Null Space Framework and EM Mass

Rhoderick J Beery III
University of Nebraska, Lincoln
rjbeery@gmail.com

Summary

In this paper we define a toy world model with physical origins of time dilation, spatial dimension contraction, quantum effects and wave/particle duality; we then explore this model's ability to describe our own familiar world.

The Model

The world model consists of two components: particle topology and relational information, both of which determine energy transfer conditions.

Particle Topology

A (primitive) particle P_n is described by the path of a single photon moving in periodic wave cycles of a single wavelength. We shall describe the photon's position relative to its spatial center using spherical polar coordinates (r, $\boldsymbol{\theta}$, $\boldsymbol{\varphi}$), and consider its movement, or progression, through an internal fourth degree of freedom, T. As such, we can refer to *events* by the identification of particles and their respective internal "clocks" as $P_n(T)$. It should be noted that these clocks are particular to each particle such that the frequency of two otherwise identical particles need not be equal.Although there have been many proposed models of EM mass, in this paper we shall generally confine particle discussion to electrons using the model proposed by J.G. Williamson and M.B. van der Mark [1]. Figure 1 shows such a particle.

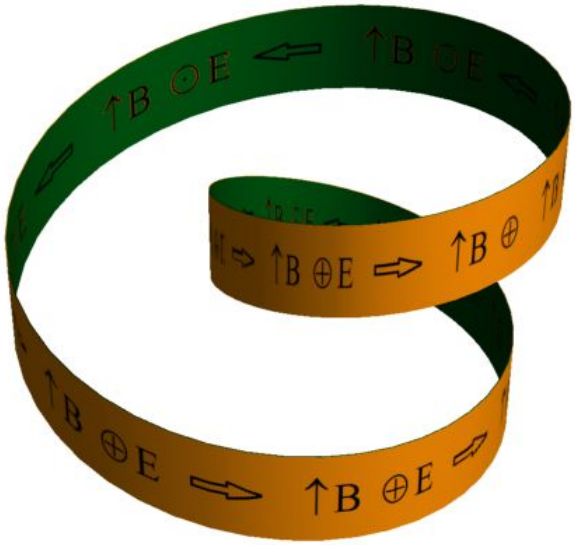

Figure 1 - EM Mass Electron Topology

Relational Attributes

Particles are related via a weighted graph. A connection between particles P_m and P_n indicates contact, and the weight between those particles is referenced as $w_{\{m,\ n\}}$. Connections are mutual but weights may differ by direction. The particles, being spatially-extended, are in contact at a surface whose area between pairs of them is defined in steradians as a function of the respective radii r_m and r_n, and $w_{\{m,\ n\}}$. We shall consider the surface area of contact between two particles to be a two dimensional projection rather than a three dimensional overlapping. A given particle is in contact with other particles on all points of its surface.

In this model the weight of a connection determines the local area of contact with another particle but does not affect the area of that particle with which it is in contact. In other words, the graph weight $w_{\{1,\ 2\}}$ represents a uniform dimensional scaling of the physical features of P_2 as perceived by P_1. Example:

$$Radius\ of\ P_1 = r_1 = 3.87 * 10^{13} m$$

$$Radius\ of\ P_2 = r_2 = 1.00 * 10^{13} m$$

$$Weight\ of\ Connection = w = 9.9 * 10^{-3}\ [dimensionless]$$

$$r_2 \; from \; the \; perspective \; of \; P_1 = r_2' = r_2 * w = 9.9 * 10^{-16} m$$

Figure 2 illustrates this connection from the perspective of P_1.

