“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

On Deriving Relativity & Entanglement from MDT’s Fundamental Physical Reality: \(\frac{dx_4}{dt}=ic\)

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’s \(\frac{dx_4}{dt}=ic\). E pur si muove!

by Dr. Elliot McGucken

\(\frac{dx_4}{dt}=ic\)

“Equations are more important to me, because politics is for the present, but an equation is something for eternity.” – Albert Einstein

ABSTRACT:
Over the past few decades prominent physicists have noted that physics has diverged away from its classical, heroic journey traditionally defined by 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 \(\frac{dx_4}{dt}=ic\), providing both the “elementary foundations” for relativity which Einstein yet sought 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, massless, nonlocal photon of Galileo’s/Einstein’s “empirical world” is explained via a foundational physical model, alongside the fact that \(c\) is constant, independent of the source, and the maximum velocity in the universe, as well as the only velocity through space-time. 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
Galileo, Newton, and Einstein: The Heroic Physicists

Time as an Emergent Phenomenon & Deriving Einstein’s Relativity from Moving Dimensions Theory’s \( \frac{dx^4}{dt} = ic \): Traveling Back to the Heroic Age of Physics

In Memory of John Archibald Wheeler

by Dr. Elliot McGucken

MDT’s postulate: The fourth dimensions is expanding relative to the three spatial dimensions at \( c \). MDT’s equation: \( \frac{dx^4}{dt} = ic \).

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 \( x^4 = ict \). Ergo \( \frac{dx^4}{dt} = ic \).

**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: \( \frac{dx^4}{dt} = ic \) —from [http://twitter.com/45surf](http://twitter.com/45surf)

**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 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.

“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 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.
“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’ entanglement, and entropy all 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. For the first time in the history of relativity, change is woven into the fundamental fabric of spacetime as we are liberated from the block universe. MDT’s 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 (as the expanding fourth dimension distributes locality, fathering nonlocality) 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. The t axis on space-time axis is a human construct—a useful construct, but one that misleadingly implies the possibility of time travel into the past.

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. And hence the interference pattern seen in Young’s Double-Slit experiment, as the photon passes through both slits as a nonlocal wave.

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 at the rate of c (\(dx4/dt=ic\)), thusly weaving change into the fundamental fabric of spacetime where it needs to be as without change there can be no measurement, and without measurement there can be no physics. MDT liberates 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. The nonlocality of the fourth dimension, caused by its expansion at $c$, gives rise to the physical connectivity between the separated photons.

Is it not curious that entanglement only occurs for two initially-interacting particles or photons? Is it not curious that all nonlocality has a local point of origin in the three spatial dimensions? Is it not curious that the maximum rate of the distribution of nonlocality is $c$? All of this points to the fact that the fourth dimension is expanding relative to the three spatial dimensions at $c$, or $\frac{dx_4}{dt} = ic$.

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 $9 \times 10^{16}$ 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 instantly 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 $3 \times 10^8$ 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 $dx_4/dt = ic$

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 $\alpha_{ij}$ 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.

Begin with a 4D universe \( x_1, x_2, x_3, \) and \( x_4 \) wherein \( dx_4/dt=ic \), and all of relativity naturally arises. 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:

\[
\frac{dx_4}{dt} = ic
\]

\[
\int_a^u \frac{dx_4}{dt} \, dx_4 = \int_a^u ic \, dx_4
\]

\[
\int_a^u \frac{dx_4}{dt} \, dx_4 = x_4(u) - x_4(a)
\]

\[
\int_a^u ic \, dx_4 = icu - ica
\]

\[
x_4(u) - x_4(a) = icu - ica
\]

\[
x_4(u) = icu - ica + x_4(a)
\]

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. Einstein did not perceive that quantum mechanics’ nonlocality and entanglement—its characteristic trait according to Schrodenger—could be accounted for with \(dx^4/dt=ic\), as Einstein did not fully accept QM’s nonlocality and entanglement. 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 due to the constant expansion of the fourth dimension, which is the fount of all change in the universe, as well as of all of time’s arrows and asymmetries.

