information<sup>1</sup> is fundamental to the physics of the universe. According to this 'it from bit' doctrine,<sup>2</sup> the laws of physics can be cast in terms of information, postulating different states that give rise to different effects without actually saying what those states are. It is only their position in an information space that counts. If so, then information is a natural candidate to also play a role in a fundamental theory of consciousness. We are led to a conception of the world on which information is truly fundamental, and on which it has two basic aspects, corresponding to the physical and the phenomenal features of the world."<sup>3</sup>

This paper will explore the role that "[information](#)" might play through a convergence of physics and neuroscience in a new theory of consciousness. It will be my suggestion that information is the monistic "common denominator" through which the Cartesian mind-body problem might be resolved. In the "Meditations" that follow, I will begin with a speculative quantum mechanical model which, among others<sup>4</sup>, potentially provides the information reservoir that Chalmers believes a "fundamental theory of consciousness" requires. I will next examine the model's underlying assumptions and provide supporting arguments based on Black Hole cosmology and Reversible Computers. I will then restate the model as modes of thought and as the Hindu Aum (or Om). Finally, I will explore the model's implications in our lives, to include how prayer and intentionality may alter the probabilities of what occurs in our lives.

## A MEDITATION FROM THE PHYSICS.

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<sup>1</sup> See: [http://en.wikipedia.org/wiki/Quantum\\_information](http://en.wikipedia.org/wiki/Quantum_information); [http://en.wikipedia.org/wiki/Physical\\_information](http://en.wikipedia.org/wiki/Physical_information); [http://en.wikipedia.org/wiki/Entropy\\_\(information\\_theory\)](http://en.wikipedia.org/wiki/Entropy_(information_theory)) and [http://en.wikipedia.org/wiki/Entropy\\_in\\_thermodynamics\\_and\\_information\\_theory](http://en.wikipedia.org/wiki/Entropy_in_thermodynamics_and_information_theory)

<sup>2</sup> "It from bit. Otherwise put, every it—every particle, every field of force, even the space-time continuum itself—derives its function, its meaning, its very existence entirely—even if in some contexts indirectly—from the apparatus-elicited answers to yes or no questions, binary choices, *bits*. It from bit symbolizes the idea that every item of the physical world has at bottom—at a very deep bottom, in most instances—an immaterial source and explanation; that what we call reality arises in the last analysis from the posing of yes-no questions, and the registering of equipment-evoked responses; in short, that all things physical are information-theoretic in origin and this is a *participatory universe*." Wheeler, at Home in the Universe, 296.

While this view serves as a starting point for this Meditation, there are reasons to believe that information is independent of and transcendent to the measuring devices that Wheeler referenced.

<sup>3</sup> *Journal of Consciousness Studies* 2(3):200-19, 1995. Also "[Moving Forward on the Problem of Consciousness](#)" (<http://consc.net/papers/facing.html>)

See Endnote: "[Everything is Information](#)"

<sup>4</sup> The time-evolution of quantum mechanical systems generally requires that our knowledge of the physical world (the initial state) first be mapped onto some mathematically-defined space; the applicable dynamical laws are then applied to transform this initial state into a new, computed state; and the computed state is finally mapped back into the physical world. There are a number of wavefunction-based approaches, to include Yakir Aharonov's [A time-symmetric formulation of quantum mechanics](#) (TSQM) and the Aharonov-Vaidman [Two-state vector formalism](#), [Ghirardi-Rimini-Weber](#)-style flash ontologies, and Cramer's [Transactional Interpretation](#), where the wavefunction is arguably not ontological. However, they each assume a configuration space from which their "beables" arise. Because quantum mechanical wave and field functions are not seen to reside in ordinary spacetime, QM-based ontologies frequently posit some higher-dimensional spacetime-based reality to underlie and explain quantum theory. Also, reasonable extensions to Aharonov's TSQM and Two-state vector formalism imply the preexistence of immaterial informational states as an ontological reality. The view that "[Everything is Information](#)" goes even further to hold that "information" is the fundamental reality from which our physical world arises.

As my starting point, I have "borrowed" from a promising quantum gravity theory called "Causal Dynamical Triangulation" (CDT) and, like CDT theorists, have assumed a [superposition](#) of all possible information states, including space-time geometries as my initial state.<sup>5</sup>

In [quantum mechanics](#), the initial [quantum state](#) of any system [evolves](#) over time into a [probability distribution](#) of all possible states consistent with the initial [boundary condition](#). Because I have posited an initial state in which all possible states and spacetime geometries are subsumed, a probability distribution of possible states, including both observable and unobservable states, will necessarily arise. Additionally, these potential states will be present in [superposition](#) such that our initial state and all predicate states may be understood to be present in our point of origination. Applying [time symmetry](#), this probability distribution will simultaneously constitute the set of all futures and the set all histories which can arise from and lead to this single point of origination. As this point of origination constitutes both the system's beginning and ending boundary condition, all actualizations must occur within this contextuality.

If the big bang is then understood to have occurred as an actualization event within this preexistent contextuality, it would constitute the initial boundary condition for our universe and, inter alia, embody all of the laws of physics pursuant to which our universe could thereafter evolve. All subsequent actualizations would then be strongly bounded by these laws of physics and the set of all actualization event that immediately precede each successive "now"; but would also be subtly influenced by the future boundary condition toward which all of our possible futures would necessarily converge.<sup>6</sup>

In the context of the following figure, each actualization event (the observed state) is probabilistically resolved from a set of alternatives or potential states (represented by the future light cone) where the probability of actualization is represented by the potential state's proximity to the vertical "time" line. As determined by the set of temporally preceding events (contained in the past light cone) and a "destiny state" (represented by a point at the end of time's arrow), the number of potential states will gradually decrease with the passage of time (represented by the cones movement up the time line) until only one potential state remains and, with a probability of 100%, becomes actualized. The time evolution of larger systems would then be represented by sets of future and past light cones emergent from the radial plane of the figure's observed state.

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<sup>5</sup> See: <http://en.wikipedia.org/wiki/Spacetime> [http://en.wikipedia.org/wiki/Quantum\\_gravity](http://en.wikipedia.org/wiki/Quantum_gravity) [http://en.wikipedia.org/wiki/Causal\\_dynamical\\_triangulation](http://en.wikipedia.org/wiki/Causal_dynamical_triangulation) and <http://arxiv.org/abs/hep-th/0509010>

<sup>6</sup> "Philosophically or ideologically, one may or may not like the idea of a cosmic final state. The point is, however, that quantum mechanics offers a place to specify both an initial state and an independent final state. What the final state would be, if there is one, we don't know. But if quantum mechanics says it can be done, it should be taken seriously." Yakir Aharonov, Sandu Popescu, and Jeff Tollaksen, "A time-symmetric formulation of quantum mechanics", Physics Today, November 2010, Page 32.

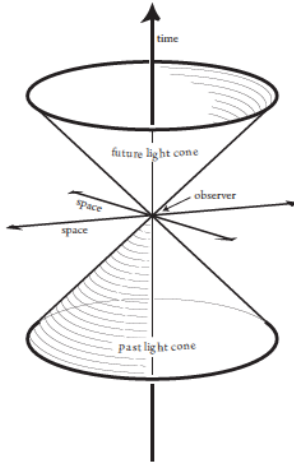


Figure 1

It we then apply concepts which have their origin in [chaos theory](#), the "destiny state" may be understood to create a "[basin of attraction](#)" in which the time evolution of each state, system and our entire universe participates. It is in this context that the information of our lives probabilistically preexists the choices that we make and the planckian particulars of our choices become ontologically fixed within the matrix of what might otherwise have been. This is the information reservoir in which consciousness is emergent, memories reside, and thought and intentionality participate in the [density matrix](#) of what will happen next in our lives. It is also the information reservoir that David Chalmers' speculation requires.

The obvious next question is question how can this informational realm be mentally accessed. The answer, however, requires us to first ask the question "What is matter?" When this question is addressed later in this paper, we will be lead us to the realization that corporeality may be reduced to oscillations<sup>7</sup> and that the superposition of these oscillatory states provide the means for future contingencies and past alternatives to be stored. Additionally, if the Primal Point were equivalent to an infinite dimensional hyperpoint as Carlos Castro, Alex Granik, and Mohamed El Naschie have speculated<sup>8</sup>, the universe's potential information content would be unlimited. Now, let's look at the assumptions that are implicit to this model.

### Are the Model's Assumptions Reasonable?

As to the model's initial state, every theory that contemplates a beginning must assume something about that beginning. For [loop quantum gravity](#) (LQG), Planckian-sized loops are woven into a quantized spacetime.<sup>9</sup> Similarly, the initial state that I have posited is, as noted above, "borrowed" from one of the three leading theories of quantum called "[Causal Dynamical Triangulation](#)" (CDT)<sup>10</sup> As described by Renate Loll, one of CDT's originators, the path integral for gravity is a superposition of all possible "paths" our universe could have followed. A recipe for finding the desired quantum dynamics of gravity is therefore to compute a superposition of all

<sup>7</sup> "The basis for quantum mechanics is the recognition that everything has a wavelike nature, even those things we normally consider particles." Foundations of Modern Cosmology [http://www.astro.virginia.edu/~jh8h/Foundations/Foundations\\_1/chapter16.html](http://www.astro.virginia.edu/~jh8h/Foundations/Foundations_1/chapter16.html)  
See Also [What is Matter?](https://www.facebook.com/notes/jon-trevathan/what-is-matter/10150360011394263) (<https://www.facebook.com/notes/jon-trevathan/what-is-matter/10150360011394263>), which includes an expanded examination of this topic,

<sup>8</sup> Castro, Granik, & El Naschie, "[Why We Live in 3+1 Dimensions](http://arxiv.org/PS_cache/hep-th/pdf/0004/0004152v1.pdf)" ([http://arxiv.org/PS\\_cache/hep-th/pdf/0004/0004152v1.pdf](http://arxiv.org/PS_cache/hep-th/pdf/0004/0004152v1.pdf))

<sup>9</sup> See also: Lee Smolin, Atoms of Space and Time, Scientific American, January 2004, <http://www.phys.lsu.edu/faculty/pullin/sciam.pdf>

<sup>10</sup> See also: R. Loll, J. Ambjorn, J. Jurkiewicz, The Universe from Scratch, Contemporary Physics 47 (2006), (<http://arxiv.org/abs/hep-th/0509010v3>)

possible spacetime geometries, which differ by being curved in arbitrary ways. Such a quantum averaging should produce the true, nonperturbative ground state of quantum gravity, in other words, "the mother of all vacua". The geometric properties of this vacuum state will reflect the collective behaviour of the quantum ensemble of all virtual spacetime geometries, including those with large curvature fluctuations at very small scales...".<sup>11</sup>

The approach taken is one of several where spacetime is emergent from more fundamental "building blocks"<sup>12</sup> and may be seen as roughly analogous to [Leibnitz's "monads"](#)<sup>13</sup>, [Spinoza's "substance"](#)<sup>14</sup>, and Bertrand Russell's "[neutral monads](#)"<sup>15</sup>.

