A Toy Universe

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This Toy Universe is constructed from geometry, force, dimension, particle and such. Of necessity, it steals liberally from the standard theories of physics. It would be impossible to build a somewhat credible Toy Universe from scratch. This Toy Universe is conceptually sufficient to accommodate many ideas from the standard theories of physics; but ultimately it is an incomplete and an incorrect metatheory. Nevertheless, it gives physical insight into how a more complete metatheory of our universe might be built; and why such an explicit metatheory is desirable.

The current Standard Model of Cosmology has an implicit metatheory. We will not try to explicate that standard metatheory; such a task would be too contentious. Our intent is to sketch this Toy Universe, as a metatheory, that can be built one descriptive Axiom at a time; and held in one's mind.

Hopefully, this Toy Universe will stimulate discussion on why and how to construct metatheories. As well, this Toy Universe offers insights into how various non-local cosmic phenomenon might emerge simply by reinterpreting current theories' equations within the framework of a different metatheory.

Finally, every Toy Universe must make predictions that are accountable to the real universe. This Toy Universe is not a flight of fantasy; its Toy Predictions are falsifiable by experiments in the real universe. Because to learn from a Toy Universe; it must be breakable in the real universe.

Introduction

A Toy Universe gives physical insight that is difficult to visualize in the complex details of our real universe. By definition a Toy Universe is incomplete, incorrect and easily broken; but to break such a toy before examining its insight is a waste of imagination.

The purpose of this Toy Universe is to show, in a simple way, how the ideas of geometry, force, dimension, and particle interrelate to build a profound worldview. This Toy Universe is worth examining because it is rich in insights. But it is only one example of how to build a Toy Universe; you may wish to change these few dozen Axioms and build a different Toy Universe.

This Toy Universe is sketched from spherical geometry, Newton's gravity, T-duality, and assumptions suggested by physical observations in the real universe. But this Toy Universe brings these ideas together with handwaving not with detailed mathematical construction. Handwaving is both weakness and strength; it allows rapid construction and visualization; but its assertions are not proof and may prove to be logically or physically unjustified.

For completeness, aspects of the electromagnetic, strong and weak forces are included briefly in building a toy universe; but Newton's gravity and spherical geometry considerations are at the core of this Toy Universe. As well various ideas from special relativity, quantum mechanics, general relativity, quantum field theory, string theory, thermodynamics will contribute to the Axioms of this Toy Universe. It would not be a very good Toy Universe; if we did not try to make it sufficient to accommodate these many important physical ideas. As well this Toy Universe, to be a good metatheory, must offer original insight beyond accommodation of various theories.

Critics will easily break this Toy Universe; and they will be correct. The experimental and theoretical scientific detail about the real universe is of mind-boggling precision. In contrast, this Toy Universe is made of broad assumptions simple enough to hold in one's mind as a toy. For precisely this reason, this Toy Universe should not be casually dismissed. A good toy offers more insights than shortcomings; because it holds the interest of one's mind at play.

The mathematical models in our current golden age of observational astronomy and experimental physics are extremely complex; but they cannot adequately explain persisting observational conundrums[1] (e.g. baryon asymmetry, dark matter, dark energy). Precision experiment and observation over decades have focused upon these conundrums with little more than null results. For sure, the limits of our ignorance have been bounded; but our knowledge is embarrassingly little. This exasperating situation calls for persistence, precision, and imagination.

Toy Universes are metatheories within which physical imagination can play without the full rigor of a Standard Cosmology. But "Standard Cosmology is a narration constructed on the basis of a series of scientific theories that attempt to group together facts and events of a very diverse nature. One cannot affirm that the narration is true for being based on scientific knowledge. No narration is true or false, only more or less credible; its credibility depends on the cultural religious values of its age, and the knowledge the narration is capable of integrating within those cultural value systems."[2]

This Toy Universe is an explicit metatheory constructed of the very same scientific theories and diverse groups of facts from which the Standard Cosmology narrative is constructed. But the Axioms of the Standard Cosmology narrative are neither explicit nor organized as a clear metatheory. The Axioms of the Standard Cosmology metatheory are hidden from general view and debate; they are scattered across physics subspecialties where they are separately debated. We will not explicate the Axioms of the Standard Cosmology's metatheory; that would be too contentious an undertaking. Rather, this Toy Universe is an example of an explicit metatheory framework of Axioms, within which the standard physics theories and experimental facts can be insightfully organized.

From the beginning, this Toy Universe's Axioms offer a different interpretation of specific theories and experiments of physics than the implicit metatheory of Standard Cosmology. This is necessary to illustrate how an overarching metatheory changes the interpretations of equations and observed phenomenon. Not a single equation of physics is changed in this Toy Universe. Yet the narrative is very different, because the overarching metatheory within which equations are interpreted has been changed.

The point is not that this explicit Toy Universe metatheory is correct. The point is that changing a metatheory may offer fresh interpretations of long-standing conundrums and paradoxes. This Toy Universe is but an example of an approach to metatheory building and use.

Let us repeat, the Axioms of this Toy Universe are defined with hand waving; they are neither mathematically proven nor physically precise. The Axioms are merely sufficiently descriptive to geometrically visualize and somewhat consistently build this Toy Universe. Nor is this Toy Universe composed of the fewest number of Axioms; we have not tried to eliminate redundancy. Rather, we selected Axioms for descriptive emphasis. As well much necessary description is written between the Axioms. This process may seem quite arbitrary; but to build a Toy Universe we describe; we do not explain why? However, the process of building a Toy Universe follows an internal logic. Once you assume any Axiom; it sets a direction that must be adhered to; it can be reinterpreted but it can't be deviated from.

It bears repeating that none of the equations from standard physics have been changed. Not one! They have been reinterpreted in extra dimensions, with imaginary numbers, under T-duality symmetry and by other such means that we compose this Toy Universe metatheory.

Toy Gravity and Geometry

A1) Toy Particles occupy a finite 1-dimensional circular space where $x \in \mathbf{R}$.

Thus all Toy Particles reside upon a 1-sphere, at various locations x relative to one another; where the x's are real numbers.

A2) Toy Particles' obeys Newton's gravity $F= G\, m_a m_b/(x_{ab})^2$.

These first two axioms of this Toy Universe are already physically incorrect. Newton's gravity applies to flat 3-dimensional Euclidean space; and not is a suitable theory for a 1-sphere. However, we ask that you restrain your easy criticism; and allow these two Axioms with the following explanation. This Toy Universe's 1-sphere (i.e. circular spatial dimension) is a place-holder for a 3-sphere (which we introduce soon enough). And even then, we will continue to think of a 1-sphere, because it is nearly impossible to think of a 3-sphere. As for Newton's gravity; it is geometrically linked to 3-dimensional Euclidean space, not 1-dimensional Euclidean space[3] and not the 3-dimensional space of a 3-sphere. But of course, a sufficiently large 3-sphere can be made locally flat (in a 3-dimensional Euclidean spatial sense) to whatever degree of precision necessary[4] to accommodate Newton's gravity.

Furthermore, all mass in this paper is m_g, gravitational mass. Inertial mass, m_i, will be explicitly noted when occasionally it is discussed in this Toy Universe. Thus we have not yet defined inertial mass or time in this Toy Universe.

Feynman and Wheeler's idea, that a positron is an electron going backward in time, is a useful concept and equivalent to other QED interpretations.[5] This idea inspires us to reflect upon Newton's gravity and in particular the necessary action-at-a-distance concept which was such a great concern to Newton. Newton's gravity, unlike Einstein's, requires instantaneous action. Hence Newton's gravity does not need a temporal dimension to act. And so far, we have not given this Toy Universe a time dimension. Nevertheless for the moment, we will assume the conventional definition of time so we can assert our next Axiom inspired by Feynman/Wheeler.

A3) Two Toy Particles m_a and m_b moving backwards in time will appear to repel one another gravitationally from our time-forward point of view.

We have not introduced the electromagnetic force yet. So two Toy Particles, m_a and m_b, have no electric charges. And since we haven't really introduced the idea of time yet; we need to formulate A3 and Toy Particles m_a and m_b without the concept of time.

A3 suggests an answer in the form of a question: how do we achieve a negative F_g force of gravity? The answer that a Toy Antiparticle is gravitationally of the same or opposite mass charge as a Toy Particle will work because of assumption A3 in this Toy Universe. We are now ready to define Toy antiParticles as follows.

A4) The gravitational mass of Toy Particles is expressed in real number physical units, e.g.. $m_a \in \mathbf{R}$; the gravitational mass of Toy antiParticles are imaginary number values, e.g. $m_b\mathbf{i} \in \mathbf{I}$.

The use of imaginary numbers is necessary, if we accept A2 and A3. Thus pondering A4, we see that $mass_g$ is no longer simply a scalar quantity. In this Toy Universe mass appears to be a vector quantity, in the sense that it can have either an imaginary number value or a real number values, i.e. $m \in \mathbf{R}$ or $m\mathbf{i} \in \mathbf{I}$.

We see that Newton's gravity $F= G\ m_am_b/(x_{ab})^2$ when applied to two imaginary number masses, $m_a\mathbf{i}$ and $m_b\mathbf{i} \in \mathbf{I}$, mass variables (i.e. both Toy antiParticles) located in the 1-sphere real number geometric space, $x_{ab} \in \mathbf{R}$, of this Toy Universe results in a negative real number force (i.e. a repulsion when $m_a\mathbf{i}$ and $m_b\mathbf{i} \in \mathbf{I}$.)

In this Toy Universe, inertial mass is the absolute value of gravitational mass. Thus

A5) Inertial mass is $m_i = |m_g|$, where $m_g \in \mathbf{R}$ or $m_i = |m_g\mathbf{i}|$, where $m_g\mathbf{i} \in \mathbf{I}$.

Next we reflect upon the observational fact that in the real universe; antiparticles do not exist as a stable state. Antiparticles exist briefly in various particle physics transitions. This clue helps us decide where to put the antiparticles in this Toy Universe.

Examining Newton's gravity equation, we see that the force between two masses, where $m_a \in \mathbf{R}$ and $m_b\mathbf{i} \in \mathbf{I}$ and where $x_{ab} \in \mathbf{R}$ or $x_{ab} \in \mathbf{I}$, results in an imaginary number $F_g\mathbf{i} \in \mathbf{I}$. This observation helps us to decide upon our next Axiom.

A6) Toy antiParticles occupy a finite 1-dimensional circular space where $y\mathbf{i} \in \mathbf{I}$.