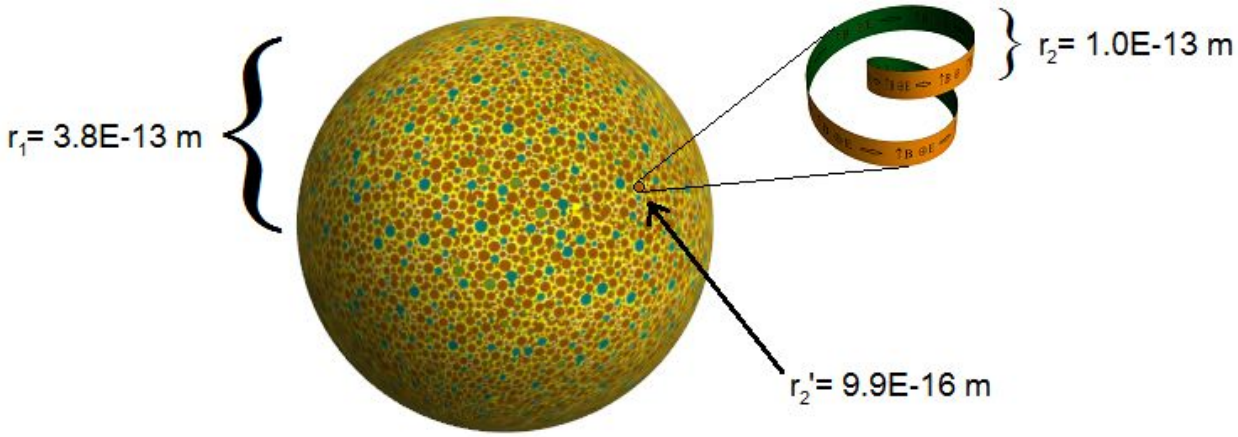

Figure 2 - Sample Particle Contact Surface

Energy Transfer Conditions

In this model there are three types of energy transfer between two particles: kinetic, reflective and transformative. Kinetic energy transfer affects interparticle weighting with no change in intraparticle topology; reflective energy transfer causes temporary constructive interference of a particle's internal orbit but is insufficient to alter its topology; transformative energy transfer occurs when the constructive interference to a particle's internal photon affects its orbit such that the particle reaches a new and topologically stable configuration.

Since both reflective and transformative energy transfer between P_1 and P_2 require constructive interference, their occurrence is dependent on the internal photon orbit positions of both particles. We would expect this to require that, at a minimum, the centers of P_1 and P_2 and their internal photons are all approximately collinear and the paths of the photons are essentially coincident. Regardless of the details, this conditional behavior would necessarily exhibit quantum effects and, because the conditions of certain energy transfer are dependent upon both the emitting and absorbing particles, a notion of causality will need readdressing.

Model Locality

In this model we shall define the local system of a given particle as the collection of particles with which it is in contact.

Simultaneity

Combining our definition of locality with the time parameter inherent in the internal structure of particles allows for an absolute definition of simultaneity:

Events $P_1(T_1)$ and $P_2(T_2)$ are simultaneous if

1) P_1 and P_2 are local at T_1 and T_2, respectively, or

2) There is a transitive chain of events {$P_1(T_1)$, $P_3(T_3)$, $P_4(T_4)$, $P_5(T_5)$, $P_6(T_6)$...$P_2(T_2)$}, mutually simultaneous, indirectly linking $P_1(T_1)$ and $P_2(T_2)$.

If we consider universal simultaneity we can define Ŧ as the progression through this 4th degree of freedom for all respective particles with no reference to frames.

Consequential Features

This model has no inherent stochastic mechanisms and any apparent stochastic behavior would have epistemological roots. Despite our possible ignorance of them, the photons comprising our particles have definite, unique internal coordinates (r, $\boldsymbol{\theta}$, $\boldsymbol{\varphi}$, T) for any value Ŧ. Energy, and therefore information flow, is confined to local elements. By design, this world is time-symmetrically deterministic, local and real.

Classical Locality

The traditional definition of the principle of locality is that an object is only directly influenced by its immediate surroundings. However, “directly" and "immediate" are imprecise terms; in fact, given the relative motion (at *all* scales) of the various components in any spatially separated environment, relativity has prohibited the phrase “state of a system” from having any absolute meaning at all. For any arbitrary distance D between two objects there is a frame which would consider them to be within any naturally considered distance d defining immediate surroundings and/or belonging to a considered “state”. Additionally, energy transference between particles is never direct in the strictest classical

sense. Lastly, "immediate surroundings" has an implied temporal element with its spatial element. With these points in mind we can clarify and formalize the colloquial definition of locality in a mathematically rigorous way by saying that events are local to a particle which are separated by it at a spacetime interval of zero. In this paper we refer to this definition as the *null space framework* within which particles reside.

