How Can Paradox Happen?

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by

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Abstract. Einstein's special and general theories of relativity leave us today with a variety of puzzles and paradoxes that are all too often discussed in the scientific and philosophical literature without universally satisfying resolution. This paper develops a novel analysis of the paradoxes, one based on concepts borrowed from the engineering literature. It develops the typically engineering view that physical reality is one thing, while our conceptual model for it is quite another. The two do not necessarily match, and if they do not, then we will make wrong inferences from data. Wrong inferences can very well be inconsistent, and that can lead to apparent paradoxes. The possibility for a wrong physical model to be embedded in Einstein's relativity theories is traced to the historical development sequence: as his point of departure, Einstein had Maxwell's electromagnetic theory, but not modern quantum mechanics. The paper discusses a post-Maxwell model for light that includes facts learned with the advent of quantum mechanics. When interpreted in terms of the model actually used in relativity theories, data predicted by this new light model produce 1) the main kinematic features of special relativity, but without paradoxes, and 2) general relativity's predictions for its main observational tests, but without any extraordinary mathematics.

Introduction

Einstein's special and general theories of relativity today leave us with a variety of puzzles and paradoxes that are all too often discussed in the scientific and philosophical literature without satisfactory resolution. A partial list of pending questions includes the following:

- The relationship between speed observed and time elapsed over a traversed distance becomes inconsistent among observers with increasing relative speed, but is it right to call that situation 'time dilation'? Is there a 'Twins Paradox'?
- Do lengths really contract? Did Ehrenfest really find a Paradox? What about the barn, the train and all the rest of the related paradoxes?
- The observed speed of an object is limited to light speed c, but is this really a physical limit? Does 'mass increase' occur to enforce it?
- In Special Relativity Theory (SRT), rotation sometimes considered within scope, sometimes out of scope. Which way is it?
- General Relativity Theory (GRT) seems to be an aether theory. How can SRT's aether rejection stand?
- How does GRT fit with Quantum Mechanics (QM)?

A variety of attitudes toward these questions is to be found in the physics and philosophical literature. Among defenders of Einstein's SRT, the most common may be characterized as denial: Many authors argue that there really are no paradoxes. Another common response may be characterized as evasion: in the very macro realm of cosmology or the very micro realm of QM, it can be argued that human intuition is only applicable to human-scale phenomena. This line of thought extends naturally to high speed, intense gravity, and associated relativistic phenomena. It leads naturally to what may be characterized as tolerance: in modern mathematics it is known for a fact that rational analysis is fundamentally limited in how far it can go, and a similar condition is attributed to QM. Why not also relativistic domains? Tolerance leads naturally to embrace: the Copenhagen school of thought about QM holds that Nature is fundamentally capricious, and many think the same of relativity.

The purpose of the present paper is to articulate an attitude different from any of the currently common ones. The viewpoint expressed traces to the authors experience in the world of control engineering. There it is recognized that physical reality is one thing, while our conceptual model for it is quite another, and the two may not necessarily match. That is, the engineer is always dealing with a "plant" that has some "state" that is not known directly, but rather has to be inferred from "data", using a mathematical model for how the plant state relates to the data. If the plant and the mathematical model for the plant do not match, then inferences about the plant state made from the data we will be wrong.

Wrong inferences can very well be inconsistent, and that can very well lead to paradoxes. The following Sections illustrate how this mechanism could apply in relativity theories. It recognizes that because it was conceived so early, we could have an incorrect "plant model" for the process of light propagation. It suggests a different model incorporating facts learned since the advent of relativity theories. It shows that if that if the new model would in fact be right, then use of the old model would produce incorrect inferences from all observations of moving objects. It shows how those incorrect inferences could produce all the well-known oddities and paradoxes of SRT. It also shows how the new light model would reproduce all the trophy results of GRT.

Preliminaries

History reveals that light is something very subtle indeed. Newton originally imagined particle-like "corpuscles" of light, which would be affected by forces in matter. But as was determined later, not all the details of his analysis were consistent with experiment. Newton thought that attractive forces in matter would make light speed there greater than in vacuum. When it became evident that this detail was wrong, particle-like light was abandoned in favor of wave-like light. The wave conception came to a flowering in the development Maxwell's electromagnetic theory, which led ultimately to Einstein's SRT.

But important issues were not yet settled. Maxwell's theory had been *based* on a luminiferous aether, but Einstein's SRT completely *disavowed* an aether: a paradox. Then Einstein exploited the metric tensor of SRT to develop his General Relativity Theory (GRT). Focussing on the space-time rather than the particles, it is a theory of aether renewed: a paradox. The status of the aether, arguably inseparable from waves, is still unclear.