Thus all antiparticles reside upon a 1-sphere, at various locations $y\mathbf{i}$ relative to one another where the $y\mathbf{i}$'s are imaginary numbers. Now if the only purpose of A6 was to solve the baryon asymmetry problem; then A6 would be self-serving and this Toy Universe would not be very credible or interesting. However, if A6 offers insight into diverse and unexplained real universe phenomenon from baryon asymmetry to dark matter to neutrino handedness; then to have A6 or not is an important decision in building this Toy Universe metatheory.

At this point, this Toy Universe is composed of two 1-spheres (i.e. 2-spatial dimensions) in which the $x \in \mathbf{R}$ spatial dimension is orthogonal to the $y\mathbf{i} \in \mathbf{I}$ spatial dimension. (3-sphere ideas will be discussed shortly). But this Toy Universe is not a 2-sphere; it composed of two orthogonal 1-spheres that are related by T-duality symmetry.

A7) Toy subUniverse**R** consisting of 1-sphere of $x \in \mathbf{R}$ and the Toy subUniverse**I** consisting of 1-sphere $y\mathbf{i} \in \mathbf{I}$ are T-duality[6] dimensions relative to one another.

Thus this Toy Universe, though partially visualizable, is becoming an extremely complex mathematical object that can not be fully envisioned in classical Euclidean 3-dimensional space. But we can envision it enough to clarify that this 2-dimensional Toy Universe is bifurcated into two physically separated Toy subUniverse. As well, later we will give a physical interpretation with equation of the specific T-duality between Toy subUniverse**R** and Toy subUniverse**I**.

A8) This Toy Universe is bifurcated into two physically equivalent Toy subUniverse points-of-view of classical observers. The first POV is from an Observer**R** of $m \in \mathbf{R}$ located in the real number 1-sphere Toy subUniverse**R**. The second POV is from an Observer**I** of $m\mathbf{i} \in \mathbf{I}$ located in the imaginary number 1-sphere Toy subUniverse**I**.

With these Axioms, we are attempting clear geometric visualization, not concise mathematical logic. Thus, we are not concerned with the intricacies of covering a 2-sphere with Cartesian coordinates.[7] The mathematical difficulties of n-spheres are not the concern or the focus of our descriptive Axioms. Our concern is solely to describe enough to allow sufficient geometric visualization of what will become an 8-dimensional Toy Universe metatheory.

Reflecting upon this Toy Universe, as so far developed; we realize that it is not static; its geometry as well as particles are quite dynamic. Furthermore, we maintain that Newton's gravity does not imply absolute space; it is Newton's other laws that that imply absolute space. Rather, Newton's gravity, with its action-at-a-distance, implies a certain non-locality of space. And it is that sense of non-locality, that Einstein's otherwise superior theory of gravity has lost, and which a quantum theory of gravity must recover from Newton's gravity. Thus we assert that in this Toy

Universe, that space[8] must not be an independent background. So as we define the Axioms of this Toy Universe, the ideas of Toy Particles and Toy Space will become more entangled.

So far, this Toy Universe still has only one force, Newton's gravity and 2-spatial dimensions related by T-duality. We must now assure ourselves, as T-duality requires; that the physics in the Toy subUniverse**I** (from an Observer**I** point of view) is identical to the physics in the Toy subUniverse**R** (from an Observer**R** POV).

In both universes there is one law of physics, Newton gravity, $F = G\ m_a m_b/(x_{ab})^2$. And from an Observer**I** POV in the Toy subUniverse**I**, Newton's law would predict as follows.

$F = G\ m_a\mathbf{i} m_b\mathbf{i}/(y_{ab}\mathbf{i})^2$, multiplying imaginary numbers, we get

$F = G\ (-1)m_a m_b/[(-1)(y_{ab})^2]$ and simplifying, we get

$F = G\ m_a m_b/(y_{ab})^2$

Hence, the laws of physics (i.e. Newton's gravity) in the Toy subUniverse**I** are identical to the laws of physics in the Toy subUniverse**R**.

$F = G\ m_a m_b/(x_{ab})^2$

Thus from the Toy subUniverse**I** POV an Observer**I** will perceive his dimension as being a real number dimension $y \in \mathbf{R}$ 1-sphere. Thus T-duality reciprocity is met; in that neither Observer**I** nor Observer**R** can determine if his dimension is best described by curled imaginary numbers or large real numbers; because obviously either description is equivalent. So for Newton's gravity, we have demonstrated T-duality equivalent physics in both Toy subUniverses. This mathematical assertion is incomplete; however, we are more interested in description than proof. As well later, we will use supersymmetry physical concepts, which will make this T-duality geometric description even more complicated.

It is not yet apparent, why we have chosen to define this Toy Universe as bifurcated into two orthogonal Toy subUniverses that are T-duality equivalent. That will require consideration of specific Toy Universe gravitational phenomenon and the description of effects of the other three forces of physics in this Toy Universe.

We develop a deeper understanding phenomenon in this Toy Universe associated with Newton's gravity by considering the interactions between Toy Particles and Toy antiParticles from an Observer**R** POV. Newton's gravity gives an imaginary number Force of gravity, $F_g\mathbf{i}$; when particle m_a and antiparticle $m_b\mathbf{i}$ are separated by either a real number distance x_{ab} or an imaginary number distance $y_{ab}\mathbf{i}$.

Newton's gravity results in a negative imaginary number Force of gravity, $F_g\mathbf{i} = -$, which cannot be locally observed in the Toy subUniverse**R**, when particle m_a and antiparticle $m_b\mathbf{i}$ are separated by an imaginary number distance $y_{ab}\mathbf{i}$. The force on a Toy Particles m_a in the Toy subUniverse**R** from a Toy antiParticles $m_b\mathbf{i}$ a distance $y_{ab}\mathbf{i}$ in the Toy subUniverse**I** is:

$F_g\ (y_{ab}\mathbf{i}) = G\ m_a m_b\mathbf{i}/(y_{ab}\mathbf{i})^2$

$F_g\mathbf{i} = -\ G\ m_a m_b\mathbf{i}/(y_{ab})^2$

On the other hand, the imaginary number force on a Toy Particles m_a in the Toy subUniverse**R** from a Toy antiParticles $m_b\mathbf{i}$ a distance x_{ab} in the Toy subUniverse**R** is $F_g\mathbf{i} = +$, a positive imaginary number.

$F_g\ (x_{ab}) = G\ m_a m_b\mathbf{i}/(x_{ab})^2$

$F_g\mathbf{i} = +\ G\ m_a m_b\mathbf{i}/(x_{ab})^2$

Now, because these two forces of gravity are imaginary numbers there is no observable real number action within the local Toy subUniverse**R** of real numbers, in which all measurements, e.g. of distance, mass, and time, are by definition all real numbers. However, these $F_g\mathbf{i}$ result in non-local actions that result in quite large non-local phenomenon in the Toy subUniverse**R**. These non-local effects may be thought of as a kind of non-local quantum superposition at the Toy subUniverse**R** level relative to the Toy subUniverse**I** structure; that are due to the classical Newtonian gravity. Newton's gravity is the only force so far.

We must emphasize that the correct interpretations of F_g**i** as non-local phenomenon is based upon logic applied to a higher dimension point of view, i.e. a Toy Universe POV rather than just a Toy subUniverse**R** POV. A higher dimension POV asserts itself in this Toy subUnivere**R**, which is analogous to the real universe; just as multiverses and cosmic landscapes assert themselves as logical physical necessities.

The logic of this Toy Universe implies that certain non-local observable phenomenon in Toy subUniverse**R** can only be understood as non-local phenomenon resulting from cumulative effect of many imaginary number gravitational force interactions, F_g**i** = -**i** and F_g**i** = +**i**.

Thus this Toy Universe predicts two such types of non-local superimposed phenomenon that cannot be observed locally; but that can be inferred from unexplainable non-local observations within the Toy subUniverse**R**. These two Toy subUnivere**R** F_g**i** = -**i** and F_g**i** = +**i**. phenomenon seem to be very different; but they are two sides of the T-duality coin. One is caused by a pervasive force, F_g**i** = -**I**, that must be enormous because y_{ab}**i** is a tiny curled distance. The other F_g**i** = +**i** is caused by a large but sparse force because the occurrence of m_b**i** in the Toy subUniverse**R** is rare. Now we must imagine two non-local phenomenon that might be associated with these two imaginary number forces in this Toy subUniverse**R**.

From the higher dimension Toy Universe view, we visualize the effect of the F_g**i** = -**i** force upon the Toy subUniverse**R** as an orthogonal force trying to push the Toy Particles m_a out of the Toy subUniverse**R**. But the Toy subUniverse**R** gravitationally holds together; hence the entire 1-sphere of Toy subUniverse**R** spins like a ring relative to the curled Toy subUniverse**I**. As well in pushing each Toy Particle orthogonally to its Toy subUniverse**R,** this orthogonal force manifests itself to an Observer**R** as a nonlocal apparent expansion of the Toy subUniverse**R**. That is, the rotation of each individual Toy Particle in the 1-sphere Toy subUniverse**R** can not be thought of as part of classical spinning rigid ring or even as the orthogonal stretching of a classical spinning springy ring. The rotation of each individual Toy Particle orthogonally to the 1-sphere dimension of the Toy subUniverse**R** must be cumulatively thought of as the quantum superposition of the many dimensional rotations of all of the Toy Particles of the entire Toy subUniverse**R**. Thus the spinning classical springy ring analogy fails; and has been replaced by a superposition of multi-dimensional quantum rotations; which is an Observer**R** sees as an apparent nonlocal expansion of the entire Toy subUniverse**R**. This observation is nonlocal because locally this Toy subUniverse**R** is everywhere flat.

On the other hand, we can visualize the F_g**i** = +**i** force as an orthogonal force pushing particles m_a of the Toy subUniverse**R** away from the Toy subUniverse**I**; and thus the entire 1-sphere Toy subUniverse**R** rotates like a wheel relative to the curled Toy subUniverse**I**. As well, this orthogonal force in pushing each particle m_a in a direction parallel to the 1-sphere dimension of the Toy subUniverse**R** creates a gravitational pressure or shock wave traveling around the Toy subUniverse**R**. This pervasive gravitational shock wave manifests itself to an Observer**R** as non-local clumps and voids of Toy Particles in the Toy subUniverse**R**. Thus Newton's gravity appears stronger at the non-local level. This orthogonal gravitational force persistently pressures the toy dust of the Toy subUniverse**R** to organize into cosmic piles and voids of toy dust. Just as Leonardo daVinci[9] noticed, "when a table is struck in different places.. dust that is upon it.. commences to create.. hillocks." Similarly F_g**i** = +**i** is a gravitational shock force that non-locally organizes the Toy Matter of the Toy subUniverse**R** in addition to real number Newtonian gravity $F_g \in \mathbf{R}$. Whereas in the real universe Newton gravity has only a local and real number $F_g \in \mathbf{R}$.