For the purposes of this conjecture, I have assumed that the initial state is a superposition of all possible states, to include all possible space time geometries.<sup>16</sup> "Quantum superposition is a fundamental principle of [quantum mechanics](#) that holds a physical system ... exists partly in all its particular theoretically possible [states](#) (or, configuration of its properties) simultaneously." "The principle of superposition states that if the world can be in any configuration, any possible arrangement of particles or fields, and if the world could also be in another configuration, then the world can also be in a state which is a [superposition](#) of the two..."<sup>17</sup>

"In quantum physics, the "unmeasured" state of the Universe is a superposition of *all* possible states, and the physics has to take into account (in principle) of *all* those states".<sup>18</sup>

This initial state I have assumed can also be philosophically/theologically apprehended from the following:

"(C)onsider the dot (or point); how letters and words are folded up and hidden within the essence (huwiyat, ipseity) and reality of a dot with perfect effacement and annihilation so that no trace can be discerned of the existence of these letters and words nor is there any differentiation between them. Rather they are completely obliterated and utterly annihilated and have no existence except in the essence [dhat] of the point. In the same way the Names and Attributes of God and the Essential Dispositions [shu'únát dhátiyya] [15] are completely and utterly annihilated in the station of Primary Oneness so that not a whiff can be inhaled from them of substantial or intellectual existence [16]. This original point is the 'Hidden Treasure' of these letters and words and they were incorporated and immersed within it and from it they appeared."<sup>19</sup>

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<sup>11</sup> Renate Loll - Radboud Universiteit, ([www.hef.ru.nl/~rloll/Web/research/research.html](http://www.hef.ru.nl/~rloll/Web/research/research.html))

<sup>12</sup> [http://en.wikipedia.org/wiki/Quantum\\_spacetime](http://en.wikipedia.org/wiki/Quantum_spacetime); See also: George Johnson, How Is the Universe Built? Grain by Grain, The New York Times Company, 1999, <http://faculty.washington.edu/smcohen/320/GrainySpace.html>

<sup>13</sup> "In Leibniz's view, every created monad is subject to both actions and passions. As such, it must be regarded as possessing both a "primitive active power," its entelechy or principle of force, and a "primitive passive power," its "primary matter."<sup>48</sup> In a sense, therefore, a monad can be characterized as a hylomorphic substance, or a composite of form and matter. ... [However.] Under no circumstances should we think of monads as material substances. Leibniz, on the contrary, explicitly describes them as 'incorporeal automata'." Nicholas Jolley, The Cambridge Companion to Leibniz, Cambridge University Press, 1995, pages 139-140.

<sup>14</sup> See also: Curtis Brown, Spinoza on Why There Can Only Be One Substance, <http://www.trinity.edu/cbrown/modern/spinozaPartI.html>

<sup>15</sup> "Contemporary versions of monism tend to say not that the world itself is one substance, but that everything in the world is made of the same sort of thing: materialism says that the world is made of matter, idealism says that it made of ideas, and Russell's 'neutral monism' of the 1920s says that the world is of one nature, while remaining neutral on whether it is mental or material." Tim Crane, Elements of Mind, An Introduction to the Philosophy of Mind, Oxford University Press, 2001, page 44.

<sup>16</sup> "The universe was a huge quantum superposition of all possible states..." Santhosh Mathew, Essays on the Frontiers of Modern Astrophysics and Cosmology, page 151

<sup>17</sup> See also: [http://physics.gmu.edu/~dmaria/590%20Web%20Page/public\\_html/qm\\_topics/superposition/superposition.html](http://physics.gmu.edu/~dmaria/590%20Web%20Page/public_html/qm_topics/superposition/superposition.html)

<sup>18</sup> Gribbin, John, Schrödinger's Kittens and the Search for Reality: Solving the Quantum Mysteries. Little, 1995, page 180).

<sup>19</sup> 'Abdu'l-Bahá, Commentary on the Islamic Tradition 'I was a I was a Hidden Treasure',

[http://bahai-library.com/abdulbaha\\_kuntu\\_kanzan\\_makhfiyyan](http://bahai-library.com/abdulbaha_kuntu_kanzan_makhfiyyan)

Additionally, the information content of this "primal point"<sup>20</sup> may be infinite. According to the physicists, Carlos Castro, Alex Granik, and Mohamed El Naschie, a hyperpoint is "the infinite-dimensional analog of a point, where infinite Dimensions, infinite Energy and infinite Information merge and become ONE. The hyperpoint is an infinite dimensional hyper-sphere of unit Planck radius and zero volume/measure. A hypersphere of finite radius but zero size: we are imbuing a mathematical 'point' with a true physical meaning."<sup>21</sup>

Our second assumption is that this initial state should be subject to the principles of quantum mechanics. Applying this assumption, we find that the initial state of any quantum system evolves over time into a [statistical ensemble](#) (a probability distribution over possible states) that are consistent with the initial state and boundary conditions. Because I have posited an initial state in which a universal set of possible states and spacetime geometries are subsumed, a probability distribution of these possible states, including all observable states, will of necessity arise. Additionally, these potential states will be present in superposition such that our initial state and all predicate states will be subsumed within our point of origination.<sup>22</sup>

Again, this process may be philosophically/theologically apprehended from the following:

"When He purposed to call the new creation into being, He sent forth the Manifest and Luminous Point from the horizon of His Will; it passed through every sign and manifested itself in every form until it reached the zenith, as bidden by God, the Lord of all men.

This Point is the focal centre of the circle of Names and marketh the culmination of the manifestations of Letters in the world of creation."<sup>23</sup>

Our third assumption is that the principles of time symmetry should also apply. (See below for an analysis of this assumption.) Doing so transforms our probability distribution into the set of all futures and the set all histories which can simultaneously arise from and lead to the monadic point of origination we initially posited. However, again because these contingencies continue in superposition, Leibniz's, "Identity of indiscernibles" preserves the unity of our initial state until an actualization event probabilistically occurs.<sup>24</sup>

The Big Bang is our fourth assumption. In the context of this meditation, the Big Bang that "created" our universe would be one of innumerable other universes that would necessarily arise within the preexistent contextuality I have described. As previously noted, our Big Bang would define the initial boundary conditions for our universe including the laws of physics pursuant to which our universe could thereafter evolve. All subsequent actualizations would thereafter be strongly bounded by our universe's initial actualized state and the set of all actualizations immediately preceding each successive state, or "now". However, these successive states ("nows") would also be subtly influenced by the initial state we posited, which in the context of "time" may be understood to be a final boundary condition for our universe and a future unity toward which each future actualized state must necessarily converge.

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<sup>20</sup> Ernesto J. Fernández, The Metaphysics of the Primal Point, [http://bahai-library.com/pdf/f/fernandez\\_metaphysics\\_primal\\_point.pdf](http://bahai-library.com/pdf/f/fernandez_metaphysics_primal_point.pdf)

<sup>21</sup> Castro, Granik, & El Naschie, "Why We Live in 3+1 Dimensions" ([http://arxiv.org/PS\\_cache/hep-th/pdf/0004/0004152v1.pdf](http://arxiv.org/PS_cache/hep-th/pdf/0004/0004152v1.pdf))

<sup>22</sup> See: [http://en.wikipedia.org/wiki/Quantum\\_mechanics](http://en.wikipedia.org/wiki/Quantum_mechanics); See also: [http://en.wikipedia.org/wiki/Statistical\\_mechanics](http://en.wikipedia.org/wiki/Statistical_mechanics);

[http://en.wikipedia.org/wiki/Density\\_matrix](http://en.wikipedia.org/wiki/Density_matrix); [http://en.wikipedia.org/wiki/Probability\\_amplitude](http://en.wikipedia.org/wiki/Probability_amplitude);

[http://en.wikipedia.org/wiki/Quantum\\_superposition](http://en.wikipedia.org/wiki/Quantum_superposition)

<sup>23</sup> Baha'u'llah, Tablets of Baha'u'llah, p. 101 (Tablets of Bahá'u'lláh)

<sup>24</sup> [http://en.wikipedia.org/wiki/Identity\\_of\\_indiscernibles](http://en.wikipedia.org/wiki/Identity_of_indiscernibles)