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 \(\Sigma\) relative to which every light ray propagates in vacuum with velocity \(c\). According to the relativity principle, all reference systems \(\Sigma\) in uniform translation motion to \(\Sigma\) 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 \(\Sigma\)) and \(x', y', z', t'\) (with respect to \(\Sigma'\)) 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 \(\Sigma\) and \(\Sigma'\), 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 \(x, y, z, t\). 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 \(\lambda^2\) for the time being is that it must not vanish. But one can see that \(\lambda^2\) must be independent of \(x, y, z, t\), for otherwise the right-hand side divided by \(\lambda^2\) 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, as well as the more fundamental physical reality underlying and motivating relativity, quantum mechanics, and entropy, as well as time’s arrows and asymmetries—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:

\[
y' = \alpha_{21}x + \alpha_{22}y + \alpha_{23}z + \alpha_{24}dt
\]

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 \( \alpha \) 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 \( x_4 = ict \), 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 unfreezing time, liberating us from a block universe, and providing physical interpretations for quantum mechanical phenomenon and statistical mechanics, as well as a fundamental physical model upon which relativity and quantum mechanics rests.

**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 antimatter. 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 $dx^4/dt=ic$, 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

by Dr. Elliot McGucken

dx4/dt=ic

“Equations are more important to me, because politics is for the present, but an equation is something for eternity.” –Albert Einstein

ABSTRACT:

Over the past few decades prominent physicists have noted that physics has diverged away from its classical heroic journey traditionally defined by boldly describing, fathoming, and characterizing foundational truths of physical reality via simple, elegant, logically-consistent postulates and equations which humbled 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, massless, nonlocal photon of Galileo’s/Einstein’s “empirical world” is explained via a foundational physical model, alongside the fact that c is constant, independent of the source, and the maximum velocity in the universe, as well as the only velocity through space-time. 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. ² –Einstein

Galileo, Newton, and Einstein: The Heroic Physicists

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. ³ –Einstein, 1954
**The only real valuable thing is intuition.** –Einstein

A person starts to live when he can live outside himself. –Einstein

The only thing that interferes with my learning is my education. –Einstein

Peace cannot be kept by force. It can only be achieved by understanding. –Einstein

No great discovery was ever made without a bold guess. –Einstein

For an idea that does not at first seem insane, there is no hope. –Einstein

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

In questions of science, the authority of thousands is not worth the humble reasoning of one individual. –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. –Einstein/Infeld, *The Evolution of Physics*

**Heroism on command, senseless violence, and all the loathsome nonsense that goes by the name of patriotism -- how passionately I hate them!** –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. –Einstein, *Ideas and Opinions*

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

... my dear Kepler, what do you think of the foremost philosophers of this University? In spite of my oft-repeated efforts and invitations, they have refused, with the obstinacy of a gluttonous adder, to look at the planets or Moon or my telescope. –Galileo

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

---

**Max Planck, Niels Bohr, and Erwin Schrödinger: Heroic Fathers of the Quantum**

How wonderful that we have met with a paradox. Now we have some hope of making progress. –Niels Bohr

MDT was born by explaining away the paradoxical implications of Godel’s block universe as well as the Einstein, Rosen, Podolsky effect. Until MDT came along, time was frozen in a block universe and there was no underlying physical model for relativity not quantum mechanics, let alone one which united them.

Every great and deep difficulty bears in itself its own solution. It forces us to change our thinking in order to find it. –Niels Bohr

...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 ... Beside themselves with passion, some of them would not be backward even about scheming to suppress and silence their adversaries.... No good can come of dealing with such people . . . their company may be not only unpleasant but dangerous.13 —Galileo

Maxwell, Farady, and Ampere—the Heroic Fathers of Classical Electricity and Magnetism

Millions saw the apple fall, but Newton was the one who asked why.14 —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.15 —Newton

Everything should be made as simple as possible, but not simpler.16 —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.17 —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.18 —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 and equation 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 Relativity19 and derives the Einsteinian/Minkowskian formulation of relativity from MDT’s dx4/dt=ic: Time as an Emergent Phenomenon: Traveling Back to the Heroic Age of Physics: fqxi.org/community/forum/topic/238 & fqxi.org/community/forum/topic/432.

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.20 –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?21 –Wheeler

Three Rules of Work: Out of clutter find simplicity; From discord find harmony; In the middle of
difficulty lies opportunity.22 –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.

A simple postulate and equation \[ dx4/dt=ic \] bestowed upon us a myriad of profound consequences
across all realms of physics—granting us both the “elementary foundations” for relativity that Einstein yet
sought, while also providing the elementary foundations for Schrodinger’s “characteristic trait” of QM—
entanglement. 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.23 –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.  

I don't believe in mathematics.  

Do not worry about your difficulties in mathematics, I assure you that mine are greater.  

Geometry is not true, it is advantageous.  

In *Einstein's Mistakes*, Dr. Hans Ohanian reports on how physics advances via the emphasis not on math, but on *physical* reality, “(Max) Born described the weak point in Einstein's work in those final years: ‘. . . now he tried to do without any empirical facts, by pure thinking. He believed in the power of reason to guess the laws according to which God built the world.’”  