We interpret these two imaginary gravitational forces as being responsible for specific Toy subUniverse**R** non-local phenomenon. In particular, $F_g\mathbf{i} = -\mathbf{i}$ results in a Toy Dark Energy type phenomenon (i.e. an apparent cosmic inflation/expansion); while $F_g\mathbf{i} = +\mathbf{i}$ results in a Toy Dark Matter type phenomenon (i.e. a gravitational shock wave that enhances the gravitational clumping of matter into toy galaxies).

Here, we simply accept the non-local action of these two imaginary number forces; we do not attempt the difficult calculations with many assumptions from a Toy subUniverse**R** POV. In particular when T-duality is taken into account, $F_g\mathbf{i} = -\, G\, m_a m_b \mathbf{i}/(y_{ab})^2$ is an enormous and pervasive force; since y_{ab} is everywhere very tiny from a Toy subUniverse**R** POV. However for $F_g\mathbf{i} = +\, G\, m_a m_b \mathbf{i}/(x_{ab})^2$, we see that x_{ab} can be quite large, and thus assumptions about the distribution of $m_b\mathbf{i}$ in the Toy subUniverse**R** are most important. Also notice that with T-duality, the Newton's gravity force calculations will always results is precisely a real number or an imaginary number force; but never a complex number F_g.

These two imaginary number toy gravitational effects are non-local, cosmic emergent phenomenon that are observable in this Toy subUniverse**R**. Non-local and emergent because such effects can not be observed at the smallest scale of toy elementary particle physics, or even at intermediate scales of classical physics, and must be inferred from phenomenon that deviate from Newton's real number gravity in locally Euclidean and real number Toy subUniverse**R**.[10] Without the concept of the curled imaginary number dimensions of this Toy Universe, an Observer**R** would assume that the Toy subUniverse**R** is an expanding Euclidean space filled with dark matter and dark energy as is the apparent situation in the real universe.

Emergence, in our sense, refers to phenomenon that do not exist at every scale. The solid emerges at the classical scale as an observable; but does not exist at the scale of an atom or a star. Similarly, in this Toy Universe, Toy Dark Matter type phenomenon emerge at the toy galactic scale that are not observables at the classical local scale. The observed Toy Dark Matter type phenomenon in this Toy subUniverse**R** is a cumulative non-local effect of the positive imaginary number force of Newton's gravity, $F_g\mathbf{i} = +\mathbf{i}$.

Thus apparent toy dark matter is explained as a Newtonian gravity T-duality imaginary number shock force. Let us reflect upon this insight. Initially our definition of Toy antiParticles, as existing in an imaginary number 1-sphere Toy subUniverse**I**, perhaps seemed like self-serving fudge to solve the baryon asymmetry problem of our real universe. But now we see that in this Toy subUniverse**R**, Axiom A6 solves not only the toy baryon asymmetry problem; but also the toy dark matter and toy dark energy problem as non-local T-duality $F_g\mathbf{i}$ consequences of Newton's gravity. We will also see that A6 lead to new interpretations of Toy Cosmic Redshift and Toy CMB in the Toy subUniverse**R** as well.

That these five non-local Toy subUniverse**R** cosmic phenomenon results from Axiom A6 shows the far reaching unintended consequences of Axioms; whether the metatheory Axioms is implicit as in big bang metatheories or explicit as in this Toy Universe metatheory.

Toy Time and Energy

We are now ready to enhance this basic 2-spatial-dimension Toy Universe with additional forces and dimensions. We begin by considering the insight of special relativity in the real universe that the time of physics is an imaginary number spatial dimension represented by numbers, $\mathbf{i}ct \in \mathbf{I}$.

Thus special relativity suggests the next Axion in this Toy Universe.

A9) y**i** = ct**i** ∈ **I** is the time-dimension.

In this Toy Universe, the time of special relativity is the curled T-duality 1-sphere dimension of y**i** ∈ **I** and c (i.e. the speed of light) is the constant of T-duality that relates the two Toy subUniverses. But we are not ready to discuss the electromagnetic force yet. This Toy Time replaces the large unseen dimension of time of the real universe, ct**i** ∈ **I**, with a tiny curled unseen dimension of imaginary space, y**i** ∈ **I**, in this Toy Universe. We assert that a tiny curled unseen imaginary number dimension of time is practically speaking identical to a large unseen imaginary number dimension of time; because the measurement process in both cases is indirect, meaning that time is inferred from changes in spatial states in the Toy subUniverse**R** just as it is in the real universe. However, there is a narrative interpretive difference.

As well, in the real universe the best atomic clocks oscillate between energy states; and then we count up the number of changes of state to precisely determine elapsed time. The pragmatic astronomic and atomic clocks that measure changes of state in the real universe are the same pragmatics clocks of this Toy subUniverse**R**. But in this Toy subUniverse**R**, time is the unobservable change-of-state of the large Toy subUniverse**R** relative to the tiny curled Toy subUniverse**I**, i.e. a rotation of x ∈ **R** relative to y**i** ∈**I**. Thus in both the real universe and the Toy subUniverse**R** an unobservable change-of-state is approximated by clocks.

Somewhat paradoxically, we accept the A9 Toy Time Dimension in this Toy Universe and also preserve the Toy Classical Time that is pragmatic and emergent time in both the Toy subUniverse**R** and the real universe. The Toy Time Dimension and Toy Classical Time are related but not necessarily the same idea. The connection is that quantum mechanically; both Toy Times are indicated or inferred by changes-of-state in the Toy subUniverse**R**. We also note that change-of-state of observable phenomenon in the Toy subUniverse**R** is always relative to change-of-state of an Observer**R**. Thus intriguingly, the importance of an Observer**R** emerges from classical or without explicit quantum considerations. Further, we suggest that the change-of-state of an ObserverR is equivalent to the assumption of Toy Classical Time.

Nevertheless, we will use the term Toy Time ambiguously for both Toy Classical Time and for the Toy Time Dimension, because we cannot resolve these perplexities of time. We simply suggest that Toy Time emerges as an essential consequence of the T-duality of this Toy Universe. As well, T-duality symmetry is a mathematical approach to understand many level of physical structure from elementary particles to cosmologies.[11] But we leave those important mathematical complexities to others. We focus on developing this visualizable Toy Universe; pondering its insights and acknowledging its shortcomings.

Moving forward in our Toy Universe development, two orthogonal 1-spheres are no longer sufficient. Hence.

A10) The Toy Universe is composed of 2 orthogonal 3-sphere Toy subUniverses. Toy Particles occupy a finite 3-sphere space of x1, x2, x3 ∈ **R**.; while Toy antiParticles occupy a finite 3-sphere space of y1**i**, y2**i**, y3**i** ∈**I**.

Now, we must now clarify several lurking problems that result from the A9 and A10. Also, we must quickly acknowledge that the many paradoxes of time (e.g. philosophical, psychological, physical) in the real universe are not solved in this Toy Universe. But we can satisfactorily address some of the lurking problems of Toy Time.

In special relativity of the real universe, time, ct**i**, is one imaginary number dimension not three imaginary number dimensions. What do three imaginary number dimensions of time mean in this Toy Universe?

In physics there are many equations in which time is a variable. In the Toy subUniverse**R,** we will interpret those physics equations in which the time variable occurs in much the same classical way as in the real universe. Though beyond the working world pragmatics the narrative of the Toy subUniverse**R** is quite different than the narrative of the real universe.

Furthermore, in string theory, a tiny 3-dimensional string can be approximated as a 1-dimensional string. (e.g. a thick rope is obviously a 3-dimensional object; but from a certain perspective, it can be treated simply as a 1-dimensional object.) Just so the tiny curled orthogonal 3-sphere of the Toy subUniverse**I** can approximately be thought of as a 1-sphere, ct**i** = cy**i** ∈ **I**, from the cosmically large Toy subUniverse**R** POV.

In the real universe, special relativity introduced the idea of (x, y, z, ct**i** ∈**I**). And there continues to be much philosophical discussion upon the meaning of the dimension ct**i** ∈**I**. However, the pragmatic operational use of the time variable in equations and experiment seldom bothers with the imaginary number aspect of time in the real universe.

Similarly Axioms A9 and A10 do not change the pragmatic use of the cy**i** variable (i.e. Toy Time) in this Toy subUniverse**R**. A9 and A10 simply suggest that at a fundamental level, ideas may need to be reinterpreted with a different narrative in this Toy subUniverse**R** than in the real universe. Be that as it may, in this Toy subUniverse**R**, the pragmatic use of Toy Time identically informs the same equation and experiment as in the real universe. The pragmatic use of clocks is indifferent; as to whether the unseen imaginary number dimensions of time are large and of one dimension as in the real universe; or tiny, curled and of three Toy Time dimensions as in the Toy subUniverse**R**. The pragmatics of clocks is identical; but the cosmic narrative differs.

A9 and A10 are direct consequences of the assumption that this Toy Universe is bifurcated into two Toy subUniverse, A4 and A6, one occupied by particles of m ∈ **R** and the other populated with antiparticle of m**i** ∈ **I**. We emphasize that many riddles of time still remain, in this Toy subUniverse**R**. We suggest that three curled unseen dimensions (y1**i**, y2**i**, y3**i**) is no more difficult for our imagination and logic to accept than a single large unseen ct**i** dimension.

But without the large Euclidean time dimension symmetry of the real universe, conservation of energy cannot be a universal law as in the real universe; it must be an emergent local law within the Toy subUniverse**R**. Conservation of energy loses meaning at the non-local level because interactions with the unseen Toy subUniverse**I** must be taken into account (i.e. the Toy subUniverse**R** is not a closed system) to explain non-local phenomenon that are observed within the Toy subUniverse**R**.

This Toy Universe still has time symmetry in that ct**i** = (y1**i**, y2**i**, y3**i**) is approximately true from a sufficiently local Toy subUniverse**R** POV. But conservation of energy is not a fundamental law in this Toy Universe. However, conservation of energy emerges in the Toy subUniverse**R** in the local domain in which Toy Time emerges as a local reasonable interpretation of phenomenon. The lack of conservation energy at non-local levels is an insight advantage of this Toy Universe metatheory. Toy dark matter and toy dark energy explanations arise naturally from the Axioms of this Toy Universe metatheory.

Now that we have defined some terminology, let us summarize.

In this Toy subUniverse**R**, there are relative coordinates (x1, x2, x3, **i**y), where **i**y is inferred by Observer**R**. And the Toy subUniverse**R** of classical objects rotates and spins relative to a curled y**i**, where **i**y ∈ **I** which is equivalent to (y1**i**, y2**i**, y3**i**) from an Observer**R** POV.