In his book, "The God Delusion", Richard Dawkins does not reject the God of Spinoza and Einstein "who reveals himself in the orderly harmony of what exists."<sup>25</sup> Instead Dawkins contend that there is no possibility that the Einsteinian God could be teleologically active in Creation. ) However, if the assumptions of this mediation are correct, there would be a future boundary condition for our universe that could subtly introduce a teleology into the time-evolution of Creation. In this speculation, the determinism that Einstein yearned for is achieved in a contextuality of contingency that preserves "Free Will". Further, in a system that is the mirror opposite of Everett's multi-world hypothesis, the information reservoir that Chalmers' speculation requires is preserved as a preexistent "matrix" of potentialities while addressing Chalmers' concern that "the Everett interpretation is almost impossible to believe".<sup>26</sup> The reasonableness of there being a matrix of potentialities that pre-existed our Big Bang will be more thoroughly assessed below. However, as the astrophysicist, Paul Davies stated in his book, *The Fifth Miracle: The Search for the Origin and Meaning of Life*, "If information can't get made, it must have been there at the beginning, as part of the initial input. The conclusion we are led to is that the universe came stocked with information, or negative entropy, from the word 'go.'<sup>27</sup> The approach also resolves the concern raised by Fritz-Albert Popp in his paper titled "Consciousness as Evolutionary Process Based on Coherent States" that "consciousness could never have developed in a closed system."<sup>28</sup>

Our fifth assumption is relates to the primacy of information.<sup>29</sup> This is a topic that I am still working on. However, I have included my work in progress as an endnote to this paper.<sup>i</sup>

Albert Einstein first linked matter to energy. Louis de Broglie went on to postulate that all particles with momentum would have a wavelength  $\lambda$ . Albert Einstein claimed that "Matter is frozen energy" and the physicist, David Bohm, said that "Matter is frozen light". In order to connect information to matter we must first consider that all corporeality may be reduced to oscillations, which permit the superposition of these oscillatory states. This is explored in a second endnote in answer to the question "What is Matter?"<sup>iii</sup>

Our sixth assumption is necessary to address the Dualists' dilemma -- How can there be any interaction between the macro structures and systems of the physical brain with the quantum superpositions in which the requisite information resides.<sup>30</sup> It was the contention of Drs. Furman and Gallo in their book "The Neurophysics of Human Behavior", that the "theoretical scientist must search for the most fundamental level of description possible...". "That is, we must describe brain, mind, behavior, and information in terms of a fundamental process that is ever present, that can be found in all of the elements at all times: the common denominator".<sup>31</sup>

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<sup>25</sup> Dawkins, Richard. *The God Delusion*. Boston: Houghton Mifflin Co, 2006, pages 15, 16, 101-10, 181

<sup>26</sup> See David J. Chalmers. *The Conscious Mind: In Search of a Theory of Conscious Experience*, (27 November 1996), page 331.

<sup>27</sup> Paul Davies, *The Fifth Miracle: The Search for the Origin and Meaning of Life*, Page 62

<sup>28</sup> Popp FA., *Consciousness as Evolutionary Process Based on Coherent States*, *NeuroQuantology* | December 2008 | Vol 6 | Issue 4 | Page 436.

<sup>29</sup> "At the heart of this arresting vision is an insistence on the cosmic primacy of information and computation. Strangely and miraculously, the vision reveals deep linkages and unanticipated correlations between the qualities of what we think of as inanimate nature and the essential characteristics of life itself." Gardner, James N, *Intelligent universe : AI, ET, and the emerging mind of the cosmos* (2007) page 25.

<sup>30</sup> (As Background: [http://en.wikipedia.org/wiki/Hard\\_problem\\_of\\_consciousness](http://en.wikipedia.org/wiki/Hard_problem_of_consciousness), [http://en.wikipedia.org/wiki/Mind%E2%80%93body\\_problem](http://en.wikipedia.org/wiki/Mind%E2%80%93body_problem), [http://en.wikipedia.org/wiki/Philosophy\\_of\\_mind](http://en.wikipedia.org/wiki/Philosophy_of_mind), <https://www.facebook.com/notes/jon-trevathan/what-is-matter/10150360011394263>)

<sup>31</sup> Mark E. Furman, Fred P. Gallo, *The Neurophysics of Human Behavior: Explorations at the Interface of Brain, Mind, Behavior, and Information*, 2000, Page 3.

At present, the most fundamental theory of matter is quantum mechanics. The issue that I have begun to explore in the third endnote to this paper is whether quantum mechanics might provide us with a candidate "common denominator" to connect corporeality and consciousness through properties of harmonic oscillation, light, and the holographic principle. <sup>iii</sup>

### **Are there any reasons to believe in time symmetry?**

In this regard, please note that virtually all of the "laws of physics are time symmetric"<sup>32</sup> I wish the consideration of time symmetry in the context of a final boundary condition were entirely original to me. It is not. For example, Roger Penrose, in the article titled "The Big Bang and its thermodynamic legacy", wrote:

"Normally, one thinks in terms of systems evolving into the future, from data specified in the past, where the particular evolution takes place is determined by differential equations. ... One does not, on the other hand, tend to think of evolving these same equations into the past, despite the fact that the dynamical equations of classical and quantum mechanics are symmetrical under a reversal of the direction of time! As far as the mathematics is concerned, one can just as well specify final conditions, at some remote future time, and evolve backward in time.

Mathematically, final conditions are just as good as initial ones for determining the evolution of a system." <sup>33</sup>

In a paper titled "New Insights on Time-Symmetry in Quantum Mechanics" Yakir Aharonov and Jeffrey Tollaksen have written as follows:

"Up until now we have limited ourselves to the possibility of 2 boundary conditions which obtain their assignment due to selections made before and after a measurement. It is feasible and even suggestive to consider an extension of QM to include both a wavefunction arriving from the past and a second "destiny" wavefunction coming from the future, which are determined by 2 boundary conditions, rather than a measurement and selection. This proposal could solve the issue of the "collapse" of the wavefunction in a new and more natural way: every time a measurement takes place and the possible measurement outcomes decohere, then the future boundary condition simply selects one out of many possible outcomes [35, 32]. It also implies a kind of "teleology" which might prove fruitful in addressing the anthropic and fine-tuning issues [77]."<sup>34</sup>

It must next be asked if the claims of those promoting Time-Symmetry in Quantum Mechanics (TSQM) should be believed? In this regard it is extremely relevant that recent studies have quantitatively confirmed predicted outcomes which were unique to the TSQM formulation of quantum mechanics. As these outcomes cannot be explained by the traditional formulations of quantum mechanics, it appears that paradigm shifting "proofs" of TSQM are both beginning to be reported by independent research groups and to be recognized in the popular media.<sup>35</sup>

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<sup>32</sup> Hawking, Stephen W. *The theory of everything: The origin and fate of the universe*. Phoenix Books; Special Anniv, 2006. page v.

<sup>33</sup> (Quoted from Roger Penrose, *The Road to Reality: A Complete Guide to the Universe*, Chapter 27, "The Big Bang and its thermodynamic legacy", p. 687)

<sup>34</sup> Aharonov and Tollaksen "New Insights on Time-Symmetry in Quantum Mechanics." *Quantum Mechanics Preprint Archive* (2007), page 44 <http://arxiv.org/pdf/0706.1232 Jun 2007>.

<sup>35</sup> (See: <http://arxiv.org/pdf/0706.1232 Jun 2007>)

See also [Introduction to Time Symmetric Quantum Mechanics \(TSQM\)](#) (TSQM) and other explorations into TSQM's explanatory value:

[The Einstein, Podolsky and Rosen \(EPR\) Paradox -- Explained](#)

[Can Quantum Mechanics Help Resolve the Origin of Life Mystery?](#)

[Relativity of Simultaneity - Why Should You Care?](#)

[Relativity of Simultaneity](#) - a very speculative solution.

[Can quantum gravity help explain the origin of the universe? -- my response](#)

[Information Capacity of the Universe](#) - another unresolved problem

Yakir Aharonov, Sandu Popescu, and Jeff Tollaksen in a book chapter titled "Each Instant of Time a New Universe" <sup>36</sup> recently provided a summary of (and support for) many of the points I wish to make in this paper, as follows:

"Each moment of time ... has associated to it not one but two Hilbert spaces, one corresponding to the 'past' boundary of this time moment and one to its 'future'" boundary. Time evolution is represented by correlations between subsequent moments of time, more precisely between the 'future'" boundary of the earlier time moment and the 'past' boundary of the later time moment.

Unitary time evolution is implemented by maximal entanglement between subsequent moments of time.

A measurement induced collapse destroys the entanglement and effectively decouples the entire time evolution up to that moment by what happens later; technically, the state before the moment of collapse is in a direct product with the state after it.

A partial collapse, such as one due to an incomplete measurement will result in entanglement but less than maximal." (pages 30-31)<sup>37</sup>

Additionally, they reached these conclusions without making the informational or ontological assumptions I have explored elsewhere in this paper, simply stating: "If a measurement and its associated collapse occur at time  $t$  it is there and only there that [...] information is present" (pages 31-32), that the measured state "doesn't characterize directly any other moment of time" (page 32), that the measured (actualized) state "influence the physics at these other moments, but it does so only indirectly, via a chain of time correlations" (page 32), and that "what propagates along the chain is a completely independent issue". (page 32)<sup>38</sup>

## **Are there any reasons to believe that our universe is evolving into a matrix of preexistent contingency?**

### An argument based on Black Hole cosmology:

Black hole based thermodynamics and cosmology have provided support for two theories:

1. Information is conserved.<sup>39</sup>

2. The [holographic principle](#).

However, although black holes provide the genesis/support for these theories, they are in conflict if we assume the following:

1. The conservation of information law is "true"<sup>40</sup> (e.g. the [no cloning](#) and the [no-deleting](#) theorems are true).

