The McGucken Principle

$$\frac{dx_4}{dt} = ic$$

Five Foundational Papers

2008–2013

1. *Time as an Emergent Phenomenon: Traveling Back to the Heroic Age of Physics* (2008)
2. *What is Ultimately Possible in Physics? Physics! A Hero's Journey with Galileo, Newton, Faraday, Maxwell, Planck, Einstein, Schrödinger, Bohr, and the Greats towards Moving Dimensions Theory. E pur si muove!* (2009)
3. *On the Emergence of QM, Relativity, Entropy, Time, $\hbar$, and ic from the Foundational, Physical Reality of a Fourth Dimension x_4 Expanding with a Discrete (Digital) Wavelength l_p at c Relative to Three Continuous (Analog) Spatial Dimensions* (2011)
4. *MDT's $dx_4/dt = ic$ Triumphs Over the Wrong Physical Assumption That Time is a Dimension* (2012)
5. *It from Bit or Bit From It? What is It? Honor! Where is the Wisdom we have lost in Information? Returning Wheeler's Honor and Philo-Sophy — the Love of Wisdom — to Physics* (2013)

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Princeton University · UNC Chapel Hill

In Memory of John Archibald Wheeler (*1911–2008*)

A Note on This Compendium

This volume collects, in chronological order, the five essays Dr. Elliot McGucken submitted to the Foundational Questions Institute (FQXi) essay contests between 2008 and 2013. Together they establish the core program of *Moving Dimensions Theory* (MDT) and what is now called the *McGucken Principle*: the postulate that the fourth dimension is expanding relative to the three spatial dimensions at the rate of c, expressed in the single equation

$$\frac{dx_4}{dt} = ic.$$

The principle has its origin in undergraduate work conducted at Princeton University under John Archibald Wheeler, in projects on the Schwarzschild time factor, Einstein–Podolsky–Rosen and delayed-choice experiments, and time-reversal asymmetry. It first appeared in print as an appendix to the author's 1998–99 UNC Chapel Hill doctoral dissertation, and was developed across the FQXi essays reproduced here, two books (2016–17), and the ongoing series of technical papers published at elliotmcguckenphysics.com.

The five papers in this compendium are:

1. *Time as an Emergent Phenomenon: Traveling Back to the Heroic Age of Physics* (2008)
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Editorial conventions. Each paper is preceded by a separator page providing the FQXi essay-contest context, current and legacy URLs, the verbatim FQXi abstract, and cross-references. The papers themselves are reproduced exactly as submitted to FQXi — no figure, equation, citation, or word of the original text has been altered. Internal page numbers carried by the original papers have been left untouched; the front matter and per-paper separator pages carry their own continuous compendium numbering at the bottom of the page.

"More intellectual curiosity, versatility and yen for physics than Elliot McGucken's I have never seen in any senior or graduate student… Originality, powerful motivation, and a can-do spirit make me think that McGucken is a top bet for graduate school in physics."

— John Archibald Wheeler, Princeton University, 1990

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Time as an Emergent Phenomenon

Traveling Back to the Heroic Age of Physics

Elliot McGucken, Ph.D.

August 25, 2008

FQXi Essay Contest • *The Nature of Time*

FQXi d/238

Essay Abstract (*as published on FQXi*)

In his 1912 *Manuscript on Relativity*, Einstein never stated that time is the fourth dimension, but rather he wrote $x_4 = ict$. The fourth dimension is not time, but ict. Despite this, prominent physicists have oft equated time and the fourth dimension, leading to un-resolvable paradoxes and confusion regarding time's physical nature. By postulating that time is an emergent phenomenon resulting from a fourth dimension expanding relative to the three spatial dimensions at the rate of c, this paper shows that diverse phenomena such as relativity's equivalence of mass and energy, quantum mechanics' nonlocality, and entropy arise from a common, deeper physical reality which underlies concepts including the EPR Paradox, the classic double-slit experiment, and Gödel's block universe, while finally uniting time's arrows with a simple physical model expressed with $dx_4/dt = ic$. This model underlies and accounts for time in quantum mechanics, relativity, and statistical mechanics, as well as entropy, the universe's expansion, and time's arrows and asymmetries in all arenas.

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Companion papers in this compendium: Paper 2 (FQXi d/511, 2009) · Paper 3 (FQXi d/873, 2011) · Paper 4 (FQXi d/1429, 2012) · Paper 5 (FQXi d/1879, 2013).

Time as an Emergent Phenomenon: Traveling Back to the Heroic Age of Physics
In Memory of John Archibald Wheeler
by Dr. Elliot McGucken

ABSTRACT

In his *1912 Manuscript on Relativity*, Einstein never stated that time is the fourth dimension, but rather he wrote $x_4 = ict$. The fourth dimension is not time, but *ict*. Despite this, prominent physicists have oft equated time and the fourth dimension, leading to un-resolvable paradoxes and confusion regarding time's physical nature, as physicists mistakenly projected properties of the three spatial dimensions onto a time dimension, resulting in curious concepts including frozen time and block universes in which the past and future are omni-present, thusly denying free will, while implying the possibility of time travel into the past, which visitors from the future have yet to verify. Beginning with the postulate that time is an emergent phenomenon resulting from a fourth dimension expanding relative to the three spatial dimensions at the rate of *c*, diverse phenomena from relativity, quantum mechanics, and statistical mechanics are accounted for. Time dilation, the equivalence of mass and energy, nonlocality, wave-particle duality, and entropy are shown to arise from a common, deeper *physical* reality expressed with $dx_4/dt=ic$. This postulate and equation, from which Einstein's relativity is derived, presents a fundamental model accounting for the emergence of time, the constant velocity of light, the fact that the maximum velocity is *c*, and the fact that *c* is independent of the velocity of the source, as photons are but matter surfing a fourth expanding dimension. In general relativity, Einstein showed that the dimensions themselves could bend, curve, and move. The present theory extends this principle, postulating that the fourth dimension is moving independently of the three spatial dimensions, distributing locality and fathering time. This *physical* model underlies and accounts for time in quantum mechanics, relativity, and statistical mechanics, as well as entropy, the universe's expansion, and time's arrows and asymmetries in all arenas.

"More intellectual curiosity, versatility and yen for physics than Elliot McGucken's I have never seen in any senior or graduate student. . . Originality, powerful motivation, and a can-do spirit make me think that McGucken is a top bet for graduate school in physics. . . I say this on the basis of close contacts with him over the past year and a half. . . I gave him as an independent task to figure out the time factor in the standard Schwarzchild expression around a spherically-symmetric center of attraction. I gave him the proofs of my new general-audience, calculus-free book on general relativity, *A Journey Into Gravity and Space Time*. There the space part of the Schwarzchild geometric is worked out by purely geometric methods. "Can you, by poor-man's reasoning, derive what I never have, the time part?" He could and did, and wrote it all up in a beautifully clear account. . . .his second junior paper . . .entitled *Within a Context*, was done with another advisor, and dealt with an entirely different part of physics, the Einstein-Rosen-Podolsky experiment and delayed choice experiments in general. . . this paper was so outstanding. . . I am absolutely delighted that this semester McGucken is doing a project with the cyclotron group on time reversal asymmetry. Electronics, machine-shop work and making equipment function are things in which he now revels. But he revels in Shakespeare, too. Acting the part of Prospero in the Tempest. . . " --John Archibald Wheeler, Princeton University, Recommendation for Elliot McGucken for Admission to Graduate School of Physics

Dr. Elliot McGucken's Biography: **"**Dr. E" received a B.A. in physics from Princeton University and a Ph.D. in physics from UNC Chapel Hill, where his research on an artificial retina, which is now helping the blind see, appeared in *Business Week* and *Popular Science* and was awarded a Merrill Lynch Innovations Grant. While at Princeton, McGucken worked on projects concerning quantum mechanics and general relativity with the late John A. Wheeler, and the projects combined to form an appendix treating time as an emergent phenomenon in his dissertation. McGucken is writing a book for the Artistic Entrepreneurship & Technology (artsentrepreneurship.com) curriculum he created.

Time as an Emergent Phenomenon: Traveling Back to the Heroic Age of Physics
In Memory of John Archibald Wheeler
by Dr. Elliot McGucken
(~4,992 words)

> "My solution was really for the very concept of time, that is, that time is not absolutely defined but there is an inseparable connection between time and the signal [light] velocity." –Einstein

> "(Wheeler) had been the last notable figure from the heroic age of physics lingering among us — a man who could claim to be the student of Bohr, teacher of Feynman, and close colleague of Einstein." –Colby Cosh, network.nationalpost.com

> "Should we be prepared to see some day a new structure for the foundations of physics that does away with time? Yes, because "time" is in trouble." –John A. Wheeler

Introduction: Einstein's Clues for Time as an Emergent Phenomenon

In his *1912 Manuscript on Relativity*, Einstein never stated that time is the fourth dimension, but rather he wrote $x_4 = ict$. The fourth dimension is not time, but *ict*. Despite this, prominent physicists have oft equated time and the fourth dimension, leading to un-resolvable paradoxes and confusion regarding time's physical nature, as physicists mistakenly projected properties of the three spatial dimensions onto a time dimension. Such projections have resulted in curious concepts including frozen time and block universes in which the past and future are omni-present, thusly denying free will, while implying the possibility of time travel into the past, which visitors from the future have yet to verify.

By postulating that time is an emergent phenomenon resulting from a fourth dimension expanding relative to the three spatial dimensions at the rate of c, this paper shows that diverse phenomena such as relativity's equivalence of mass and energy, quantum mechanics' nonlocality, and entropy arise from a common, deeper *physical* reality which underlies concepts including the EPR Paradox, the classic double-slit experiment, and Godel's block universe, while finally uniting time's arrows with a simple *physical* model expressed with:

$$\frac{dx_4}{dt} = ic$$

The above postulate and equation, from which Einstein's relativity is derived in our 4D universe (x_1, x_2, x_3, x_4) where $x_4 = ict$, presents a fundamental model accounting for the emergence of time, the constant velocity of light, the fact that the maximum velocity through space-time is c, and the fact that c is independent of the velocity of the source, as photons are but matter surfing a fourth expanding dimension. In general relativity, Einstein showed that the dimensions themselves could bend, curve, and move. The present theory extends this principle, postulating that the fourth dimension is moving independently of the three spatial dimensions, fathering time. This model underlies and accounts for time in quantum mechanics, relativity, and statistical mechanics, as well as entropy, the universe's expansion, and time's arrows and asymmetries in all arenas.

The above equation physically accounts for quantum mechanics' action-at-a-distance and relativity's length contraction, as well as entanglement and the equivalence of mass and energy. Diverse dualities—wave/particle, time/space, and mass/energy—all originate from this same principle. The model accounts for the gravitational redshift and the gravitational slowing of

clocks, while showing why there is no need to quantize gravity as no physical entities are transferred in gravitational alterations of energy. The theory provides a *physical* model for time and its arrows—time is not the fourth dimension, but rather a phenomenon that emerges because the fourth dimension is expanding relative to the three spatial dimensions in units of the Planck length. As the measurement of time is inextricably wed to energy, which is the propagation of photons, and as photons propagate as matter surfing the fourth expanding dimension, time inherits properties of the fourth dimension in relativity's mathematics, but time, as measured on our watches, recorded in our memories, and perceived in radioactive decays and entropy, is not the fourth dimension.

Relativity freezes the expansion of the fourth dimension, only ever considering instantaneous snapshots of the universe. Quantum Mechanics treats the fourth dimension as a dynamical element, and hence quantum mechanics is a science defined by flux—by differential operators. QM's nonlocality and the relativity of simultaneity both derive from the fundamental expansion of the fourth dimension, which distributes a local point into a nonlocal probability distribution at the rate of c, invoking de Broglie's pilot waves and Kaluza-Klein geometries, where each point can be viewed as a compactified dimension, expanding in accordance with Huygens' principle. Hence a photon's motion is described by a spherically-symmetric probabilistic wave-front expanding at c; as a photon is but matter fully rotated into the fourth expanding dimension.

QM, relativity, and statistical mechanics all offer parallel clues not only into the nature of time, but into the more fundamental nature of a universe in which the fourth dimension is expanding relative to the three spatial dimensions, thusly liberating us from a block universe, while unifying time's arrows and accounting for curious phenomena in QM and relativity with a unique and simple physical model, which views time as an emergent phenomenon. The expansion of the fourth dimension is the fundamental motion underlying all motion, setting the singular velocity through space-time for every physical entity to c, while fostering Huygens' Principle—the fundamental expansive wave nature of all matter and energy—in both the quantum mechanical and classical worlds, manifesting the above postulate and equation in Feynman's many-paths interpretation and wave pools alike.

Both QM's "nonlocality"—manifested in the double-slit experiment, tunneling, and the EPR paradox, and relativity's ageless photon—which represents time dilation's limit, are founded upon a *physical reality* wherein no matter how far a photon travels in the three spatial dimensions, it yet retains a locality in the fourth dimension, implying the inherent nonlocality of the fourth dimension which is naturally accounted for by its fundamental expansion relative to the three spatial dimensions. The expansion of the fourth dimension manifests itself as an expanding 3D spherical surface, and every point on that sphere retains its original compactified locality and orthogonality, in turn expanding (Huygens' principle), as locality is "smeared." Hence two initially-interacting photons separated by the width of the universe may yet influence one-another instantaneously, as *they yet inhabit the same place in the fourth dimension*, as relativity's math also attests to by presenting us with a timeless, ageless photon whose path through the universe is defined by a null vector—a vector of zero length, which defines the radius of a photonic wave's spherically-symmetric, expanding nonlocality.

The correspondence between the *first* derivative with regards to time and the *second* derivative with regards to space in Schrödinger's Equation may be accounted for with the postulate. Time's quantum mechanical arrow, radiative arrow, and thermodynamic arrow may all be witnessed in the expansion and collapse of a photon's wave function, which expands at the rate of c until encountering an irreversible process whence the matter trapped in the expanding fourth dimension is brought to rest in the three spatial dimensions via a "measurement" or localization. Thus time's very direction and tangible, physical character in all arenas emerges from a fourth dimension that is expanding relative to the three spatial dimensions.

Another clue is found in length contraction—all moving objects are foreshortened in the direction of their motion. They are foreshortened via their rotation or "boost" into the fourth dimension, which is moving relative to the three spatial dimensions, and thus they experience augmented momentum and motion, in proportion to the energy component of their momenergy.

Moving Dimensions Theory—which regards time as an emergent phenomena—was inspired in part by Einstein's words pertaining to the higher purpose of physical theories: "*Before I enter upon a critique of mechanics as a foundation of physics, something of a broadly general nature will first have to be said concerning the points of view according to which it is possible to criticize physical theories at all. The first point of view is obvious: The theory must not contradict empirical facts. . . The second point of view is not concerned with the relation to the material of observation but with the premises of the theory itself, with what may briefly but vaguely be characterized as the "naturalness" or "logical simplicity" of the premises (of the basic concepts and of the relations between these which are taken as a basis). This point of view, an exact formulation of which meets with great difficulties, has played an important role in the selection and evaluation of theories since time immemorial*."

Einstein's Annus Mirabilis: The Photon Holds the Key to Time as an Emergent Phenomenon

As contemplations on the photon lead Einstein to the theories of relativity and quantum mechanics that revolutionized our notions of space, time, and physical reality, this paper again turns towards the photon and Einstein's original works to shed light on time. Various phenomena in Einstein's 1905 papers can be united with a simple postulate representing an underlying physical reality from where time itself emerges—the fourth dimension is expanding relative to the three spatial dimensions at the rate of *c*.

Consider the emission of a photon in free space. One second later, the photon has equal probability of being found anywhere upon a sphere with a radius of 186,000 miles, as the velocity of light is 186,000 miles/second. If we covered the surface of said sphere with detectors, one, and only one detector, would detect the photon. Although having traveled 186,000 miles through space, the photon will not have aged one iota, for time stops at the speed of light. It will not have moved one iota in the fourth dimension. And there lies a clue to the reality that the fourth dimension is expanding relative to the three spatial dimensions. For how can a photon propagate 186,000 miles in the three spatial dimensions, and yet not budge an inch in the fourth dimension, unless that fourth dimension is moving right along with it, just as a wave moves right along with a surfer?

Consider two interacting photons that propagate in opposite directions, as in experiments inspired by *Bell's Inequality* and conducted by Aspect *et al*. One second later, each photon's polarization is measured at detectors separated by 372,000 miles. According to the laws of quantum mechanics and numerous supporting experiments, the measurement at one detector instantaneously affects the measurement at the second detector. It is as if the photons are yet side-by-side during the measurement. This "spooky action-at-a-distance," as Einstein called it, is not so spooky in the context of a fourth expanding dimension, for although separated by 372,000 miles, the photons yet inhabit a common locality in the fourth dimension, as the fourth dimension is expanding relative to the three spatial dimensions, distributing locality at the rate of *c*. So it is that both quantum and relativistic phenomena are accounted for with the simple elegance of the postulate: the fourth dimension is expanding relative to the three spatial dimensions.

Another paper Einstein penned in 1905 was devoted to Brownian motion and statistical mechanics. Drop a thimbleful of food coloring in a pool. The laws of statistical mechanics dictate that there is a high probability that the coloring will spread throughout the entire pool and never again reassemble. Entropy is a fundamental condition of physical reality which informs our perceptions and definitions of time, and entropy is physically accounted for with the current

model. As the fundamental motion of the universe is the expansion of the fourth dimension relative to the three spatial dimensions, two photons originating from a common origin will harbor a vast probability of being found one second later separated by a distance that is far greater than the distance that separated them at their origin. Recall our system of detectors placed everywhere upon the surface of a sphere with a radius of 186,000 miles—each photon has an equal chance of being found at any detector one second after they were emitted at a common origin, and chances are that the photons will be detected by detectors separated by a distance greater than approximately zero, which defined their original separation. Hence entropy. All particles undergoing thermal vibrations interact with photons, and all photons reside in the fourth expanding dimension, dragging all of entirety into random disorder.

Yet another paper published by Einstein in 1905 was devoted to the equivalence of mass and energy. Consider the fascinating physical reality implied by Einstein's most famous equation—$E=mc^2$. A kilogram of gold or lead or feathers sitting on a desktop is the same thing as $9x10^{16}$ joules of energy—an exorbitant amount of energy—enough to power, or to destroy, a major city. How is it that a stationary mass possesses such a great energy? It is because the mass, which appears stationary in the lab, is yet propagating through space-time at the rate of *c*, as is every object, as the fourth dimension is expanding at *c*. Matter surfing the fourth expanding dimension appears at photons.

The primary invariant is *c*—all matter and/or photons—be it propagating through space or time, or some combination thereof, always move at the rate of *c* through space-time, and this reality arises because of the deeper physical invariance of a fourth dimension that is expanding relative to the three spatial dimensions at the rate of *c*. To be stationary in the three spatial dimensions means to propagate at the rate of *c* through the fourth dimension, as a stationary clock ticks away this distance at a maximal rate, as the photons in the unwinding clock's spring travel at *c* relative to the stationary clock. To be stationary in the fourth dimension means to propagate at the rate of *c* through the three spatial dimensions, as does the ageless photon. Ergo the fourth dimension is expanding at the rate of *c* relative to the three spatial dimensions.

Nonlocality stems from the inherent nonlocality of the fourth dimension, which is nonlocal via its expansion. The below fundamental equation comes straight from Einstein's manuscripts, and it recognizes that *time is not the fourth dimension*, as many modern physicists have supposed, but that *time is a phenomenon that emerges because a fourth dimension is expanding relative to the three spatial dimensions*:

$$\frac{dx_4}{dt} = ic$$

The fourth dimension is inherently nonlocal. In the photoelectric effect, the photon's wave distribution *immediately* collapses in the act of measurement. This is because although the expanding wave-front is distributed as spherically-symmetric wave-front in 3D, it yet defines a locality in the fourth dimension. The ultimate goal of *physics* is to provide *physical* models of reality which support diverse phenomena with a logically-simple *physical* explanations—as simple as possible, but not more-so.