So from a Toy subUniverse**R** POV of four spatial coordinates (x1, x2, x3, y**i**), in which the real number spatial coordinates are spinning and rotating relative to the curled imaginary number spatial coordinate. Of note, it is possible to go backward spatially only to the extent that the space is classically local. For an Observer**R** the real number space, (x1, x2, x3) ∈ **R**, is classically local for a large space; whereas the imaginary number space, **i**y ∈ **I**, is the quantum space of the Toy subUniverse**I**, which is curled and unseen by an Observer**R**. And since this imaginary number space is everywhere unseen; an Observer**R** might hypothesize that time is a large flat dimension. In summary, the classical actions in the Toy subUniverse**R** are real number spatial changes, (Δx1, Δx2, Δx3) ∈ **R**, relative to imaginary number spatial changes Δ**i**y ∈ **I**.

But since the **i**y ∈ **I** are unseen and unmeasureable variables; it would seem that a somewhat consistent Toy subUniverse**R** worldview can be constructed with Δ**i**y ∈ **I** being assumed to be large or tiny. However, T-duality symmetry is an essential property of the Toy subUniverse**R** relative to the Toy subUniverse**I**. Thus from an Observer**R** POV, if changes-of-state (Δx1, Δx2, Δx3) ∈ **R** are viewed as large; then the unseen changes-of-state Δ**i**y ∈ **I** must be inferred to be small. Furthermore, an Observer**R** would describe the various changes-of-state (Δx1, Δx2, Δx3) ∈ **R** (e,g, day and night, spring and winter, birth through death) as real number spatial pattern cycles relative to an unseen imaginary number spatial pattern cycles Δ**i**y ∈ **I**, inferred to be curled. Upon reflection, this Observer**R** would concludes that fundamental actions in the Toy subUniverse**R** are always relative to actions Δ**i**y ∈ **I** that are cyclical not linear.

Thus in this Toy subUniverse**R** the idea of going forward in Toy Time is fundamentally a cyclical idea. But the Observer**R** and classical objects persists in the Toy subUniverse**R** in the sense that changes-of-state (Δx1, Δx2, Δx3) = 0 for many change-of-state cycles of the Δ**i**y ∈ **I** space. Thus Observer**R** pragmatically builds clocks based upon persistent phenomenon. Motion, action, change-of-state is the persistent reality in this Toy subUniverse**R**, without change-of-state there is neither phenomenon nor observer. Toy Time is an unseen dimension; because there are no local observable actions between classical objects of the large Toy subUniverse**R** and quantum curled Toy subUniverse**I**. Repetition of spatial pattern is the fundamental change-of-state from which Observer**R** infers Toy Time as an unseen curled imaginary number dimension Δ**i**y ∈ **I**, in T-duality relationship to the Toy subUniverse**R**.

In this Toy subUniverse**R**, the real number space and imaginary number space are fundamentally orthogonal as in the real universe. But the toy cosmic event horizon is not moving away at the speed of light c. Rather from an Observer**R** POV, the entire Toy subUniverse**R** of classical objects, located at (Δx1, Δx2, Δx3) ∈ **R** relative to other classical objects of reference, is rotating relative to the entire curled imaginary number Toy subUniverse**I** of Δ**i**y ∈ **I**.

This is not the terminology of the real universe. In the real universe, the big bang metatheory is frustrated by its inability to explain non-local cosmic observations (e.g. dark matter, dark energy, baryon asymmetry). Decades of hypotheses continue to produce experimental null results (e.g. no dark matter particle found yet), which leave these non-local observations unexplained. Fundamentally, these observations perplex because they suggest a violation of conservation of energy in the real universe. The real universe is assumed to be a closed system, with the time symmetry of a large dimension; hence conservation of energy is fundamental. Thus in the implicit big bang metatheory, an encyclopedia of new phenomenon have been hypothesized to explain these perplexing observations. But the persistent null results, across the so many experiments of so many hypotheses, suggest the possibility that the big bang metatheory is incorrect.

Here we must make an important point about physical laws such as conservation of energy. Nature does not follow the laws of nature; rather the laws of nature follow nature. “Laws.. do not direct traffic, do not oversee, or govern, or steer the course of nature, but merely express recurring patterns among similar things."[12] Conservation of energy has proven to be an exceptionally useful law of nature, because its symmetry has been persistently observed in nature. Apparent exceptions to the law of conservation of energy have invariably been found to agree in the detail with the patterns predicted by the law of conservation. Thus when cosmic observations, such as dark energy, suggest a violation of the law of conservation of energy; scientists are reluctant to question this law, even after decades of null results. But in this Toy Universe, there is no question; by definition, conservation of energy is local and emergent.

Of significance, the Toy subUniverse**R** is an open system in which failure of conservation of energy is expected to manifest itself in various non-local toy phenomenon. As well, this Toy Universe is an explicit whole; therefore there is no need for a cosmic corrective. But the real universe of the implicit big bang metatheory requires some kind of cosmic corrective such as multiverses, landscapes of universes, string gas cosmologies, ekpyrotic universes.

Continuing our development of this Toy Universe, we briefly define Toy Energy.

A11) Toy Energy comes in two orthogonal forms $E \in \mathbf{R}$ and $E\mathbf{i} \in \mathbf{I}$.

We needed to clearly assert this A11 Axiom; because it has been anticipated and appears problematic. Significant reinterpretation will be required; in particular, Toy Energy is a local phenomenon that is not conserved at the non-local cosmic Toy subUniverse**R** level. We will reinterpret this Toy Energy later. For now, we just needed to be clear in which direction we are defining the Axioms of this Toy Universe.

Toy Particles

Now, we will further clarify the ideas of Toy Particles and Toy antiParticles. We do this by introducing the electromagnetic force into this Toy Universe

Thus far, the Toy Particles and Toy antiParticles have implicitly been classical point particles. This is no longer sufficient even in this Toy Universe; because we have defined a dynamic Toy subUniverse**R** that is spinning and rotating relative to a Toy subUniverse**I**. But with only the one force of Newton's gravity in this Toy Universe; we cannot envision any kind of classical contact between objects. So we need more than geometry and gravity.

Now just for a moment as we begin, let's consider the toy top to be a toy particle. A toy top often has a stable and an unstable point of balance as it spins. Sometimes, when we let the toy top loose; it spins for a few moment upside down before flipping over and spinning in the stable right side up orientation. Let's consider a right side up spinning top as a toy particle and an upside down spinning top as a toy antiparticle. Such a toy antiparticle is unstable and must either flip over, and change thus into a toy particle; or perhaps it could move into a suitable toy world where toy antiparticle tops are stable.

Now why would such a toy antiparticle top be stable in one world and a toy particle stable in the other world. The usual reason for stability in this Toy Universe, the real universe, or any world is a local energy well, in which a particular orientation or state is stable. A toy particle top is stable in one world; whereas toy antiparticle top is stable in another world.

Now we return to our Toy Universe, where real number energy Toy Particles are stable in the Toy subUniverse**R**; and where imaginary number energy Toy antiParticles are stable in the Toy subUniverse**I**; because each seeks its proper local energy well.

Next we begin re-imagining our Toy Particles as spinning, rotating, waving and pulsing similar to our description of this Toy Universe as composed of two 1-spheres Toy subUniverses.

With these introductory ideas, we are now ready to define our first specific Toy Particle as a necessarily quantum object. Our first Toy Particle looks like the simplest picture of our Toy

Universe, which was composed of two orthogonal 1-spheres (one composed of real numbers, the other of imaginary numbers). This complex dynamic geometric object is our first Toy Particle.

Next we introduce the quantum mechanical concept of superposition into our Toy Universe. We imagine the idea of a Toy Particle (as a miniature of a simple Toy Universe) from a higher dimensional point of view. Our Toy Particle rotates clockwise in x ∈ **R** dimension, and rotates counterclockwise in y**i** ∈ **I** dimension. This is a classically impossible object; but we can envision this Toy Particle as the quantum superposition of two quantum strings that are rotating relative to one another. We do not explain why the quantum geometry of this Toy Particles is so; we just describe and define this Toy Particle as such a quantum dynamic object. (Note: We have not introduced gravity inside this Toy Particle; it is a quantum string object.) We need the logic of quantum mechanical superposition to imagine this non-classical object. We now define our first specific Toy Particle.

> A12) Our first specific Toy Particle is a quantum superposition of clockwise rotating 1-sphere string in the x ∈ **R** dimension and counterclockwise rotation of an orthogonal 1-sphere string in the y**i** ∈ **I** dimension.

We will not develop the idea of toy particle spin in this Toy Universe; it is an available idea; but to keep simple, we adhere to the particle spin of the real universe. We see that this first Toy Particle is a 2-dimensional object of (x, y**i**) components; that can be physically oriented to fit into either a 3-dimensional real number space of (x1, x2, x3) ∈ **R** or an imaginary number space of (y1**i**, y2**i**, y3**i**) ∈ **I**.

Ignoring many details, we will now turn this A12 Toy Particle into a Toy antiParticle. From our higher dimensional point of view, we turn this first specific Toy Particle inside out. This topological procedure defines our first Toy antiParticle.

The topological rules for turning a sphere inside out are complicated, and beyond our concern here. As well this first specific Toy Particle is a more complex mathematical object than a 2-dimensional sphere. Also this first Toy Particle is a quantum object, not a classical object; thus the mathematics for the geometric transformation that we have imperfectly envisioned is quite complex. We leave it to mathematicians to prove the following assertion or not.

> A13) Our first specific Toy antiParticle is a quantum object that is the superposition of counterclockwise rotating 1-sphere string in the x ∈ **R** dimension and clockwise rotating 1-sphere string in the y**i** ∈ **I** dimension. Where these two 1-spheres are T-duality related to one another.

Upon further geometric visualization, it is obvious that as defined, this A12 Toy Particle and A13 Toy antiParticle are geometrically indistinguishable from one another, when placed side by side in the Toy subUniverse**R**. Thus we may consider a A12/A13 Toy Particle as the superposition of the A12 Toy Particle state and A13 Toy antiParticle state. We keep the A12 and A13 states distinct to allow for further possible Axiom definition. We are now ready to introduce the electromagnetic force.

> A14) The A12/A13 Toy Particle is a Toy Boson.

This Toy Boson could be considered a toy photon, W or Z, or toy gluon; but it doesn't much matter because in this Toy Universe, we will not define a Toy Particle for each and every elementary particle of the standard model of the real universe. Our intention is to offer a glimpse that allows us to describe and visualize well enough to see how a Toy Universe can be build up from toy dimensions, toy forces, toy particles and such. Much is wrong and missing from our toy descriptions and axioms; but hopefully enough is shown to glimpse how a minimalist Toy Universe might be built.