On first consideration this may seem a nonsensical definition. Speaking in classical terms, if we start with a light source which emits a photon at t=0, and a mirror (say, 10 light-seconds away) which reflects this photon back to the light source, then our accumulated spacetime interval is zero and our definition of locality appears to be contradictory. Are the light source spacetime points at t=0 and t=20 local to each other, or are they timelike separated? This problem arises from considering the reflecting particle as a point particle, and the reflection as instantaneous; it is resolved when we properly consider the situation with our proposed model.

The reflecting particle at the mirror has unique coordinates (r, $\boldsymbol{\theta}$, $\boldsymbol{\varphi}$, T_{absorb}) during the absorption event, and is only local to the light source particle on a single surface area of contact. It is nonsensical for two particles to both mutually emit and absorb photons between themselves at the same time; the terms *emission* and *absorption* are merely descriptions of a net energy transfer, and are therefore mutually exclusive. The subsequent emission event will necessarily occur at a different point in time T_{emit} and therefore the round-trip interval distance from the light source to the mirror and back is non-zero. From this logic it is clear that the light source is not local to itself at various points in its history.

Physical Derivation of Graph Weightings

We postulate that graph weight between two particles is related to the spatial distance between them and is perceived as a physical scaling down of spatial dimensions. The weight between two particles P_m and P_n is trigonometrically visualized in Figure 3.

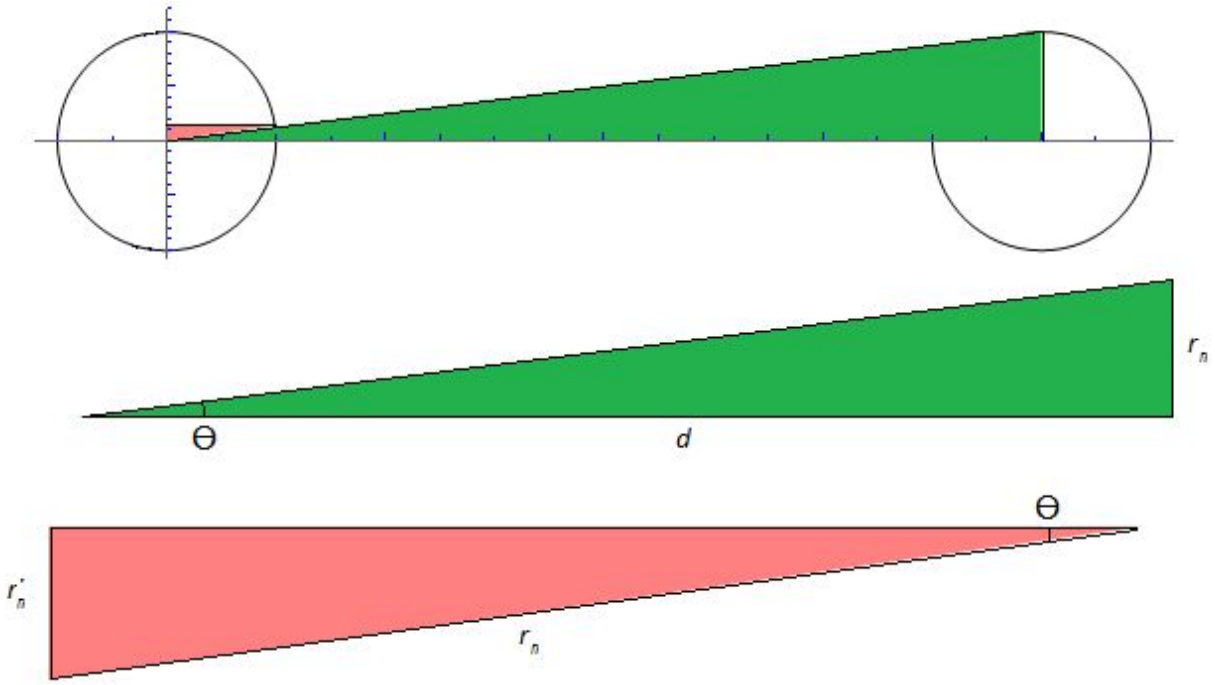

Figure 3 - Physical derivation of *w*

The pink and green triangles are similar. We can see:

$$tan\theta = \frac{r_n}{d}$$

$$sin\theta = \frac{r'_n}{r_n}$$

$$tan^{-1}\frac{r_n}{d} = sin^{-1}\frac{r'_n}{r_n}$$

$$r'_n = \frac{r_n^2}{d\sqrt{\frac{r_n^2}{d^2}+1}}$$

Normalizing and rearranging gives us:

$$w = \frac{r}{\sqrt{r^2+d^2}}$$

As such, the graph weightings between particles are interpreted as *parallax*. With this in mind we can now quantitatively analyze the scenario mentioned earlier. We consider an electron, P_1, emitting a photon which is absorbed by another electron, P_2, 10 light-seconds away; we assume that the photon will be emitted from P_2 back to P_1 after a single complete internal cycle in order to again arrive at a suitable configuration for reflective energy transfer. We use Williamson and van der Mark's suggestion of the electron having a cycle length of a single Compton wavelength:

$$Cycle\ length\ of\ P_2 = o_2 = 2.40 * 10^{-12}m$$

$$Radius\ of\ P_2 = r_2 = 1.93 * 10^{-13}m\ (cycle\ is\ twice\ the\ circumference)$$

$$Radius\ of\ P_1 = r_1 = 1.93 * 10^{-13}m$$

$$d = 10\ light\ seconds * c = 3.00 * 10^9 m$$

$$w_{\{2,1\}} = \frac{r_1}{\sqrt{r_1^2 + d^2}}$$

$$= \frac{1.93 * 10^{-13}m}{\sqrt{(1.93 * 10^{-13})^2 + (3.00 * 10^9 m)^2}} = 6.43 * 10^{-23}$$

We are analyzing this from the perspective of P_2 which we know only completes a single wave cycle (i.e. twice the circumference) before transferring its surplus energy back to P_1. From P_2's point of view:

$$\frac{o_2}{c} = 8.00 * 10^{-21} seconds$$

will have passed between T_{absorb} and T_{emit}. We calculate attributes of P_1 as follows:

$$Radius\ of\ P_1\ from\ the\ perspective\ of\ P_2 = r_1' = w_{\{2,1\}} * r_1$$

$$= 6.43 * 10^{-23} * 1.93 * 10^{-13}m = 1.24 * 10^{-35}m$$

$$Cycle\ length\ of\ P_1\ from\ the\ perspective\ of\ P_2 = o_1'$$

$$= 4 * \pi * 1.24 * 10^{-35}m = 1.56 * 10^{-34}m$$

In this time frame we expect P_2 to consider P_1 as having made:

$$= 4 * \pi * 1.24 * 10^{-35} m = 1.56 * 10^{-34} m$$

$$\frac{T_{emit} - T_{absorb}}{o_1'} * c = \frac{8.00 * 10^{-21} seconds}{1.56 * 10^{-34} m} * \frac{3.00 * 10^{8} m}{1\ second} = 1.54 * 10^{22}\ cycles$$

While traditionally in a 20-second round trip we would expect:

$$\frac{6.00 * 10^{9} m}{\frac{2.40 * 10^{-12} m}{cycle}} = 2.5 * 10^{21}\ cycles$$

There are two problems with this result. The first is that parallax has overpredicted the expected time dilation (by roughly $2\boldsymbol{\pi}$); the second is that this analysis would not hold from the perspective of P_1 since both particles would agree that this time dilation is not relative, but absolute. These can be potentially remedied with the acknowledgement that P_1 and P_2 are not equivalent systems due to the additional energy supplied by the transferred photon. There are a couple of methods for exploring what effects this additional energy may have on the electron's inner configuration.

Wavelike Behavior

As defined in our model, the internal clock of a given particle P_m determines its configuration and suitability for energy transfer. We know that the weight of the connection between particles is related to the reciprocal of their classical spatial distance. If the energy transfer conditions were partially dependent upon the surface area of contact (i.e. the reciprocal of *d*) we would expect to see energy transfer patterns emerge as a function of spatial distance (keeping in mind that we remain at a spacetime interval of zero from P_m). Such energy transfer patterns could manifest as "fields" if we were to consider empty space anything but illusory in this model.

The spherically-symmetric nature of classical fields (as opposed to planar spirals, etc) would apparently require that a particle's configuration appears identical at a given time for all particles local to it. In other words, despite our description of the internal configuration of a particle in terms of spherical polar coordinates, its arrangement for energy transfer at a given time *T* is spherically invariant.