The *instantaneous* collapse of the wave function in quantum mechanics parallels the notion of simultaneity in relativity. Both of these concepts derive from the fact the fourth dimension is expanding relative to the three spatial dimensions. Relativity tells us that two photons emitted from a common origin will remain at the same place in time—they will never age, and their coinciding spherical wave-fronts will define a sphere of simultaneity. A compactified fourth dimensional sphere expands in a spherically-symmetric manner, obeying Huygens' principle while underlying all of its manifestations throughout nature. Quantum mechanics tells us that no matter how far apart two photons travel, they will be connected in a local manner until one is measured, whence the measurement on one instantaneously effects the other. So it is that the current theory $dx_4/dt = ic$ underlies both relativity and quantum mechanics.

The time on a watch or clock, whether linked to an oscillating circuit, quartz crystal, or unwinding copper spring, is based on changes in energy, which is based on the emission and propagation of photons. Photons surf the fourth expanding dimension, and thus time inherits properties of the fourth dimension, but time is not the fourth dimension. Past, present, and future are but states contained in our mind—past is what we remember—order stored in our brains. The present is physical change that creates the order in our brain. The future is but in our imaginations—changes we can potentially effect which will be recorded in the order of our memories.

In relativity we often equate one second of time with $3x10^8$ meters—the distance traveled by a photon in one second. This is because photons are matter surfing the fourth dimension which expands at *c*.

Deriving Relativity from *dx4/dt = ic*

Let us travel on back to *Einstein's 1912 Manuscript on the Special Theory of Relativity*, where we see that he does not say that time is the fourth dimension, but rather, inspired by Minkowski, he stipulates that the fourth coordinate *u* or x_4 is defined by *ict*. Einstein writes,

> If, in three-dimensional geometry, a new orthogonal coordinate system with the same coordinate origin is introduced alongside the original system (*x, y, z*) (rotation of the coordinate system), then the laws of this coordinate transformation are possible from the following two stipulations:
>
> (1) The transformation equations are linear and homogeneous with respect to the coordinates
> (2) The distance of an arbitrary point from the coordinate origin is the same with respect to both systems
>
> For, according to (1), the transformation is determined by equations of the form
>
> $$x' = \alpha_{11}x + \alpha_{12}y + \alpha_{13}z$$
>
> $$y' = \alpha_{21}x + \alpha_{22}y + \alpha_{23}z$$
>
> $$z' = \alpha_{31}x + \alpha_{32}y + \alpha_{33}z$$
>
> Where the quantities α are independent of *x*, *y*, *z*. According to (2), these equations must make the equation
>
> $$x^2 + y^2 + z^2 = x'^2 + y'^2 + z'^2$$
>
> into an identity. . .
>
> If we compare this with the considerations leading to the general Lorentz transformation, then we see that the transformation equations holding between *x*, *y*, *z, u = ict* and *x'*, *y'*, *z', u' = ict'* of two justified space-time reference systems satisfy the same conditions and are constructed in the same way as in the just considered three-dimensional case. ***The only difference is that we now have four coordinates instead of three. We can formulate this in the following way: All of the "justified" time-space reference systems to which the four-dimensional manifold of events is referred are orthogonal coordinate systems to which the four-dimensional manifold of events is referred are orthogonal coordinate systems with four axes that can be transformed into each other by mere rotation. One has to keep in mind that the fourth coordinate u is always purely imaginary***. (Bold italics added)

Einstein definitively states $x_4 = ict$, and time and *ict* are very different entities. Einstein states, "*One has to keep in mind that the fourth coordinate u (which Einstein sometimes writes as x_4) is always purely imaginary*." It is imaginary because the expansion of the fourth dimension is

orthogonal to the three spatial dimensions in every direction, just as the radii of an expanding sphere are perpendicular to its surface at every point.

Let us derive the Lorentz Transformations and Einstein's relativity, including time dilation, length contraction, and the equivalence of mass and energy from our simple postulate that the fourth dimension is expanding relative to the three spatial dimensions and its representative equation:

$$\frac{dx_4}{dt} = ic$$

$$\int_a^u \frac{dx_4}{dt} dx_4 = \int_a^u icdx_4$$

$$\int_a^u \frac{dx_4}{dt} dx_4 = x_4(u) - x_4(a)$$

$$\int_a^u icdx_4 = icu - ica$$

$$x_4(u) - x_4(a) = icu - ica$$

$$x_4(u) = icu - ica + x_4(a)$$

Let D be the constant $-ica+x_4(a)$ and re-label u with t. Then we have

$$x_4(t) = ict + D$$

Dropping the arbitrary constant, we get:

$$x_4(t) = ict$$

Or

$$x_4 = ict$$

Armed with this simple result, we are ready to return to Einstein's 1912 manuscript and provide the motivation for a four-dimensional coordinate system where the fourth dimension is written as $x_4 = ict$. When Einstein wrote $x_4 = ict$, inspired by Minkowski's work, he never qualified the fundamental motivation for this—the fact that the fourth dimension is expanding relative to the three spatial dimensions. When Einstein penned his 1912 manuscript, he did not perceive that relativity's equivalence of mass and energy and QM's wave-particle duality—time dilation and the EPR paradox—entropy and length contraction—$E=mc^2$ and the double slit experiment—could all be accounted for with a fourth expanding dimension. Nor did he recognize that while relativity considers instantaneous frozen snapshots of the universe, quantum mechanics acknowledges the fundamental flux of the expanding fourth dimension, and is thus based on differential operators and probabilistic wavefronts, which acknowledge the perpetual smearing of locality into non-locality, and the emergence of time.

In *Einstein's 1912 Manuscript on the Special Theory of Relativity*, Einstein writes:

> The principle of the constancy of the velocity of light demands the existence of a reference system ∑ relative to which every light ray propagates in vacuum with velocity c. According to the relativity principle, all reference system∑′ in uniform translation motion to ∑ must possess the same property. Together with Laue, we call each such system "justified." Now we ask: What kind of transformation equations must obtain between the space-time coordinates *x, y, z, t* (with respect to ∑) and *x′,y′,c′,t′* (with respect to ∑′) of the same point event so that the principle of the constancy of the velocity of light would hold with respect to both systems? . . .
>
> . . . Suppose that at this moment of the coincidence of the two origins a vacuum light signal is sent from *O* or *O′*, which, according to the principle of the constancy of the

velocity of light, propagates in a spherical wave with respect to both systems then the spatial points that are just reached by the signal at times *t* and *t´* with respect to ∑ and ∑´, respectively, will be determined by the equations

$$\sqrt{x^2 + y^2 + z^2} = ct$$

and

$$\sqrt{x'^2 + y'^2 + z'^2} = ct'$$

This means that the equations

$$x^2 + y^2 + z^2 - c^2 t^2 = 0$$

and

$$x'^2 + y'^2 + z'^2 - c'^2 t'^2 = 0$$

must be equivalent. Thus, the transformation equations that we are seeking must be so constituted that the second equation turns into the first one if *x´,y´,z´,t´* are replaced by their expressions in terms of *x,y,c,t*. The transformation must therefore make the equation

$$\lambda^2 (x^2 + y^2 + z^2 - c^2 t^2) = (x'^2 + y'^2 + z'^2 - c^2 t'^2)$$

into an identity, where all that we know about the factor λ^2 for the time being is that it must not vanish. But one can see that λ^2 must be independent of *x, y, z, t*, for otherwise the right-hand side divided by λ^2 could not be a homogeneous, complete function of second order in *x,y,z,t* after the substitution is carried out. For now we will examine the substitution for the case $\lambda^2 = 1$ and we will show later that from a physical point of view this is the only case deserving of consideration. Instead of (15), we then have:

$$x^2 + y^2 + z^2 - c^2 t^2 = x'^2 + y'^2 + z'^2 - c^2 t'^2$$

If one introduces the variable *u* = *ict* or *u´* = *ict´* in place of the time variables *t*, where *i* denotes the imaginary unit, one obtains, instead of (15a), the form

$$x^2 + y^2 + z^2 + u^2 = x'^2 + y'^2 + z'^2 + u'^2$$

Note that when Einstein states "**If one introduces the variable *u* = *ict* or u´ = ict´ in place of the time variables *t,*"** he states no motivation. Moving Dimensions Theory presents the deeper reasons why this substitution works—the fourth dimension is expanding relative to the three spatial dimensions. It works because:

$$\frac{dx_4}{dt} = ic$$

Which implies: $x_4 = ict$. Einstein continues in his 1912 Manuscript:

As is well known, this choice of time variables derives from Minkowski. Its great significance consists in the fact that by means of it, equation (15a), which governs the substitution that we are seeking, is brought into a form into which the spatial coordinates and the temporal coordinate enter in the same manner.

Let the coefficients of the substitution that we are seeking be denoted as in the accompanying array; the second horizontal row, for example, shall signify that the equation:

$$y' = \alpha_{21} x + \alpha_{22} y + \alpha_{23} z + \alpha_{24} u$$

Obviously, those from among these coefficients that do not contain the index "4" or contain it twice are real, the rest being purely imaginary. . .

And replaces *x´,y´,z´,u´* by their expressions in terms of *x, y, z, u* then one obtains x as the result. The situation is analogous with the other vertical rows of the above array. Thus, the array also yields the inverse substitution, which expresses x etc.

> by means of x', y', z', u'. Hence, the quantities α must also satisfy those conditional equations that are analogous to equations (16) in that merely the vertical and the horizontal rows change their roles.
>
> As we already can see from equation 15b which determines them, the transformations we seek are exactly the same as those we have to apply to the spatial coordinates when passing from an orthogonal coordinate system to another one with the same origin, the only difference being that here one deals with a four-dimensional manifold rather than with a three-dimensional manifold as in the other case. ***This knowledge forms the basis of Minkowski's four-dimensional treatment of the theory of relativity, which brought about a splendid simplification of the system of the theory of relativity. We shall go into this in greater detail in the next chapter, while in this chapter we will derive the most important results of the theory of relativity in the most elementary way, in order for its physical relationships to emerge more clearly.***

So it is that by providing the motivation for representing a fourth coordinate with x4 = *ict*, our simple postulate and equation underlies the Lorentz Transformation, Minkowski's four-dimensional treatment of the theory of relativity, and Einstein's relativity, while also liberating us from a block universe and providing *physical* interpretations for quantum mechanical phenomenon and statistical mechanics.

Time's Arrows and Asymmetries Unified:

Time's arrows are time's messengers, manifesters, and definers. Time, as measured by the ticking seconds on a clock, the melting of a snowman, the propagation of an electromagnetic wave, or the dissipation of a drop of food coloring throughout a pool, is an emergent phenomenon, which results because the fourth dimension is expanding relative to the three spatial dimensions, carrying energy in the form of matter rotated into the fourth expanding dimension. This principle, which naturally suggests time's radiative and entropic asymmetries, may also account for the preponderance of matter over anti-matter. The vast majority of matter sees the fourth dimension as expanding. While a central point that receives shrinking spherical waves from a spherically-symmetric emitter consisting of numerous point emitters can be imagined, such central points, or positrons, are unstable, and adversely-susceptible to small imperfections, perturbations, and asymmetries in the incoming waves of the fourth dimension.

The Radiative Arrow of Time: As photons surf the fourth expanding dimension, radiation is fundamentally denoted by expanding spherical wave-fronts, and not shrinking spherical wave-fronts. Two photons originating from a common origin will harbor a vast probability of being found at great distances from one-another one second later—distances far greater than the distance that separates them at their emission. Hence entropy.

Entropy—Time's Thermodynamic Arrow: Consider two or more particles in close proximity. The fourth dimension is expanding as a spherical wave-front relative to the three spatial dimensions. Two particles in close initial proximity have a greater chance of moving further apart as opposed to closer together. All particles will have a probability of being caught in the fourth expanding dimension in proportion to their energy, and thus increased energy correlates with increased motion. Hence a drop of food coloring dropped in a swimming pool will dissipate and effectively never converge.

The Cosmological Arrow of Time: As all motion derives from the fundamental motion *dx4/dt=ic*, the universe's general motion is expansion. If the absolute rate of *c* changes, the rate of expansion of the universe will appear to change. Hence an accelerating/decelerating universe.

The Causal Arrow of Time: The causal and psychological arrows of time are related to the capability of our minds to record events, as well as imagine future events, based on the cause and effect logic learned via our empirical existence. However, neither the past nor the future exist out there. There is but one present, though observers may disagree on its nature, due to the inextricable, tautological relationship between measurement and light, light and time, and time and measurement.

The Quantum Arrow of Time: The Copenhagen interpretation sees quantum evolution to be governed both by the Schrödinger equation, which is time-symmetric, and by the time-irreversible collapse of the wave function. Up until now, the mechanism of wave function collapse was philosophically obscure, but the current theory proposes that the wave function collapses as momenergy is removed from the fourth expanding dimension and localized, as when a photon is measured or localized as a blackened grain on a photographic plate. At quantum, microscopic distances, and as t approaches zero, there is still a probability that an emitted photon can yet be found at its origin—that it has not moved—and thus entropy's thermodynamic arrow is not as apparent, and time symmetry can appear intact in the quantum world in the realm of Planck times and distances. But as the fourth dimension expands at the rate of c, as t grows, so does entropy, thusly dominating time's arrows and our concept of time in the macroscopic world. Time travel to any significant degree is impossible because the fourth dimension never reaches deeper than Planck's length. One could only go back in time by Planck's time.

Conclusion & Moving Away From Godel's Block Universe:

In 1949 Godel published a paper showing that within the theory of relativity, time as we understand it does not exist. Einstein recognized Godel's paper as "an important contribution to the general theory of relativity." Since then, physicists have not been able to find any logical shortcomings in Godel's work, and nobody has quite been able to account for the existence of time, nor divorce relativity from a block universe. The current model accounts for time in both GR and QM by showing that it is not the fourth dimension, but that it is an emergent property of the underlying dimension's intrinsic relative movement. While we lose the eternal recurrence of a frozen past and future, we gain our free will, as well as a physical model that supports both GR and QM, as well as the time we perceive in this universe we inhabit. And so it is that "there is an inseparable connection" between time and light, as time naturally emerges from the physical expansion of the fourth dimension relative to the three spatial dimensions, and light, by which we measure time and distance, is but matter caught in the fourth expanding dimension.

"More intellectual curiosity, versatility and yen for physics than Elliot McGucken's I have never seen in any senior or graduate student. . . ." –John Archibald Wheeler, Princeton University

2

Paper Two of Five

What is Ultimately Possible in Physics? Physics!

A Hero's Journey with Galileo, Newton, Faraday, Maxwell, Planck, Einstein, Schrödinger, Bohr, and the Greats towards Moving Dimensions Theory

E pur si muove!

Elliot McGucken, Ph.D.

September 16, 2009

FQXi Essay Contest • *What Is Ultimately Possible in Physics?*

FQXi d/511

Essay Abstract (*as published on FQXi*)

Over the past few decades prominent physicists have noted that physics has diverged away from its heroic journey of exalting and uncovering deeper, simpler physical models of reality. Herein, a novel physical theory — Moving Dimensions Theory (MDT) — is proposed, complete with a novel physical model celebrating a hitherto unsung universal invariant and an equation reflecting the foundational physical reality of a fourth dimension expanding relative to the three spatial dimensions at the rate of c: $dx_4/dt = ic$. MDT provides both the 'elementary foundations' of relativity that Einstein yet sought and the foundational physical reality underlying and causing quantum nonlocality and entanglement, which Schrödinger labeled the 'characteristic trait' of quantum mechanics. Einstein's Principle of Relativity, as well as his two postulates, derive from MDT's simple physical model and single postulate, which has the added benefits of providing for free will, liberating us from the block universe, weaving change into the fundamental fabric of space-time for the first time in the history of relativity, and providing an elementary foundational physical model for time and all its arrows and asymmetries, entropy, and QM's nonlocality and entanglement.

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Companion papers in this compendium: Paper 1 (FQXi d/238, 2008) · Paper 3 (FQXi d/873, 2011) · Paper 4 (FQXi d/1429, 2012) · Paper 5 (FQXi d/1879, 2013).

What is Ultimately Possible in Physics? Physics! A Hero's Journey with Galileo, Newton, Faraday, Maxwell, Planck, Einstein, Schrodinger, Bohr, and the Greats towards Moving Dimensions Theory. E pur si muove!

by Dr. Elliot McGucken

ABSTRACT:

Over the past few decades prominent physicists have noted that physics has diverged away from its heroic journey defined by boldly describing, fathoming, and characterizing foundational truths of *physical* reality via simple, elegant, logically-consistent postulates and equations humbling themselves before *empirical* reality. Herein the spirit of physics is again exalted by the heroic words of the Greats—by Galileo, Newton, Faraday, Maxwell, Planck, Einstein, Bohr, and Schrodinger—the Founding Fathers upon whose shoulders physics stands. And from that pinnacle, a novel *physical* theory is proposed, complete with a novel *physical* model celebrating a hitherto unsung universal invariant and an equation reflecting the foundational *physical* reality of a fourth dimension expanding relative to the three spatial dimensions at the rate of *c*, or $dx4/dt=ic$, providing both the "elementary foundations" for relativity and QM's "characteristic trait"—entanglement, and its nonlocal, probabilistic nature. From *MDT*'s experimentally-verified equation relativity is derived while time is unfrozen and free will exalted, while a *physical* model accounting for quantum nonlocality is presented. Entropy, Huygens' Principle; the wave/particle, energy/mass, space/time, and *E/B* dualities; and time and all its arrows and asymmetries emerge from a common, foundational *physical* model. *MDT* exalts Einstein's "empirical facts," "naturalness," and "logical simplicity." For the first time in the history of relativity, change is woven into the fabric of space-time, and the timeless, ageless, nonlocal photon of Galileo's/Einstein's "empirical world" is explained via a foundational *physical* model, alongside the fact that *c* is both constant and the maximum velocity in the universe. The *empirical* GPS clocks' time dilation/twins paradox is resolved by proposing a frame of absolute rest—the three spatial dimensions, and a frame of absolute motion—the fourth expanding dimension upon which *ageless* photons of *zero rest mass* surf; which underlie and give rise to Einstein's *Principle of Relativity*.