Thus far, our general Toy Particles have been unable to touch one another; because we have described our Toy Universe with only one force, Newton's gravity. With only Newton's gravity, our Toy Universe can only contain ghost particles, such as various ideas for dark matter in the real universe suggest. Such gravitational ghost particles can never touch one another.

If the classical objects of this Toy Universe are to make contact with one another; then we must introduce the electromagnetic force and toy fermions. Mostly, we will simply steal and use ideas as needed from Maxwell's electromagnetism, QED and so on; we are not modifying any of these equations. Rather we are trying to build a complete enough Toy Universe of Toy Particles, to give some Toy Insights into how force equations in this explicit Toy Universe metatheory might be interpreted differently, than in the implicit metatheory of the real universe.

These Toy Insights may us grasp conundrums, paradoxes and problems in a simple Toy Universe. Thus perhaps, we can better appreciate similar and vastly more complex observational conundrums, paradoxes and problems in our real universe, as described and understood by the standard models, theories, and interpretations of physics.

For now, we will consider our Toy Boson to be a toy photon. With this single statement, we have introduced the electromagnetic force, i.e. all of Maxwell's equations and QED, into this Toy Universe. And since the Toy Particles in our Toy Universe may now have electric charge; they may now attract or repel one another electromagnetically.

Furthermore, electric charge enables Toy Particles and Toy antiParticles to make contact in the classical sense of experience and experimental measurement. Thus in this Toy subUniverse**R**, when an Observer**R** drops a sphere of matter from a leaning tower; he will observe that the sphere of matter accelerates, collides and stops upon the planet. Whereas before the introduction of the electromagnetic force, the dropped sphere of matter would pass right through the planet. Without electromagnetic repulsion, there could be no collision and no contact between the dropped sphere and the planet; only the reciprocal oscillation between ghost sphere and ghost planet that can attract but never repel or make contact.

As well, without the electromagnetic force, we are unable to envision either animal senses or scientific instruments with which to observe nature. But with the introduction of our toy photon, and thus charge and the electromagnetic force; we have defined electromagnetic repulsion between Toy Particles and hence physical contact, including observation and measurement, in this Toy subUniverse**R**.

Our next effort of imagination is to define our second Toy Particle, a Toy Fermion. However, it is not enough to simply assert that the second Toy Particle is a Toy Fermion; we must describe such a Toy Fermion, in such a way that we agree it is sort of a Toy Fermion.

We begin our toy description of a toy fermion by remembering the Kaluza-Klein theory; which expanded general relativity to include electromagnetism by adding an additional curled spatial dimension to represent charge. In the KK theory[13], a positive electric charge results from movement in one curled circular direction (e.g. clockwise) and a negative electric charge by movement in the other direction (e.g. counterclockwise). Thus we define.

A15) The electromagnetic force arises from a curled spatial dimension x4 ∈ **R**

We have thus defined one curled spatial dimension x4 ∈ **R**. (We will define y4**i** ∈ **I** later). Thus up to here, the Toy subUniverse**R** (from an Observer**R** POV) includes

- 3 large real number spatial dimensions x1, x2, x3 ∈**R**.
- 1 curled imaginary number dimension y**i** ∈ **I**, i.e. time. (to Observer**R** there is difference between one or three imaginary number dimensions y1**i**, y2**i**, y3**i** ∈ **I**)
- And now also, 1 curled real number dimension x4 ∈ **R**, i.e. electric charge.

In this 5-dimensional Kaluza-Klein Toy subUniverse**R** that is rotating and spinning; we quite easily can envision various black holes of general relativity. Now the black hole of interest to us in this Toy subUniverse**R** is a Kerr-Newman[14] black hole; which is simply an electrically charged rotating black hole.

We envisioned our toy fermion as a kind of tiny Kerr-Newman black hole. But more specifically, we envision it as a multi-dimensional closed string (i.e a brane) that is stable outside of the black hole event horizon, i.e. it is sort of a geon. We can almost think of a wave of photons racing around in such a small circle that it forms a black hole of attraction that imitates a charged mass of an electron at the center.

This description of a toy fermion needs further support to be credible even as a toy. Hence we quote Burinskii, "Electron as a closed heterotic theory... gravity definitely indicates the presence of a closed string of Compton radius.. In the electron background geometry... The Kerr-Newman solution, together with interpretation of its source as a closed heterotic string, forms a bridge between gravity, superstring and the Dirac quantum theory (of electrons)."[15]

Thus inspired, we define our Toy Electron from a Toy subUniverse**R** POV.

> A16) A Toy Electron is a 3-dimensional negatively charged Kerr-Newman brane that is a function of the large dimension x1, x2, x3 ∈ **R** and is stably oriented in the Toy subUniverse**R** outside the event horizon of the KN BH; and that is also a function of the curled time-like dimension y**i** ∈ **I**, where y**i** ∈ **I** is an approximation for y1**i**, y2**i**, y3**i** ∈**I**.

Furthermore, we similarly define a Toy Positron from a Toy subUniverse**R** POV.

> A17) A Toy Positron is a 3-dimensional positively charged Kerr-Newman brane that is a function of y1**i**, y2**i**, y3**i** ∈ **I** but which is unstably oriented in the Toy subUniverse**R**; and that is a function of the curled space-like dimension x1 ∈ **R**, where x1 ∈ **R** is an approximation for x1, x2, x3 ∈ **R**.

In the Toy subUniverse**R**, a particle accelerator creates a vast assortment of Toy Particles and Toy Antiparticles. Toy Antiparticles may be Toy Particles that have been turned inside out; or they may be virtual toy particle/toy antiparticle pairs from the Toy subUniverse**I** that have been kicked and expanded into the Toy subUniverse**R**. (Such virtual toy particle/toy antiparticle pairs inhabiting the Toy subUniverse**I** will be discussed later). The point here is that our description is similar to Dirac's idea[16] about kicking particles out of an infinite sea of negative-energy electrons leaving a positron to be observed.

In our Toy subUniverse**R**, an A17 Toy Positron is energetically unstable in the Toy subUniverse**R**; just as an upside down spinning toy top is energetically unstable. The Toy Positron has imaginary number energy, which is unstable in the real number energy world of the Toy subUniverse**R**. Without a stabilizing electromagnetic field, an A17 Toy Positron may quickly rotate into an imaginary number energy well of the Toy subUniverse**I**.

But the more usual transition may be described thus. An A17 Toy Positron is simply an inverse state of an A16 Toy Electron. Just as we turned our Toy Boson inside out; we can turn the wave function of an A16 Toy Electron inside out and thus creates an A17 Toy Positron of opposite spin, opposite charge and imaginary gravitational mass. Thus a suitable strong electromagnetic impulse may turn an A17 Toy Positron inside out and into the wave function state of an A16 Toy Electron, and vice versa.

Now we will leave the Toy Electron and Toy Positron and turn our attention to the toy strong force. We begin by reconsidering our Toy Boson.

Previously we had defined our A14 Toy Boson as a dynamic 2-dimensional quantum superposition object A12/A13. It occurs to us that in this Toy Universe, we can now define nine such quantum superposition objects.

A18) The nine Toy Bosons are quantum superposition objects composed of counterclockwise rotating 1-sphere strings in the x_1, x_2, or $x_3 \in \mathbf{R}$ dimension and clockwise rotating 1-sphere strings in the y1**i,** y2**i,** or y3**i,** ∈ **I** dimension.

We defined the quantum superposition A12/A13 as an A14 Toy Boson that was both Toy Particle and Toy antiParticle. Just so, the nine A18 Toy Bosons are both Toy Particle and Toy antiParticles. Furthermore by definition, we identify these nine A18 Toy Bosons with the apparent nine real gluons in the real universe. In the real universe one of the apparent nine real gluons is redundant. Thus, there are eight real gluons; similarly we define eight Toy Gluons.

A19) Thus the apparently nine A18 Toy Bosons are only eight Toy Gluons.

The real gluons have functional names like Red/antiBlue, Blue/antiGreen and Green/antiRed, which relate transitions from the Red state to the Blue state and so on. But these names suggest nothing, except that the Pauli exclusion principle requires three distinct states for the three real quarks, which compose a real proton.

We give our Toy Gluons the physically suggestive names x1/y2**i**, x2/y3**i**, x3/y1**i** and so on. As these names suggest, Toy Gluons enable Toy Quarks to change from one toy color-dimension state to another toy color-dimension state. We use the term color-dimension state as a bridge to the similar real universe terminology color-charge. But in this Toy subUniverse**R**, the three classical spatial-dimensions emerge from quantum superposition within protons and neutrons of the three toy quark three color-dimension states. Later, we will define these eight Toy Gluons which are indicated by these apparently nine Toy Bosons of A18. We will use a different symmetry for our eight Toy Gluons than is used in the real universe.

A20) Toy Quarks stably occupy the three color-dimension states:
x1, x2, or x3 ∈ **R** dimensions.

A21) Toy antiQuarks stably occupy the three anti-color-dimension states:
y1**i,** y2**i,** or y3**i** ∈ **I** dimensions.

This alignment of quark color-dimension in this Toy Universe is done as a matter of Axiom definition. We could have chosen, as in the real universe that the quark states are Red, Blue and Green and have nothing to do with the classical 3-spatial dimensions. However, this is a Toy Universe; so for illustrative purposes, we can define capriciously that the three classical spatial dimension of the Toy subUniverse**R** emerge from the quark the color-dimensions.

The purpose of a Toy Universe is to think upon the why, what and how to construct a possible toy universe with various assumptions, i.e. Axioms. From the beginning, we assume that our Toy Universe is incomplete, incorrect and easily broken. Nevertheless, we carefully build our capricious toy; so that we may develop insight and understanding that may influence our development of hypotheses, theories, models, experiments and metatheories in the real universe. It is important to play and construct various alternative Axioms with which one can build a toy universe. Different toy insights will result. This particular Toy Universe is but an example illustrating the value of metatheory thinking. A good metatheory is not passive; by being explicit, it suggests new hypotheses as well as accommodates current theory and experiment. A good Toy Universe metatheory credibly serves as an overarching descriptive framework within which theories may be developed and tested with detailed experiments and observations of the real universe. Occam's razor must be applied: What is the minimum toy universe metatheory that can serve as a framework for organizing theories and observations; and from which a relatively consistent, concise and complete narrative of the real universe can be told?