With this in mind we are now able to speculate on the effect of additional internal energy on an electron: because wavelength decreases as the reciprocal of energy in an electromagnetic wave, the internal wave cycle of an electron must shorten with an increase in energy as well. This would mean

that the number of cycles expected to have been completed by P_1 from the perspective of P_2 in the scenario above would be decreased because less time has passed, which aligns with our quantitative prediction. Additionally, we would expect more complex particles such as neutrons and protons as having smaller radii, which is also the case.

Time Dilation

We could also plausibly analyze the situation in terms of time dilation. In this analysis we shall require that the time dilation be absolute in the sense that both (or all) parties agree as to the behavior of respective clock rates.

It has been suggested that special relativistic time dilation is a consequence of velocity, and only velocity. This conclusion is problematic for a variety of reasons, one of which is the fact that clock rates due to relative inertial velocity are observer dependent, while we are seeking absolute answers. By analogy, we begin with two parallel rulers and rotate them away from one another to visualize that each would perceive a length contraction in the other (see Figure 4).

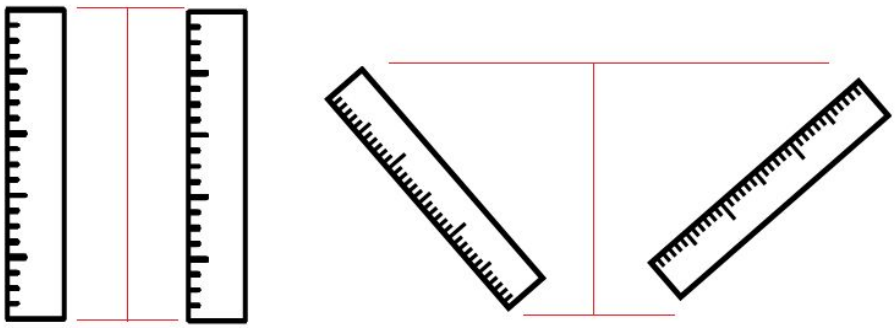

Figure 4 - Illusory dimensional contraction due to rotation

Here we would not naturally question whether the rulers are “actually” contracting, from any perspective, nor would either ruler expect to find any lasting contraction were they to square up and reunite. Special relativity predicts such mutual length contraction in relative velocity from the Penrose-Terrell effect (apropos a.k.a. the Terrell Rotation); we therefore consider these effects and their corresponding time dilation predictions to be mutually equal, even illusory, and therefore irrelevant. We shall seek an alternate cause for time dilation.

There have been many experiments whose results have apparently supported the idea that time dilation is caused by velocity, and Figure 5 shows such an experiment.