The wave conception of light implied that light energy would be dependent on wave amplitude, and that continuous energy values would be possible, but black-body radiation and atomic spectral radiation eventually proved these implications wrong: real light has energies that are discrete, not continuous, and dependent on frequency, not amplitude.

Today Newton's light corpuscles are reborn as "light quanta", or "photons". But still we are not at the end of the intellectual journey about light. Modern Quantum Field Theory (QFT) makes (virtual) particles the mediators of all forces. But gravity does not fit this pattern. We have GRT, a theory of continua, not quanta. And there is a modern experimental problem in regard to SRT too: there is ample laboratory evidence of non-locality of interactions, distant entanglement of photons, *etc*.

All this suggests that rather than progressing linearly, physics has to some extent been going around in circles. We may need to review how we got into this situation, and possibly start over on some things. For example, Maxwell's theory may have been too preliminary a theory of light to form a sound basis for SRT. Maybe the development of relativity theory would have been better initiated after the advent of quantum mechanics (QM). Had that been the sequence, the model for light could have been more complete than wave or particle.

About Light

Consider the lengthy list of facts about light that the twentieth century has given us:

- Black-body radiation is quantized; *i.e.* Planck's constant exists.
- Light is a lot like a particle: *i.e*. the photo-electric effect and Compton scattering are explainable with particle-like light.
- Light emission and absorption are quantized; *i.e.* Planck's constant is involved in atoms.
- Photons are indistinguishable; *i.e*. they are Bosons.
- Emission and absorption can be stimulated; *i.e.* lasers are feasible.
- All light sources are somewhat like lasers, *i.e.* somewhat coherent.
- Non-local effects occur among multiple photons entangled in a single state.

All of these facts about light are potentially important, but even more important I believe is an attitude that has been acquired along with the facts. QM offers a new viewpoint, a distinction. In QM we acknowledge that there is always an observer effect: any observation tool affects the system observed. So QM can be viewed not as directly a theory of reality, but rather as a **theory of observer knowledge.**

The idea of observer knowledge (inference), as distinct from system state (reality), is presently very well appreciated in the world of engineering. Our modern technological society runs on multifarious control systems that are designed to respect that difference. There is no doubt that it is a powerful way of organizing things.

But by contrast, the idea or inference as distinct from reality is under-exploited in our present-day understanding of relativity theories. For example, in interpreting effects predicted by SRT, individual authors can be quite inconsistent: sometimes effects can be considered purely observational, but sometimes they are believed to be real. For example, we have time dilation and length contraction: the former is usually considered to be real, but there is an unclear state of hedging about the latter.

As for GRT, the contrast with QM is stark and apparently indefensible. In QM, measurements are indirect, mediated by light or something like it. This allows QM to be viewed as a theory of observer knowledge, rather than a theory of underlying reality. But despite the fact that in GRT too there is always an observation tool, *i.e*. light, GRT is never recognized as anything less than a theory of reality.

The present author believes idea of a **theory of observer knowledge** is something to apply to light, and then exploit in the context of relativity theory. The present paper is the most recent attempt to articulate the view. Readers can also look into earlier references.[1,2,3,4.5.6]

Two-Step Propagation

The basic ideas to be exploited are as follows: The right thing to think about is not the wave nor the photon, but rather the **photon state**. Whether in a black box, an atom, or between emitter and absorber atoms, photon state is generally bounded by **matter**. So a photon state generally has some **spatial extent** to it. And since the bounding matter can move, a photon state can have **temporal evolution** to it. So it is reasonable to think about light as if it were **an evolving, extended body.** Now consider **emission** and **absorption** of light: for energy to be transported from one place to another, both processes have to be involved. Emission and absorption are essentially similar except for reversal of time. So think **inch worm**. Think **slinky spring**. Think **two-step propagation**.

The observed phenomenology clearly drives us in this direction; only the paucity of mathematical tools dissuades us. Neither Maxwell's equations nor any other linear wave equation will describe two-step propagation without unbelievable boundary conditions. Nither Newton's laws nor any other description of point-particle mechanics will model two-step propagation. We just have to build a mathematical model from scratch.

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1 "Re-Doing Relativity in Light of New Data", Proceedings of Fifth International Conference on Problems of Space, Time and Motion, Saint Petersburg, Russia, 1998; "SRT: About That Light in the Beginning", preliminary version read at the Philadelphia Meeting of the NPA, 1998.

2 "The Twins, the Mesons, and the Paradox", Apeiron **4** (4) 104-109 (1997).