Proceeding with this Toy subUniverse**R** description, A18, A19, A20 and A21 suggest:

A22) Toy Quarks are 1-dimensional closed strings with three color-dimension states (i.e. degrees of freedom). Whereas, a Toy Baryon, i.e. the superposition of three confined Toy Quarks, has no color-dimension degree of freedom.

We further consider the strong force in our real universe. There are six quarks in our real universe; but our real universe would seem to do quite well with only the up and the down quarks. We do not speculate upon which states, phases or modes of the real universe require strange, charm, top or bottom quarks. This Toy subUniverse**R** only has the Toy Up and Toy Down quarks, which are similar to those two real quarks of the real universe.

A23) Toy Up Quark and Toy Down Quark are essentially the real up quark and the real down quark; but they are defined as closed strings with real number mass and have a color-dimension property x1, x2 or x3.

Inventing Toy Particles from scratch is well beyond the scope of any Toy Universe metatheory. Unless otherwise stated, this Toy subUniverse**R** accepts the elementary particles and their properties as described by the Standard Model of the real universe. But, as we have already seem, some properties of Toy Particles are not exactly the same as the properties of their counterparts in the Standard Model of the real universe.

We are now ready to explicitly state the relationship between the Toy Strong Force and the Toy Gravitational Force.

A24) The 3-spatial dimensions of Toy Force of Gravity in the Toy subUniverse**R** emerge from the 3-color-dimension properties of the Toy Strong Force.

In this Toy Universe the unification of the strong and the gravitation forces is a matter of Axiom definition. But what this means is not a matter of definition; it is an importance insight to be discovered and understood within the context of this Toy subUniverse**R**.

Toy Wave Function

A24 suggests that in this Toy subUniverse**R**, that the quantum wave function of a Toy Proton must be approximately identical to the superposition of quantum wave functions of the three confined Toy Quarks of a Toy Proton. Thus

A25) $\Psi_{\text{Toy Proton}}(x1, x2, x3) = \Psi_{3\text{ Toy Quarks of Toy Proton}}(x1, x2, x3,.. x1N, x2N,x3N)$; where N = 3.

That the time independent quantum wave function of three Toy Quarks is approximately equal to the time independent wave function of a Toy Proton simply means that in this Toy subUniverse**R** the Toy Proton is approximately a classical object.

In other words, the state of a Toy Proton is given by 3 variables (x1, x2, x3) and the state of each quark is given by one variable Toy Up Quark1 (x1), Toy Up Quark2 (x2), Toy Down Quark (x3). Thus the state variables of Toy Quark are aligned with geometric position variable of Toy Proton in the Toy subUniverse**R**. Of course, this alignment of Toy Protons and Toy Up Quarks and Toy Down Quark to the larger geometry of Newton's Gravity is a matter of philosophical debate, approximation and mathematical interpretation of the Hamiltonian that is well beyond the scope of this paper. For a real universe physical/philosophical discussion of the range of wave function interpretation, read Alyssa Ney, David Z Albert, et al.[17]

And further in the Toy subUniverse**R**, Toy Leptons occupy a similar tri-color-dimension superposition state of x1, x2, and x3 $\in$ **R**, as the Toy Protons. Of course Toy Bosons share these state variables. As well, Toy antiParticles' y1**i,** y2**i,** y3**i** ∈ **I** tri-anticolor-dimension states may unstably align with the x1, x2, x3 ∈ **R** tri-color-dimension states. As previously defined, Toy antiParticles are energetically unstable in the Toy subUniverse**R**.

Thus the wave function of the Toy subUniverse**R** of N such Toy Protons, Toy Electrons and Toy Photons is $\Psi_{\text{Toy subUniverse}\mathbf{R}}$ (x1, x2, x3,...., x1N, x2N,x3N).

In this Toy subUniverse**R**, spatial geometry is thus seen to be identical to the set of state variables of Toy Particles; because the movement of a Toy Proton or a Toy Planet in geometry from point ($x1_a$, $x2_a$, $x3_a$) to point ($x1_b$, $x2_b$, $x3_b$) is simply a relative change of tri-color-dimension state variables of classical objects. In this Toy subUniverse**R**, the wave function variables are approximately identical to classical spatial variables; because the Toy subUniverse**R** can approximately be understood as composed of local classical objects.

When there are non-local phenomenon; then the wave function of the Toy subUniverse**R** must be expanded to included the appropriate y1**i,** y2**i,** y3**i,** ∈ **I** dimensions as state variables. In this Toy subUniverse**R**, the analog to the time dependent wave function of the real universe is the wave function of the entire Toy Universe

A26) $\Psi_{\text{Toy Universe}}$ (x1, x2, x3,.. x1N, x2N,x3N, y1**i**, y2**i**, y3**i**,.. y1**i**M**,** y2**i**M**,** y3**i**M); where N = M is the number of Toy Particles in Toy subUniverse**R** = number of Toy antiParticles in Toy subUniverse**I**.

We will also note in passing, that a full toy quantum general relativity will need a 6x6 metric tensor rather than the 4x4 metric tensor[18] of the toy classical general relativity of the Toy subUniverse**R**, as in the real universe. But of course, the variables y1**i**, y2**i**, y3**i**,.. y1**i**M**,** y2**i**M**,** y3**i**M are indeterminate or hidden from a Toy subUniverse**R** POV.

Let us now return to reconsider the Toy Photon.

Toy Photon

As in the real universe, our Toy Photon is both particle and its own antiparticle. In other words, in our Toy Universe, the total energy of a Toy Photon is **E̳** = E + E**i** where E ∈ **R** E**i** ∈ **I**, where **E̳**, bold-double underlined, signifies the energy vector of a Toy Photon in this Toy Universe. And furthermore, the absolute values of |**E̳** |= |E| = |E**i**|= E ∈ **R**.

This absolute value |**E̳**| = |E| = |E**i**|= E may appear troublesome because **E̳** = E + E**i** and hence one might suggest that maybe |**E̳** |= |E + E**i**| = $2^{1/2}$E. But this is not the case; because here our addition is a quantum superposition of states, not a Euclidean geometric or algebraic addition. Hence, a Toy Photon in the Toy subUniverse**R** is simultaneously in the E state and the E**i** state. The E state of such a Toy Photon interacts with a Toy Fermion; while its E**i** state interacts with a Toy antiFermion. With this understanding, we state the following Axiom.

A27) A Toy Photon is a quantum vector with energy **E̳** = E + E**i**.

Now in the apparently flat Euclidean real universe, a real photon emitted at any point x_e is cosmically redshifted as it travels to point of observation at x_o. And the standard explanation of the cosmic redshift in the real universe is that the universe has expanded between the time the photon was emitted at x_e and the time the photon is observed at x_o.

But the Toy subUniverse**R**, like Gödel's universe[19], is rotating and not expanding. However, unlike Gödel's universe, the Toy subUniverse**R'**s rotation (i.e. change-of-state) is relative to time (i.e. y**i** ∈ **I**); not relative to any preferred spatial axis (i.e. x ∈ **R**). The change-of-state (i.e. rotation) in Gödel's universe was relative to a preferred spatial axis. And since Gödel's universe was also not expanding; there is no cosmic redshift in a Gödel's universe.

However, this Toy subUniverse**R**, $\Psi_{\text{Toy subUniverse}\mathbf{R}}$ (x1, x2, x3,.. x1N, x2N,x3N), is not rotating relative to some preferred real number spatial axis x. From an Observer**R** POV, the Toy subUniverse**R** must be rotating relative to the Toy subUniverse**I**, $\Psi_{\text{Toy subUniverse}\mathbf{I}}$ (y1**i**, y2**i**, y3**i**,.. y1**i**M**,** y2**i**M**,** y3**i**M). This rotation-like change-of-state can only approximately be imagined. We give the following approximate descriptions of this change-of-state of the Toy subUniverse**R** relative to the Toy subUniverse**I**.

First, Toy subUniverse**R** (viewed as an x ∈ **R** 1-sphere) is rotating relative to Toy subUniverse**I**, (viewed as a y**i** ∈ **I** 1-sphere). Second and more correctly, Toy subUniverse**R** viewed as an x1, x2, x3 ∈ **R** 3-sphere is rotating as a superposition of rotations relative to three orthogonal axis y1**i**, y2**i**, y3**i** ∈ **I** of the Toy subUniverse*I* viewed as a y1**i**, y2**i**, y3**i** ∈ **I** 3-sphere. Third more correctly yet, rotating like the second but with additional orthogonal spinning of the Toy subUniverse**R** relative to the Toy subUniverse**I**, where the spinning is a superposition of three orthogonal spin states. This is quite enough quantum geometric visualization.

Whichever description we visualize, Toy subUniverse**R** experiences a constant acceleration due to its rotation-like change-of-state relative to time, i.e. due to its change-of-state relative to Toy subUniverse**I**. And this pervasive constant acceleration in Toy subUniverse**R** accounts for the Toy Cosmic Redshift in Toy subUniverse**R**. Thus a Toy Photon, $\underline{\underline{\mathbf{E}}}$ = hv(1 + **i**) is emitted at a point x_e in the Toy subUniverse**R**. The Toy Photon then changes quantum states in Toy subUniverse**R** (i.e. travels across the cosmos) from the point x_e to a point x_o where the Toy Photon is absorbed by a photon detector and hence observed. In this Toy subUniverse**R** such a Toy Photon cosmically redshifts according to Hubble's Law, i.e. in the approximately linear relation to cosmic distance traveled.

The reason for this Toy Cosmic Redshift is that this Toy subUniverse**R** is rotating relative to Toy subUniverse**I**. Thus every local point of Toy subUniverse**R** is experiencing a persistent non-local acceleration due to the imaginary number force of gravity between the photon in the Toy subUniverse**R** and the Mass of the curled Toy subUniverse**I**.

> A28) As a Toy Photon travels across the Toy subUniverse**R**, it experiences a persistent non-local force of gravity between itself and the curled Toy subUniverse**I**
>
> $$F_g\,(m, M, y\mathbf{i}) = G\, m_{\text{effective mass of Toy Photon}} M_{\text{Toy subUniverse}\mathbf{I}}\, \mathbf{i}/(y\mathbf{i})^2$$
>
> which acts upon the effective mass of a Toy Photon persistently over the distance traveled in the Toy subUniverse**R** from point of emission x_e and point of observation x_o. Hence, Hubble's law.

Let us further describe the rotation of the Toy subUniverse**R** relative to the Toy subUniverse**I**. The rotation of the Toy subUniverse**R** relative to the Toy subUniverseI is not in a direction within the Toy subUniverse**R**. This rotation can only be envisioned from a higher dimension Toy Universe point of view. Furthermore, this rotation cannot be viewed as simple classical rotation; it must be viewed as a quantum superposition of rotations. Thus it is a quantum superposition of the relative rotations and spins of three orthogonal pairs of 1-spheres. This is not a classical rotation as was the case with Gödel's universe. In this Toy Universe, the rotations and spins (i.e. changes-of-state) of this Toy subUniverse**R** must be described as quantum mechanical superpositions relative to the curled Toy subUniverse**I**.