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[Can the Landauer principle provide an explanation for the Big Bang's enormous energies?](#)

[A Speculative Improvement to the Causal Dynamical Triangulation \(CDT\) Model](#)

<sup>36</sup> Yakir Aharonov, Sandu Popescu, and Jeff Tollaksen. "Each Instant of Time a New Universe", Chapter 3 in Quantum Theory: A Two-Time Success Story -- Yakir Aharonov Festschrift, Daniele C. Struppa and Jeffrey M. Tollaksen (Editors), (Springer Milan, 2014)

<sup>37</sup> Ibid

<sup>38</sup> Ibid

<sup>39</sup> Conservation of information (as a prohibition on the creation of information within a closed system) implies and is implied from the [no-cloning principle](#). Conservation of information (as a prohibition on the loss of information within a closed system) implies and is implied from the [no-deleting principle](#). See [http://en.wikipedia.org/wiki/Black\\_hole\\_information\\_paradox](http://en.wikipedia.org/wiki/Black_hole_information_paradox) and [http://en.wikipedia.org/wiki/Black\\_hole\\_complementarity](http://en.wikipedia.org/wiki/Black_hole_complementarity)

"...[C]onservation of information/entropy is connected with the conservation of energy" Singleton, Douglas, Elias C. Vagenas, and Tao Zhu. "[Self-similarity, conservation of entropy/bits and the black hole information puzzle](#)." *Journal of High Energy Physics* 2014.5 (2014): page 5.



2. The Holographic principle is "true".<sup>41</sup>

3a. The Hubble expansion of the universe is "true"<sup>42</sup>  
and/or

3b The volume of the universe immediately after the Big Bang was smaller than it is now.

The problem is: the information of the universe shortly after the Big Bang, as determined using the holographic principle, would have been less than it is today and, in an expanding universe, the information available to the universe must continue to increase. However, if the information of the universe increases, where does this information come? How could such an increase in information be consistent with a conservation of information law? It is my conjecture that the information reservoir comes first. Then, the Big Bang occurs, and expands, within this preexistent contextuality.

#### An argument based on reversible computers<sup>43</sup>

Rolf Landauer wrote: "Information is not a disembodied abstract entity, it is always tied to a physical representation."<sup>44</sup> Erasure of memory/information increases the entropy of the universe and according to the Landauer Principle the loss of access to information (entropy) results in a heat penalty.<sup>45</sup> It also "represents the fundamental physical limit of irreversible computation" and according to a March 8, 2012 article appearing in "Nature", the Landauer's Principle has been experimentally verified.<sup>46</sup>

In this context, the referenced "preexistent contingency" would be analogous to the computer's registers being "loaded" with all possible computational outcomes consistent with the systems boundary conditions. This information would be differentially accessible and the record of each of our life choices would be permanently and unchangeably recorded. Additionally, as this

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<sup>40</sup> "...[W]e regard the conservation of information in black hole evaporation as a fundamental law of nature." Leonard Susskind and James Lindesay An Introduction to Black Holes, Information and the String Theory Revolution, World Scientific Publishing Co, 2005, page 77.

[http://staff.ustc.edu.cn/~wzhao7/c\\_index\\_files/main\\_files/blackhole.pdf](http://staff.ustc.edu.cn/~wzhao7/c_index_files/main_files/blackhole.pdf)

"In both classical and quantum world, information cannot appear or disappear." Zhang, Baocheng, et al. Information conservation is fundamental: recovering the lost information in Hawking radiation." *International Journal of Modern Physics D* 22.12 (2013)

For brief summary: <https://www.buffalo.edu/news/releases/2015/04/006.html>

See also Endnote: **Everything is Information**

<sup>41</sup> **Holographic principle** Vienna University of Technology. "Is the universe a hologram?." ScienceDaily, 27 April 2015.

[www.sciencedaily.com/releases/2015/04/150427101633.htm](http://www.sciencedaily.com/releases/2015/04/150427101633.htm)

<sup>42</sup> See: **Hubble's law** and **The Hubble Expansion**

<sup>43</sup> "Reversible computing is, in fact, the one and only possible way to 'save the universe' from doomsday scenarios ... that is both (1) consistent with known fundamental physics, and (2) doesn't depend on the existence of improbable new hypothetical phenomena such as wormholes to other universes, etc." Frank, Michael P. "Approaching the Physical Limits of Computing." *Proceedings of the 35th International Symposium on Multiple-Valued Logic*. IEEE Computer Society, 2005.

<sup>44</sup> The recent discoveries(4–8) concerning processing of information in the quantum regime(9) convince us more and more that Landauer's slogan, "Information is physical", (10) is not empty. (11) The idea that the notion of information should be regarded as a fundamental ingredient in a physical theory was proposed in different contexts. (12–16) However, it is not quite clear, what the term "physical" means, in the above context. In fact, there are two opposing pictures of information: (i) subjective, according to which information represents knowledge, (ii) objective, which treats information (just like energy) as a property of the physical system. This cognitive duality can be surmounted by postulating that any consistent description of Nature, is a sort of isomorphism between the laws of Nature and their mathematical representation. According to this view(3) (called informational isomorphism), although no notion itself is reality, yet it reflects physical reality. Then any theoretical structure, although is not a real thing, is an isomorphic image of the existing reality. In this sense, information can be treated as physical, and it is natural to ask: "What are the fundamental consequences of such statement?" ...

"Our result supports the view that the quantum formalism is just about information, which however, is governed by some specific constraints, making it more robust under processing. In this spirit, one can consider the laws of Nature as constraints on processing of information."

Horodecki, Horodecki, Sen(De), and Sen; Common Origin of No-Cloning and No-Deleting Principles – Conservation of Information, *Foundations of Physics*, Vol. 35, No. 12, December 2005, page 2042 and 2047.

<sup>45</sup> See: [http://en.wikipedia.org/wiki/Landauer%27s\\_Principle](http://en.wikipedia.org/wiki/Landauer%27s_Principle).

<sup>46</sup> (See: Antoine Bérut, et al., "Experimental verification of Landauer's principle linking information and thermodynamics" *Nature* 483, 187–189 (08 March 2012) and <http://www.physorg.com/news/2012-03-landauer-dissipated-memory-erased.html>)

information would be present in superposition, the entire information content of the universe, and each of our lives, would be resident in each Planck-sized register.

When understood in this context, individual consciousness and experiences would be resident in the underlying reality of each quark, atom, molecule, cell, neuronal process and thought. In this context, the qualia of "redness" would be unique to each individual in the superposition of the individual's prior experiences with the color red.<sup>47</sup> My model, therefore, internalizes and externalizes memory and consciousness both in the structures of our minds but more importantly in an "Aether" underlying everything that is.<sup>48</sup>

### **A MEDITATION FROM HARMONICS.**

Previously I asked the question: "What is Matter?" and suggested that it might be reduced to oscillatory patterns. For this meditations, please visualize a perfect tone or sound where the fineness of the oscillation transcends the human capacity of imagination. As the divine primordial vibration it would, in the Hindu traditions, be called Aum (or Om) and represent "...the one ultimate reality, underlying and encompassing all of nature and all of existence."<sup>49</sup> We will simply call this the "Tone" and since the mathematics of acoustic resonance is analogous to the mathematics of quantum dynamics we will borrow the quantum world to illustrate these concepts:

Please visualize a Planckian-sized string that is in the presence of this Tone.

What happens? If the string is in a harmonic, would it not vibrate?

In string theory, matter is represented by multi-dimensional strings that are curled up in what is called a Calabi–Yau manifold.<sup>50</sup> When curled up, each shape is understood to behave in a way that is roughly analogous to a crystal such that each shape will manifest a unique vibratory pattern. Therefore, if we place our Calabi-Yau "crystal" in the presence of our Tone, it will, if it is a harmonic of the Tone, vibrate.

If our initial state was a infinitively dimensional hyper point as speculated above<sup>51</sup> the number of potential Calabi-Yau shapes would also be infinite. However, as already noted, only those Calabi-Yau shapes which are a harmonic of our Tone will vibrate. There are five recognized string theories which are each based on a different, and totally incompatible, Calabi–Yau configuration. However, these five only reflect a high-level classification. "The actual number of mathematically distinct theories which are compatible with observation and would therefore have to be examined to find the one that correctly describes nature is currently believed to be at least  $10^{500}$  (a one with

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<sup>47</sup> See: <http://en.wikipedia.org/wiki/Qualia>

<sup>48</sup> "logical reversibility (and reversible computation) implies the conservation of information.(Page 108), Fresco, Nir, and Phillip J. Staines. "A revised attack on computational ontology." *Minds and Machines* 24.1 (2014): 101-122.

<sup>49</sup> [Hindu iconography](#).

"Hindus believe that as creation began, the divine, all-encompassing consciousness took the form of the first and original vibration manifesting as sound "OM".<sup>[1]</sup> Before creation began it was "Shunyākāsha", the emptiness or the void. Shunyākāsha, meaning literally "no sky", is more than nothingness, because everything then existed in a latent state of potentiality. The vibration of "OM" symbolises the manifestation of God in form ("sāguna brahman"). "OM" is the reflection of the absolute reality, it is said to be "Adi Anadi", without beginning or end and embracing all that exists.<sup>[2]</sup> The mantra "OM" is the [name of God](#), the vibration of the Supreme. When taken letter by letter, A-U-M represents the divine energy (Shakti) united in its three elementary aspects: Bhrahma Shakti (creation), Vishnu Shakti (preservation) and Shiva Shakti (liberation, and/or destruction)." "[Om or Aum](#)

<sup>50</sup> See [http://en.wikipedia.org/wiki/String\\_theory](http://en.wikipedia.org/wiki/String_theory) and [http://en.wikipedia.org/wiki/Calabi%E2%80%93Yau\\_space](http://en.wikipedia.org/wiki/Calabi%E2%80%93Yau_space)

<sup>51</sup> See: [Why We Live in 3+1 Dimensions](#)).

five hundred zeroes)".<sup>52</sup> These represent the minimum number of configurations that, for our universe, may be understood to be a harmonic of the Tone and participate in the actualization of matter. Equivalent numbers may be compatible to other universes with different law of physics. And, if analogous to panpsychism's monads as I believe, even more may constitute the contingent constituents of consciousness.<sup>53</sup> The beauty of superposition is that all of these harmonically compatible Calabi-Yau configurations, and more, may be present in each planck volume of our universe.