3 "The Mass Connected Photon", Proceedings of Vigier Conference at Toronto, Canada, 1997.

4 "Challenging the Speed of Light", Proceedings of NASA Breakthrough Propulsion Physics Meeting at Cleveland OH, 1997.

5 "Light is the Subject, Not the Object!", read at NPA meeting at Storrs, CT, USA, 1997.

6 "Finding Absolution for Special Relativity Theory: Parts I, II and III; Galilean Electrodynamics **7**, 23-29, 63-74(1996), and **8**, 8-15(1997).

Consider first the simplest case, where there is no relative motion between light emitter and light absorber. A mathematical model for two-step propagation can be constructed as follows. To embrace both emission and absorption, imagine **expansion** from a source at $x = 0$, followed by **collapse** to an absorber at $x = L$. To account for the total time known to be required for the whole process, $T = L / c$, allow half the total time for each step: $T_1 = L / 2c$ for expansion, and $T_2 = L / 2c$ for collapse. The light itself then becomes something quite different from either photon **or** wave; because it is always attached to an **anchor particle**, either at $x = 0$ or $x = L$, it nearly always has some spatial extent to it, and hence built-in non-locality.

Now consider two-step propagation with relative Galilean velocity $\mathbf{V}$ between source and receiver. Say the scenario starts at time t_0 with separation x_0, and separation *x* increases with speed *V*. Then after step 1, the time has become $t_1 = t_0 + x_0 / 2c$ and the separation has become $x_1 = x_0 + \dfrac{Vx_0}{2c} = (1 + V / 2c)x_0$. Similarly, after step 2, the time has become $t_2 = t_1 + x_1 / 2c = t_1 + (1 + V / 2c)x_0 / 2c$, and the separation has become $x_2 = x_1 + \dfrac{Vx_1}{2c} = (1 + V / 2c)x_1 = (1 + V / 2c)^2 x_0$.

Paradoxes

Standard SRT assumes one-step propagation, so it assumes a different result, $x_2 = (1 + V / c)x_0$. This does not fit the presumed two-step reality $x_2 = (1 + V / 2c)^2 x_0$. In order to fit the one-step model to the two-step reality, one would need $x_2 = (1 + V / c')x_0$, with $c' = \dfrac{c}{1 + V / 4c}$. So while the two-step $2c$ is independent of relative motion between source and receiver, the one-step c' is not. This is the key factor that makes the two-step process very different from the one-step model that SRT assumes.

The discrepancy between *c* and c' carries a serious implication in regard to time coordinates. Consider that time coordinates of events located away from a coordinate origin are not generally measured by a clock actually located at the event, but rather they are **inferred** by assuming that the image of the event propagated at speed c to an observer at the origin. But if the "event" is the passage of a source moving through a fixed spatial point, then correct inference of time requires c', not *c*. So for a **moving source**, time coordinates inferred assuming *c* are **biased**; *i.e*. **wrong**. This fact alone can account for a lot of strange results in SRT.

Example: The Twins Paradox

According to SRT, a moving clock looks slow. But in choosing *a priori* between two moving clocks, one can well wonder which of them is **really** moving. This question leads to the well-known Twins Paradox: twins are imagined to separate, one going on a journey while the other stays at home. SRT seems to predict that the traveling twin ages less than the sedentary one. All of the possible attitudes listed in the Introduction of this paper are to be found in the extensive literature about this paradox.

A simple resolution to the whole situation emerges from consideration of two-step light propagation. The image of a clock passing through x at T is observed at $t_o = T + x / c'$, and wrongly inferred to have passed through x at $t = t_o - x / c = T + Vx / 4c^2$. With $x = VT$, we have $t = (1 + V^2 / 4c^2)T > T$. So T progresses slower than t, but only because inferred time t is simply wrong.

Example: The Ehrenfest Paradox

According to SRT, a moving rod contracts. This is usually understood to be an observational effect, but if it is instead considered to be a real effect, then there is a paradox. According to Ehrenfest, the perimeter of a rotating disk is like a sequence of rods. So does the rotating disk shatter at the rim?

A resolution to the paradox emerges as follows. A rod has two ends, x_i, $i = 1, 2$. From $t_i = T_i + \frac{Vx_i}{4c^2}$, equal inferred t_i' s has to mean unequal true T_i' s. If we pair the ends for unequal T_i' s, we get a wrong length L', Indeed if $x_1 = VT$ and $x_2 = VT + L$, then equal t_i' s mean $T_2 = T_1 - VL' / 4c^2$, and $L' = L - V^2 L' / 4c^2$ so $L' = \frac{L}{1 + V^2 / 4c^2} < L$. So a moving rod *looks* short, but only because inferred times are wrong.