Before leaving discussion of this Toy Photon, we must discuss T-duality a bit more. T-duality is a symmetry that can be applied at the Toy Particle or Toy subUniverse level

> A29) In this Toy Universe, the T-duality equation, given by x = c/y where c is the speed of light, is the T-duality equation between Toy Particles and Toy

antiParticles in the Toy subUniverse**R** and Toy Particles and Toy antiParticles in the Toy subUniverse**I**.

This is a reinterpretation of equations dx/dt = c or $\lambda\nu = c$. This is the meaning of the equation $\lambda = c/\nu$, in this Toy Universe. Thus in this Toy subUniverse**R**, the meaning of c = speed of light as a maximum speed is a secondary and emergent meaning, like time and energy. The primary meaning of c in this Toy Universe is that **i**c is the T-duality constant which relates Toy subUniverse**R** Toy Particles to the Toy subUniverse**I** Toy Particles. We will later introduce Toy Supersymmetry ideas.

Let's return the Toy Photon's energy decreases as it travels non-locally across the Toy subUniverse**R**. We think this Toy Cosmic Redshift is insufficient to account for the Toy CMB Radiation. But we think another toy phenomenon is responsible for Toy CMB Radiation.

As a Toy Photon travels across the Toy subUniverse**R** the probability increases that the Toy Photon's energy will be low enough to be captured by the T-dual Toy subUniverse**I**. Thus few Toy Photons in the Toy subUniverse**R** will travel far around the Toy subUniverse**R** before being absorbed in the large Toy subUniverse**R** or captured in the curled Toy subUniverse**I**.

As well, Toy Photons emitted in the Toy subUniverse**I** will be captured and then absorbed in the Toy subUniverse**R**. An Observer**R** would see Toy Photons emitted in Toy subUniverse**I** and subsequently absorbed and observed in Toy subUniverse**R** as if they had expanded to large $\lambda_{o\mathbf{R}}$, where $\lambda_{e\mathbf{I}}$ is curled Toy subUniverse**I** wavelength of emission and $\lambda_{o\mathbf{R}}$ is the large Toy subUniverse**R** wavelength and these are related by the T-duality constant **i**c. The actual mathematics is much more complicated and problematic than indicated here.

Thus from an Observer**R** POV the wavelength of such Toy Photons have undergone an apparent expansion due their transition from a curled Toy Photon Toy subUniverse**I** to a large Toy Photon in Toy subUniverse**R**. Such observed Toy Photon wavelength expansions, from $\lambda_{e\mathbf{I}}$ to $\lambda_{o\mathbf{R}}$, are analogous to the real universe CMB photon wavelength expansions from a primordial tiny real universe to the present day large real universe.

Toy Gluons and Toy Supersymmetry

Though we started with classical particles, forces and geometries in constructing this Toy Universe; we have found it necessary for visualization to include the idea of quantum superposition not only at the Toy Particle level, but also at the level of the Toy subUniverse**R**. We see no way to avoid such quantum non-locality and quantum superposition at the large scale of this Toy subUniverse**R**.

Now, we explicitly discuss the symmetry involved in the 8 Toy Gluons as they relate to the 6 Toy Dimensions (x1, x2, x3, y1**i**, y2**i**, y3**i**) of this Toy Universe. First, we reiterate that Axiom A18 is an incorrect approximation as A19 suggested; just as in the real universe there are only eight gluons not nine, so also in this Toy Universe. Now, we will define the eight Toy Gluons in this Toy Universe using a different symmetry than used in the real universe for the eight real gluons.

Remember, we are defining this Toy Universe to show how to build a metatheory. We are illustrating metatheory thinking. So our Axioms need to be simple to illustrate how to build a Toy Universe and they need only be almost correct so that this Toy Universe is credible and useful as an illustrative toy. Thus in this Toy Universe our definitions of Toy Gluons is for illustrative purpose and ease of geometric visualization.

We now define eight Toy Gluon; we use a symmetry that relates these eight Toy Gluons to transitions between the six Toy Dimensions (x1, x2, x3, y1**i**, y2**i**, y3**i**) of this Toy Universe.

We begin by imagining a cube. A cube has six sides corresponding to the six Toy Dimensions; and a cube has eight vertices corresponding to the eight Toy Gluons. Thus if each Toy Gluon is thought of as a superposition of three Toy Dimensional states; then these eight Toy Gluons can enable transitions between the six Toy Dimensions. (As noted: These eight Toy Gluons are quite different from the eight gluons of the real universe.)

A30) The 8 Toy Gluons from a Toy subUniverse**R** POV are:
4 clockwise (x1, x2, x3), (x1, x3, y2**i**), (x2, x1, y3**i**), (x3, x2, y1**i**),
4 counterclockwise (y1**i**, y2**i**, y3**i**), (y1**i**, y3**i**, x2), (y2**i**, y1**i**, x3), (y3**i**, y2**i**, x1).
Each Toy Gluon enables a modulo transition (i.e. rotation) from one Toy Quark color-dimension state to another Toy Quark color-dimension or to another Toy antiQuark anticolor-dimension.

We will now discuss these Toy Quark transition rules using these eight Toy Gluons in the Toy subUniverse**R**. As an example, the (x1, y3**i**, x2) Toy Gluon can rotate a Toy x2-Quark into a Toy x1-Quark or a Toy y3i-antiQuark. Though these Toy Gluons have a different symmetry than the real gluons; the toy-color-dimension transitions within a Toy Proton are similar to the real color charge transitions in a real proton in the real universe. The advantage of these Toy Gluons' symmetry is that the physical transition of Toy Quark color-dimension states in this Toy Universe can be imagined geometrically. In contrast, the physical interpretation of real gluons symmetry in the real universe is not so easy to visualize.

As well, in this Toy subUniverse**R**, four 2-Toy Gluon glueballs may be imagined, one of which seems suitable to be a Toy Photon; and eighteen 4-Toy Gluon glueballs may be imagined that seem to have spin-2. However, the term glueball is misleading in our Toy Universe context; because it suggests a classic rigid structure similar to a molecule. We prefer the term Toy Gluon Wavicle, where a 2-Toy-Gluon-Wavicle is the quantum superposition of two Toy Gluons.

Thus in this Toy Universe, we see that the Toy Photon, ToyW, ToyZ and Toy Gravitons are Toy Gluon Wavicles that emerge from the superposition of the various Toy Gluons. We will not pursue this idea further here.

Moving on, we remember that the geometry of this Toy Universe so far has 7-spatial dimensions when the Kaluza-Klein electric charge dimension is included; we will soon add an anticipated final 8-spatial dimension to this Toy Universe. We cannot easily visualize 8-spatial dimensions. To help in this 8-spatial dimension visualization, we need to better visualize the rotation of the large 3-sphere Toy subUniverse**R** relative to curled 3-sphere Toy subUniverse**I**. At first, we will ignore the curled electric charge real number dimension as we visualize.

First, we visualize the rotation of a large 1-sphere rotating orthogonally to a tiny curled 1-sphere. Next we build the full 3-sphere of our Toy subUniverse**R** in our mind from three large 1-spheres, that are orthogonal to one another and orthogonal the three tiny curled imaginary number 1-spheres. Visualizing the actions of Newton's gravity, we see the Toy subUniverse**R** as a much more dynamic object than a classical 3-sphere. In fact, our Toy subUniverse**R** is like the quantum superposition of three orthogonal rotating spinning 1-sphere dimensions. Locally this Toy subUniverse**R** is flat but cosmically it is circular like a 3-sphere. However, this Toy subUniverse**R** is not a 3-sphere; and we suggest that visualization is impossible without the quantum superposition idea. Classical rigid logic is inadequate at the Toy subUniverse**R** level as well as at the Toy Particle level in this Toy Universe.

Chaos and complexity entered the description of this Toy Universe from the very beginning. So that the shape of the Toy subUniverse**R**, even when viewed as 1-dimensional, could only approximately and locally considered a 1-sphere. Thus the Toy subUniverse**R** when imagined dynamically geometrically is a very wiggly kind of 3-sphere wave function; regardless of it appearing locally flat to an Observer**R** in the Toy subUniverse**R**.

> A31) Quantum mechanical superposition logic is necessary at every level of this Toy Universe from the Toy Particle to the Toy subUniverse**R** (even when it is limited to the one force of Newton's gravity).

Quantum superposition is necessary and indeterminacy too, because the wave function variables of the Toy subUniverse**R** (i.e. the locations of Toy Particles in the Toy subUniverse**R**) depends non-locally upon interactions with Toy antiParticles in the curled Toy subUniverse**I**. We have almost finished the description of our Toy Universe. But before we stop building this Toy Universe, we need to describe aspects of the Toy Weak Force, and Toy Thermodynamics.

> A32) From several perspectives, this Toy subUniverse**R** is mathematically and physically a finite but open system (e.g. non-local force of gravity the $F_g\mathbf{i} = -\mathbf{i}$ acts upon the Toy subUniverse**R** but does not conserve energy within the locally observable Toy subUniverse**R**). The idea of a thermodynamically closed system is always an approximation in this Toy subUniverse**R**; because in this Toy Universe every part from Toy Particle to Toy subUniverse**R** is fundamentally a finite and open system with non-local interactions.

As well, the idea of Toy Energy is emergent and a non sequitur at the Toy Universe level. At the Toy Universe level, even the idea of a fixed number of Toy Particles seems problematic. In the sense of Godel's incompleteness theorem[20], it seems indeterminate whether this Toy Universe is a closed or an open system.

This Toy Universe, like all idea toys, is fragile and easily broken as has been apparent throughout with each additional Axiom. We now add our final troublesome Axioms.

> A33) The Kaluza-Klein real number curled electric charge dimension has a large (T-duality) imaginary number electric charge dimension which gives neutrinos a charge $q = + \mathbf{i}e$ and antineutrinos a charge $q = - \mathbf{i}e$, where $\mathbf{i} \in \mathbf{I}$ and e is the charge of an electron.

We assert A33 because it completes our Toy Universe in the sense of symmetry of the electromagnetic force and in the sense of including some aspect of each of the four forces of gravity, electromagnetism, strong and weak of the real universe. But mostly, we include A33 because it implies a serious Toy Prediction. And Toy Predictions are the essential to falsify or verify any Toy Universe metatheory.