*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.  

Not everything that counts can be counted, and not everything that can be counted counts.  

Mathematics are well and good but nature keeps dragging us around by the nose.  

In *Disturbing the Universe*, Freeman Dyson writes, “Dick [Feynman] fought back against my skepticism, arguing that Einstein had failed because he stopped thinking in concrete *physical* images (as *MDT* does!) and became a manipulator of equations. I had to admit that was true. 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.” 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.” Please see *MDT*’s *Fig. 1*, presenting a *physical* model, at the end of this document. (Many more to come!)  

In *Dark Matters*, Dr. Percy Seymour writes, “Albert Einstein was a great admirer of Newton, Faraday, and Maxwell. In his office he had framed copies of portraits of these scientists. He had this to say about Faraday and Maxwell: ‘The greatest change in the axiomatic basis of physics—in other words, of our conception of the structure—since Newton laid the foundation of theoretical physics was brought about by Faraday's and Maxwell's work on electromagnetic phenomena.’”  

In his book *Einstein*, Banesh Hoffman and the great Michael Faraday exalt *physical reality* over mere math:  

Meanwhile, however, the English experimenter Michael Faraday was making outstanding experimental discoveries in electricity and magnetism. Being largely self-taught and 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.  

Bohr and Einstein debating the nature of quantum mechanics.  

Einstein: God does not play dice with the universe.  

Neils Bohr: Einstein, stop telling God what to.

Had Einstein wholeheartedly accepted the physical reality of quantum mechanics and the natural nonlocality and entanglement of photons it implied, perhaps he would have seen that not only were light and time connected in relativity, but that relativity and quantum mechanics were connected by a deeper physical reality of a fourth dimension expanding relative to the three spatial dimensions at c. After all, Einstein did write \( x_1 = x, x_2 = y, x_3 = z, \) and \( x_4 = ict \) (implying \( dx_4/dt = ic \) to those bold enough to see it), only he arrived at this years after he set forth the principle of relativity and its two postulates. MDT starts with a more fundamental physical principle and equation—\( dx_4/dt = ic \)—and it derives all of relativity while also providing a physical model for quantum entanglement and nonlocality, and thus its probabilistic nature.

**MDT asks: Why Relativity, Entanglement, Entropy, Nonlocality & Time? The Beauty of Wonderment**

The most beautiful thing we can experience is the mysterious. It is the source of all true art and all science. He to whom this emotion is a stranger, who can no longer pause to wonder and stand rapt in awe, is as good as dead: his eyes are closed. –Einstein

The important thing is not to stop questioning.  

–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?” What physical model—what deeper physical reality underlies relativity? Why relativity, entanglement, entropy, nonlocality, and time? Why free will and motion, and how come we’re not frozen in a block universe, as certain popular interpretations of relativity suggest? And I found the answer in a more fundamental invariance—the fourth dimension is expanding relative to the three spatial dimensions, or \( dx_4/dt = ic \). Change is fundamentally embedded in space-time. And not only can all of relativity be derived from this (as it is in Dr. E’s 2008 paper *Time as an Emergent Phenomenon: Traveling Back to the Heroic Age of Physics:* [fqxi.org/community/forum/topic/238](fqxi.org/community/forum/topic/238) & [fqxi.org/community/forum/topic/432](fqxi.org/community/forum/topic/432)), 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 pure energy—photons with zero rest mass—surf along at $c$.

In *Einstein's Mistakes*, Ohanian writes, “Einstein acknowledged his debt to Newton and to Maxwell, but he was not fully aware of the extent of Galileo's fatherhood. In an introduction he wrote for Galileo's celebrated *Dialogue Concerning the Two Chief World Systems*, he faults Galileo for failing to produce a general mathematical proof. Galileo regarded relativity as an *empirical*, observational fact, that is, a law of nature, and 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.”