Next, consider what happens if two vibrating strings are proximate to each other. It is my understanding that, as compatible, they may resonate in sympathy with each other. As analogy, if the individual strings may be thought of as letters, those strings vibrating in sympathy with other strings may be thought of as words. Therefore, as letters combine to form words and words combine to form thoughts, we are returned to our Meditation from the Metaphysical, where the Primal Thought might be understood to become manifest through the actualization of its constituent Calabi-Yau manifolds.

### **A MEDITATION FROM THE METAPHYSICAL**

We will call the starting point for this meditation the "First" or "Primal" Thought. From the frame of reference of religious believers, it would be the Divine Thought which, having been thought, would be eternal. Also, as the Devine Thought, it could not be exclusive of any other Divine Thought. Therefore, from this Primal Thought, one might imagine additional thoughts subsumed within the first Thought as its necessary predicates. If so, I contend that I have described "the Primal Thought" as a state which is in superposition of all harmonious thoughts that may be subsumed within the initial Thought. If so, and if the principles of quantum mechanics were to also apply, would not all of the subsumed Thoughts necessarily emerge from the Primal Thought. Those Thoughts which are eternal and unchanging might then be referred to as the names and attributes of God and cumulatively be called the "Word of God". And, should one thought, if actualized, conflict with the actualization of any other thought, all such conflicting thoughts might be understood to eternally exist in contingency to each other. If so, all such Thoughts might additionally be understood to comprise a continuum of thought as greater and greater particularity emerges.

I propose that this continuum of thought may be seen as roughly analogous to a series of transmissive holograms which takes the light from all prior holograms and at each stage draws out and makes apprehendable some of the not yet expressed "thoughts" that were still subsumed within the light being transmitted. No possible thought consistent with or subsumed within the Primal Thought could remain unthought. However, some thoughts might find potential manifestation in extension given one set of Natural Laws (physics) and other "thoughts" might only be potentially manifest as extension if the Natural Laws (physics) were different. (Here I would contend that all possible universes which might be derived from the First Thought would of necessity arise in extension.) Now, within the set of all possible Thoughts which might potentially become actualized within the extension of our universe would be thoughts that might become manifest in extension only if other thoughts do not become manifest. (If so, it would be reasonable to assume that there must be a multiplicity of universes with Natural Laws like our

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<sup>52</sup> [http://en.wikipedia.org/wiki/Superstring\\_theory](http://en.wikipedia.org/wiki/Superstring_theory)

<sup>53</sup> (See: <http://en.wikipedia.org/wiki/Monism> and <http://plato.stanford.edu/entries/panpsychism/>)

own.) I would also contend that although all such thoughts must be eternal, that as these Thoughts embody greater and greater particularity, they engage in increasing degrees of interplay with "what is" in the determination of what next will be.

## A FOUNDATION IN METAPHYSICS AND THEOLOGY

The first thing which emanated from God is that universal reality, which the ancient philosophers termed the "First Mind," and which the people of Baha call the "First Will." This emanation, in that which concerns its action in the world of God, is not limited by time or place; it is without beginning or end -- beginning and end in relation to God are one. The preexistence of God is the preexistence of essence, and also preexistence of time, and the phenomenality of contingency is essential and not temporal... Though the "First Mind" is without beginning, it does not become a sharer in the preexistence of God, for the existence of the universal reality in relation to the existence of God is nothingness, and it has not the power to become an associate of God and like unto Him in preexistence."<sup>54</sup>

Therefore, the knowledge of God in the realm of contingency does not produce the forms of the things. On the contrary, it is purified from the past, present and future. It is identical with the reality of the things; it is not the cause of their occurrence.<sup>55</sup>

### Conclusion.

"Creation" for me describes the Realm of Being from which corporeality and time are emergent. It is a realm in which the potentialities of "what could be" become actualized and condense into "what is" and are forever after fixed in the eternal interplay of "what was" and "what could have been.

It is also a realm in which human thought participates<sup>56</sup>.

Could it be that the probability density of our contingent futures are defined at our conception by what we call "souls" and that the potentialities of our souls are actualized through the intermediary we call "spirit" by the agency we call "mind". If so, soul and spirit could be understood to constitute the essential and eternal human reality that is merely connected with what we call "body". What if the teleological principles discussed above also operated within the matrix of our souls' potentials? If so, divine guidance would, through prayer and meditation, be continually available in our lives. In the model I have presented, the probability density of future potentialities or contingencies would be influenced by our thoughts and prayers. Given the interconnectedness of all things, the model provides a way to explain synchronicity. It provides a scientifically plausible explanation for the intercessory prayer and the "New Age" "law of attraction". Recalling the above "Meditation from the Metaphysical", the model provides a means to affirm the eternal and unchanging forms of Platonic and the transcendent virtues common to all

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<sup>54</sup> Abdu'l-Bahá, Some Answered Questions, p. 203

<sup>55</sup> Abdu'l-Bahá, Some Answered Questions, p. 138

<sup>56</sup> "If a harmful and non-harmful unconscious experience exists in a superposed state of space-time geometries, the motive embedded as Platonic information might slightly influence the individual objective reduction, resulting in a deviation from randomness and serving the ultimate goal of survival. Thus, our first assumption was that our unconscious mind can automatically avoid *potentially* harmful events. Potential in the context of quantum mechanics means that the harmful experience exists in form of a pre-reality during the state of superposition (see Stapp, 2007)." Maier, Markus and Buechner, Vanessa L and Kuhbandner, Christof and Pflitsch, Markus and Fernandez-Capo, Maria and Gamiz-Sanfeliu, Maria, Feeling the Future Again: Retroactive Avoidance of Negative Stimuli (January 30, 2014). Available at SSRN: <http://ssrn.com/abstract=2388097>

religions while simultaneously confirming Hericlitian change, Nietzsche's individual specific virtue ethics and the situational ethics of Kierkegaard, Sartre, and Heidegger. Many physicists have embraced an impersonal "First Cause" but have rejected the "Personal God" of the Bible. The model I have presented provides a frame of reference wherein both concepts may be understood and the battles between science and religion finally be resolved.

*"Put all your beliefs into harmony with science; there can be no opposition, for truth is one. When religion, shorn of its superstitions, traditions, and unintelligent dogmas, shows its conformity with science, then will there be a great unifying, cleansing force in the world which will sweep before it all wars, disagreements, discords and struggles -- and then will mankind be united in the power of the Love of God." <sup>57</sup>*

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<sup>57</sup> Abdu'l-Bahá, Paris Talks, p. 146

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## **<sup>i</sup> EVERYTHING IS INFORMATION**

John A. Wheeler "divided his own life into three parts. The first part he called '*Everything is Particles.*' The second part was '*Everything is Fields.*' And the third part, which Wheeler considered the bedrock of his physical theory, he called '*Everything is Information.*'" [John Wheeler's Participatory Universe](#)

Rolf Landauer wrote: "Information is not a disembodied abstract entity, it is always tied to a physical representation." Erasure of memory/information increases the entropy of the universe and according to the Landauer Principle the loss of access to information (entropy) results in a heat penalty. See: [http://en.wikipedia.org/wiki/Landauer%27s\\_Principle](http://en.wikipedia.org/wiki/Landauer%27s_Principle). It also "represents the fundamental physical limit of irreversible computation" and according to a March 8, 2012 article appearing in "Nature", the Landauer's Principle has been experimentally verified. (See: Antoine Bérut, et al., "Experimental verification of Landauer's principle linking information and thermodynamics" See: Nature 483, 187–189 (08 March 2012) and <http://www.physorg.com/news/2012-03-landauer-dissipated-memory-erased.html>)

"Current attempts to unify modern physics, such as string theory and quantum gravity, depend on information encodings and on how much information is needed to describe something. In these models, it is information that imparts sense to the forces in the universe and to matter itself. In quantum gravity space and time are not fundamental; it is information that constitutes the most basic level of physical reality. That is, everything arises out of information. Relativity had already relegated space and time to this status, because there is nothing special about either dimension; it is just what happens in each that distinguishes space from time. Events taking place in them have only a subjective meaning, with information playing a fundamental role. In quantum gravity too, the exchange of information is fundamental. These theories are believed to introduce a compatibility between quantum mechanics and general relativity through the concept of information (in particular, maximum information), connecting energy from quantum theory and energy from relativity theory, and finally bridging the two.

" Hector Zenil, Introducing the Computable Universe, A COMPUTABLE UNIVERSE: Understanding and Exploring Nature as Computation, World Scientific Review, May 28, 2012, page 17 (With backgrounds in math, computer science and philosophy, Hector Zenil considers himself a kind of *experimental philosopher* or a *computational natural scientist*.)

Energy is still an important ingredient of our understanding of the universe, of course, but information has attained a conceptual and practical status equal to — and frequently surpassing — that of energy. Our new understanding of the universe is not in terms of the driving power of force and mass. Rather, the world we see around us arises from a dance between equal partners, information and energy, where first one takes the lead and then the other. The bit meets the erg, and the result is the universe.