Next we proceed to define spin and supersymmetry in this Toy Universe. But let us first emphasize that we indeed choose each Axiom's definition. Our choice of Axioms is arbitrary, except that these Axioms must build a somewhat credible Toy Universe for illustrative purposes. But we would also suggest that the real universe of so many unsolvable observational riddles is simply beyond imagining, i.e. more incredible than any Toy Universe metatheory. Or as Robert B. Laughlin suggests, "In the world we actually inhabit, dark laws abound and they destroy predictive power by exacerbating errors and making measured quantities wildly sensitive to uncontrollable external factors."[21] Thus in the real universe, we are obliged by Occam's razor to decide upon the simplest useful Toy Universe metatheory.

Now we define the spin of Toy Particles identical to the spin of the Standard Model particles of the real universe, with the following exception.

> A34) The spin of the Toy W^+ and W^- Bosons is **-i**.

The rule of supersymmetry in the Toy subUniverse**R** is the following.

A35) Each Toy Fermion has a toy superpartner whose spin differs by (-½ - ½**i**); each Toy Boson has a toy superpartner whose spin differs by (-1-**i**).

With this, we see that the Toy subUniverse**I** is not populated with Toy antiParticles but with Toy antiParticle Superpartners. For Toy Fermions, this is a modest change. Though we did not explicitly describe them, the Toy Fermions already had four Toy Quantum States: large Toy Fermion and Large Toy antiFermion in the Toy subUniverse**R**; and Curled Toy Fermion and Curled Toy antiFermion in the Toy subUniverse**I**.

Previous to A34 and A35, the Toy Photon, Toy W^+, Toy W^-, and Toy Z^o Bosons were there own Toy antiParticles in the Toy subUniverse**R**; and it was presumed that for example the large Toy Photon became a curled Toy Photon in the Toy subUniverse**I**. But now, we will explicitly assert, that in the Toy subUniverse**I**, the function of Toy Photon is played by the curled Toy W^- Boson. We will not write the explicit Axiom to explain further here.

We have written quite enough arbitrary descriptive Axioms with hardly a hint as to why this Toy Universe metatheory should be so. It is so for illustrative purposes and to serve as a counterpoint to the big bang metatheory of the real universe. But the real universe gives hardly a hint as to why it is even more strange.

In summary, we assert that it is important to understand how this Toy subUniverse**R** of the Toy Universe metatheory differs from the real universe of the big bang metatheory. The Toy subUniverse**R** is locally flat and has been deliberately defined to preserve the validity of the equations of standard physics; as well the Toy subUniverse**I** has also been so defined. But the interactions between these two Toy subUniverses creates phenomenon in the Toy subUniverse**R** that are not described by the same equations of the real universe. And these non-local cosmic phenomenon of the Toy subUniverse**R** serve the enormously useful purpose of suggesting simple explanations for a variety of phenomenon observed but not explained in the real universe.

Toy Discussion

As promised, we have constructed this Toy Universe metatheory to be conceptually sufficient to accommodate many ideas from the standard theories of physics. Specifically, we assert that this Toy subUniverse**R** is a credible approximation of the real universe, in that classical physics calculations locally give precisely the same results in this Toy subUniverse**R** as they do in the real universe. This is expected; since the Toy subUniverse**R** has been intentionally retrofitted to give exactly the same local results as calculations in the real universe. Furthermore, if this is not the case for any Toy Universe metatheory; then that metatheory needs to be corrected if it is to be a useful framework for scientific theory development.

The agreement of the Toy subUniverse**R** and the real universe regarding classical physics calculations rests upon a fudge factor and a questionable idea. The fudge factor is that the Toy subUniverse**R** is "a sufficiently large 3-sphere can be made locally flat (in a 3-dimensional Euclidean spatial sense) to whatever degree of precision necessary." The questionable idea is that "a tiny curled unseen imaginary number dimension of time is practically speaking identical to a large unseen imaginary number dimension of time."

Given that Toy subUniverse**R** is defined to be locally identical to the real universe; we are then at liberty to invent Axioms that define the Toy subUniverse**R** in such a way that it possibly solves long standing astrophysics and physics problems. Such an exercise cannot be gratuitous; it must offer new insights and possible explanations of unexplained phenomenon in the real universe. As well it must be constrained by physically credible reasoning and assumptions.

Thus the Toy subUniverse**I** is constrained by T-duality, in which an Observer**I** sees the laws of physics in the Toy subUniverse**I** as indistinguishably from the laws of physics that an Observer**R** sees. Spin clockwise versus counterclockwise being the only difference. But asserting that T-duality applies is quite different than mathematically proving the T-duality relationship. We have asserted and described; but not proven T-duality.

Next, this Toy Universe makes several predictions involving imaginary number quantities of mass, charge, and spin. Some would suggest that these predictions are better named assumptions. We will not argue about correct naming. Rather we simply argue that comparing Toy Predictions in the Toy subUniverse**R** with real experiment and observation results in the real universe is the only point of a Toy Universe metatheory.

Many of Toy Predictions about Toy Phenomenon such as Toy Dark Matter may be very difficult to calculate and compare to real universe phenomenon. As well, we must emphasize that a qualitative correct direction is not good enough; for example, a qualitative toy shock wave must be shown to be exactly, in detailed calculations, what is needed to account for the dark matter phenomenon in the real universe. If not, we have a Toy Universe phenomenon perhaps useful for educational illustrative purposes; but useless as an explanation of the dark matter observations in the real universe. We must remember that dozens of qualitatively credible dark matter hypotheses have proved to be quantitatively, in the detail, incorrect. The real universe as determined by precise experiment and observation is the final arbiter.

Thus our most important and precise Toy Predictions of this Toy subUniverse**R** is:

P1) Locally Toy antiMatter gravitationally neither attracts nor repels Toy Matter in the Toy subUniverse**R**.

We predict that the force of gravity between matter (e.g. the Earth) and an antimatter (e.g. an antihydrogen beam) is a precisely $F_g = 0.0000$. Thus a beam of antihydrogen will follow a quite different path than a beam of hydrogen.

Both the CERN ALPHA and CERN AEGIS antihydrogen gravitational measurement experiments[22, 23, 24] hope to finally determine whether antimatter gravitationally attracts, repels or ignores matter. The leading hypothesis is that antimatter gravitationally attracts matter; that antimatter behaves gravitationally identically to matter. The secondary hypothesis is that antimatter and matter repel one another. Essentially no one suggests the hypothesis of this Toy Universe; that gravitationally antimatter neither attracts nor repels matter, but that antimatter and matter gravitationally ignore one another (i.e. are neutral locally within the Toy subUniverse**R**). Of course many detail factors much be accounted for in these difficult experiments.

Thus, we confidently assert that many other Toy Prediction of this Toy subUniverse**R** may be ignored; if CERN ALPHA or CERN AEGIS gravitational measurement experiments determine that either antimatter attracts matter or that antimatter repels matter. We assert this because without Axioms A3 and A4, most of this Toy Universe collapses like a house of cards. We described this Toy Universe metatheory with quite assertive words; but now we must just as strongly assert that a Toy Universe metatheory must make predictions that are accountable to experimental verification or falsification in the real universe.

Regardless of the experimental results at CERN, we assert that this Toy Universe metatheory is a useful illustrative Toy Universe. Creative metatheory construction is not gratuitous fantasy; but reasoned exploration, discovery and learning leading towards deeper understanding of the real universe. This Toy Universe metatheory has tried to give insight into a variety of real universe phenomenon from baryon asymmetry to emergence, from dark matter to antihydrogen gravity, from T-duality to time, from supersymmetry to quantum wave functions.

As well, we have attempted to build this Toy Universe metatheory such that the Toy subUniverse**R** appears to an Observer**R** exactly as our real universe appears to us. As well, we constrained the development of the Toy subUniverse**I** with the requirement of T-duality, such that an Observer**I** confirms the identical laws of physics as an Observer**R**.

Yet this Toy Universe metatheory differs from the implicit metatheory of the real universe in significant ways. Its value is not as a fantasy metatheory upon a pedestal never to be tested against the real universe, and not because it may prove to be correct. The value of this Toy Universe is that it is an explicit metatheory that demonstrates the approach of metatheory narrative development with which we attempt to explain and understand the real universe. As Haldane suggests "our only hope of understanding the universe is to look at it from as many different ways as possible."[25] And this Toy Universe metatheory demonstrates a different way.

Major non-local observations have persistently resisted theoretical explanation for decades. The predictions of a wide variety of theories continue to achieve null research results (e.g. dark matter, dark energy, baryon asymmetry). This suggests that the overarching implicit big bang (i.e. Standard Model of Cosmology) metatheory presents and incorrect narrative of the real universe and may be mis-focusing scientific hypotheses upon the non sequitur.

Unfortunately current big bang metatheory is implicit, and discussion of implicit axioms is divided among subspecialties and thus discussion is open to the broader scientific community. But metatheory is the broad framework and narrative, not the subspecialty equations; and thus metatheory should not be hidden and defended behind subspecialty walls. Metatheory best frames current physics theory and experiment and stimulates new physics hypotheses when it is explicit and discussed broadly by the scientific community.

This Toy Universe metatheory may also be of general interest; because the four forces of nature are explicitly unified in the Toy subUniverse**R**. Gravity and EM are unified via Kaluza-Klein theory, strong and gravity via the toy wave function, EM and weak via toy imaginary number charge. As well, from the first axioms defining toy spherical space and T-duality to the last axioms defining toy supersymmetry, this Toy Universe metatheory has been built as a whole Toy Universe; within which the various physics theories, and subspecialty theories can be framed, played with and explained. This Toy Universe does not require the invention of "the many-worlds interpretation… of an infinity of universes or minds, almost all of them unobservable (which) violates the principle of Occam's razor, i.e. that we should not introduce a multiplicity of unnecessary assumptions"[26] to make sense of the observed real universe.

This Toy Universe metatheory is not a closed system, in that mathematically it has no boundary surface and physically conservation of energy is a local and emergent phenomenon. As well this Toy Universe is indifferent to whether there are two Toy subUniverses or more, four forces of nature or more, whether photons are fundamental and gluons emergent or vice versa. This Toy subUniverse**R** is fundamentally indeterminate from the smallest to the largest scales. Thus in many ways, this Toy Universe is a metatheory worthy of study and understanding in comparison to the real universe.

Finally, this Toy Universe metatheory must either be broken through falsification of P1 or other predictions; or this Toy Universe metatheory must be enhanced with special and general relativity (e.g. toy subuniverse rotations near the speed of light and Ehrenfest paradox[27]), and QCD (e.g. low energy chiral phase transitions, superconductivity-like quark antiquark pairs)[28, 29].

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