When the solution is simple, God is answering.[1] –Einstein

If, relative to K, K' is a uniformly moving co-ordinate system devoid of rotation, then natural phenomena run their course with respect to K' according to exactly the same general laws as with respect to K. This statement is called the principle of relativity.[2] –Einstein, 1954

No great discovery was ever made without a bold guess.[3] –Newton

For an idea that does not at first seem insane, there is no hope.[4] - Einstein

If I have seen further than others, it is by standing upon the shoulders of giants.[5] –Newton

In questions of science, the authority of thousands is not worth the humble reasoning of one individual.[6] –Galileo

Books on physics are full of complicated mathematical formulae. But thought and ideas (the fourth dimension is expanding relative to the three spatial dimensions at *c*), not formulae, are the beginning of every physical theory.[7] —Einstein/Infeld, *The Evolution of Physics*

> But before mankind could be ripe for a science which takes in the whole of reality, a second fundamental truth was needed, which only became common property among philosophers with the advent of Kepler and Galileo. Pure logical thinking cannot yield us any knowledge of the empirical world; all knowledge of reality starts from experience and ends in it. Propositions arrived at by purely logical means are completely empty as regards reality. Because Galileo saw this, and particularly because he drummed it into the scientific world, he is the father of modern physics—indeed, of modern science altogether. - Einstein[8], *Ideas and Opinions*

Epur si muove – (And yet it does move.)[9] –Galileo

.. my dear Kepler, what do you think of the foremost philosophers of this University? In spite of my invitations, they have refused … to look at the planets or Moon or my telescope.[10] –Galileo

A new scientific truth does not triumph by convincing its opponents and making them see the light, but because its opponents eventually die, and a new generation grows up with it.[11] -Planck

…my observations have convinced me that some men, reasoning preposterously, first establish some conclusion in their minds which, either because of its being their own or because of their having received it from some person who has their entire confidence, impresses them so deeply that one finds it impossible ever to get it out of their heads. Such arguments in support of their fixed idea ... gain their instant acceptance … whatever is brought forward against it, however ingenious and conclusive, they receive with disdain or with hot rage.... No good can come of dealing with such people . . . their company may be not only unpleasant but dangerous.[12] –Galileo

Millions saw the apple fall, but Newton was the one who asked why.[13] –Baruch

What is Possible in Physics? Physics! Moving Dimensions Theory

We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.[14] –Newton

Everything should be made as simple as possible, but not simpler.[15] –Einstein

A physical theory can be satisfactory only if its structures are composed of elementary foundations. The theory of relativity is ultimately as little satisfactory as, for example, classical thermodynamics was before Boltzmann had interpreted the entropy as probability.[16] –Einstein

When two systems, of which we know the states by their respective representatives, enter into temporary physical interaction due to known forces between them, and when after a time of mutual influence the systems separate again, then they can no longer be described in the same way as before, viz. by endowing each of them with a representative of its own. I would not call that one but rather the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought. By the interaction the two representatives [the quantum states] have become entangled.[17] -Schrodinger

MDT provides both the "*elementary foundations*" of relativity that Einstein yet sought, and the foundational *physical* reality underlying and causing quantum nonlocality and entanglement, which Schrodinger labeled the "*characteristic trait"* of QM. Einstein's *Principle of Relativity,* as well as his two postulates, derive from MDT's simple *physical* model (Fig. 1) and single postulate which is more concise and has the added benefits of providing for free will, liberating us from the block universe, weaving change into the fundamental fabric of space-time for the first time in the history of relativity, and providing an elementary, foundational *physical* model for time and all its arrows and asymmetries, entropy, and QM's nonlocality and entanglement, as well as reality's probabilistic nature. The fourth dimension is inherently nonlocal via its invariant expansion, which is the *source* of nonlocality as well as relativity. All of this is more fully developed in Dr. E's 2008 paper on *MDT* which examines Einstein's *1912 Manuscript on Relativity*[18] and derives relativity from *MDT*'s *dx4/dt=ic*: *Time as an Emergent Phenomenom*: *fqxi.org/community/forum/topic/238*.

Simple, logical proofs of *MDT*:

MDT PROOF#1: Relativity tells us that a timeless, ageless photon remains in one place in the fourth dimension. Quantum mechanics tells us that a photon propagates as a spherically-

symmetric expanding wavefront at the velocity of c. Ergo, the fourth dimension must be expanding relative to the three spatial dimensions at the rate of c, in a spherically-symmetric manner. The expansion of the fourth dimension is the source of nonlocality, entanglement, time and all its arrows and asymmetries, *c*, relativity, entropy, free will, and all motion, change, and measurement, for no measurement can be made without change. For the first time in the history of relativity, change has been wedded to the fundamental fabric of spacetime in MDT.

MDT PROOF#2: Einstein (*1912 Man. on Rel.)* and Minkowski wrote $x4=ict$. Ergo $dx4/dt=ic$.

MDT PROOF#3: The only way to stay stationary in the three spatial dimensions is to move at c through the fourth dimension. The only way to stay stationary in the fourth dimension is to move at c through the three spatial dimensions. Ergo the fourth dimension is moving at c relative to the three spatial dimensions.

MDT twitter proof (limited to 140 characters): SR: photon is stationary in 4th dimension. QM: photon is probability wave expanding @ *c*. Ergo: 4th dimension expands @ *c* & MDT: $dx4/dt=ic$ –from http://twitter.com/45surf

> A people that were to honor falsehood, defamation, fraud, and murder would be unable, indeed, to subsist for very long.[19] –Einstein

MDT Sides With the Simplicity of the Heroic Greats in Word, Equation, and Deed

MDT presents a new universal invariant reflecting a foundational physical reality of a fourth expanding dimension—an elementary law from which Einstein's *Principle of Relativity* can be built by pure deduction. Begin with a universe with four dimensions *x1, x2, x3, x4* where the fourth dimension is expanding relative to the three spatial dimensions at the rate of *c*, $dx4/dt=ic$, and all of relativity is shown to naturally emerge in Dr. E's above paper, as does quantum mechanics' nonlocality and entanglement, wave-particle duality, space-time duality, mass-energy duality, entropy, and time and all its arrows and asymmetries.

> Behind it all is surely an idea so simple, so beautiful, that when we grasp it - in a decade, a century, or a millennium—we will all say to each other, how could it have been otherwise? How could we have been so stupid?[20] –Wheeler

> Three Rules of Work: Out of clutter find simplicity; From discord find harmony; In the middle of difficulty lies opportunity.[21] –Einstein

MDT presents a physical principle more fundamental than Einstein's *Principle of Relativity*, as all of relativity naturally emerges from *MDT*'s postulate, along with time and all its arrows. And too, *MDT*, via the natural smearing of locality into nonlocality heralded via the expansion of the fourth dimension, provides a *physical* model for quantum entanglement—that which Schrodinger stated was the "characteristic trait" of quantum mechanics. So it is that *MDT* provides a common, foundational *physical* model for quantum mechanics and relativity, thusly unifying them on a *physical* level. *MDT* rides with the simplicity of the heroic Greats in word, equation, and deed:

> Any intelligent fool can make things bigger, more complex, and more violent. It takes a touch of genius—and a lot of courage—to move in the opposite direction.[22] –Einstein

> Mathematicians may flatter themselves that they possess new ideas which mere human language is as yet unable to express. Let them make the effort to express these ideas in appropriate words without the aid of symbols, and if they succeed they will not only lay us laymen under a lasting obligation, but, we venture to say, they will find themselves very much enlightened during the

process, and will even be doubtful whether the ideas as expressed in symbols had ever quite found their way out of the equations into their minds.[23] –Maxwell

I don't believe in mathematics.[24] –Einstein

Do not worry about your difficulties in mathematics, I assure you that mine are greater.[25] –Einstein

Geometry is not true, it is advantageous.[26] –Poincare

In *Einstein's Mistakes*, Ohanian reports on how physics advances via the emphasis not on math, but on *physical* reality.[27] *MDT* exalts nature and the physical reality of a timeless, ageless photon, providing a simple, unifying *physical* model for entropy, statistical mechanics, relativity, and quantum mechanics.

A good decision is based on knowledge and not on numbers.[28] –Plato

Not everything that counts can be counted, and not everything that can be counted counts.[29] –Einstein

Mathematics are well and good but nature keeps dragging us around by the nose.[30] –Einstein

In *Disturbing the Universe*, Freeman Dyson writes, "The great discoveries of Einstein's earlier years were all based on direct *physical* intuition. Einstein's later unified theories failed because they were only sets of equations without *physical* meaning. Dick's sum-over-histories theory was in the spirit of the young Einstein, not of the old Einstein. It was solidly rooted in physical reality."[31] In *The Trouble With Physics*, Lee Smolin writes that Bohr was not a Feynman "shut up and calculate" physicist, and from the above Dyson quote, it appears that Feynman wasn't either. Lee writes, "Mara Beller, a historian who has studied his [Bohr's] work in detail, points out that there was not a single calculation in his research notebooks, which were all verbal arguments and pictures."[32]

In his office Einstein had framed copies of portraits of , *Faraday, and Maxwell*. In *Einstein*, Hoffman exalts *physical reality* over mere math:

Meanwhile, however, the English experimenter Michael Farady was making outstanding experimental discoveries in electricity and magnetism. ... lacking mathematical facility, he could not interpret his results in the manner of Ampere. And this was fortunate, since it led to a revolution in science. . . most physicists adept at mathematics thought his concepts mathematically naïve.[33]

MDT Asks: Why Relativity, Entanglement, Entropy, Nonlocality, and Time?

The important thing is not to stop questioning.[34] –Einstein

It is interesting that Einstein introduced relativity as a principle—as a primary law not deduced from anything else. Millions have seen Einstein's relativity born out via experiment, but it was I who asked, "*why* relativity?" And I found the answer in a more fundamental invariance—the fourth dimension is expanding relative to the three spatial dimensions, or $dx4/dt = ic$. Change is fundamentally embedded in space-time. And not only can all of relativity be derived from this, but suddenly we have a *physical* model for entropy, time and its arrows and asymmetries in all realms, free will, and quantum nonlocality

and entanglement. MDT accounts for the constant speed of light *c*—both its independence of the source and its independence of the velocity of the observer, while establishing it as the fastest, slowest, and *only* velocity for all entities and objects moving through space-time, as well as the maximum velocity that anything is measured to move. And suddenly we see a *physical* basis for $E=mc^2$. Energy and mass are the same thing—it's just that energy is mass caught upon the fourth expanding dimension, and thus it surfs along at *c*.

In *Einstein's Mistakes,* Ohanian writes, "Einstein's own formulation of the Principle of Relativity three hundred years later imitated Galileo's in treating this principle as a law of nature and not as a mathematical deduction from anything else." [35]

Einstein's Principle of Relativity Derived from MDT: MDT's Diverse Successes

Well, MDT provides a more fundamental law with an equation: $dx4/dt = ic$, from which relativity is derived in Dr. E's above paper. An added benefit are all the other entities $dx4/dt=ic$ accounts for with a *physical* model, ranging from entropy, to QM's entanglement and nonlocality, to time and all its arrows. MDT accomplishes a diverse array of *physical* feats:

- ∗provides the "elementary foundations" for Einstein's relativity and Schrodinger's "characteristic trait" of QM—entanglement.
- ∗unfreezes time & liberates us from the block universe, allowing for and exalting free will
- ∗weaves change into the fundamental fabric of space-time for the first time in the history of relativity
- ∗derives relativity from a more fundamental universal invariant: $dx4/dt=ic$
- ∗provides a physical model for entropy
- ∗provides a physical model for quantum entanglement (QM's characteristic trait)
- ∗provides a physical mechanism for nonlocality—the fourth expanding dimension distributes locality
- ∗provides a physical model unifying the dualities—space/time, energy/mass, wave/particle, E/B
- ∗provides a physical model for the invariance of c—both its independence of the source and its independence of the observer
- ∗provides a physical model for the spherically-symmetric expanding wave-front of probability that defines a photon's path
- ∗offers a resolution for both the EPR Paradox and Godel's problems with the block universe relativity implied
- ∗offers a physical model for why nothing can move faster than c.
- ∗offers an intuitive model for the length-contraction can accompanies all motion
- ∗accounts for both the agelessness (from relativity—nonlocality in time) and the nonlocality (from QM) of the photon
- ∗accounts for the gravitational slowing of time and light, as well as the gravitational redshift
- ∗provides a unique physical model underlying wide-ranging phenomena in quantum mechanics, relativity, and statistical mechanics.
- *provides a physical model for time and all its arrows and asymmetries

MDT & Nobel Laureate Physicists vs. String Theory/LQG

MDT was inspired in part by Einstein's words pertaining to the higher purpose of physical theories:

> Before I enter upon a critique of mechanics as a foundation of physics, something of a broadly general nature will first have to be said concerning the points of view according to which it is possible to criticize physical theories at all. The first point of view is obvious: The theory must not contradict empirical facts. . . The second point of view is not concerned with the relation to the

> material of observation but with the premises of the theory itself, with what may briefly but vaguely be characterized as the "naturalness" or "logical simplicity" of the premises (of the basic concepts and of the relations between these which are taken as a basis). This point of view, an exact formulation of which meets with great difficulties, has played an important role in the selection and evaluation of theories since time immemorial.[36] –Einstein

Contrast MDT's elegant, unifying successes with String Theory's "not even wrongishness." The first page of *String Theory in a Nutshell* states in a footnoted sentence:

> String Theory … gained popularity because it provides a theory that is UV finite.(1) . . . The footnote (1) reads: "Although there is no rigorous proof to all orders that the theory is UV finite..."[37]

So you see, string theory is not a finite theory, but this is generally kept to the footnotes, when mentioned at all. Many Nobel Laureate physicists harbor reservations regarding strings:

> We don't know what we are talking about[38]. --David Gross

> It is anomalous to replace the four-dimensional continuum by a five-dimensional one and then subsequently to tie up artificially one of those five dimensions in order to account for the fact that it does not manifest itself. -Einstein to Ehrenfest (Imagine doing this for 10-30+ dimensions!)

> String theorists don't make predictions, they make excuses[39]. – Feynman

> String theory is like a 50 year old woman wearing too much lipstick.[40] - Laughlin, Nobel Laureate

> Actually, I would not even be prepared to call string theory a "theory" rather a "model" or not even that: just a hunch.[41] –'t Hooft

> It is tragic, but now, we have the string theorists, thousands of them, that also dream of explaining all the features of nature. . .when one person spends 30 years, it's a waste, but when thousands waste 20 years in modern day, they celebrate with champagne.[42] -Glashow

> I don't like that they're not calculating anything. I don't like that they don't check their ideas. I don't like that for anything that disagrees with an experiment, they cook up an explanation-a fix… It doesn't look right.[43] -Feynman

> superstring physicists … cannot demonstrate that the standard theory is a logical outcome of string theory. …they have not yet made even one teeny-tiny experimental prediction. ..superstring theory does not follow as a logical consequence of some appealing set of hypotheses about nature.[44] — Glashow

> The great irony of string theory, however, is that the theory itself is not unified.… !![45] *Introduction to Superstrings & M-Theory* –Kaku

> If Einstein were alive today, he would be horrified at this state of affairs... The unsubstantiated belief of our day is relativity itself. It would be perfectly in character for him … conclude that his beloved principle of relativity was not fundamental at all but emergent (emergent from MDT!) [46] - *A Different Universe*, Laughlin

MDT and Socrates' & Feynman's Honorable Pursuit of Truth

MDT delivers an ultimate theory underlying Huygens' Principle which Feynman's many-paths formulation of QM also exalts, whereas Loop Quantum Gravity and String Theory only sustain a myth of an ultimate theory. Feynman echoes the words of the heroic Achilles (whom Socrates referenced in the *Apology*[47]) in defining science as an *honest, honorable* pursuit: "As I detest the doorways of death, so too do I detest that man who speaks forth one thing while hiding in his heart another."[48]

> The first principle is that you must not fool yourself—and you are the easiest person to fool. … You just have to be honest. . . you should explain to the layman what you're doing—and if they don't want to support you under those circumstances, then that's their decision. [49] –Feynman, *Cargo Cult Science*

> To me there has never been a higher source of earthly *honor* or distinction than that connected with advances in science.[50] –Newton

> Errors are not in the art but in the artificers.[51] –Newton

MDT and the GPS Clocks/Twins Paradox

> My solution was really for the very concept of time, that is, that time is not absolutely defined but there is an inseparable connection between time and the signal [light] velocity.[52] –Einstein

Anyone who uses or benefits from GPS readily admits the glaring asymmetry in the twins paradox, and thus that there must be a frame of absolute rest and a frame of absolute motion. Now Einstein's *Principle of Relativity* is also absolutely true, as due to MDT's *dx4/dt=ic*'s inextricable linking of light, time, change, and dimension in all acts of measurements, it is impossible to conduct experiments allowing one to fathom relative motion in the confines of an inertial frame. But the empirical fact that the GPS clocks on the orbiting satellites must be adjusted for relativistic time dilation, testify to the fact that their frame of reference is fundamentally different from the earthbound clocks'. MDT accounts for this asymmetry in the twin paradox/GPS, while also fully supporting the mathematics of Einstein's relativity and *Principle of Relativity*, which is derived from *dx4/dt=ic* in Dr. E's *Time as an Emergent Phenomena*. MDT proposes a frame of absolute motion—the fourth expanding dimension which photons surf, supported by the *empirical* facts that 1) a photon is in a state of absolute motion, having no rest mass; and 2) a timeless, ageless, nonlocal photon remains in one place in the fourth dimension, whose expansion is the source of nonlocality.

Experimental Proofs of MDT

In addition to the GPS asymmetry which proves MDT, let us study the fourth dimension via experiment in earthbound labs. A photon, which is known to stay stationary in the fourth dimension, provides the ideal *physical* entity and tool to probe and characterize the fourth dimension on a physical level, so let us study a photon as it is emitted from a source. Via numerous experiments ranging from double-slit interference experiments to those demonstrating nonlocal entanglement, the photon, in its simplest, most natural form, exists as a nonlocal, spherically-symmetric, probabilistic wave-front expanding at *c*. As relativity tells us that the timeless, ageless, nonlocal photon remains in one place in the fourth dimension, we can deduce that the fourth dimension must be a spherically-symmetric expanding wavefront of locality, supported directly by experimental evidence and observation, thusly proving MDT's postulate of a fourth expanding dimension and equation *dx4/dt=ic*.

I think that in the discussion of natural problems we ought to begin not with the Scriptures, but with experiments, and demonstrations[53]. –Galileo

By denying scientific principles, one may maintain any paradox[54]. –Galileo

A man may imagine things that are false, but he can only understand things that are true, for if the things be false, the apprehension of them is not understanding[55]. –Isaac Newton

Conclusion

What is ultimately possible in physics? Physics! MDT & $dx4/dt=ic$!

Gradually the conviction gained recognition that all knowledge about things is exclusively a working-over of the raw material furnished by the senses. ... Galileo and Hume first upheld this principle with full clarity and decisiveness[56]. -Einstein

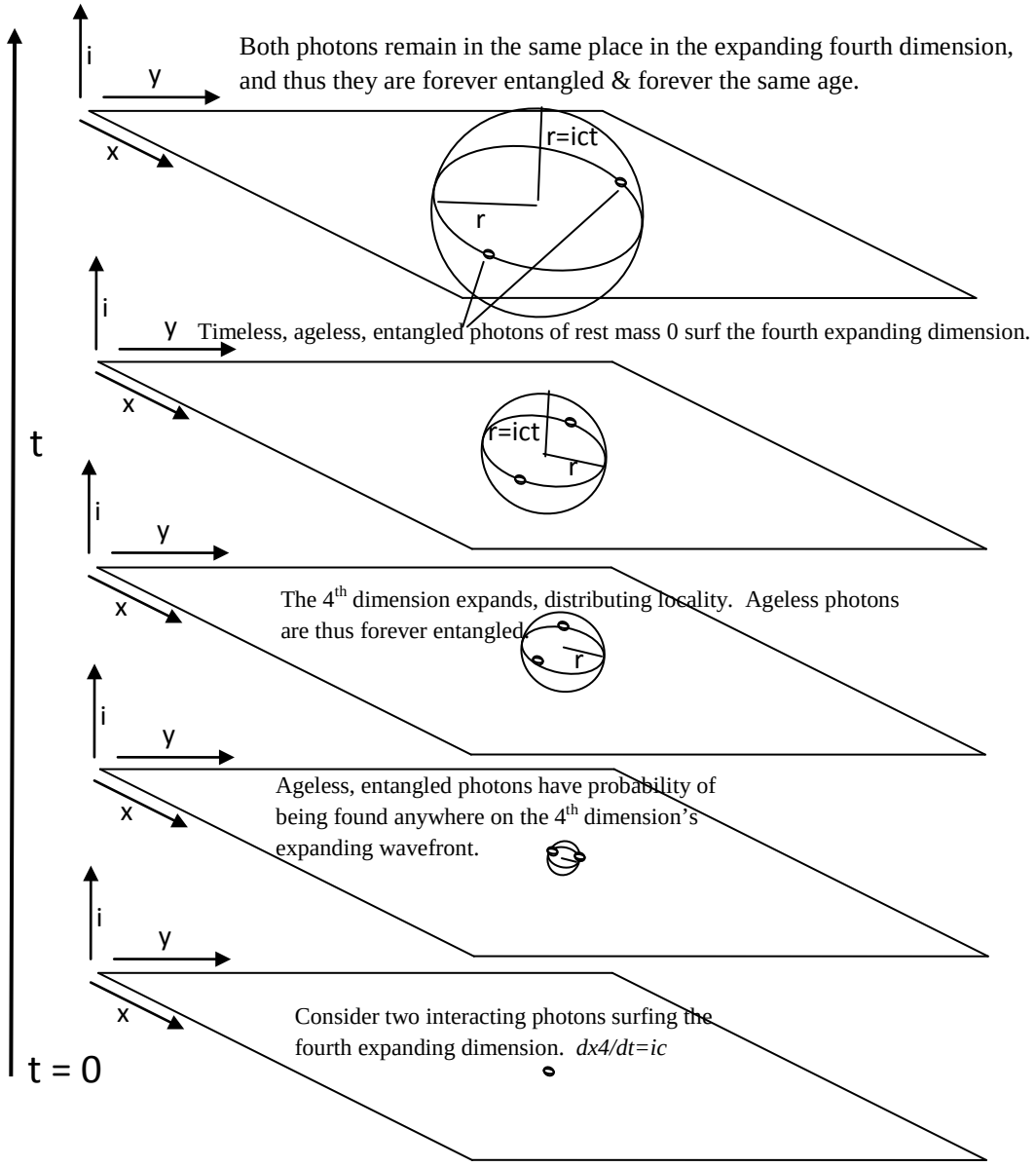

Fig. 1: MDT'S concrete *physical* mechanism for Einstein's *Principle of Relativity*, nonlocality, entanglement, QM's probabilistic, nonlocal character, time's radiative arrow and asymmetry, *Huygens' Principle*, pilot waves, entropy, the constancy of *c*, the independence of *c* from the source, and the timeless, ageless photon: *dx4/dt=ic*. As photons remain in the same place (agelessness/entanglement) in the fourth dimension which expands in a spherically symmetric manner, radiation appears as expanding (never shrinking) probabilistic spherically-symmetric wavefronts (time's radiative arrow). Entangled photons have a higher chance of being found further apart over time (entropy).