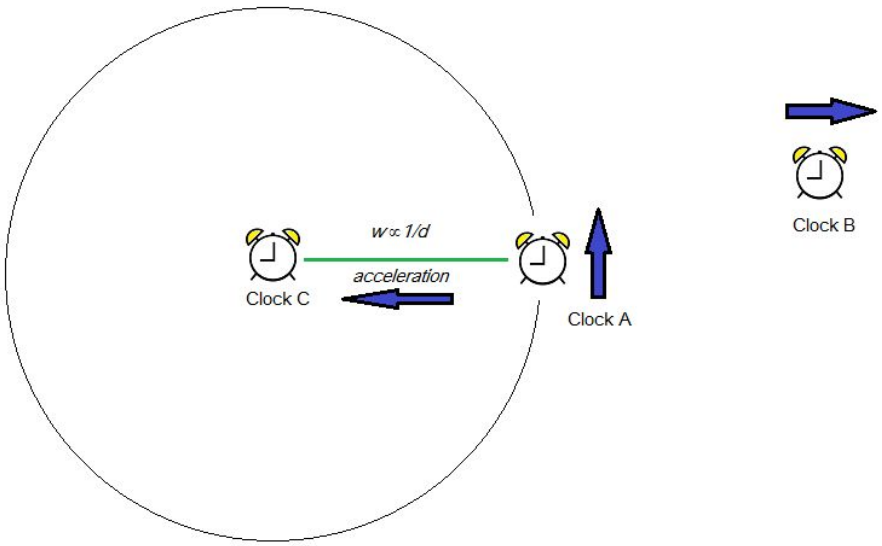

Figure 5 - Typical "acceleration vs velocity" time dilation experiment

Due to being on a centrifuge, Clock A undergoes velocity relative to Clock C (which is inertial) as well as centripetal acceleration; Clock B is undergoing no acceleration but moving linearly at the same instantaneous speed as Clock A (both relative to Clock C). To date, these experiments show that Clock C observes both A and B as experiencing identical time dilation effects, and the conclusion has been that acceleration plays no role in time dilation. We submit that the experiments have been slightly misinterpreted due to the restriction of frames under consideration (i.e. inertial). The dilation effects between B and C are relative (and mutually equal), and any attempt to establish absolute dilation would demand a Twin Paradox-type solution, requiring acceleration and a breaking of symmetry. On the other hand, the dilation effects observed by Clock C regarding Clock A are absolute in the sense that, even though A would consider C as being in relative motion to itself, A would not observe such relative and mutually equal time dilation effects. Additionally, if we place Clock D in a similar arrangement on a centrifuge, say, spinning clockwise, A and D would detect no mutual time dilation effects between them, despite the clear existence of relative motion. Lastly, we could place Clock E, rotating quickly, next to Clock C; a complete absence of relative velocity yet the presence of absolute time dilation. It is simply of questionable logic to constrain analyses of special relativity to inertial frames if we are seeking to make absolute declarations.

We submit that the velocity-vs-acceleration debate on the cause of time dilation is a false dichotomy. It has been demonstrated [2] [3] through general relativity that the time dilation factor in a uniformly accelerated system (gamma) can be expressed as:

$$uniform\ acceleration\ time\ dilation\ factor = \gamma = (1 + \frac{a * d}{c^2})$$

A more elementary approach gives:

$$d = \frac{a * t^2}{2}$$

$$v = \frac{d}{t}$$

$$v^2 = \frac{d^2}{t^2} = \frac{a * t^2}{2} * \frac{d}{t^2} = \frac{a * d}{2}$$

$$acceleration\ time\ dilation\ factor = \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{\sqrt{1 - \frac{a*d}{2*c^2}}}$$

Involving centripetal forces:

$$a_c = \frac{v^2}{r}$$

$$v^2 = a_c * r$$

$$centripetal\ time\ dilation\ factor = \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{\sqrt{1 - \frac{a*r}{c^2}}}$$

Let us consider the second derivative of the function of position of an object with respect to time as being a special case for the definition of acceleration. In this model, a more generalized definition might be “nonhomogeneous or asymmetric forces experienced by an object”. This would allow for:

$$F = m * a = \frac{G * M * m}{r^2}$$

$$a = \frac{G * M}{r^2}$$

$$gravitational\ time\ dilation\ factor = \frac{1}{\gamma} = \sqrt{1 - \frac{2 * G * M}{r * c^2}}$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{2*a*r}{c^2}}}$$

Regardless, framing time dilation in terms of acceleration and distance is preferable in this model for a variety of reasons:

First, it aligns with our rejection of velocity as being a cause of time dilation. Any experiment in the absence of acceleration would reduce gamma to unity as evidenced by any of the equations above.

Second, it provides an additional plausible explanation for the overprediction of the time dilation via parallax as it reflects from a distant mirror (i.e. additional acceleration imparted on the particle). The concept of acceleration is complicated when we're considering photons, but we can analogously apply it to the twin paradox [4] (Figure 6).