At bottom, the information that makes up the universe is not just ordinary classical information (bits). Rather, it is quantum information (qubits). Consequently, the computational model that applies the universe at its smallest and most fundamental level is not conventional digital computation, but quantum computation [1]. The strange and weird aspects of quantum mechanics infect the universe at its very beginning, and — as will be seen — provide the mechanism by which the universe generates its peculiar mix of randomness, order, and complexity. Seth Lloyd, "The Universe as Quantum Computer", A COMPUTABLE UNIVERSE: Understanding and Exploring Nature as Computation, World Scientific Review, May 28, 2012, page 570

Is the universe a quantum cellular automaton? While we cannot unequivocally answer this question in the affirmative, we note that the proofs that show that a quantum computer can simulate any local quantum system efficiently immediately imply that any homogeneous, local quantum dynamics, such as that given by the standard model and (presumably) by quantum gravity, can be directly reproduced by a quantum cellular automaton. Indeed, lattice gauge theories, in Hamiltonian form, map directly onto quantum cellular automata. Accordingly, all current physical observations are consistent with the theory that the universe is indeed a quantum cellular automaton. Seth Lloyd, "The Universe as Quantum Computer", A COMPUTABLE UNIVERSE: Understanding and Exploring Nature as Computation, World Scientific Review, May 28, 2012, page 580

If quantum physics is best understood as a theory of information, can general relativity also be brought closer to information theory? That might help us bridge the gap between the quantum and relativistic aspects of reality. The relationship between information and general relativity has also had a rich and exciting history. The first inkling came from the black hole entropy and Bekenstein bound [8]. If a bit of information is written into an area of

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the size of Planck length squared, then the Black hole entropy is equal to the number of bits that can be written into its area [3]. This led to the development of black hole thermodynamics. But, if a black hole has entropy and temperature, then it must radiate, a process that could only be explained quantum mechanically and this was done by Hawking [9].

A real breakthrough, however, came from Jacobson [10]. In 1995, he published a letter in the Physical Review, where he argued that one can derive Einstein's field equations for gravity from thermodynamics itself. The key to Jacobson's logic was the Bekenstein relationship between entropy and area, which, as we mentioned, has a strong information-theoretic foundation.

Vlatko Vedral, "Information and Physics", Information 2012, 3, Page 221

If both quantum physics and general theory of relativity have information theoretic underpinnings, perhaps this offers us a way to bring them closer to each other. Of course, this logic would seem to be contrary to that of my own field of quantum computation. This is because quantum computing follows Landauer's dictum [16] that "information is physical". According to this, the laws of physics dictate the laws of information processing (which is why quantum information processing is different to classical). But the above way of arguing that information underlies both quantum physics and relativity goes in the exact opposite direction and puts information before physics ("it from bit" as Wheeler suggested [3]). And putting information before physics is difficult to do, simply because information would have to obey some rules, some axioms that would come prior to the laws of physics. It is hard to imagine where such axioms for information would come from, if not a deeper law of physics.

I do not think that this is a problem, however.

Vlatko Vedral, "Information and Physics", Information 2012, 3, Page 222

"...[I] information is the underlying thread that connects all phenomena we see around us as well as explaining their origin. Our reality is ultimately made up of information."

Vlatko Vedral, "DECODING REALITY: The Universe as Quantum Information", 2010, page 13.

"...[I]nformation is the only appropriate entity on which to base the ultimate theory of everything."

Vlatko Vedral, "DECODING REALITY: The Universe as Quantum Information", 2010, page 22

There is no prior information required in order for information to exist. Information can be created from emptiness. In presenting a solution to the sticky question of 'law without law' we find that information breaks the infinite chain of regression in which we always seem to need a more fundamental law to explain the current one. This feature of information, ultimately coming from our understanding of quantum theory, is what distinguishes information from any other concept that could potentially unify our view of reality, such as matter or energy. Information is, in fact, unique in this respect.

Viewing reality as information leads us to recognize two competing trends in its evolution. These trends, or let's call them arrows, work hand in hand, but point in opposite directions. The first arrow orders the world against the Second Law of thermodynamics and compresses all the spontaneously generated information in the Universe into a set of well-defined principles. The second arrow then generates our view of reality from these principles.

Vlatko Vedral "DECODING REALITY: The Universe as Quantum Information", 2010, page 215-6

"Information theory is so powerful because information is physical. Information is not just an abstract concept, and it is not just facts or figures, dates or names. It is a concrete property of matter and energy that is quantifiable and measurable. It is every bit as real as the weight of a chunk of lead or the energy stored in an atomic warhead, and just like mass and energy, information is subject to a set of physical laws that dictate how it can behave—how information can be manipulated, transferred, duplicated, erased, or destroyed. And everything in the universe must obey the laws of information, because everything in the universe is shaped by the information it contains." Charles Seife, DECODING THE UNIVERSE: How the New Science of Information is Explaining Everything in the Cosmos, From Our Brains to Black Holes, page 2.

"...information is as real and concrete as mass, energy, or temperature. You cannot see any of these properties directly, but you accept them as real. Information is just as real.

Charles Seife, DECODING THE UNIVERSE: How the New Science of Information is Explaining Everything in the Cosmos, From Our Brains to Black Holes, page 9.

"This idea that something as seemingly abstract as information is actually measurable—and tangible—is one of the central tenets of information theory."

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Charles Seife, DECODING THE UNIVERSE: How the New Science of Information is Explaining Everything in the Cosmos, From Our Brains to Black Holes, page 10.

The laws of information had already solved the paradoxes of thermodynamics; in fact, information theory consumed thermodynamics. The problems in thermodynamics can be solved by recognizing that thermodynamics is, in truth, a special case of information theory. Now that we see that information is physical, by studying the laws of information we can figure out the laws of the universe. And just as all matter and energy is subject to the laws of thermodynamics, all matter and energy is subject to the laws of information. Including us.

Charles Seife, DECODING THE UNIVERSE: How the New Science of Information is Explaining Everything in the Cosmos, From Our Brains to Black Holes, page 87.

### **Information Conservation**

"In both classical and quantum world, information cannot appear or disappear." Zhang, Baocheng, et al. Information conservation is fundamental: recovering the lost information in Hawking radiation." *International Journal of Modern Physics D* 22.12 (2013) For brief summary: <https://www.buffalo.edu/news/releases/2015/04/006.html>

"...[W]e regard the conservation of information in black hole evaporation as a fundamental law of nature." Leonard Susskind and James Lindesay *An Introduction to Black Holes, Information and the String Theory Revolution*, World Scientific Publishing Co, 2005, page 77. [http://staff.ustc.edu.cn/~wzhao7/c\\_index\\_files/main.files/blackhole.pdf](http://staff.ustc.edu.cn/~wzhao7/c_index_files/main.files/blackhole.pdf)

"... conservation of information is predicted by a long list of ... approaches to Hawking's information loss paradox" Stoica, Ovidiu Cristinel. "The geometry of black hole singularities." *Advances in High Energy Physics* 2014 (2014), page 10

"It was found in [B. Zhang, Q.y. Cai, L. You, M.S. Zhan, *Phys. Lett. B* 675 (2009) 98] that information is conserved in the process of black hole evaporation, by using the tunneling formalism and considering the correlations between emitted particles..." ... In this letter [w]e conclude that, in the case of quantum gravity corrections, the information loss paradox can also be explained, and unitarity of black hole evaporation process can be preserved. Chen, Yi-Xin, and Kai-Nan Shao. "Information loss and entropy conservation in quantum corrected Hawking radiation." *Physics Letters B* 678.1 (2009): 131-134.

"Our formalism gives us an explicit form of the wave function of the emitted radiation, which contains complete information". Anshul Saini & Dejan Stojkovic. 2015. Radiation from a Collapsing Object is Manifestly Unitary. *Phys. Rev. Lett.* 114, 111301; doi: [10.1103/PhysRevLett.114.111301](https://doi.org/10.1103/PhysRevLett.114.111301)

Since Hawking radiation can carry information through this correlation between the radiated particles, the conservation of total information can be restored by taking this correlation into account. (page 3) and "it can be concluded that the conservation of information will not be broken if Hawking radiation is treated as tunneling process, as has been proved in many references [4, 11, 12] (page 2). Hui, Dong, et al. "One hair postulate for hawking radiation as tunneling process." *Communications in Theoretical Physics* 61.3 (2014): 289. <http://arxiv.org/pdf/0907.2085>

"The proof of information conservation in Hawking radiation in [14, 15] is based on the nonthermal spectrum derived in [13] where back-reactions of emitted particles are included." (page 2982) Additionally, because "entropy is conserved in Hawking radiation", the authors "conclude that information conservation holds in Hawking radiation from dynamical horizons." (page 2985) Guo, Xiao-Kan, and Qing-yu Cai. "[Information Recovery with Hawking Radiation from Dynamical Horizons](#)." *International Journal of Theoretical Physics* 53.9 (2014): 2980-2987.

"The conservation of information is derived from quantum field theory via the quantum Liouville theorem. Quantum field theory works both forward and backward in time, so the conservation of entropy (or information) works both ways. If quantum field theory is correct (as it so far seems to be) then information, in the abstract, is neither created nor destroyed. Pure states remain pure states. A probabilistic combination of pure states keeps the same set of probabilities". <http://van.physics.illinois.edu/qa/listing.php?id=24045>

The axiom that "[e]very physical process can be simulated in an essentially unique way as a reversible evolution of the system interacting with a pure environment" (the "purification principle"), "...expresses a strengthened form of the principle of Conservation of Information [and] guarantees that one can always account for irreversibility by formulating a model where, at the fundamental level, information is preserved". Chiribella, Giulio, and Carlo Maria Scandolo. "Conservation of information and the foundations of quantum mechanics." *arXiv preprint arXiv:1411.2723* (2014).