Many more MDT figures and text were edited out due to length limitations.

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3

Paper Three of Five

On the Emergence of QM, Relativity, Entropy, Time, $i\hbar$, and ic

from the Foundational, Physical Reality of a Fourth Dimension x_4
Expanding with a Discrete (Digital) Wavelength l_p at c
Relative to Three Continuous (Analog) Spatial Dimensions

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February 11, 2011

FQXi Essay Contest • *Is Reality Digital or Analog?*

FQXi d/873

Essay Abstract (*as published on FQXi*)

The photon is used to physically probe and trace the discrete, digital, dynamic nature of x_4 as the quantum nature of physical measurement is examined, while the foundational papers of Planck, Bohr, Heisenberg, et al. are exalted, lead by Einstein's statement that physics "starts from experience and ends in it." In its simplest case, a photon oscillates while propagating at c as a probabilistic wave-front expanding through the three spatial dimensions in a spherically-symmetric manner, as demonstrated by the classic double-slit experiment, leading to the natural conclusion that x_4, in which the photon remains stationary according to relativity, must thusly be oscillating and propagating at c as a spherically-symmetric expanding wavefront. Relativity informs us that all of a photon's motion is through the three spatial dimensions, thusly dictating that the timeless, ageless photon remains stationary in the fourth dimension x_4. As electromagnetic radiation (the photon) is quantized, while there is no evidence for quantum gravity, we may conclude that x_4 is quantized and digital in nature, while the three spatial dimensions are continuous and analog in nature. $qp - pq = i\hbar$ (Born & Heisenberg) and $x_4 = ict$ or $dx_4/dt = ic$ (Einstein & Minkowski) are fundamental relationships of QM and relativity. Both equations have differentials on the left and an i on the right, as Bohr noted, suggesting that a foundational change is occurring in a "perpendicular" manner, implying a fourth moving dimension. $qp - pq = i\hbar$ reflects the discrete increment and quantum action —$\hbar$ — that emerges from the dynamic, discretely parceled space-time geometry born by the discrete wavelength of x_4's expansion; while $dx_4/dt = ic$, from which relativity and its postulates derive, sets the velocity of the expansion of x_4 to c. A physical model encompassing both

Einstein's "elementary foundations" of relativity and Schrödinger's "characteristic trait" of QM — entanglement — is presented.

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Companion papers in this compendium: Paper 1 (FQXi d/238, 2008) · Paper 2 (FQXi d/511, 2009) · Paper 4 (FQXi d/1429, 2012) · Paper 5 (FQXi d/1879, 2013).

On the Emergence of QM, Relativity, Entropy, Time, $i\hbar$, and ic from the Foundational, Physical Reality of a Fourth Dimension x_4 Expanding with a Discrete (Digital) Wavelength l_p at c Relative to Three Continuous (Analog) Spatial Dimensions

Dr. E. McGucken

ABSTRACT

The photon is used to *physically* probe and trace the discrete, digital, dynamic nature of x_4 as the quantum nature of physical measurement is examined, while the foundational papers of Planck, Bohr, Heisenberg, *et al*. are exalted, lead by Einstein's statement that physics "*starts from experience and ends in it*." In its simplest case, a photon oscillates while propagating at c as a probabilistic wave-front expanding through the three spatial dimensions in a spherically-symmetric manner, as demonstrated by the classic double-slit experiment, leading to the natural conclusion that x_4, in which the photon remains stationary according to relativity, must thusly be oscillating and propagating at c as a spherically-symmetric expanding wavefront. Relativity informs us that *all* of a photon's motion is through the three spatial dimensions, thusly dictating that the timeless, ageless photon remains stationary in the fourth dimension x_4. As electromagnetic radiation (the photon) is quantized, while there is no evidence for quantum gravity, we may conclude that x_4 is quantized and digital in nature, while the three spatial dimensions are continuous and analog in nature. $qp-pq=i\hbar$ (Born & Heisenberg) and $x_4=ict$ or $dx_4/dt=ic$ (Einstein & Minkowski) are fundamental relationships of QM and relativity. Both equations have differentials on the left and an i on the right, as Bohr noted, suggesting that a *foundational change* is occurring in a "perpendicular" manner, implying a fourth moving dimension. $qp-pq = i\hbar$ reflects the discrete increment and quantum action—$\hbar$—that emerges from the dynamic, discretely parceled space-time geometry born by the discrete wavelength of x_4's expansion; while $dx_4/dt=ic$, from which relativity and its postulates derive, sets the velocity of the expansion of x_4 to c. A *physical* model encompassing both Einstein's "elementary foundations" of relativity and Schrodinger's "characteristic trait" of QM—entanglement—is presented.

1. Quantum Mechanics & Relativity @ Princeton with Wheeler, Peebles, & Taylor

Three of my fondest, and most definitive, memories at Princeton University occurred during my junior year in the offices of P.J.E. Peebles, J.A. Wheeler, and the now Nobel Laureate J. Taylor. Peebles was letting us use the galleys for his forthcoming book *Quantum Mechanics*[i], and after one of the first classes, I visited his office and asked, "So when a photon is emitted from a source, all we can say is that the photon is represented by a spherically-symmetric wavefront of probability expanding at c?" "Yes," he said, "The photon has an equal chance of being detected anywhere defined by the area of a sphere's surface, which is expanding at c." How crazy was that! Couple this with the fact that Wheeler had just described to me how the photon remains stationary in x_4, and one had a physical tracer for the movement of the fourth dimension[ii]! The second most definitive memory (of many!) derives from when I walked into my junior paper advisor J.A. Wheeler's office in Jadwin Hall and found him staring out his window. He heard me come in, and he slowly turned with his effervescent smile and that twinkle in his eye, and stated, "*Today's world lacks the noble. . . and it's your generation's duty to bring it back*." Talk about the classic "*Call to adventure*!" And the third definitive memory came in J. Taylor's office, when while working on my JP on quantum nonlocality/entanglement[iii], Taylor stated, "Schrodinger said that entanglement is the characteristic trait of QM. Figure out the source of entanglement, and you'll figure out the source of the quantum, as nobody really knows what, nor why, nor how $\hbar$ is." Wheeler wrote[iv]: "I

gave (Dr. E) the proofs of my… *A Journey Into Gravity and Space Time*… the space part of the Schwarzchild geometric is worked out by purely geometric methods. "Can you, by poor-man's reasoning, derive what I never have, the time part?" He could and did, and wrote it up in a beautifully clear account. . . .his second junior paper . . . was done with another advisor (J. Taylor), and dealt with … the Einstein-Rosen-Podolsky experiment and delayed choice experiments... this paper was so outstanding…" And so *Moving Dimensions Theory* (MDT) would be born as a unifying, foundational *physical* model for *both* the "elementary foundations" of relativity that Einstein yet sought and Schrodinger's "characteristic trait" of QM—entanglement, showing that *both* relativity and the discrete, digital nature of energy and measurement arose from the discrete geometry carved into space-time by x_4's expansion, which parcels mass and energy in discrete units proportional to $\hbar$ as it propagates at c.

Wheeler oft referred to the direction of particle physics as "ino-itus" whence more and more funding was spent pursuing smaller and smaller particles and details, void of novel grand ideas or new *physical*, *foundational* insights. The LHC is a noble accomplishment, as is the mathematics of String Theory some say, but when history is written, it is likely that a patent clerk named Einstein will have made a greater contribution to physics in 1905[v] with naught but a pencil, a piece of paper, a courageous and free imagination, and an unyielding loyalty to *physical* phenomena and a *physical* interpretation of the mathematics. Wheeler, like the heroic physicists of yore, was in physics for the *big <u>physical</u> ideas*, as was Einstein, who wrote, "I want to know God's thoughts; the rest are details."[vi] Colby Cosh saluted the late J.A. Wheeler: "At 96, he had been the last notable figure from the heroic age of physics lingering among us. . . the student of Bohr, teacher of Feynman, and close colleague of Einstein. . . Wheeler was as much philosopher-poet as scientist, seizing on Einsteinian relativity early . . . He was ready to believe in the new world before most physicists. . ."[vii]

And so Fig. 1 presents an illustration from a paper[viii] by Wheeler's teacher Bohr from Wheeler's compilation *Quantum Theory and Measurement*[ix], which I first happened upon in my freshman dorm. The illustration pertains to the classic double-slit experiment, of which Wheeler's student Feynman was fond of stating, "The whole of QM can be gleaned from pondering the implications of the double-slit experiment."[x]

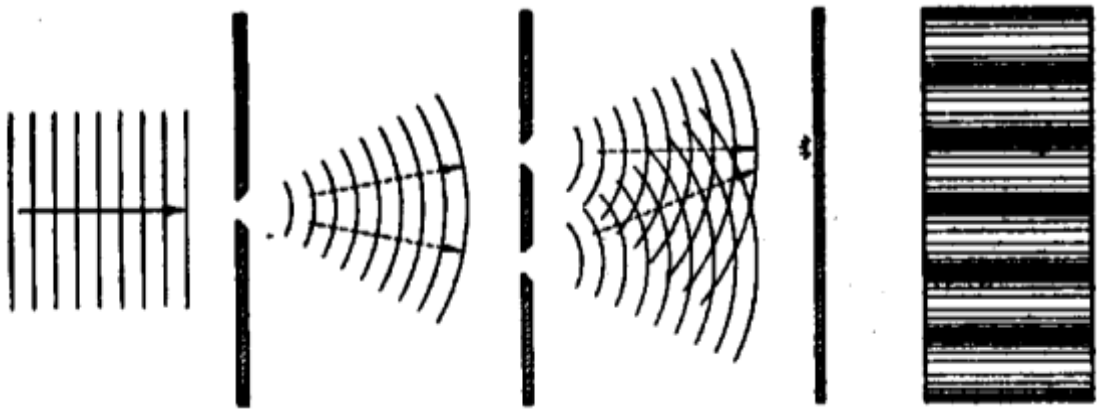

Fig. 1: Bohr's rendition of the classic double-slit experiment.

The above double-slit diagram illustrates the wavelike nature of all particles, including the photon. But what Bohr, Einstein, Feynman, *et al*. seemed to have missed was that they were looking not only at the motion and character of the photon, but they were looking at *the motion and character* of x_4, as relativity dictates that the ageless photon remains stationary in the fourth dimension, thusly providing an

ideal tracer following the movement of x_4. Thus we can conclude that not only is x_4 a spherically-symmetric wavefront expanding at c [xi], distributing locality into nonlocality and giving rise to entanglement and entropy as well as time and all its arrows and asymmetries, but it is also oscillating in a quantized manner, thusly quantizing (digitizing) all energy it carries in discrete packets, which in turn quantizes (digitizes) all measurement, as measurement hinges upon the propagation of energy—photons.

2. How the Quantum $\hbar$ arises from the Physical Geometry of x_4's Expansion

The velocity of x_4 is also apparent in the *physical* interpretation of $x_4=ict$—a relationship first proposed by Minkowski which appeared in Einstein's famous 1912 manuscript[xii]. But just as Planck at first failed to accept the *physical* interpretation of $E=hv$, diminishing the grandeur of his discovery of the quantum by labeling $E=hv$ "a purely formal assumption," admitting, "actually I did not think much about it…"[xiii], so too did Einstein *et al.* miss the grander interpretation of their magnificent equation $x_4=ict$. It was Einstein who first recognized the *physical* significance of Planck's $E=hv$, which Einstein applied to the photoelectric effect in his 1905 paper[xiv], resulting in a Nobel Prize. And it is I who have realized the *physical* significance of $x_4=ict$, which can be rewritten as $dx_4/dt=ic$, [xv] naturally implying that x_4 is moving and expanding at c. Once we realize this, it logically follows that since a photon remains stationary in x_4, and yet oscillates in a quantized manner, x_4 itself must also be oscillating in a quantized, digital manner in addition to moving at c, as that is the only manner the photon can be stationary relative to x_4, and yet propagate at c while oscillating. Couple all this with $qp-pq=i\hbar$, and it can be seen that x_4 is expanding with a fixed wavelength of the l_p, with the spacetime geometry generated by the fourth expanding dimension giving rise to the discrete unit of $\hbar$, thusly quantizing all energy and measurement, while providing a deeper foundation for the double-slit experiment and relativity, as well as entropy, and time and all its arrows and asymmetries[xvi].

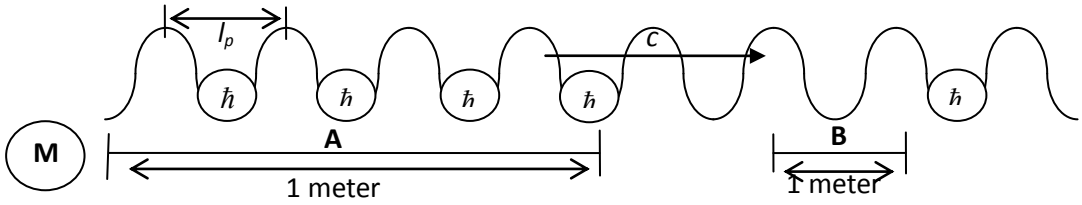

Fig. 2: The invariant expansion of x_4 creates the geometry which carries mass in units of action $\hbar$ at the velocity of c in the form of photons.

In Fig. 2, we superimpose the universe's fundamental invariant—x_4's expansion, represented by a sine wave (in reality it is a spherically symmetric wave-front, defining the propagation of all photons)—over the regions **A** & **B** which represent space curved and stretched by the mass **M**. The expanding x_4 carries all photons, quantizing them in units of $\hbar$ via the geometry of its very wave nature, as its fixed wavelength "chops" discrete intervals in the fixed width of l_p, giving rise to the discrete geometry in which discrete parcels (*corpuscles)* of mass/energy are carried. The invariance of the expansion of x_4 is the *foundational invariant underlying the invariance of c and ħ*. Energy is quantized and digitized by the space-time geometry generated via the fixed wavelength of the fourth dimension expanding dimension expanding at c. Photons are but mass surfing the fourth dimension's partitioning geometry at c, echoing Einstein's words: "There is no essential distinction between mass and energy. Energy has mass and mass represents energy. Instead of two conversation laws we have only one, that of mass-energy."[1]

The standard light clock in region **B**, discussed further by Dr. E[xvii] [xviii], will tick about four times every time the clock in stretched region **A** ticks once. This is because x_4's expansion has to travel four fundamental wavelengths in stretched region **A**, while only a single one in region **B**. Thus, if the two clocks from **A** and **B** are reunited, all will agree that clock **A** registered less time, and thus that stronger gravitational fields slow time. Both **A** and **B** represent lengths of one meter, and the mass **M** stretches the space in region **A**. Note also that a photon with a certain frequency in **A**—one that oscillates four times as it traverses the distance of one meter, will only oscillate once while traversing the distance of one meter at **B**. Thus the frequency of the wave is higher in **A** and lower in **B**, while the wavelength is lower in **A** and longer in **B**, just as the gravitational redshift dictates.

3. Why Electromagnetism is Quantized (Digital) in Nature, while Gravity is Continuous (Analog)

Fig. 2 and the Fig.1 at the end of my earlier paper[xix] bring to light several remarkable features of MDT. MDT explains why energy is quantized and why clocks run slower in stronger gravitational fields where space is stretched. Time, as measured on a light clock, is also stretched, but only because of a foundational invariant which never stretches—the expansion of x_4 relative to the three spatial dimensions—a foundational invariant which maintains the invariance of both c and $\hbar$, while curving the measurement of time in proportion to the curvature of space. Even though time and space are stretched, the expansion of x_4 remains invariant: $dx_4/dt=ic$. Space is continuous (analog), while quantization (the discrete, digital character of energy and measurement) arises from the quantized invariant expansion of x_4 relative to the three spatial dimensions in units of l_p. The invariant wavelength of the expanding x_4 "chops" measurements of space—of time, energy, and momentum—into discrete geometrical units proportional to the Planck action $\hbar$ and l_p, while also providing the fundamental wave nature that gives rise to Heisenberg's Uncertainty Principle and Huygens' Principle (seen in Fig. 2) across all realms, as well as the fundamental space-time geometry which parcels action and energy in discrete units proportional to $\hbar$, exalting the quantum. It is enough for x_4 to be wavelike in nature, while the three spatial dimensions are continuous, to give rise to the quantum, digital features of QM, and the classical, continuous nature of gravity. In the electromagnetic field, force hinges upon the transfer of physical particulates—photons, while in the gravitational force, no particles are transferred, as gravity arises via the geometrical curvature of space-time, as my mentors Wheeler[xx] and Taylor taught.

Freeman Dyson writes[xxi], "(Brian) Greene takes it for granted, and here the great majority of physicists agree with him, that the division of physics into separate theories for large and small objects is unacceptable. General relativity is based on the idea that space-time is a flexible structure pulled and pushed by material objects. QM is based on the idea that space-time is a rigid framework within which observations are made. Greene believes there is an urgent need to find a theory of quantum gravity that works for large and small objects alike. . . As a conservative, I do not agree that a division of physics into separate theories for large and small is unacceptable. . . I propose as an hypothesis that it is impossible in principle to observe the existence of individual gravitons." MDT sides with Dyson and Occam's Razor, as well as Einstein and Planck. Let us first see a graviton, or find a consistent, unique theory that predicts gravitons, before we conclude that gravity must be quantized.