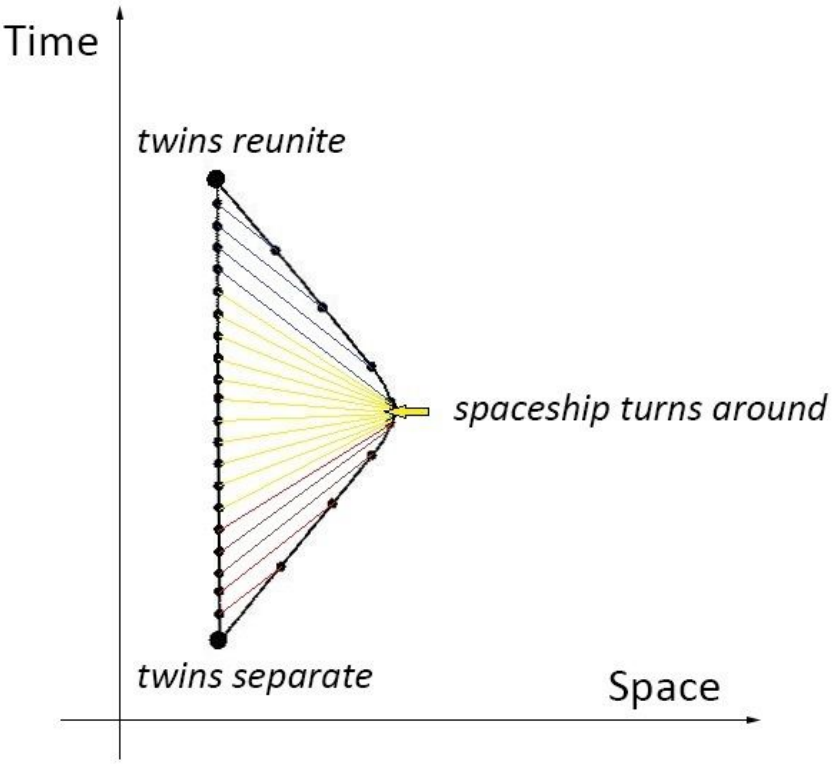

Figure 6 · Absolute time dilation as a function of *d* and acceleration

Stationary twin A and travelling twin B begin together on Earth. For simplicity we shall neglect B's initial acceleration from and deceleration to A, as well as time dilation effects experienced by A in Earth's gravity well. From A's perspective, B travels at 80% the velocity of light for 5 years, turns around in a relatively tight radius while maintaining his speed, and returns after a total of 10 years. A pure velocity-induced time dilation analysis would show:

$$v = .8 * c$$

$$T_B = T_A\sqrt{1 - \frac{v^2}{c^2}}$$

$$T_B = 10\sqrt{1 - .64} = 6\ years$$

However, we can also consider A's aging from B's perspective purely in terms of B's turn-around behavior. Initially we consider B's path to be circular and under constant acceleration:

$$T_A = 10\ years$$

$$Circumference\ of\ B's\ path = .8c * 10\ years = 8\ LY$$

$$r = \frac{8\ LY}{2 * \pi} = 1.27\ LY$$

$$a = \frac{v^2}{r} = c * .503\frac{m}{s^2}$$

$$T_B = T_A * \frac{1}{\sqrt{1 - \frac{a*r}{c^2}}} = 10 * \frac{1}{\sqrt{1 - .36}} = 6\ years$$

This result remains regardless of B's actual return path:

$$T_A = 10\ years$$

$$Length\ of\ B's\ actual\ semicircle\ turnaround = 0.1\ LY$$

$$r = \frac{2 * 0.1\ LY}{2 * \pi} = .0318\ LY$$

$$a = \frac{v^2}{r} = c * 20.106\ \frac{m}{s^2}$$

$$T_B = T_A * \frac{1}{\sqrt{1 - \frac{a*r}{c^2}}} = 10 * \frac{1}{\sqrt{1 - .36}} = 6\ years$$

Third, and most importantly, framing time dilation in terms of acceleration and distance elevates the equivalency between gravity and acceleration from being a fundamental first principle to a literal physical identity, which has obvious aesthetic appeal.

GPS Corrections

The reader may continue to object to the notion that velocity does not cause time dilation, and correctly reference the fact that GPS satellites must make both gravitational- and velocity-based time dilation adjustments in order to maintain accuracy. We suggest that this is due to our presumption that

a geodesic path is necessarily free from asymmetric forces. We submit that any spatially-extended object in gravitational orbit is in fact subjected to such forces (i.e. torque, in addition to tidal).

$$orbital\ velocity = \sqrt{\frac{G * M}{r}} = \sqrt{a * r}$$

$$orbital\ length = 2 * \pi * r$$

$$frequency\ of\ rotation\ of\ object\ in\ orbit = \frac{\sqrt{a * r}}{2 * \pi * r}$$

Null Space Framework vs Classical Fields

While null space framework and classical fields would be largely indistinguishable there is a difference. Direct influence on a particle in the null space framework is restricted to local particles (as defined by the model). This means that the abundance of the types of matter and its distribution might produce a charged environment even in an electrically neutral universe. Considering the relatively large radius of electrons and the small nucleal bundle of protons typical in most baryonic matter, we would expect that the contact surface for a given particle is almost entirely negatively charged. This could plausibly give rise to the perception of non-zero permittivity and permeability of “free space”. Additionally, this negative charge might provide the confining forces required to keep an electron with EM mass stable, along with a reason why positrons (see Figure 7) are not abundant in nature.