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“Thou shall not erase the information” (page 118) “When the physicists found they could save the conservation of information tenet and data must be retrievable, it also provided the idea that this information must be recorded somewhere.” (page 119) Mathew, Santhosh. "[Holographic Universe: The Ultimate Illusion](#)." *Essays on the Frontiers of Modern Astrophysics and Cosmology*. Springer International Publishing, 2014. 117-131.

## ii **What is Matter?**

Often, our assumptions limit the questions that we ask and the answers that we obtain. Therefore, it is important that we think about the assumptions we are bringing to our discussions. Please spend a moment to reflect on your assumptions regarding a simple question: What is Matter? Most people will define matter as atoms and molecules. Others will consider the constituents of atoms and mention the atom's electrons and its protons, neutrons and their constituent quarks. A few may define matter as "things" which have mass and occupy space. In any event, the assumptions that most of us have about "matter" is very similar to Newton's. Should it be? This paper will address that question.

### 1.0 Mass Energy Equivalence:

Let's first consider the "matter" in the context of Einstein's famous equation  $E=mc^2$ .

"According to the theory of relativity, mass and energy as commonly understood, are two names for the same thing." (See: [http://en.wikipedia.org/wiki/Mass-energy\\_equivalence](http://en.wikipedia.org/wiki/Mass-energy_equivalence))

Louis de Broglie then connected energy, mass, and momentum through the relativistic relation  $E^2 = (mc^2)^2 + (pc)^2$   
Where E=Energy; m=mass; c=the speed of light; and p=momentum

Which he reduced to its nonrelativistic limit:  $E = \frac{p^2}{2m}$ .

Louis de Broglie went on to postulate that all particles with momentum would have a wavelength lambda

$$\lambda = \frac{h}{p}$$

where h is Planck's constant, and p is the magnitude of the momentum of the particle.

This became one of the basis of quantum mechanics and experiments have since shown that elementary particles, atomic nuclei, atoms, and even molecules exhibit wave properties.

(See: [http://en.wikipedia.org/wiki/Matter\\_wave](http://en.wikipedia.org/wiki/Matter_wave)) and  
([http://en.wikipedia.org/wiki/Wave\\_packet](http://en.wikipedia.org/wiki/Wave_packet))

### 2.0 Wave -Particle Duality:

[Wave-particle duality](#) "postulates that all [matter](#) exhibits both [wave](#) and [particle](#) properties."

In the following, I will suggest that the wave state is the default state of matter.

My purpose is to open the door to a possible reality that redefines corporeality within the context of quantum field interactions.

### 2.1 Philosophical Overview:

the following is quoted from the Preface (pages ix-x) of Michael Epperson's book titled "Quantum Mechanics and the Philosophy of Alfred North Whitehead",

"Quantum mechanics describes nature in two competing and seemingly incompatible ways. (i) Are the fundamental constituents of nature particular and its apparent wave-like properties an abstraction?  
(ii) Is nature fundamentally wave-like wherein particulate properties become the abstraction?  
(iii) Is the dichotomy to pass through these two horns and deny that nature is capable of fundamental characterization at all.

"To each of these three viewpoints we can associate various theorists—Einstein, for example, to the first, Schrodinger to the second, Bohr to the third, and so forth—and we can trace the many various subsequent mediations of these three viewpoints back to a commitment to one against the others.

As you will observe in what follows, I do not fully accept any of the three alternatives as outlined above. Instead, although I, like Schrödinger recognize nature to be fundamentally wave-like, I believe that corporeality is emergent through interactions and is thus more than a mere abstraction.

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In the following Sections, I will provide an outline the wave and corpuscular theories of light and provide a conceptual basis to distinguish these two competing "natures."

## 2.2 Arguments Supporting the Wave and Corpuscular Theories of Light:

In Henry Margenau book titled "The Nature of Physical Reality--A Philosophy of Modern Physics", Dr. Margenau (on page 152) presents the arguments supporting the wave and corpuscular theories of light wave as follow:

### a. Evidence for assuming that Light Is a Wave

1. The propagation of light
2. Interference of light
3. Diffraction
4. Light may be polarized
5. No evidence of intrinsic mass. (Only waves that have no intrinsic mass can move at the speed of light.)

### b. Evidence for Assuming that Light Is Corpuscular

1. Planck's discovery of quantized energies
2. The photoelectric effect
3. The propagation X rays through the high-speed bombardment of electrons on a metal plate.

## 2.3 Is there anything that distinguishes the two lists that Margenau has provided?

I believe the answer to this question is "Yes"

First, it should be observed that the corpuscular nature of light is commonly referred to as a "collapse of the wave function" and contrary to a persistent fiction - the presence of a conscious observer need not be involved. Second, it should be noted that each of the phenomena that Dr. Margenau has associated with the corpuscular nature of light involve acute perturbations. It must be further noted that each of the arguments favoring the wave nature of light involve minimal, if any, environmental interactions.

It is my contention that the corpuscular attributes of light (and matter) arise from self and environmental interactions. In support of this contention, please consider the following "matter wave" experiment involving buckyballs fullerenes (comprised by 70 carbon atoms). The experiments were conducted by Lucia Hackermüller, Klaus Hornberger, Björn Brezger, Anton Zeilinger, and Markus Arndt and was reported in a paper titled "Decoherence of matter waves by thermal emission of radiation". [[http://arxiv.org/PS\\_cache/quant-ph/pdf/0402/0402146v1.pdf](http://arxiv.org/PS_cache/quant-ph/pdf/0402/0402146v1.pdf)]

The paper reports on the authors' matter wave interferometer experiments in which C70 molecules appear to gradually lose their quantum attributes (wave-like properties) as a function of temperature through the thermal emission of radiation. The authors specifically found that around 3,000 K the C70 molecules had a high probability of emitting several visible photons which, when emitted, yielded "...sufficient which-path information to effect a complete loss of fringe visibility...". The authors concluded that they "have presented conclusive empirical and numerical evidence for observation of the quantum-to-classical transition of a material object caused by its own emission of thermal radiation."

I believe that most physicists would understand this study to constitute strong support for the proposition that the interaction of quantum systems with their environment can "entangle" the two and distribute the original quantum coherence of the system over additional degrees of freedom such that the original coherence, as manifested in the original interference pattern, gradually becomes unobservable.

In his December 2006 paper "Introduction to Decoherence Theory" [<http://arxiv.org/abs/quant-ph/0612118v1>], Klaus Hornberger wrote as follows:

"It is important to note that this loss of coherence occurs in a special basis, which is determined only by the scattering operator, i.e., by the type of environmental interaction, and that it occurs to a degree that is determined by both the environmental state and the interaction. This loss of the ability to show quantum behavior due to the interaction with an environmental quantum degree of freedom is the basic effect of decoherence. One may view it as due to the arising correlation between the system with the environment. After the interaction, the joint quantum state of system and environment is no longer separable, and part of the coherence initially located in the system now resides in the non-local correlation between system and the environmental particle; it is lost once the environment is

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disregarded. A complementary point of view argues that the interaction constitutes an information transfer from the system to the environment. The more the overlap in (7) differs in magnitude from unity, the more an observer could in principle learn about the system state by measuring the environmental particle. Even though this measurement is never made, the complementarity principle then explains that the wave-like interference phenomenon characterized by the coherences vanishes as more information discriminating the distinct, "particle-like" system states is revealed."

#### 2.4 Matter Waves:

Now let's look at each of the arguments in Margenau's lists, introduce matter waves and see if the above distinction will continue to apply.

##### 1. The propagation of light (and matter waves)

Both light waves and matter waves are understood to "propagate". However, it is understood that the propagation of matter waves are profoundly affected by interactions between atoms which, as actualization events, would collapse the wave function.

##### 2. Interference of light (and matter waves)

Interference patterns have been experimentally observed for elementary particles, atomic nuclei, atoms, and molecules, including the c70 experiments cited above.

[http://en.wikipedia.org/wiki/Interference\\_%28wave\\_propagation%29](http://en.wikipedia.org/wiki/Interference_%28wave_propagation%29)

[http://absimage.aps.org/image/MWS\\_MAR11-2010-006241.pdf](http://absimage.aps.org/image/MWS_MAR11-2010-006241.pdf)

##### 3. Diffraction of light (and matter waves)

Diffraction has also been experimentally observed for elementary particles, atomic nuclei, atoms, and small molecules. <http://en.wikipedia.org/wiki/Diffraction>

##### 4. Light (and matter waves) may be polarized

A number of papers have referenced polarized matter waves including one where a beam-split wave was used as a "tool" in the search for quantum gravity <http://www.springerlink.com/mutex.gmu.edu/content/36498vxkjk632358/>

##### 5. Matter, unlike light, has an intrinsic rest mass, which is present in the momentum term (p) in the De Broglie's wavelength equation.

[http://en.wikipedia.org/wiki/Wave%E2%80%93particle\\_duality#De\\_Broglie.27s\\_wavelength](http://en.wikipedia.org/wiki/Wave%E2%80%93particle_duality#De_Broglie.27s_wavelength)  
[http://en.wikipedia.org/wiki/Rest\\_mass](http://en.wikipedia.org/wiki/Rest_mass) .