4. The Heroic, Unifying, Foundational, *Physical* Glory of MDT

> Albert Einstein: A theory is the more impressive the greater is the *simplicity of its premises*, the *more different are the kinds of things it relates* and the more *extended the range* of its applicability.[xxii]

MDT's foundational, unifying *physical* model exalts the *physical meaning* of Born's/Heisenberg's $qp-pq=i\hbar$ and Einstein's/Minkowski's $x_4=ict$, which emerge from MDT. Dr. E's rephrasing of the relationship $x_4=ict$ as $dx_4/dt=ic$[xxiii] gives rise to <u>*the simple premise*</u> that x_4 is expanding relative to the three spatial dimensions, thusly <u>*relating an extended range*</u> of hitherto disparate phenomena in a simple, *physical* model, as MDT unfreezes time and liberates us from the block universe, weaving change into the fundamental fabric of spacetime for the first time in the history of relativity, while finally providing a fundamental model for the inherent change and differentials in QM, alongside the quantum, discrete nature of all energy and measurement, whose discreteness arises from the discrete geometry created via x_4's expansion. As relativity dictates that a photon remains stationary in x_4, MDT's simple model also provides a *physical* model for the digital, discrete nature of QM via x_4's wavelength, as well as for Huygens' Principle and all wave behavior, entropy, time and all its arrows and asymmetries, and all the dualities—space/time, mass/energy, wave/particle, *E/B,* and digital/analog*;* setting the universe's maximum velocity to *c*, while providing a *physical* model for quantum nonlocality and entanglement, as well as the quantization of energy and thus the discrete, digital nature of all measurement, as the expansion of x_4 distributes locality in a discrete manner as implied by $qp-pq=i\hbar$. $dx_4/dt=ic$ provides a foundational physical model for time and all its arrows and asymmetries, entanglement, and entropy, while also establishing an absolute frame of rest—the three spatial dimensions, and an absolute frame of motion—the expanding x_4, thusly finally resolving the GPS/twins paradox.[xxiv] $dx_4/dt=ic$ presents a more concise, fundamental way of phrasing relativity, as instead of beginning with Einstein's two postulates, one can merely write, "Suppose a 4D universe wherein $dx_4/dt=ic$," and both of Einstein's postulates, as well as all of relativity, naturally emerge[xxv]. While there is no physical evidence for strings, nor multiverses, and while the mathematics for such speculative entities never adds up in a definitive manner, MDT is supported by *the physical reality* of the double slit experiment, entanglement, nonlocality, entropy, the quantization of energy, and all relativistic phenomena, as well as by the mathematics of $x_4=ict$ and $qp-pq=i\hbar$. MDT adheres to Einstein's, Bohr's, Planck's, Galileo's, *et al.'s* views on what physical theory is and ought to be—below I have underlined and italicized the Greats' emphasis on <u>*physical*</u>, <u>*empirical reality*</u>, which MDT exalts:

> Einstein: But before mankind could be ripe for a science which takes in the <u>*whole of reality*</u>, a second fundamental truth was needed. . . Pure logical thinking cannot yield us any knowledge of the empirical world; all knowledge of reality starts from <u>*experience*</u> and ends in it. . . Because Galileo saw this, and particularly because he drummed it into the scientific world, he is the father of modern physics—indeed, of modern science altogether. [xxvi]
>
> Planck: Let us get down to <u>*bedrock facts*</u>. The beginning of every act of knowing, and therefore the starting-point of every science, must be our own personal <u>*experience*</u>.[xxvii] (All physicists have personally experienced the double-slit experiment, and as relativity tells us that photons remain stationary in x_4, x_4 must thus be propagating at *c* with both a wavelike and quantum nature!)
>
> Einstein: Mathematics are well and good but <u>*nature*</u> keeps dragging us around by the nose.[xxviii]
>
> Einstein: The theory must not contradict <u>*empirical facts*</u>. . . The second point of view is not concerned with the relation to the material of observation but with the premises of the theory itself, with what

may briefly but vaguely be characterized as the "*naturalness*" or "*logical simplicity*" of the premises of the basic concepts and of the relations between these which are taken as a basis. [xxix]

Planck: That we do not construct the external world to suit our own ends in the pursuit of science, but that vice versa *the external world forces itself upon our recognition* with *its own elemental power*, is a point which ought to be categorically asserted again and again . . . From the fact that in *studying the happenings of nature* . . . it is clear that we always look for *the basic thing behind* the dependent thing, for what *is absolute* behind what is relative, for *the reality* behind the appearance and for *what abides* behind what is transitory. . this is characteristic not only of *physical* science but of all science.[xxx] (*dx4/dt=ic* is the "basic, abiding thing" behind all relativity, entropy, and QM!)

Einstein: Truth is what stands the test of *experience*.[xxxi]

Heisenberg: Science. . . is based on personal *experience*, or on the *experience* of others, reliably reported. . . Even today we can still learn from Goethe . . . trusting that *this reality* will then also reflect the essence of things, *the 'one, the good, and the true*.[xxxii]

Since we experience both particles and waves, and since the Greats agree that physics *begins and ends in experience*, MDT follows the Greats in providing a foundational model underlying the physical, experiential reality of waves and particles—of the analog and digital—of relativity, QM, and entropy, as well as time and all its arrows and asymmetries. MDT agrees with the Greats:

Schrodinger: *The world is given but once*. . . The world extended in space and time *is but our representation*. *Experience* does not give us the slightest clue of its being anything besides that. [xxxiii]

Bohr: The classical concepts, i.e., "wave" and "corpuscle" do not fully describe the real world and are, moreover, complementary in part, and hence contradictory. . . . Nor can we avoid occasional contradictions; nevertheless, the images help us to draw nearer to the real facts. *Their existence* no one should deny. "Truth dwells in the deeps." [xxxiv]

Schrodinger: Everything—anything at all—is at the same time particle and field.[xxxv] (This is because MDT's expanding x_4 is continually spreading and distributing locality.)

Einstein: Time and again the passion for understanding has led to the illusion that man is able to comprehend the *objective world* rationally by pure thought without any *empirical foundations*—in short, by metaphysics.[xxxvi] (MDT begins and ends with empirical foundations!)

$qp-pq=i\hbar$ and $dx_4/dt=ic$ are fundamental equations of QM and relativity. The first equation reflects the discrete increment and quantum action—$\hbar$—in which x_4 is expanding relative to the three spatial dimensions, and the second equation, from which relativity and its postulates derive, sets the velocity of the expansion of x_4 to c. Note the differentials on the left side of the equations, suggesting the fundamental, foundational change from where time and all of its arrows and asymmetries arise, and the i on the right hand side of both equations, which reflects the perpendicular nature of the change relative to our three spatial dimensions, thusly requiring an x_4 moving relative to the three spatial dimensions. When one is solving equations and an i appears, it represents an orthogonality. As both QM and relativity were

brought forth in the context of the three spatial dimensions, the *i* emerged, representing x_4. Bohr made note of the curious occurrence of *i* in QM and relativity[xxxvii]:

> Notwithstanding all differences between the physical problems which have given rise to the development of relativity theory and quantum theory, respectively, a comparison of purely logical aspects of relativistic and complementary argumentation reveals striking similarities . . . Even the formalisms, which in both theories within their scope offer adequate means of comprehending all conceivable experience, exhibit deep-going analogies. In fact, the astounding simplicity of the generalization of classical physical theories, *which are obtained by the use of multidimensional geometry and non-commutative algebra, respectively,* ***rests in both cases essentially on the introduction of the conventional symbol sqrt(-1)***.

As both QM and relativity naturally emerge from the quantized expansion of x_4, both QM and relativity needed the notion of *i*—representing a moving x_4 perpendicular to our three spatial dimensions ($dx_4/dt=ic$). Both relativity and QM deal with realms not always obvious—the very fast, the very large, and the very small, and as both fields advanced, both required—in Bohr's words, "not directly visualisable symbolism." Both relativity and QM exalted *i*—the notion of x_4 which was not quite as obvious the three spatial dimensions. And now, we see that x_4 is moving and expanding in a quantized manner. $dx_4/dt=ic$ and $pq-qp=i\hbar$ offer the foundational bedrock of all QM and relativity—a fact I touched in the concluding words to an appendix to my 1998 physics Ph.D. dissertation[xxxviii] with: "*As physics concerns itself at all levels with changes relative to both space and time, it makes sense that all physics, time, motion, reality, life, and consciousness itself are founded upon a stage which is endowed with intrinsic motion.* ***The underlying fabric of all realty, the dimensions themselves, are moving relative to one another***." $i\hbar$ represents the discrete unit of x_4's expansion, and *ic* represents its invariant velocity.

5. MDT Rescues Godel, Einstein, and Time

P. Yourgrau writes[xxxix], "Godel was quick to point out that if we can revisit the past, it never really "passed." But a time that fails to pass is no time at all. Einstein saw at once that if Godel was right, he had not merely domesticated time: he had killed it. . . . ***But now something amazing took place: nothing***. . . A conspiracy of silence descended on the Einstein-Godel friendship and its scientific consequences." Indeed, the great Godel is oft not cited in contemporary treatises on time, as sure as physics' Founding Fathers are forgotten in treatises on reality, but $dx_4/dt=ic$ saves the day by showing that both Godel and Einstein are right. Godel showed how Einstein's interpretation of relativity froze time, and MDT's $dx_4/dt=ic$ unfreezes time, weaving change into the fundamental fabric of space-time for the first time in the history of relativity, while also providing the fundamental foundation for all of relativity which Einstein yet sought, as well as entropy and entanglement.

Time travel would be possible were time x_4, but time, as measured on our watches, is not a dimension, but rather it is an emergent scalar that arises from the fact x_4 is expanding relative to the three spatial dimensions in a quantized manner. Schrodinger wrote, "The world extended in space and time is but our representation,"[xl] and Wheeler echoed this with, "The four-dimensional space-time manifold is only a fabrication, only a theory."[xli] Yes! The *t* axis, when drawn on a space-time diagram, is a purely mathematical construct, but the past and future do not exist, even though one may measure someone's past in the present or the future as distant photons take time to propagate. Never does Einstein say that *t* is x_4, but rather he writes $x_4=ict$, and *t* and *ict* are very different entities. As *t* increments, so must x_4. As

clocks are based on physical change, and as change requires the propagation of energy, physical change and clocks thus rest upon the motion of x_4, upon which energy and photons propagate. So it is that time inherited properties and characteristics of x_4 in the equations of relativity, but time, as a scalar quantity measured on our clocks, ought not be confused with the actual fourth dimension, which is a physical entity expanding at *c* relative to the three spatial dimensions as a spherically-symmetric wave-front with a wavelength of l_p.

6. Curiosity lead to MDT's Unifying, Foundational Model Underlying QM, Relativity, Entropy, & Time

Millions saw the apple fall, but Newton was the one who asked why.[xlii] –Baruch

Einstein wrote, "The important thing is not to stop questioning. Curiosity has its own reason for existing. . . Never lose a holy curiosity."[xliii] Wheeler was fond of saying, "No question, no answer,"[xliv] and MDT asks *and answers* the following questions with a simple, unifying, novel *physical* model: $dx_4/dt=ic$.

> From what foundational reality does relativity emerge? Why the quantum? Why entropy? Why the double slit experiment results? Why no graviton? Why the discrete, digital nature of energy? What foundational model can provide the "elementary foundations" for Einstein's relativity & Schrodinger's "characteristic trait" of QM—entanglement? What foundational model can unfreeze time & liberate us from the block universe, exalting free will? How can we weave change into the fundamental fabric of space-time for the first time in the history of relativity? Why quantum entanglement (QM's characteristic trait) and nonlocality? Why the dualities—space/time, energy/mass, wave/particle, E/B, analog/digital? Why is *c* invariant—both independent of the source and the observer? Why is a photon defined by a spherically-symmetric expanding wave-front of probability? What single model resolves the EPR & Twin Paradoxes? How do we resurrect time/change after Godel ended time/change? Why can nothing can move faster than *c*? Why does length-contraction accompany motion? Why is a photon ageless (in relativity—nonlocality in time) and nonlocal in space (in QM)? Why the gravitational slowing of time and the gravitational redshift? What common, *foundational* physical model underlies QM, relativity, entropy, and time and all its arrows and asymmetries?

The physical "*why?*" leads the way as we seek the foundational character of physical reality, with Heisenberg writing[xlv], "When a definite mass m is given, in our everyday physics it is perfectly understandable to speak of the position and the velocity of the center of gravity of this mass. In QM, however, the relation $pq-qp=-i\hbar$ between mass, position, and velocity is believed to hold. Therefore we have good reason to become suspicious every time uncritical use is made of the words "position" and "velocity." . . . ***The question therefore arises*** whether, through a more precise analysis of these kinematic and mechanical concepts, it might be possible to clear up the contradictions evident up to now in the physical interpretations of QM and ***to arrive at a physical understanding of the quantum-mechanical formulas***. (bold italics added by author)." MDT provides a *physical* understanding of the foundational formulas of relativity and QM by presenting a deeper *physical* model underlying both, which shows that x_4 is expanding in a discrete manner proportional to $\hbar$ at the rate of *c*, leading to the quantum and thus the discrete, digital nature of all energy and measurement, as well as to relativity, entropy, nonlocality, entanglement, and time and all its arrows and asymmetries.

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4

Paper Four of Five

MDT's $dx_4/dt = ic$ Triumphs Over the Wrong Physical Assumption That Time is a Dimension

Elliot McGucken, Ph.D.

August 24, 2012

FQXi Essay Contest • *Questioning the Foundations*

FQXi d/1429

Essay Abstract (*as published on FQXi*)

The wrong physical assumption that time is a dimension has inspired numerous non-physical, purely-speculative concepts over the past century including frozen time, block universes, and time machines. Moving Dimensions Theory (MDT) advances physics by providing a physical model and mechanism for time's arrows and asymmetries, relativity, nonlocality, and entanglement, via the postulate that the fourth dimension x_4 is expanding relative to the three spatial dimensions at the rate of c: $dx_4/dt = ic$. MDT fully agrees with the Standard Model while offering a profound new interpretation of time founded upon the physical reality of a fourth expanding dimension, which resolves the EPR and Twins paradoxes and unifies QM, relativity, entropy, and time's arrows within a single foundational physical model.

FQXi. Current URL: forums.fqxi.org/d/1429 Legacy URL: fqxi.org/community/forum/topic/1429 Essay PDF: McGucken_MDT_final_final4.pdf Author profile: forums.fqxi.org/u/dmcgucken

Companion papers in this compendium: Paper 1 (FQXi d/238, 2008) · Paper 2 (FQXi d/511, 2009) · Paper 3 (FQXi d/873, 2011) · Paper 5 (FQXi d/1879, 2013).

MDT's $dx_4/dt=ic$ Triumphs Over the Wrong Physical Assumption that Time is a Dimension, Unfreezing Time and Answering Godel's, Eddington's, *et al.*'s Challenge, Providing a Mechanism for Emergent Change, Relativity, Nonlocality, Entanglement, and Time's Arrows and Asymmetries

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"Something must be added to the geometrical conceptions comprised in Minkowski's world before it becomes a complete picture of the world as we know it."[i] –Sir Arthur Eddington calling for $dx_4/dt=ic$

Huygens' Principle: Every point on a wavefront is a source of wavelets that spread out in the forward direction at the same speed as the wave itself. The new wavefront is a line tangent to all of the wavelets: $dx_4/dt=ic$.

"Absolute, true, and mathematical time flows uniformly."[ii] —Sir Isaac Newton on the universe's foundational flux: $dx_4/dt=ic$.

"My solution was really for the very concept of time, that is, that time is not absolutely defined but there is an inseparable connection between time and the signal [light] velocity."[iii] –Einstein on the emergence of time and the velocity of light from the expansion of the fourth dimension: $dx_4/dt=ic$.

Abstract

The wrong physical assumption that time is a dimension has inspired numerous non-physical, purely-speculative concepts over the past century including frozen time, block universes, and time machines allowing time travel into the past, while failing to account for empirically-observed, *physical* realities such as free will, change, time's arrows and asymmetries, the second law of thermodynamics, nonlocality, entanglement, the equivalence of mass and energy, the maximum velocity of c, and the dynamic flow of time itself. Moving Dimension Theory's correct interpretation of time advances physics by providing a *physical* model and mechanism for time's arrows and asymmetries, relativity, nonlocality, and entanglement, while finally addressing Godel's refutation of time and Eddington's Challenge, and accounting for our low-entropy past and the vacuum's dark energy. Time is not the fourth dimension x_4, but rather, time, measured by the ticking seconds on a watch, is an entity that emerges because x_4 is expanding relative to the three spatial dimensions as described by $x_4=ict$ from Einstein's *1912 Manuscript on Relativity*[iv], which we write as $dx_4/dt=ic$ so as to emphasize the universe's fundamental flux. While time thus inherits properties of the fourth dimension x_4, time is *not* x_4. MDT fully agrees with the Standard Model while offering a profound new interpretation of time founded upon the physical reality of a fourth expanding dimension which resolves the EPR and Twins paradoxes, providing a *physical* model for QM's nonlocality and entanglement alongside the foundations of relativity which Einstein yet sought. MDT is a great, simple unifier in the spirit of Einstein who stated, "*A theory is the more impressive the greater the simplicity of its premises is, the more different kinds of things it relates, and the more extended is its area of applicability*."

MDT Trumps Wrong Physical Assumptions Regarding Time & Answers Foundational Questions

The late J.A. Wheeler, my friend and mentor at Princeton University, was fond of saying, "No question, no answer.[v]" By ignoring foundational questions regarding time, and by making the wrong

physical assumption that time is a dimension, physicists missed the foundational physical model that MDT provides—the very source of time's arrows and asymmetries, the second law of thermodynamics, relativity, and quantum mechanics' entanglement and nonlocality. In *A World Without Time: The Forgotten Legacy of Godel and Einstein*, Palle Yourgrau writes, "By 1949, Godel had produced a remarkable proof: In any universe described by the Theory of Relativity, time cannot exist. Einstein endorsed this result, reluctantly, since it decisively overthrew the classical world-view to which he was committed. But he could find no way to refute it, and in the half-century since then, neither has anyone else. *Even more remarkable than this stunning discovery by two of the greatest intellects of all time, however, was what happened afterward*: <u>*nothing*</u>.[vi]" In *The Trouble With Physics*[vii], Physicist Lee Smolin laments that physicists neglect foundational questions regarding time, adding that we must find a way to unfreeze time, which MDT's $dx_4/dt=ic$ does. Huw Price notes that "Eddington's Challenge" to apprehend a physical mechanism for time and its arrows (which MDT provides!) has been ignored, writing:

> By the end of the nineteenth century, on the shoulders of Maxwell, Boltzmann and many lesser giants, physics had realized that there is a deep puzzle behind the familiar phenomena described by the new science of thermodynamics. On the one hand, many such phenomena show a striking temporal bias. They are common in one temporal orientation, but rare or non-existent in reverse. On the other hand, the underlying laws of mechanics show no such temporal preference. If they allow a process in one direction, they also allow its temporal mirror image. Hence the puzzle: if the laws are so even-handed, why are the phenomema themselves so one-sided? What has happened to this puzzle since the 1890s? *I suspect that many contemporary physicists regard it as a dead issue, long since laid to rest*.[viii]

MDT, whose profound, far-reaching simplicity is illustrated in FIG. 1, resurrects and resolves the Giants' primal concerns regarding time while replacing Einstein's two postulates of relativity with a more fundamental maxim $dx_4/dt=ic$ and formulation: "Suppose a universe with four dimensions wherein the fourth dimension is expanding at c relative to the three spatial dimensions $dx_4/dt=ic$: ergo relativity[ix]." MDT provides a *physical* model for quantum nonlocality, entanglement, all of time's arrows and asymmetries[x], including the radiative and entropic arrows of time first noted by Maxwell, Boltzman, *et. al*, intuitively seen in FIG. 1 and my previous papers[xi] which may be viewed at http://herosjourneyphysics.wordpress.com.