Example: Limited Particle Speed

It is asserted by SRT that Galilean particle speed is limited to light speed c. The Galilean speed V is defined as $\Delta x / \Delta T$. But without infinitely many clocks, ΔT is not directly observable. The next best thing is speed expressed in terms of coordinate time, $v = \Delta x / \Delta t$. Small observable v is not the same as large Galilean V; the two speeds are related through $v = \frac{V}{1 + V^2 / 4c^2}$. This function has a maximum value of $v = c$ located at $V = 2c$. So while Galilean V can be completely unlimited, observable v is limited to the maximum value of c. Thus particle speed *looks* limited to light speed c, but only because inferred times are wrong.

Note that this analysis has distinguished between observable v and Galilean V, a distinction not recognized in SRT. Needless to say, having only one name for two different things can lead to paradoxical situations in SRT.

Note too that proper distinction between V and v is of great technological importance.

Example: Rotation Effects

In SRT, light speed is supposed to be c. But the well-known Sagnac effect belies that supposition. The Sagnac effect constitutes rotation sensing by means of the rotation-induced shift in the interference pattern produced by two light beams traveling in opposite directions around an optical loop. The implication is that light has speed c only in a nonrotating coordinate frame.

The troublesome Sagnac effect can be excluded from the domain of SRT by excluding the rotational motion that produces it. The argument goes: rotation involves acceleration, and hence motion that is not inertial. Also true although not usually mentioned, rotation invites rotating coordinate frames, and, for large enough radii, rotating coordinate frames imply relative motions at speeds in excess of c, precluded by the speed limitation accepted by SRT.

But rotation exclusion is not really feasible. The SRT Lorentz group of coordinate transformation naturally includes rotations, and non-collinear Lorentz transformations *generate* rotations. Indeed, those details are involved in explaining *another* experimental effect: the so-called anomalous magnetic moment of an electron in an atom.

All these things can become consistent only within the context of two-step light propagation. Although it goes beyond the scope of a single paper to discuss all possible rotation related effects, let us consider one of them here: the above mentioned anomalous magnetic moment of an electron in a hydrogen atom. The situation is that from the vantage point of the electron, the proton nucleus is seen to circulate around and create a magnetic field. The problem is that the energy associated with the electron coupling to this magnetic field is only about half what would be expected on the basis of the energy associated with the electron coupling to some exogenous magnetic field.

The resolution emerges as follows. Two-step light propagation implies coordinate transformation matrices that are not the same as Lorentz transformations. Instead of the $\gamma, \gamma\beta$ coefficients characteristic of Lorentz transformations, there are coefficients $1 + V^2/4c^2$, V/c, and $\frac{V}{2c}(1 + V/8c)$. This latter coefficient determines the magnetic field seen by the electron due to the nucleus in the atom "circulating", and it is about half the $\gamma\beta$ coefficient SRT uses. Thus the magnetic field communicated by two-step light propagation in this situation is only about half what SRT predicts. So the electron doesn't really have an anomalous magnetic moment, but rather it sees an "anomalous" *magnetic field*. But this field is "anomalous" only as judged by SRT.

Example: Gravity Effects

Einstein's GRT has only a handful of testable results: light deflection, image distortion, red-shift, signal slowing, clock slowing and planetary perihelion advance. While it is beyond the scope of the present paper to treat all of these effects, we can look briefly at the most unambiguously testable ones: light deflection and perihelion advance.

Let us consider first the deflection of star light traveling a path near a large mass such as the Sun. Two-step propagation means the light is always still attached to some "anchor" particle. The anchor particles are subject to gravity throughout the propagation process. Thus the anchor particles can drag the light around, which can affect the light.

Imagine the line from Earth to Sun to define a coordinate axis *z*. The Sun is at the origin, Earth is below, and a source star is above. Thus we have a deflecting mass M at $z=0$, an observer at $z \to -\infty$, and a light source at $z \to +\infty$. Consider a ray passing the deflecting star at slightly positive *y*. During propagation down an incremental propagation path $-dz$, the anchor particles accelerate along *y* by incremental speed

$$dV_y = a_y dt = \frac{-GMy}{r^3}\frac{|-dz|}{c} = -\frac{(GM/c)y\,dz}{\sqrt{y^2+z^2}^{\,3}}$$

And over the whole path, the anchor particles accumulate

$$\Delta V_y = \int_{-\infty}^{+\infty} dV_y = \left.\frac{-(GM/c)yz}{y^2\left(y^2+z^2\right)^{1/2}}\right|_{-\infty}^{+\infty} = -\frac{2GM}{yc} = -\frac{2\,|\,\Phi\,|_{\max}}{c}$$

where Φ is the gravitational potential of the Sun, and subscript 'max' evaluates that potential at the minimum offset *y*. The minus sign and magnitude serve to make explicit the sign, as Φ is always negative.