**Einstein’s Principle of Relativity Derived from MDT: MDT’s Diverse Sucesses**

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.38  –Einstein

Contrast MDT’s elegant, unifying successes with String Theory's “not even wrongishness” and now entrenched religion of failure. The first page of *String Theory in a Nutshell* states in a footnoted sentence:

String Theory has been the leading candidate … for a theory that consistently unifies all the fundamental forces of nature, including gravity. It 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…”39  –STRING THEORY IN A NUTSHELL

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 about40.  --Nobel Laureate David Gross on string theory

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 excuses41.  –Feynman, Nobel Laureate

String theory is like a 50 year old woman wearing too much lipstick.42  -Robert 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. 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?43  –’t Hooft, Nobel Laureate

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.44  –Glashow, Nobel Laureate
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 might be true.” For example, the theory requires ten dimensions. Well, maybe
there's a way of wrapping up six of the dimensions. Yes, that's all possible mathematically, but
why not seven? . . . So the fact that it might disagree with experience is very tenuous, it doesn't
produce anything; it has to be excused most of the time. It doesn't look right. —Feynman
But superstring physicists have not yet shown that theory really works. They cannot demonstrate
that the standard theory is a logical outcome of string theory. They cannot even be sure that their
formalism includes a description of such things as protons and electrons. And they have not yet
made even one teeny-tiny experimental prediction. Worst of all, superstring theory does not follow
as a logical consequence of some appealing set of hypotheses about nature. —Glashow

The great irony of string theory, however, is that the theory itself is not unified. . . For a theory
that makes the claim of providing a unifying framework for all physical laws, it is the supreme
irony that the theory itself appears so disunited!! —Kaku

If Einstein were alive today, he would be horrified at this state of affairs. He would upbraid the
profession for allowing this mess to develop and fly into a blind rage over the transformation of
his beautiful creations into ideologies and the resulting proliferation of logical inconsistencies.
Einstein was an artist and a scholar but above all he was a revolutionary. His approach to physics
might be summarized as hypothesizing minimally. Never arguing with experiment, demanding
total logical consistency, and mistrusting unsubstantiated beliefs. The unsubstantiated belief of his
day was ether, or more precisely the naïve version of ether that preceded relativity. The
unsubstantiated belief of our day is relativity itself. It would be perfectly in character for him to
reexamine the facts, toss them over in his mind, and conclude that his beloved principle of
relativity was not fundamental at all but emergent (emergent from MDT!) . . . It would mean that
the fabric of space-time was not simply the stage on which life played out but an organizational
phenomenon, and that there might be something beyond. (MDT!) —A Different Universe,
Laughlin, Nobel Laureate

[String Theory] has no practical utility, however, other than to sustain the myth of the ultimate
theory. There is no experimental evidence for the existence of strings in nature, nor does the
special mathematics of string theory enable known experimental behavior to be calculated or
predicted more easily. . . String theory is, in fact, a textbook case of Deceitful Turk, a beautiful
set of ideas that will always remain just barely out of reach. Far from a wonderful technological
hope for a greater tomorrow, it is instead the tragic consequence of an obsolete belief system-in
which emergence plays no role and dark law does not exist. —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 and thus perpetual funding. Nobel Laureates have referred to this present era as the
dark ages of physics, where progress in physics is frozen in a block universe tied together with tiny,
vibrating strings and little loops which nobody has ever physically seen, violating the fundamental maxim
of science put forth by Galileo, Einstein, *et. al.* Feynman echoes the words of the heroic Achilles (whom
Socrates referenced while defending philosophy as a virtuous pursuit in the *Apology*) 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.” (Achilles in Homer’s *Iliad*)
The first principle is that you must not fool yourself—and you are the easiest person to fool. … You just have to be honest in a conventional way after that. . . I would like to add something that's not essential to the science, but something I kind of believe, which is that you should not fool the layman when you're talking as a scientist. . . I'm talking about a specific, extra type of integrity that is not lying, but bending over backwards to show how you are maybe wrong, that you ought to have when acting as a scientist. And this is our responsibility as scientists, certainly to other scientists, and I think to laymen. . . If you're representing yourself as a scientist, then 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.  

—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.  

—Newton

Errors are not in the art but in the artificers.  

—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.  

—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 accomplished this by proposing 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 *empirically* deduce that the fourth dimension must *physically* 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 $dx4/dt=ic$—a hitherto unsung universal invariant.

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

—Galileo
By denying scientific principles, one may maintain any paradox. –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. –Isaac Newton

Conclusion
What is ultimately possible in physics? Physics! MDT & $dx/\, dt = ic$

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. –Einstein

Both photons remain in the same place in the expanding fourth dimension, and thus they are forever physically entangled & forever the same age.

Timeless, ageless, entangled photons of rest mass 0 surf the fourth expanding dimension. The 4th dimension expands, distributing locality. Ageless photons are thus forever entangled.

Ageless, entangled photons have probability of being found anywhere on the 4th dimension’s expanding wavefront. Hence entropy.

Consider two interacting photons surfing the fourth expanding dimension. $dx/\, dt = ic$
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: $dx/dt=ic$. 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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