The term "Time's Arrow" makes its first appearance in Eddington's work[xii], where he reflects that "*the geometrical conceptions comprised in Minkowski's world*" are incomplete:

> Time's Arrow. The great thing about time is that it goes on. But this is an aspect of it which the physicist sometimes seems inclined to neglect. In the four-dimensional world . . . the events past and future lie spread out before us as in a map. The events are there in their proper spatial and temporal relation; but there is no indication that they undergo what has been described as the formality of "taking place" . . . We see in the map the path from past to future or from future to past ; but there is no signboard to indicate that it is a one-way street. *Something must be added to the geometrical conceptions comprised in Minkowski's world before it becomes a complete picture of the world as we know it.* [xiii]

MDT's $dx_4/dt=ic$ *is* that something that "*must be added to the geometrical conceptions comprised in Minkowski's world before it becomes a complete picture of the world as we know it*." MDT provides time's "one-way" street via Minkowki's very own $x_4=ict$, which physically means that $dx_4/dt=ic$, or the fourth

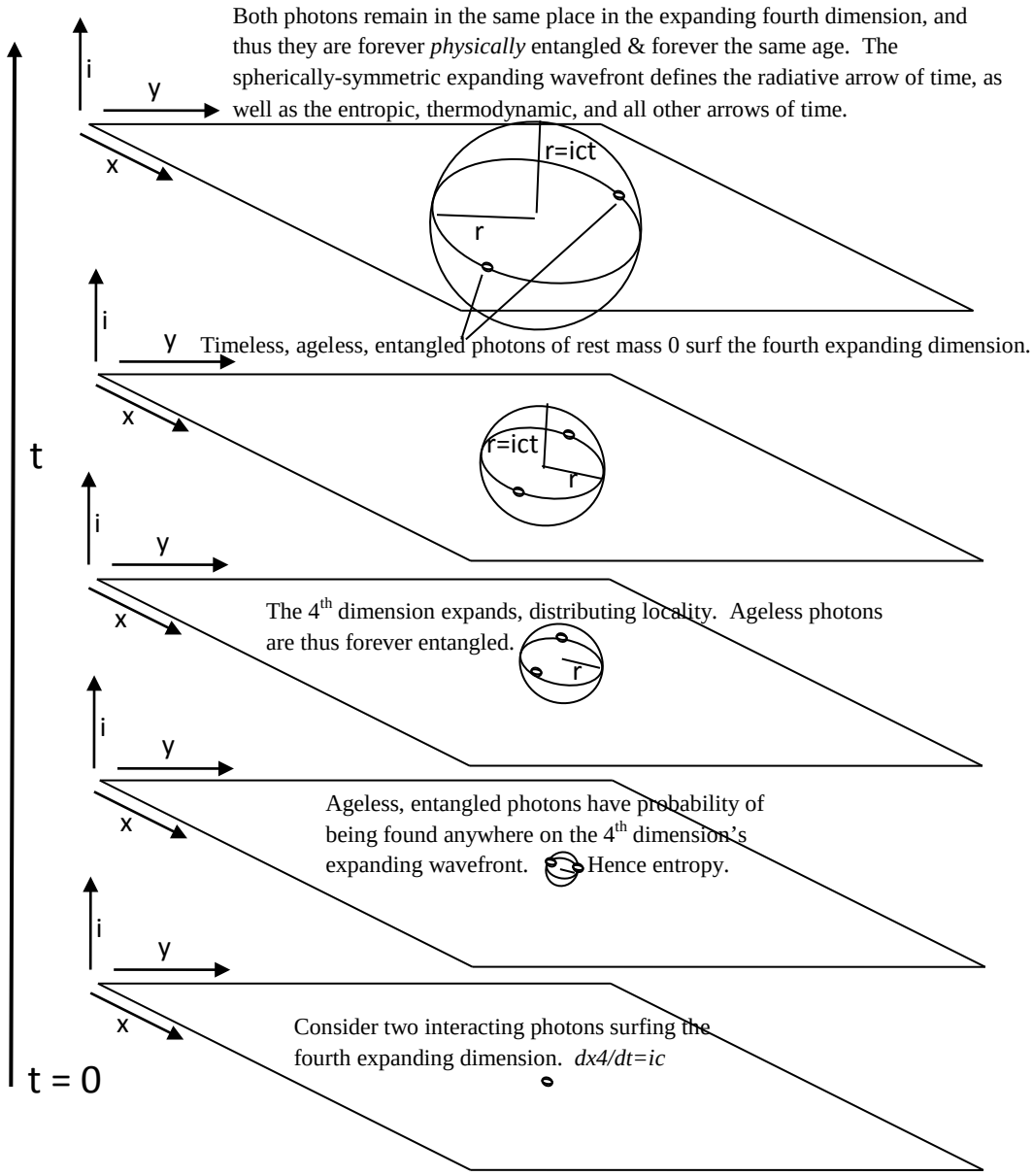

FIGURE. 1: THE UNIVERSES'S FUNDAMENTAL ASYMMETRY & MOTION: $dx_4/dt=ic$. MDT'S concrete *physical* mechanism for Einstein's *Principle of Relativity*, nonlocality, entanglement, QM's probabilistic, nonlocal character, time's radiative arrow and asymmetry, Huygens' Principle, pilot waves, entropy, the constancy of *c*, the independence of *c* from the source, and the timeless, ageless photon: $dx_4/dt=ic$. As photons remain in the same place (agelessness/entanglement) in the fourth dimension which expands in a spherically symmetric manner, radiation appears as expanding (never shrinking) probabilistic spherically-symmetric wavefronts (time's radiative arrow). Entangled photons have a higher chance of being found further apart over time (entropy). Why do we see retarded waves in nature instead of advanced? The radiative arrow of time, as illustrated by the spherically-symmetric wavefront expanding at *c* above, is nothing but the expansion of the fourth dimension x_4—the universe's fundamental motion represented by $dx_4/dt=ic$—the motion that carries matter in the form of photons, providing their nonlocal properties via the ever-expanding locality of x_4 which expands at the rate of *c,* thusly setting the universes maximum velocity. See further papers here: http://herosjourneyphysics.wordpress.com

dimension is expanding relative to the three spatial dimensions. MDT adds motion to the geometrical conceptions comprised in Minkowski's world, while also replacing the mathematical construct of a static 4D block universe with a 3D universe in which the fourth dimension manifests itself as a spherically-symmetric wavefront expanding at *c* (FIG. 1). The expansion of the fourth dimension dictates all of Time's Arrows as I show in a previous paper[xiv], from the radiative arrow, to the thermodynamic arrow, to the quantum arrow as the expansion of the fourth dimension provides the nonlocality that the photon surfs, until it is measured or the expanding wavefront collapses as the photon is absorbed in a photographic plate, darkening a grain of film.

MDT's simple $dx_4/dt=ic$ exalts a physical model with the dynamism/change/flux required by time. $dx_4/dt=ic$ represents change and its spherically-symmetric wavefront, seen expanding in FIG. 1, gives time its direction, as well as radiation its expansive properties, providing a physical mechanism for Huygens' Principle. MDT provides a physical model underlying time and all its arrows and asymmetries, accounting for why we see retarded waves but never advanced—for why the universe tends towards disorder—for why we can easily distinguish the past from the future.

In reality, the fourth dimension manifests itself not as an axis, but as a spherically-symmetric wavefront expanding at *c* through the three spatial dimensions, in the same way an expanding sphere would appear as an expanding circle in a 2D plane. The reality of the fourth moving dimension—$dx_4/dt=ic$—could have originally been seen in $x_4=ict$ in Poincare and Minkowski's work[xv,xvi], but, instead, physicists wrongly assumed that time was a physical dimension, which they oft depict as one of the axes in a common, yet misleading, space-time diagram. While such an interpretation can provide a useful tool and a fourth coordinate to locate an object in the mathematical construct of a 4D block universe, it masks the physical reality of the expansion of the fourth dimension which manifests its reality both in the mathematics of $dx_4/dt=ic$ and the *physical* reality of time's arrows and asymmetries, entropy, the equivalence of rest mass and energy, entanglement, change, and other physical phenomena. Instead of adopting a physical model of the fourth dimension physically supporting quantum mechanics, time's arrows, and relativity, physicists instead adopted the wrong physical interpretation of time as a dimension, choosing a model which supports non-physical entities such as the block universe and time travel into the past, ultimately leading to Godel's observation that time, as Einstein *et al.* knew it, could not exist. Instead of adopting the correct physical model of the fourth dimension as a moving entity reflected in $dx_4/dt=ic$—a physical model which accounts for the physical asymmetry in time dilation in the GPS system while providing a *physical* mechanism for Time's Arrows that unfreezes time, physicists instead adopted a model which failed to account for the physical reality of time's arrows and asymmetries, subsequently ignoring glaring, foundational questions regarding the nature of time posed by Godel, Eddington, *et al*. And furthermore, as if to add insult to injury, in addition to failing to account for empirically observed phenomena and time's very nature, the chosen model, which wrongly assumed time to be a physical dimension, simultaneously exalted the non-physical, never-observed concept of time-travel into the past. Physicists chose wrong assumption of time as a fourth dimension they somehow perceived in $x_4=ict$ over the mathematical and empirical reality of a fourth moving dimension plainly represented in $dx_4/dt=ic$. Physicists wrongly assigned a real-world, physical, dimensional reality to the *t*-axis in space-time diagrams, thusly freezing time in a block universe, while ignoring the physical reality of the moving dimension represented by Einstein's very own $dx_4/dt=ic$. Physicists chose wrong assumptions regarding time over the mathematical and physical reality of $dx_4/dt=ic$, and as a result, they had to sweep aside foundational questions regarding time while dismissing the fundamental concerns of brilliant physicists and mathematicians such as Boltzman, Maxwell, Eddington, Godel, *et al.*

I Was in My Twenties When I First Glimpsed the Beauty of MDT

I was in my twenties when I first glimpsed the beauty of MDT. In my award-winning physics Ph.D. dissertation titled *Multiple unit artificial retina chipset to aid the visually impaired and enhanced holed-emitter CMOS phototransistors*, which received a Merrill Lynch Innovations Award and several Fight-for-Sight and NSF Grants, while appearing in the likes of *Popular Science*, *Business Week*, and *IEEE* academic journals (and most importantly, which is now helping the blind see!), I included an appendix devoted to MDT[xvii]. There, I concluded, "The underlying fabric of all reality, the dimensions themselves, are moving relative to one-another." The theory had its roots in my Princeton days working with Professor John Archibald Wheeler—Princeton's Joseph Henry Professor of Physics. Dr. Wheeler wrote, "More intellectual curiosity, versatility and yen for physics than Elliot McGucken's I have never seen in any senior or graduate student. . . Originality, powerful motivation, and a can-do spirit make me think that McGucken is a top bet for graduate school in physics. . . I say this on the basis of close contacts with him over the past year and a half. . . I gave him as an independent task to figure out the time factor in the standard Schwarzchild expression around a spherically-symmetric center of attraction. I gave him the proofs of my new general-audience, calculus-free book on general relativity, *A Journey Into Gravity and Space Time*[xviii] (you'll find Dr. E in the appendix beside Einstein!). There the space part of the Schwarzchild geometric is worked out by purely geometric methods. "Can you, by poor-man's reasoning, derive what I never have, the time part?" He could and did, and wrote it all up in a beautifully clear account. . . .his second junior paper . . .entitled *Within a Context*, was done with another advisor, and dealt with an entirely different part of physics, the Einstein-Rosen-Podolsky experiment and delayed choice experiments in general. . . this paper was so outstanding. . . I am absolutely delighted that this semester McGucken is doing a project with the cyclotron group on time reversal asymmetry. Electronics, machine-shop work and making equipment function are things in which he now revels. But he revels in Shakespeare, too. Acting the part of Prospero in the *Tempest*. . ."[xix] And so you can see how MDT owes its existence to those formative years standing on the shoulders of giants spanning quantum mechanics, relativity, and time-reversal invariance. Since then, MDT's equation $dx_4/dt=ic$ emerged alongside numerous proofs[xx], as MDT grew to provide a physical model which underlies and unifies a broad range of physics including time and all its arrows and asymmetries, entropy, all of relativity, and quantum behavior including nonlocality and entanglement. The relativity and quantum mechanics I had studied with Wheeler were unified in MDT, which underlies both the gravitational redshift and the nonlocal entanglement found within the EPR experiments.

MDT rights the wrong physical assumptions regarding time, while remaining completely loyal to relativity and QM, providing a common physical model underlying both QM and relativity and all their observed phenomena. Empirical reality's constant change demonstrates that time is not frozen; we have free will; and nobody has yet built a time machine, nor have any visitors from the future traveled back to us to teach us how—all of which testify to the fact that *time is not a physical dimension.* While the x_4 in the Minkowski/Einstein relationship $x_4=ict$ is indeed a dimension, t is not a dimension but only a scalar parameter, while the i in ict represents the perpendicularity which signifies that x_4 is perpendicular to the three spatial dimensions. How strange that physicists took t—a well-known scalar—and tried to shoe-horn it into dimensionality! How strange that they wrongly assumed time was a dimension, even though doing so exalted non-physical, never-observed entities such as block universes and time travel into the past, while failing to account for the physical reality of quantum nonlocality and entanglement, time and all its arrows and asymmetries, and change itself! MDT rights this fundamentally wrong assumption that

time is a dimension, and provides a physical model which accounts for nonlocality, time and all its arrows and asymmetries, entanglement, and relativity; while also alleviating the need for the block universe, frozen time, and time travel into the past.

MDT is a Theory in the Heroic Tradition of Empirical Science

MDT is a theory in the heroic tradition of empirical science summarized by Einstein who wrote, "*But before mankind could be ripe for a science which takes in the whole of reality, a second fundamental truth was needed, which only became common property among philosophers with the advent of Kepler and Galileo. Pure logical thinking cannot yield us any knowledge of the empirical world; all knowledge of reality starts form experience and ends in it. Propositions arrived at by purely logical means are completely empty as regards reality. Because Galileo saw this, and particularly because he drummed it into the scientific world, he is the father of modern physics—indeed, of modern science altogether*," adding "*A theory is the more impressive the greater the simplicity of its premises is, the more different kinds of things it relates, and the more extended is its area of applicability*." MDT both begins and ends in physical reality, backing up its physical model of a fourth expanding dimension with a simple mathematical equation $dx_4/dt=ic$.

All of relativity, as well as quantum behavior including nonlocality and entanglement, time and all its arrows and asymmetries, Huygens' Principle and Feynman's many-paths interpretation of QM, the dualities including space/time, E/B, and mass/energy, naturally emerge from MDT's simple, unifying equation $dx_4/dt=ic$. The nonlocal, vibrational wave properties of the fourth expanding dimension alleviates the need for strings and/or loops (which nobody has ever seen) in uniting quantum mechanics and relativity. All change—time herself—arises from the fundamental expansion of the fourth dimension relative to the three spatial dimensions, and Godel's and Eddington's call to adventure—to find a foundational physical model of the universe which includes Time's Arrows—is answered.

Accepting Equations' Physical Reality: Einstein Accepted Planck's $E = h\nu$ & Dr. E Accepts Einstein's $dx4/dt=ic$:

The equation $dx_4/dt=ic$—representing the expansion of the fourth dimension—presents the change underlying all change, weaving change into the fundamental fabric of spacetime for the first time in the history of relativity. When Einstein/Minkowski wrote $x_4=ict$, they came close to realizing that the fourth dimension moves relative to the three spatial dimesnions. All they had to do was consider the *physical* meaning of $x4=ict$, but they stopped short of doing so, in the same way Max Planck originally dismissed the *physical* implications of his famous $E=h\nu$ as "a mere mathematical formality with no physical meaning."[xxi] It was Einstein who accepted $E=h\nu$ as representing *physical* reality, which lead to his Nobel-Prize-winning work on the photoelectric effect. And it is I who have realized the physical meaning of $x_4=ict$ as $dx_4/dt=ic$, as well as the physical meaning of all observed nonlocality and entanglement, as representing a fourth dimension that expands, distributing locality. Instead of projecting physical realities onto mere mathematical constructs such as the *t*-axis in space-time diagrams while fantasizing about time travel into the past and time machines, physicists would be better off acknowledging the physical implications of $dx_4/dt=ic$ as Einstein did with $E=h\nu$.

Max Planck never quite saw nor believed the physical significance of his equation $E=h\nu$. At first Planck considered that quantization was only "a purely formal assumption ... actually I did not think much about it..."[xxii] Today this assumption is regarded as not only the greatest intellectual accomplishment of Planck's career, but also one of the greatest physical discoveries of all time, placing the quantum

revolution on par with the Copernicun revolution, if not beyond it. In a similar fashion, Dr. E recognized the physical significance of $x_4=ict$ which first appeared in the Minkowski-Einstein treatment of special relativity. While Einstein began with his two postualtes and only reluctantly backed into $x_4=ict$ after Minkowski offered the more formal formulation, Dr. E begins with $x_4=ict$ or $dx_4/dt=ic$ as a fundamental, universal invariant representing the *physical* reality that the fourth dimension is expanding relative to the three spatial dimensions at *c*, and from this physical theory, he derives both of Einstein's postulates and all of relativity, while providing a common *physical* foundation for time and all its arrows and asymmetries, entropy, and entanglement[xxiii].

Simply put, by recognizing the physical meaning of $x_4=ict$, Dr. E was able to find both relativity's foundations and the *physical* foundations for quantum mechanics.

> A physical theory can be satisfactory only if its structures are composed of elementary foundations. The theory of relativity is ultimately as little satisfactory as, for example, classical thermodynamics was before Boltzmann had interpreted the entropy as probability.[xxiv] –Einstein

> (Entanglement is) the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought. By the interaction the two representatives [the quantum states] have become entangled.[xxv] -Schrodinger

Karl Popper writes, "As to the arrow of time, it is in my opinion a mistake to make the second law of thermodynamics responsible for its direction. Even a non-thermodynamic process, such as a propagation of a wave from a entre is in fact irreversible. . . all causes spread from centres, reminiscent of Huygens' principle."[xxvi] FIG. 1 illustrates how MDT's $dx_4/dt=ic$ provide a physical mechanism for both the second law of thermodynamics and Huygens' principle, as well as numerous other physical phenomena.

MDT's Principle of Nonlocality

MDT's principle of nonlocality is thus: In order for two systems to be entangled, they must have had a 0 space-like separation in the past, with neither one undergoing a "measurement" or localization or collapse of its wave function.

Brian Greene Represents Physicist's Wrong Physical Assumptions Regarding Time

In *An Elegant Universe*, Brian Greene almost characterizes MDT's deeper reality, but falls short because of his wrong, though commonly-held, physical assumption that time is a dimension:

> Einstein found that precisely this idea—the sharing of motion between different dimensions—underlies all of the remarkable physics of special relativity, so long as we realize that not only can spatial dimensions share an object's motion, but the time dimension can share this motion as well. In fact, in the majority of circumstances, most of an object's motion is through time, not space. Let's see what this means.[xxvii]

But time is not a dimension. Time is an emergent phenomena that arises because the fourth dimension is expanding relative to the three spatial dimensions at the rate of c: $dx_4/dt=ic$. Greene should have written:

> "In fact, in the majority of circumstances, most of an object's motion is through ***the fourth dimension, not the three spatial dimensions***. . .."

To be stationary in the three spatial dimensions implies a velocity of c through the fourth dimension. Ergo the fourth dimension is expanding relative to the three spatial dimensions. To be stationary in the fourth dimensions, as is a photon, implies a velocity of c through the three spatial dimensions. Ergo the fourth dimension is expanding relative to the three spatial dimensions as mathematically beheld in $dx_4/dt = ic$.

Greene continues:

> When we look at a clock or a wristwatch, even while we idly sit and watch TV, the reading on the watch is constantly changing, constantly "moving forward in time." We and everything around us are aging, inevitably passing from one moment of time to the next. In fact, the mathematician Hermann Minkowski, and ultimately Einstein as well, advocated thinking about time as another dimension of the universe—the fourth dimension—in some ways quite similar to the three spatial dimensions in which we find ourselves immersed.[xxviii]

Greene makes the wrong physical assumption that time, as measured on a watch, is the fourth dimension, whereas in reality time is a phenomenon that emerges because the fourth dimension is expanding relative to the three spatial dimensions. The time measured on a watch relies on the emission and propagation of photons, and as photons are matter caught in the fourth expanding dimension, our notion of "time" inherits properties of the fourth expanding dimension, but time is not the fourth dimension.