#### 3.0 What about Mass?

We have found a one-to-one correspondence between the light waves and matter waves, with one distinction -- mass, which is understood to be a necessary attribute of matter. Applying the conventional definitions, all matter would be understood to exhibit mass, but not all mass corresponded to any identifiable matter. For example, something that is hot exhibits a greater mass than the very same something that is cold (this is called trapped electromagnetic radiation). Also, something that has potential energy or kinetic energy will exhibit a greater mass than the same something that does not possess these energies. "Each proton (or neutron) is made of three quarks - but the individual masses of these quarks only add up to about 1% of the proton's mass. So what accounts for the rest of it?" [It's confirmed: Matter is merely vacuum fluctuations](#). As noted, "The [rest masses](#) of the quarks contribute only about 1% of the proton's mass...<sup>[2]</sup> The remainder of the proton mass is due to the [kinetic energy](#) of the quarks and to the energy of the [gluon](#) fields that bind the quarks together." <http://en.wikipedia.org/wiki/Proton>

#### 4.0 Conclusion:

What I have suggested in the above first carries us beyond these conventional understandings to note the equivalence between mass and energy (e.g.  $E=mc^2$ ) and then to suggest that both mass and energy are manifestations of one common underlying reality--a reality that may be best described as a wave. The further reduction of waves into vibrations/oscillations is very nearly a tautology. (<http://en.wikipedia.org/wiki/Wave>)

"As a man who has devoted his whole life to the most clear headed science, to the study of matter, I can tell you as a result of my research about atoms this much: There is no matter as such. All matter originates and exists only by virtue of a force which brings the particle of an atom to vibration and holds this most minute solar system of the atom together. ... " *Das Wesen der Materie* [The Nature of Matter], speech at Florence, Italy (1944) (from Archiv zur Geschichte der Max-Planck-Gesellschaft, Abt. Va, Rep. 11 Planck, Nr. 1797)

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In a presentation titled, "The Universe is a Strange Place", Nobel Prize winner, Frank Wilczek observed, (based on the equation  $v = mc^2$ ; where  $v$ =frequency), that "every mass is associated with a corresponding frequency" and concluded that "the masses of particles are, not are like, not are similar to, not are metaphorically suggested by; they are the tones, the frequencies, of these vibration-patterns in the dynamically void."

It is in this context that we can begin to understand Albert Einstein's claim that "Matter is frozen energy" and the physicist, David Bohm's statement that "Matter is frozen light".

For additional discussions on this topic, see: [What is Matter?](#)

### iii **Quantum Mechanics and Neuroscience**

----- How the Mind-Body Problem might be Overcome

Human consciousness and the mind-body problem have been, and remain, a seemingly intractable problem of scientists, philosophers, and theologians. At present, the most fundamental theory of matter is quantum mechanics. The question this paper will explore is whether quantum mechanics might provide us with a candidate "common denominator" to connect corporeality and consciousness. This paper will not suggest that a "common denominator" has been found, but instead references the current research of others in suggesting that quantum mechanics may provide a vehicle for its discovery. (As Background: [http://en.wikipedia.org/wiki/Hard\\_problem\\_of\\_consciousness](http://en.wikipedia.org/wiki/Hard_problem_of_consciousness), [http://en.wikipedia.org/wiki/Mind%E2%80%93body\\_problem](http://en.wikipedia.org/wiki/Mind%E2%80%93body_problem), [http://en.wikipedia.org/wiki/Philosophy\\_of\\_mind](http://en.wikipedia.org/wiki/Philosophy_of_mind), <https://www.facebook.com/notes/jon-trevathan/what-is-matter/10150360011394263>)

In quantum theory, information about the probability amplitude of position, momentum, and other physical properties of a particle is mathematically resident in the wavefunction. Although the applicable mathematics is abstract, the quantum mechanical wavefunction treats particles as if they were quantum harmonic oscillators. Quantum electrodynamics, chromodynamics, and electroweak theory are all derivatives of quantum field theory, wherein each theory associates an oscillatory field with each particle type. Additionally, each of these theories describe particle interactions in terms of field interactions. "Neuroscience and quantum physics hold that there is continuous interchange of information and energy within quantum fields. The whole human body including the nervous systems (CNS, ANS, VNS) is constructed of entangled quantum fields". (Adam Crane, "Neuronal Quantum Information and Energy Transduction Process", 2008, Page 3)

According to the "NQUIET hypothesis" glia cells "can transduce information and energy directly from quantum fields both inside and outside the brain" and that this quantum information and energy "...undergoes further transduction into holographic interference patterns which are further transduced into consciousness...". (Adam Crane, The NQUIET (Neuronal Quantum Information and Energy Transduction) Hypothesis..., [2010 abstracts - Center for Consciousness Studies](#), page 108)

Marcus Abundis, in a paper titled "Towards a Unified Field Theory of Human Behavior - Global Cultural Evolution," that is more philosophic than scientific argues that "consciousness is deeply entwined in producing 'more information,'" and believes that "[f]ractal geometry offers a holographic design for modeling consciousness;" that conforms with the holographic cosmos and holographic brain models of David Bohm and Karl Pribram. See: <http://philpapers.org/profile/4404>.

Jürgen Hennecke, in his book, "Bioresonance: a New View of Medicine" explores the proposition that "biochemical organ functions are all regulated by a superordinate electromagnetic field..."(page 42) and that a "biophysical field change precedes all biochemical metabolic processes in the body..." (page 111).

"Biologists at UC San Diego have discovered that electrical oscillations in the brain, long thought to play a role in organizing cognitive functions such as memory, are critically important for the brain to store the information that allows us to navigate through our physical environment." <http://www.sott.net/articles/show/227837-Electrical-oscillations-critical-for-storing-spatial-memories-in-brain-study>

Robin Kelly, in his book "The Human Hologram: Living Your Life in Harmony With the Unified Field " claims that there is "growing evidence that our bodies are continually being formed upon a holographic matrix [that is] 'at one'

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with a universal field of consciousness" (page 25); that this universal field holds all of the information of our universe and that this "universal information is simply another way of explaining a universal consciousness that is fundamental to all we know"(page 27).

Neurobiologists have experimentally verified that "[t]he electrochemical processes that underlie neural function manifest themselves in ceaseless spatiotemporal field fluctuations" and that these countless overlapping "extracellular fields feed back onto the electric potential across the neuronal membrane" which suggests that the electro-magnetic fields generated by neuronal activity provide a means of neural communication that is independent of synaptic activity. See: <http://papers.klab.caltech.edu/398/1/ephaptic.pdf>

In a March, 2012 paper titled "Cytoskeletal Signaling: Is Memory Encoded in Microtubule Lattices by CaMKII Phosphorylation?", physicists Travis Craddock and Jack Tuszynski, and Stuart Hameroff "demonstrate a feasible and robust mechanism for encoding synaptic information into structural and energetic changes of microtubule (MT) lattices by calcium-activated CaMKII phosphorylation." The authors then "suggest such encoded information engages in ongoing MT information processes supporting cognition and behavior..."

In an April, 2012 paper titled Modeling Quantum Mechanical Observers via Neural-Glial Networks, Eiji Konishi considers "a model based mainly on the neural and glial networks rather than microtubules" where the modeled "neural network is based on a microscopic construction of a quantum Hamiltonian of the synaptic junctions" and from which the "observer" is determined to be any "quantum system in which the superposition of the wave functions is maintained during a non-zero time span". The model thus addressed a criticism of quantum consciousness models that "classical informational mediation in the brain takes too long to make the collapses of the quantum superpositions coincide" ... "between the superposed quantum states of the objective quantum system and the observer". See: <http://arxiv.org/abs/1005.5430v6>

According to Stuart Hameroff in a paper published in the Journal of Biological Physics (J Biol Phys (2010) 36:71–93) titled "The 'conscious pilot'—dendritic synchrony moves through the brain to mediate consciousness": "Science seeks to identify specific neuronal brain processes which underlie or correlate with consciousness—the NCC (neural correlates of consciousness) . The best measurable NCC is gamma synchrony EEG, coherent field potential oscillations in the range from 30 to 90 Hz. Gamma synchrony (along with consciousness, apparently) moves and evolves through various global distributions and brain regions. Conscious perception may consist of theta-synchronized scenes, each composed of gamma-synchronized frames". As the origin of gamma synchrony, Hameroff suggests that dendrites "couple laterally (perpendicular, orthogonal to the flow of axonal–dendritic neurocomputation) to dendrites of neighboring neurons by gap junctions or "electrical synapses".

As to the criticism that "organized quantum processes in neurons and living cells ... because of 'decoherence,' would "be drowned out by the seemingly noisy 'warm, wet, and noisy' biological environment. Hameroff suggested the following:

"...recent evidence has demonstrated quantum coherence in warm biology, mediated through non-polar regions in proteins [106]. The same type of nonpolar regions in microtubules and other neuronal proteins may mediate quantum effects underlying consciousness and long-range gamma synchrony in the brain.

The boundaries of consciousness thus extend inward, to finer-scale processes inside neurons, e.g., to cytoskeletal microtubules, and further still, to quantum processes in nonpolar regions inside microtubules and other biomolecules. The origins of consciousness may even extend all the way down to the fundamental level of the universe [104, 105]. Any fine-scale process mediating consciousness occurring on membrane surfaces or within neuronal interiors could be structurally unified and temporally synchronized by gap junctions and dendritic webs." (J Biol Phys (2010) 36:84)

However, contrary to a number of popular books on the subject, it is my belief that quantum field theory without more will probably not be our "common denominator". This is because the point-particle assumption of quantum field theory has been found to be incompatible with the quantization of gravity. As a result, string theory was devised as one of the means being explored to unify general relativity and quantum mechanics. In string theory, each particle, particle property, and interaction arises from the varying modes of oscillation of planck-sized one-dimensional strings that are curled up into different geometric (called Calabi-Yau) shapes. However, because string theory is not background independent, it too without more will probably fail as our "common denominator".

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David Chalmers has written: "It is quite possible for information to be physically realized in a holistic fashion, as one finds for example with certain holographic forms of information storage. The relevant differences in states of the visual cortex might correspond to differences spread across the cortex. But as long as these are the differences that are transmitted and that have the relevant effects, the information will be realized all the same." David J. Chalmers, *The Conscious Mind: In Search of a Theory of Conscious Experience*, page 268.

I cannot contend that this common denominator has been found, only that it will be found.