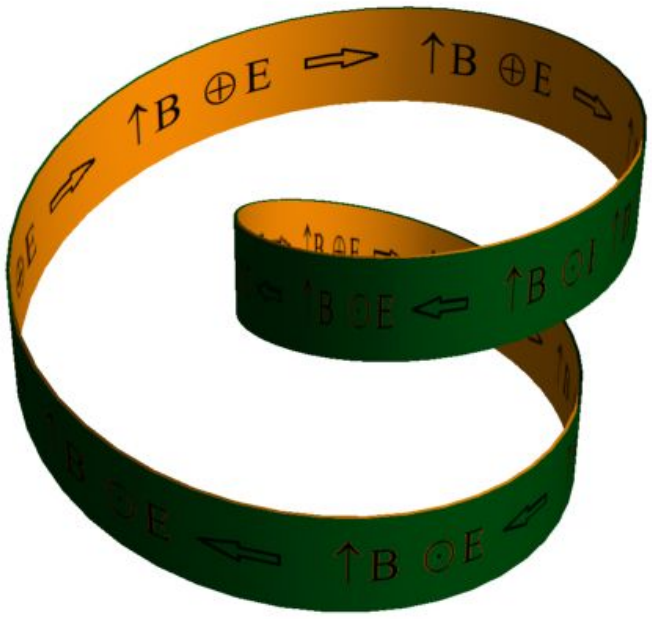

Figure 7 - EM Mass Positron

If we are allowed further speculation, it is possible that a particle's configuration and interaction with its local environment gives rise to the appearance of emergent forces which are simply effects of the single common cause of interparticle electromagnetic interactions.

Model Predictions

Because the null space framework considers time dilation to be solely a result of acceleration (as defined within the model) and distance, that would imply that gravity-induced time dilation effects would be greatest where the tidal forces are most asymmetric -- such as the surface of a sphere; in regions devoid of tidal forces, such as the interior of a massive, hollow sphere, we would expect no time dilation effects, in contrast to the prediction of general relativity.

Additionally, and more practically, null space framework is objectively real in the strictest sense of the word and considers wave functions to be pure epistemological abstractions. An EPR paradox experiment, measuring the correlation of polarization between spatially separated, entangled photons emitted from a particle's decay, could be interpreted as simply being the instruments mutually (and simultaneously) measuring the particle's decay itself. The spacetime interval between each instrument

and the decaying particle is zero, and they are all therefore local; our perception of them being separated by time and space is an artifact of the human experience, giving arbitrary yet preferential treatment to the frame of the observer, which is not supported by the math of relativity.

Making some presumptions about the physical process behind a decaying particle we could perform such an EPR experiment while having the instruments' polarization settings perpendicular to one another. The goal of such an arrangement is to measure *torque* on the instruments. If conservation of angular momentum is absolute then we would expect to find an accumulation of torque in consistent yet opposite directions on the instruments after repeated measurements; if conservation of angular momentum is an emergent property of a statistical nature we may not see an accumulation of torque in particular directions but we still may be able to discern torque correlations between instruments on a per-measurement basis. Either outcome would prove that the state of the photons was ontological "before" measurement, which would disqualify a variety of common QM interpretations.

Conclusion

In this paper we have described a model, the null space framework, consisting of a weighted graph with particles as nodes; we characterized these particles as being electromagnetic solitons, and the weight between nodes as being related to the reciprocal of distance; we considered parallax as having physical consequences for space and time; we have described energy transfer types and conditions between particles; we have considered all time dilation to derive from a common source; and we have rigorously defined locality. These features of the model allow for a world which is time-symmetric, objectively real, would display both quantum- and wavelike-behavior, and is testable where its predictions deviate from current theory.

NOTE: This paper is a work-in-progress. Please direct questions, comments and criticism to rjbeery@gmail.com and include "null space framework" in the subject line. All feedback welcome.

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