Brian Green continues on, guided by the beacon of his wrong assumptions regarding time, thusly heading off in the wrong direction (no pun intended!) and missing the central postulate of MDT:

> "Although it sounds abstract, the notion of time as a dimension is actually concrete."[xxix]

But it is not. Can one move to where one's watch reads three seconds back in time? One can walk left or right. One can climb up or down. We can move forwards or backwards. But one can't move through time like we can through the three spatial dimensions. This is because time, as measured on our watch, is not the fourth dimension, but it is a parameter which emerges as the fourth dimension is expanding relative to the three spatial dimensions, governing the emission and propagation of photons, or $dx_4/dt=ic$. When physicists transformed the emergent parameter of time into a physical dimension, they made a wrong physical assumption.

Conclusion: Moving Dimensions Theory Papers & Books

I am currently finishing several papers on MDT while working on a book titled *Hero's Journey Physics: Sailing with Einstein, Copernicus, Galileo, Newton, Maxwell, Boltzman, and Faraday toward's Time's Secret*. As MDT's $dx_4/dt=ic$ is fundamentally rooted in space-time, it thus touches upon all of physics, as all of physics rests upon $dx_4/dt=ic$'s common foundation. And how glorious it is to finally have a simple, *physical* model and equation from which one can immediately derive all of relativity, while also offering a physical mechanism for nonlocality and entanglement, the double slit experiment and Huygens' Principle, ever-increasing entropy, and time and all its arrows and asymmetries. For further reading, and several more MDT papers going into far more detail that space her does not allow, please visit my blog at http://herosjourneyphysics.wordpress.com.

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5

Paper Five of Five

It from Bit or Bit From It?
What is It? Honor!

Where is the Wisdom we have lost in Information?
Returning Wheeler's Honor and Philo-Sophy —
the Love of Wisdom — to Physics

Elliot McGucken, Ph.D.

July 3, 2013

FQXi Essay Contest • *It From Bit or Bit From It?*
FQXi d/1879

Essay Abstract (*as published on FQXi*)

I walk into my Princeton advisor John Archibald Wheeler's third-floor Jadwin Hall office one fine autumn afternoon to find him gazing out the window at October's burning leaves. Wheeler senses my presence and slowly turns towards me, dressed in his crisp signature suit and tie, his fist lightly clenched. He solemnly states, "Today's physics lacks the Noble," his blue eyes smiling, "And it's your generation's duty to bring it back." The following year (1990) Wheeler would hand me the booklet he had printed, called "It from Bit," engraved with the quantum black hole on the cover. The book would inspire the "physics as information movement," while Wheeler's far greater call to adventure — to return honor to physics — would be lost in time. The classical, exalted Spirit of physics, embodied by Wheeler and his teacher Bohr, his colleague Einstein, and his student Feynman, was sacrificed on the altar of fiat misinformation. This essay returns Wheeler's honor and philo-sophy — the love of wisdom — to physics, exalting Moving Dimensions Theory's $dx_4/dt = ic$ as the simple, physical, foundational reality beneath QM, relativity, entropy, time, and all its arrows and asymmetries.

FQXi. Current URL: forums.fqxi.org/d/1879 Legacy URL: fqxi.org/community/forum/topic/1879 Essay PDF: McGucken_I_walk_into_my_adv.pdf Author profile: forums.fqxi.org/u/dmcgucken

Companion papers in this compendium: Paper 1 (FQXi d/238, 2008) · Paper 2 (FQXi d/511, 2009) · Paper 3 (FQXi d/873, 2011) ·

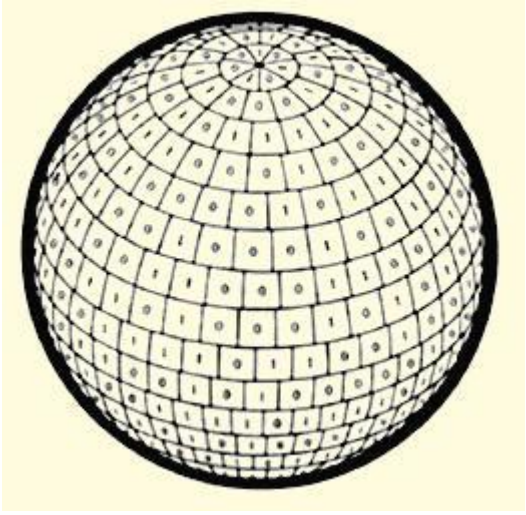
Paper 4 (FQXi d/1429, 2012).

It from Bit or Bit From It? What is It? Honor!
Where is the Wisdom we have lost in Information?
Returning Wheeler's Honor and Philo-Sophy—the Love of Wisdom—to Physics.

by Dr. Elliot McGucken

The endless cycle of idea and action,
Endless invention, endless experiment,
Brings knowledge of motion, but not of stillness;
Knowledge of speech, but not of silence;
Knowledge of words, and ignorance of the Word.
All our knowledge brings us nearer to our ignorance,
All our ignorance brings us nearer to death,
But nearness to death no nearer to GOD.
Where is the Life we have lost in living?
Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?
The cycles of Heaven in twenty centuries
Bring us farther from GOD and nearer to the Dust.
-T.S. Eliot Chorus of the Rock

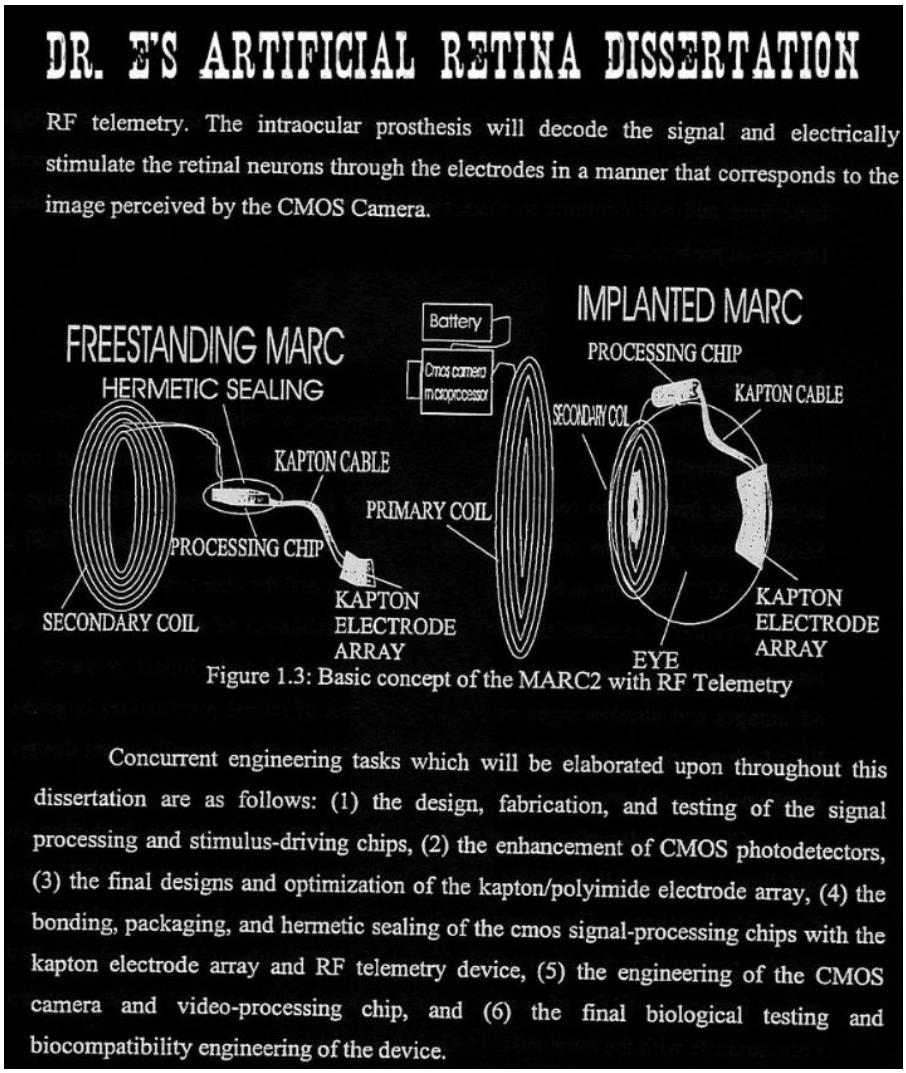
ABSTRACT



I walk into my Princeton advisor John Archibald Wheeler's third-floor Jadwin Hall office one fine autumn afternoon to find him gazing out the window at October's burning leaves. Wheeler senses my presence and slowly turns towards me, dressed in his crisp signature suit and tie, his fist lightly clenched. He solemnly states, "Today's physics lacks the Noble," his blue eyes smiling, "And it's your generation's duty to bring it back." The following year (1990) Wheeler would hand me the booklet he had printed, called "It from Bit," engraved with the quantum black hole on the cover. The book would inspire the "physics as information movement," while Wheeler's far greater call to adventure—to return honor to physics—would be lost in time, as it wasn't quite as profitable as pursuits in the fiat-debt funded, dishonorable, ignoble realms of untestable, failed groupthink "physics." The classical, exalted Spirit of physics, embodied by Wheeler and his teacher Bohr, his colleague Einstein, and his student Feynman, was sacrificed on the altar of fiat misinformation, as hundreds of millions of dollars disappeared down the black hole of the postmodern soul and progress in physics ground to a halt. Tragic as it might seem, the pseudo-physicists had to deny the heroic Spirit of Einstein, Bohr, Newton, Galileo, and Copernicus—of Wheeler and Feynam—and thus of Moving Dimensions Theory[i] [ii] [iii]. And just as MDT first appeared in Dr. E's artificial retina physics Ph.D. dissertation[iv] which is now helping the blind see, so too am I devoting myself to helping the world see the banished beauty and wisdom of

Copernicus, Newton, Einstein, Bohr, Feynman, *et al.* The great J.A. Wheeler had called me to adventure with, "Today's physics lacks the Noble, and it's your generation's duty to bring it back," as wisdom—as philo-sophy—the love of wisdom—trumps mere information.

Copernicus: Coinage is imprinted gold or silver, by which the prices of things bought and sold . . . money is, as it were, a common measure of values. That which ought to be a measure, however, must always preserve a fixed and constant standard. Otherwise, public order is necessarily disturbed, with buyers and sellers being cheated in many ways, just as if the yard, bushel, or pound did not maintain an invariable magnitude.. . . Bad (debased) coinage drives good (un-debased) coinage out of circulation.[v] (A fiat currency drives true Physics out of circulation, replacing it with fiat physics.)

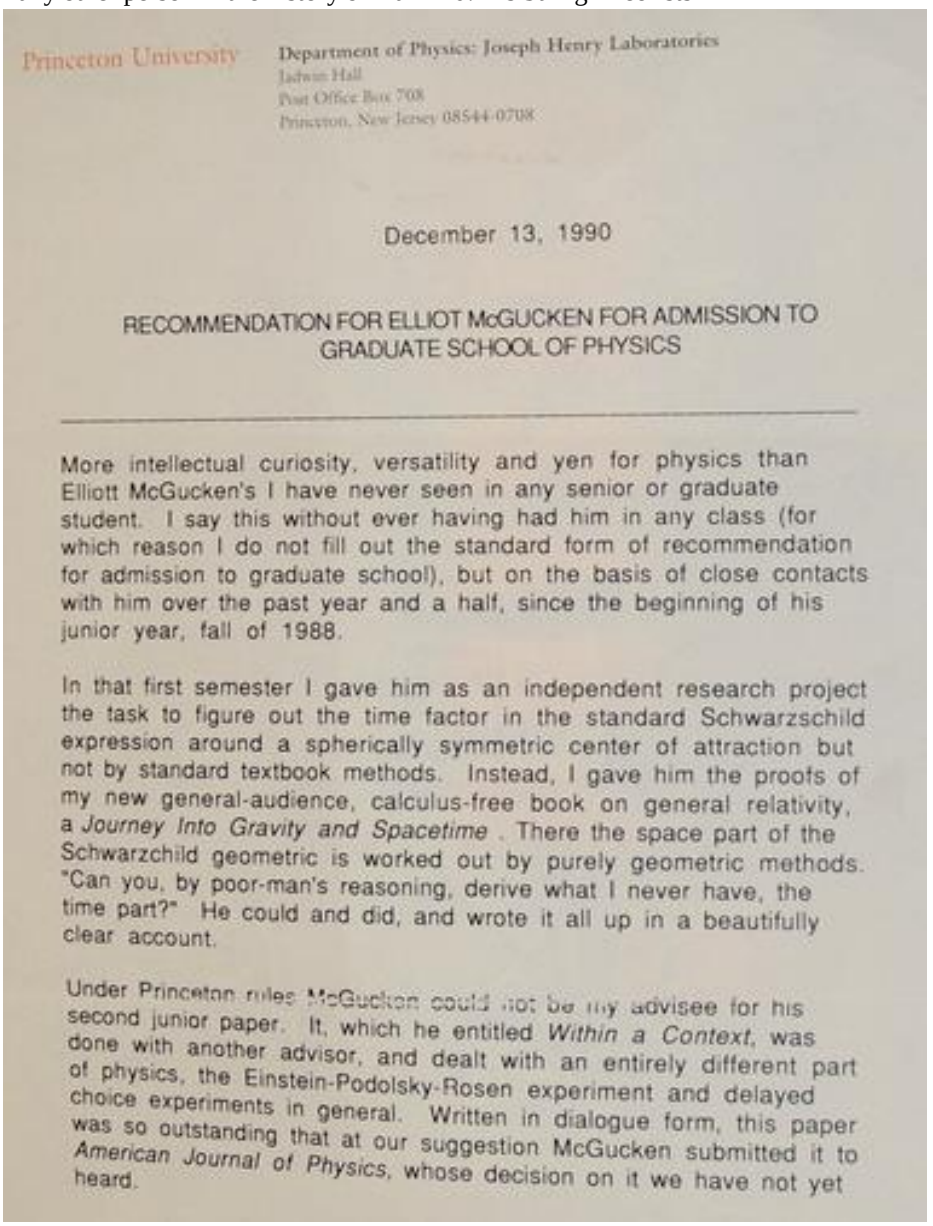


Einstein: Once it was recognized that the earth was not the center of the world, but only one of the smaller planets, the illusion of the central significance of man himself became untenable. Hence, Nicolaus Copernicus, through his work and the greatness of his personality, *taught man to be honest*.[vi]
-- Message on the 410th Anniversary of the Death of Copernicus, 1953

Albert Einstein: But before mankind could be ripe for a science which takes in the whole of reality, a second fundamental truth was needed, which only became common property among philosophers with the advent of Kepler and Galileo. Pure logical thinking cannot yield us any knowledge of the empirical world; all knowledge of reality starts from experience and ends in it. Propositions arrived at by purely logical means are completely empty as regards reality. Because Galileo saw this, and particularly because he drummed it into the scientific world, he is the father of modern physics—indeed, of modern science altogether.[vii] –Einstein *Ideas and Opinions*

Dr. E's Law: Debt-based money drives honor out of circulation. A fiat monetary system must debase honor alongside the currency, debauching classical Homeric, Mosaic notions of Natural Rights, which stand in the way of the dishonorable transfer of wealth via the inflation and deflation of bubbles, as profits are privatized while risks and are socialized, as wealth gushes on up while debt trickles on down. The fiatcrat must invert Socrates', Einstein's, and Steve Jobs' teaching that "Virtue does not come from money, but money and every lasting good of man derives from virtue," so that it becomes, "Virtue comes from creating debt to bail out

the banks while burdening the citizenry with it, which is why Ben Bernanke was Time Magazine's *Person of the Year*, as he has created more debt than any other person in the history of mankind. As String Theorists and multiversers augment the debt in an unprecedented manner, they too have been rewarded with hundreds of millions for their failed theories."



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December 13, 1990

RECOMMENDATION FOR ELLIOT McGUCKEN FOR ADMISSION TO GRADUATE SCHOOL OF PHYSICS

More intellectual curiosity, versatility and yen for physics than Elliott McGucken's I have never seen in any senior or graduate student. I say this without ever having had him in any class (for which reason I do not fill out the standard form of recommendation for admission to graduate school), but on the basis of close contacts with him over the past year and a half, since the beginning of his junior year, fall of 1988.

In that first semester I gave him as an independent research project the task to figure out the time factor in the standard Schwarzschild expression around a spherically symmetric center of attraction but not by standard textbook methods. Instead, I gave him the proofs of my new general-audience, calculus-free book on general relativity, a *Journey Into Gravity and Spacetime* . There the space part of the Schwarzchild geometric is worked out by purely geometric methods. "Can you, by poor-man's reasoning, derive what I never have, the time part?" He could and did, and wrote it all up in a beautifully clear account.

Under Princeton rules McGucken could not be my advisee for his second junior paper. It, which he entitled *Within a Context*, was done with another advisor, and dealt with an entirely different part of physics, the Einstein-Podolsky-Rosen experiment and delayed choice experiments in general. Written in dialogue form, this paper was so outstanding that at our suggestion McGucken submitted it to *American Journal of Physics*, whose decision on it we have not yet heard.

Albert Einstein: It is anomalous to replace the four-dimensional continuum by a five-dimensional one and then subsequently to tie up artificially one of those five dimensions in order to account for the fact that it does not manifest itself. [viii] -Einstein to Ehrenfest (Imagine doing this for String Theory's 10-30+ dimensions!)

R.P. Feynman: String theorists don't make predictions, they make excuses.[ix] – Feynman, Nobel Laureate

Robert Laughlin: String theory is like a 50 year old woman wearing too much lipstick. [x] -Nobel Laureate

Gerald 't Hooft: Actually, I would not even be prepared to call string theory a "theory" rather a "model" or not even that: just a hunch. After all, a theory should come together with instructions on how to deal with it to identify the things one wishes to describe, in our case the elementary particles, and one should, at least in principle, be able to formulate the rules for calculating the properties of these particles, and how to make new predictions for them. Imagine that I give you a chair, while explaining that the legs are still missing, and that the seat, back and armrest will perhaps be delivered soon; whatever I did give you, can I still call it a chair?[xi] –Gerald 't Hooft, Nobel Laureate

Sheldon Glashow: It is tragic, but now, we have the string theorists, thousands of them, that also dream of explaining all the features of nature. They just celebrated the 20th anniversary of superstring theory. So when one person spends 30 years, it's a waste, but when thousands waste 20 years in modern day, they celebrate with champagne. I find that curious.[xii] Nobel Laureate

R.P. Feynman: I think all this superstring stuff is crazy and it is in the wrong direction. … I don't like that they're not calculating anything. I don't like that they don't check their ideas. I don't like that for anything that disagrees with an experiment, they cook up an explanation—a fix-up to say "Well, it still might be true."[xiii]

The great Wheeler told me that he witnessed three distinct phases in his career in physics—when he saw particles as foundational, when he saw fields as foundational, and lastly, when he saw information as foundational. The past four decades in physics have shown little, if any, progress; while the overhyped promises of quantum computing remain a distant pipe dream. While the LHC has triumphed in further verifying the Standard Model while testing decades-old theories predicting the Higgs, theoretical physics, save for MDT, has failed to present any new predictions or offer any novel physical models unifying and explaining hitherto disparate phenomena capable of being tested. Never before has so much money been spent on theoretical physics, without any Noble results. Wheeler characterized the state of particle physics circa 1990 as "ino-itus," as it seemed to focus on the librarian's task of cataloguing the details of the Standard Model, rather than breaking new ground with majestic, profound, *foundational* ideas representing *physical* reality such as Moving Dimensions Theory's $dx_4/dt=ic$. MDT is a most simple, powerful unifier. MDT begins with the simple postulate that the fourth dimension is expanding relative to the three spatial dimensions, from where all relativity may be derived. Moving Dimensions Theory provides a physical model for the foundations of relativity and quantum mechanics, as well as for entropy. MDT's simple postulate and equation, reflecting the hitherto unacknowledged physical reality of a fourth expanding dimension, unites all of time's arrows via a physical model which shows that time is emergent from MDT's foundational reality of a fourth expanding dimension. MDT shows why both *It from Bit* and *Bit from It* offer practical interpretations of the universe, as MDT provides a physical model for the dualities—Space/Time, Wave/Particle, E/B, Mass/Energy, Body/Soul, and It/Bit. Time and all its arrows and asymmetries naturally emerge from MDT's central equation and postulate that a fourth dimension is expanding relative to the three spatial dimensions. MDT has a testable postulate and equation uniting and explaining a diverse array of physical phenomena, thusly serving the Einsteinian Spirit. Wheeler knew that wisdom and knowledge were far more important than information, and so he would also celebrate MDT's spiritual triumph, even as the maligned Copernicus notes that the insiders receive all the fiat dollars for decades of failure. MDT serves the heroic spirit of Wheeler and Einstein:

> Albert Einstein: Any intelligent fool can make things bigger, more complex, and more violent. It takes a touch of genius—and a lot of courage—to move in the opposite direction.[xiv] (*dx4/dt=ic*)

Moving Dimensions Theory—which regards time as an emergent phenomena—was inspired in part by Einstein's words pertaining to the higher purpose of physical theories: "Before I enter upon a critique of mechanics as a foundation of physics, something of a broadly general nature will first have to be said concerning the points of view according to which it is possible to criticize physical theories at all. The first point of view is obvious: The theory must not contradict empirical facts. . .(MDT is in full agreement with relativity and quantum mechanics—with entanglement, entropy, and all of times arrows and asymmetries) The second point of view is not concerned with the relation to the material of observation but with the premises of the theory itself, with what may briefly but vaguely be characterized as the "naturalness" or "logical simplicity" of the premises (of the basic concepts and of the relations between these which are taken as a basis). This point of view, an exact formulation of which meets with great difficulties, has played an important role in the selection and evaluation of theories since time immemorial." MDT's simple postulate and equation provide a physical model for a wide array of hitherto

seemingly disparate physical phenomena: The fourth dimension x_4 is expanding relative to the three spatial dimensions at *c* or $dx_4/dt=ic$. Ergo relativity, quantum mechanics, entanglement, nonlocality, all the dualities, Huygens' Principle, and time and all its arrows and asymmetries.

Over the past few decades prominent physicists have noted that physics has diverged away from its heroic journey once defined by boldly describing, fathoming, and characterizing foundational truths of physical reality via simple, elegant, logically-consistent postulates and equations humbling themselves before empirical reality. Herein the spirit of physics is again exalted by the heroic words of the Greats—by Galileo, Newton, Faraday, Maxwell, Planck, Einstein, Bohr, and Schrodinger—the Founding Fathers upon whose shoulders physics stands. And from that pinnacle, a novel physical theory is proposed, complete with a novel physical model celebrating a hitherto unsung universal invariant and an equation reflecting the foundational physical reality of a fourth dimension expanding relative to the three spatial dimensions at the rate of c, or dx4/dt=ic, providing both the "elementary foundations" for relativity and QM's "characteristic trait"—entanglement, and its nonlocal, probabilistic nature. From MDT's experimentally-verified equation relativity is derived while time is unfrozen and free will exalted, while a physical model accounting for quantum nonlocality is presented. Entropy, Huygens' Principle; the wave/particle, energy/mass, space/time, and E/B dualities; and time and all its arrows and asymmetries emerge from a common, foundational physical model. MDT exalts Einstein's "empirical facts," "naturalness," and "logical simplicity." For the first time in the history of relativity, change is woven into the fabric of space-time, and the timeless, ageless, nonlocal photon of Galileo's/ Einstein's "empirical world" is explained via a foundational physical model, alongside the fact that c is both constant and the maximum velocity in the universe. The empirical GPS clocks' time dilation/ twins paradox is resolved by proposing a frame of absolute rest—the three spatial dimensions, and a frame of absolute motion—the fourth expanding dimension upon which ageless photons of zero rest mass surf; which underlie and give rise to Einstein's Principle of Relativity.

The photon may be used to physically probe and trace the discrete, digital, dynamic nature of x4 as the quantum nature of physical measurement is examined, while the foundational papers of Planck, Bohr, Heisenberg, et al. are exalted, lead by Einstein's statement that physics "starts from experience and ends in it." In its simplest case, a photon oscillates while propagating at c as a probabilistic wave-front expanding through the three spatial dimensions in a spherically-symmetric manner, as demonstrated by the classic double- slit experiment, leading to the natural conclusion that x4, in which the photon remains stationary according to relativity, must thusly be oscillating and propagating at c as a spherically-symmetric expanding wavefront. Relativity informs us that all of a photon's motion is through the three spatial dimensions, thusly dictating that the timeless, ageless photon remains stationary in the fourth dimension *x4*. As electromagnetic radiation (the photon) is quantized, while there is no evidence for quantum gravity, we may conclude that x4 is quantized and digital in nature, while the three spatial dimensions are continuous and analog in nature. qp-pq=iħ (Born & Heisenberg) and $x4=ict$ or $dx4/dt=ic$ (Einstein & Minkowski) are fundamental relationships of QM and relativity. Both equations have differentials on the left and an *i* on the right, as Bohr noted, suggesting that a foundational change is occurring in a "perpendicular" manner, implying a fourth moving dimension. $qp\text{-}pq = i\hbar$ reflects the discrete increment and quantum action—$\hbar$ —that emerges from the dynamic, discretely parceled space-time geometry born by the discrete wavelength of *x4*'s expansion; while $dx_4/dt=ic$, from which relativity and its postulates derive, sets the velocity of the expansion of *x4* to *c*. A physical model encompassing

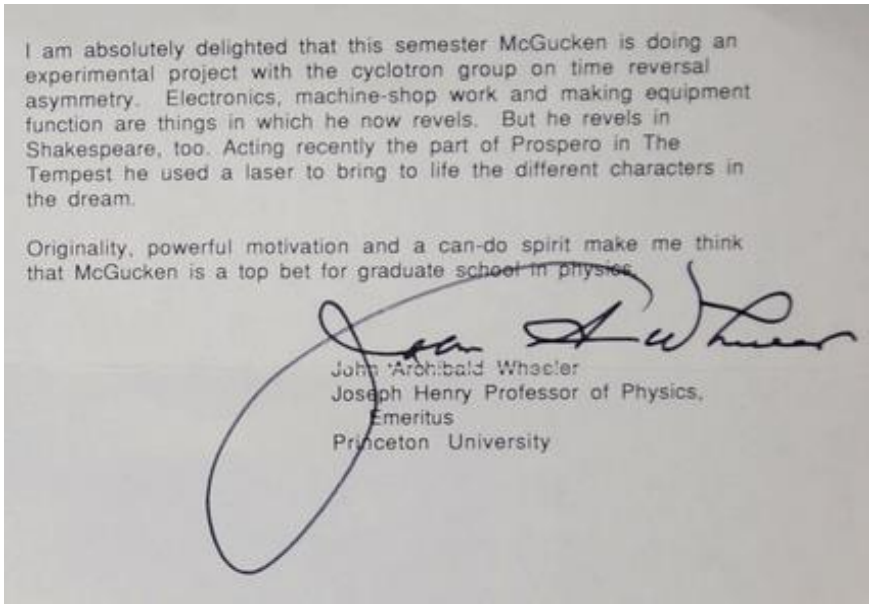
both Einstein's "elementary foundations" of relativity and Schrodinger's "characteristic trait" of QM—entanglement— is presented.

> MDT's postulate: The fourth dimensions is expanding relative to the three spatial dimensions at *c*.
> MDT's equation: *dx4/dt=ic*.
> Simple, logical proofs of MDT: MDT PROOF#1: Relativity tells us that a timeless, ageless photon remains in one place in the fourth dimension. Quantum mechanics tells us that a photon propagates as a spherically-symmetric expanding wavefront at the velocity of *c*. Ergo, the fourth dimension must be expanding relative to the three spatial dimensions at the rate of *c*, in a spherically-symmetric manner. The expansion of the fourth dimension is the source of nonlocality, entanglement, time and all its arrows and asymmetries, c, relativity, entropy, free will, and all motion, change, and measurement, for no measurement can be made without change. For the first time in the history of relativity, change has been wedded to the fundamental fabric of spacetime in MDT.
> MDT PROOF#2: Einstein (1912 Man. on Rel.) and Minkowski wrote $x_4=ict$ [xv]. Ergo $dx_4/dt=ic$.
> MDT PROOF#3: The only way to stay stationary in the three spatial dimensions is to move at c through the fourth dimension. The only way to stay stationary in the fourth dimension is to move at c through the three spatial dimensions. Ergo the fourth dimension is moving at c relative to the three spatial dimensions. MDT twitter proof (limited to 140 characters): SR: photon is stationary in 4th dimension. QM: photon is probability wave expanding @ c. Ergo: 4th dimension expands @ c & MDT: $dx_4/dt=ic$ –from http://twitter.com/45surf

In his *1912 Manuscript on Relativity*[xvi], Einstein never stated that time is the fourth dimension, but rather he wrote $x_4 = ict$. The fourth dimension is not time, but *ict*. Despite this, prominent physicists have oft equated time and the fourth dimension, leading to un- resolvable paradoxes and confusion regarding time's physical nature, as physicists mistakenly projected properties of the three spatial dimensions onto a time dimension, resulting in curious concepts including frozen time and block universes in which the past and future are omni-present, thusly denying free will, while implying the possibility of time travel into the past, which visitors from the future have yet to verify. Beginning with the postulate that time is an emergent phenomenon resulting from a fourth dimension expanding relative to the three spatial dimensions at the rate of *c*, diverse phenomena from relativity, quantum mechanics, and statistical mechanics are accounted for and unified with a hitherto unsung universal invariant $dx_4/dt=ic$. Time dilation, the equivalence of mass and energy, quantum entanglement, nonlocality, wave-particle duality, and entropy are shown to arise from a common, deeper physical reality expressed with $dx_4/dt=ic$. This postulate and equation, from which Einstein's relativity is derived, presents a fundamental model accounting for the emergence of time, the constant velocity of light, the fact that the maximum velocity is c, and the fact that c is independent of the velocity of the source, as photons are but matter surfing a fourth expanding dimension. In general relativity, Einstein showed that the dimensions themselves could bend, curve, and move. The present theory extends this principle, postulating that the fourth dimension is moving independently of the three spatial dimensions, distributing locality and fathering time. This physical model underlies and accounts for time in quantum mechanics, relativity, and statistical mechanics, as well as entropy, the universe's expansion, and time's arrows and asymmetries in all arenas.

I am forever indebted to J.A. Wheeler who called upon us all to ask foundation questions. Wheeler always used to say, "I want to know what the show is all about, before it's out." And not only were foundational encouraged in his office, but one could not enter nor leave without naturally asking them. His Great Spirit has moved on, and while the past is no longer real, the immortal soul is, as Socrates concludes.

Here're some of the poems I wrote in grad school—I sent them to Wheeler during that first year of grad school:



I am absolutely delighted that this semester McGucken is doing an experimental project with the cyclotron group on time reversal asymmetry. Electronics, machine-shop work and making equipment function are things in which he now revels. But he revels in Shakespeare, too. Acting recently the part of Prospero in The Tempest he used a laser to bring to life the different characters in the dream.

Originality, powerful motivation and a can-do spirit make me think that McGucken is a top bet for graduate school in physics.

John Archibald Wheeler
Joseph Henry Professor of Physics,
Emeritus
Princeton University

cxl.
Now suppose we have a hole in a slate,
A photon from a source passes on through,
And it darkens a grain on a film plate,
To say it went through the hole would be true.
Several photons pass through, we wait a bit,
And quite a simple pattern we do see,
A bright spot directly behind the slit,
Fading away as you move outwardly.
We choose to add an additional slit,
The photon seems to have a decision,
It must choose one of them through which to fit,
For photons are not allowed to fission.
But now there are fringes, common to waves!
In this manner, can particles behave?
cxli.
What's seen is an interference pattern,
Which is common to every type of wave,
On the vast ocean or from a lantern,
This is the way every wave does behave.
Though you think particles blacken the spot,
Between the source and plate light is a wave,
As to its whereabouts we can say not,
Such is the way reality behaves.
These ghostly facts are true of all matter,
Electrons and protons and you and me,
We're but empty waves that somehow matter,
Striving to comprehend reality.
Wavy winds blow, our consciousness is lit.
It makes up our mind, our minds make up it.
cxlii.
"The question is to be or not to be,
Whether it is nobler within the mind,
To believe in indeterminacy,
Or refute that God plays dice in the wind.
Are there many worlds, or only just this one?
And is Schrodinger's cat alive or dead?
Of p and x, can we only know one?

And of Wigner's good friend, what can be said?"
He smiled and said, "no question, no answer,
This above all, science holds to be true,
Love is in the mind of the romancer,
And the kind of love determines the view."
He looked up to the sky, a sky few see,
A sky filled with a child's curiosity."

I shared Wheeler's grand sense of the exalted, Noble nature of physics—as an heroic journey where Honor was gained by pursuing Truth instead of mere money—and Wheeler wrote a kind recommendation for me, which allowed me to continue my graduate studies whence I developed an artificial retina which is now helping the blind see. The Merrill Lynch Innovations award-winning, Fight-For-Sight and NSF-funded dissertation was titled *Multiple Unit Artificial Retina Chipset to Aid the Visually Impaired and Enhanced CMOS Phototransistors* contained an early treatment of *Moving Dimensions Theory* in an appendix. Sensing the dead-end of String Theory and other dominant forms of theoretical physics, and unable to find a mentor like Wheeler, I instead devoted myself to serving humanity and helping the blind. Little did I know it at the time that helping the blind to see would lead to my being snubbed by the elite, fiat-funded physicists. Wheeler had written in my graduate recommendation, "More intellectual curiosity, versatility and yen for physics than Elliot McGucken's I have never seen in any senior or graduate student . . . Originality, powerful motivation, and a can-do spirit make me think that McGucken is a top bet for graduate school in physics. . . I say this on the basis of close contacts with him over the past year and a half. . . I gave him as an independent task to figure out the time factor in the standard Schwarzchild expression around a spherically- symmetric center of attraction. I gave him the proofs of my new general-audience, calculus-free book on general relativity, A Journey Into Gravity and Space Time. There the space part of the Schwarzchild geometric is worked out by purely geometric methods. "Can you, by poor-man's reasoning, derive what I never have, the time part?" He could and did, and wrote it all up in a beautifully clear account. . . .his second junior paper . . .entitled Within a Context, was done with another advisor (Nobel Laureate Joseph Taylor), and dealt with an entirely different part of physics, the Einstein-Rosen-Podolsky experiment and delayed choice experiments in general. . . this paper was so outstanding. . . I am absolutely delighted that this semester McGucken is doing a project with the cyclotron group on time reversal asymmetry. Electronics, machine-shop work and making equipment function are things in which he now revels. But he revels in Shakespeare, too. Acting the part of Prospero in the Tempest. . . " –John Archibald Wheeler, Princeton University, Recommendation for Elliot McGucken for Admission to Graduate School of Physics

As Born, Feynman (Wheeler's student), Einstein (Wheeler's Colleague), Galileo, *et al.* remind us throughout all my papers and research, the greatest physicists have ever advanced physics by focusing on physical, empirical reality, as MDT does; beginning and ending not in meta-theories nor speculative meta-research on information, but in *physical reality* reflected in a physical model which unites a wide-realm of hitherto seemingly unrelated physical phenomena. The past four decades of failure in theoretical physics offers, coupled together with MDT's irrefutable triumphs, offer empirical proof.

Whether it is It from Bit, or Bit From It, It does not Come from the Top Down

Wheeler's great student, the Noble Laureate R.P. Feynman, stated that the advancement of science cannot be dictated by the top down, as FQXI has been attempting to do resulting in a five year dry-spell during which the only theory with a consistent, novel, foundational, physical, testable model of the universe, complete with a postulate and equation, was ignored. In response to the question, "Do you find that these days when you are faced with a particularly difficult problem, when you are absolutely stuck, you still tend to say, "Let's look at it like a Martian would look at it?" Wheeler's great student R.P. Feynman stated, "Sometimes. But there are a lot of things that people have done. For example, Faraday described electricity by inventing a model (field lines). Maxwell formulated the equations mathematically with some model in his head, and Dirac got his answer by just writing and guessing an equation. Other people, like in relativity, got their ideas by looking at the principles of symmetry – and Heisenberg got his quantum mechanics by only thinking and talking about the things he could measure. Now take all these ideas: Try to define things only in terms of what we can measure. Let's formulate the equation mathematically, or let's guess the equation – all these things are tried all the time. All that stuff – when we are going against the problem, we do all that. It is very useful, but we all know that. That is what we learn in physics classes – how to do that. But the new problem is where we are stuck. We are stuck because all those methods don't work. If any of those methods would work, we would have gone through them. So when we get stuck in a certain place, it is a place where history will not repeat itself. And that even makes it more exciting. Because whatever we are going to see – the method, the trick, or the way it's going to look – it's going to be very different from the way we have seen before, because we have used all the methods from before. So therefore a thing like the history of the idea is an accident of how things actually happen. And if I want to turn history around to try to get a new way of looking at it, it doesn't make any difference; *the only real test in physics is experiment*, and history is fundamentally irrelevant."[xvii]

So it is that it will do physicists little good to say, "All must be information," or "All must be strings (that nobody has ever seen, and which cannot be experimentally tested)," or "All must be tiny, little loops (that nobody has ever seen, and which cannot be experimentally tested)." Today, the numerous decades of failed physics "research," lacks the Noble that the great J.A. Wheeler called for. Einstein, Wheeler, and Feynman would not be happy to witness governmental bureaucrats dictating curiosity from top-down research programs with a four-decade history of failure in funding thousands of failed physicists. Feynman stipulates, "No government has the right to decide on the truth of scientific principles, nor to prescribe in any way the character of the questions investigated. Neither may a government determine the aesthetic value of artistic creations, nor limit the forms of literacy or artistic expression. Nor should it pronounce on the validity of economic, historic, religious, or philosophical doctrines. Instead it has a duty to its citizens to maintain the freedom, to let those citizens contribute to the further adventure and the development of the human race."[xviii] And soon, very soon, the triumph of MDT shall be recognized, as profound wisdom descends from the foundational insight (and new information) that $dx_4/dt=ic$, from where time and all its arrows and asymmetries have been shown to emerge alongside quantum mechanics and relativity.

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[viii] A. Calaprice, Dyson, *The New Quotable Einstein, Princeton University Press*; (February 22, 2005)

[ix] P. Woit*, Not Even Wrong: The Failure of String Theory and the Search for Unity in Physical Law, Basic Books 2006 p. 174*

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[xiv] A. Calaprice, Dyson, *The New Quotable Einstein, Princeton University Press*; (February 22, 2005)

[xv] A. Einstein, *1912 Manuscript on the Special Theory of Relativity*, George Braziller, 2004, p. 86

[xvi] A. Einstein, *1912 Manuscript on the Special Theory of Relativity*, George Braziller, 2004

[xvii] Feynman, RP, *Take the world from another point of view*. http://calteches.library.caltech.edu/35/2/PointofView.htm Accessed 6/22/2013 (*This is a Yorkshire Television interview with Richard Feynman, which was shown in Great Britain in 1973. Our article is an abridged – but otherwise unedited – transcript of the sound track, with the comments and questions of the interviewer in italics*.)

[xviii] R.P. Feynman, "The Uncertainty of Values", in *The Meaning of It All: Thoughts of a Citizen Scientist* (1999).