The situation created by the transverse motion of the anchor particles in the gravitational field is the same as if the Earth were moving at $-\Delta V_y = +|\,\Delta V_y\,|$ relative to the approaching light beam. The result of such motion has been known ever since 1728, when Bradley established the existence of a stellar aberration due to the orbital motion of the Earth: stars appear shifted slightly forward in the direction of Earth motion. In the gravitational case, the aberration angle is $\Delta\varphi_a = |\,\Delta V_y\,/\,c\,| = 2\,|\,\Phi\,|_{\max}\,/\,c^2$. The positive sign means the star is seen displaced in the positive *y* direction.

In addition to this aberration, there is also an effect due to longitudinal acceleration. The *z* velocity change associated with dz is

$$dV_z = a_z dt = \frac{-GMz}{r^3}\frac{|-dz|}{c} = -\frac{(GM/c)z\,dz}{\sqrt{y^2+z^2}^{\,3}}$$

The total increment accumulated in coming from $z \to +\infty$ to $z = 0$ is

$$\Delta V_z = \int_{+\infty}^{0} dV_z = \left.\frac{-(GM/c)}{\sqrt{y^2+z^2}^{\,3}}\right|_{+\infty}^{0} = -\frac{GM}{xc} = -\frac{|\Phi|_{\max}}{c}$$

And then in going from $z = 0$ to $z \to -\infty$,

$$\Delta V_z = \int_{0}^{-\infty} dV_z = \left.\frac{-(GM/c)}{\sqrt{y^2+z^2}}\right|_{0}^{-\infty} = +\frac{GM}{yc} = +\frac{|\Phi|_{\max}}{c}$$

Clearly, the anchor particles are speeding up going into the gravitational well, and slowing down coming out. This behavior is consistent with Newton's original idea of light as corpuscles going into and then coming out of a refractive medium. He imagined that in a medium with refractive index *n*, his light corpuscles would speed up according to $c \to c_p = nc$. The above calculated speed increments are consistent with local refractive index $n = 1 + |\Phi|/c^2$.

The existence of a refractive index has an additional implication for two-step light. Where the anchor particles relate to Newton's corpuscle model for light, the expanding/collapsing light needle relates to Young's model for light as a wave. For a wave model, we have the inverse behavior, $c \to c_w = c/n$. If the refractive index has a gradient in the *y* direction, that will cause a wavefront tilt, described by $\partial\varphi_w/\partial z = \partial n/\partial y$. Thus in the gravitational case

$$\frac{\partial\varphi_w}{\partial z} = \frac{1}{c^2}\frac{\partial|\Phi|}{\partial y} = \frac{-(GM/c^2)y}{\sqrt{y^2+z^2}^{\,3}}$$

and over the whole path

$$\Delta\varphi_w = \int_{-\infty}^{+\infty}\frac{\partial\varphi_w}{\partial z}\,dz = \left.\frac{-(GM/c^2)yz}{y^2\sqrt{y^2+z^2}}\right|_{-\infty}^{+\infty} = -\frac{2GM}{yc^2} = -\frac{2|\Phi|_{\max}}{c^2}$$

The negative sign means the wavefronts tilt down, and the wave vector refracts toward the Sun. The effect on the stellar image is displacement in the same direction as the aberration displacement, and of the same magnitude. The *total* angular deflection observed is then

$$\varphi = \Delta\varphi_a + |\Delta\varphi_w| = \frac{4GM}{yc^2} = \frac{4|\Phi|_{\max}}{c^2}$$

When this result was first confirmed observationally, it was rated as a major triumph for GRT. The observed result was thought to be twice what one might guess semi-classically by saying that light has energy which is equivalent to mass and subject to gravitational attraction. But clearly, the correct result is *not* unique to GRT. Indeed, it is probably not even precluded by the original semi-classical analysis, if that had been done completely. In short GRT has perhaps been oversold.

Indeed, GRT has introduced some confusion. It has established the custom of lumping the gravitational refraction and gravitational aberration together as one effect, asserting that

$$c \to c_g = c / (1 + |\Phi|/c^2)^2 \approx c / (1 + 2|\Phi|/c^2) .$$

In so doing, GRT makes itself somewhat inconsistent with SRT, which treats refraction and aberration as different effects, each of which can happen independent of the other. It also precludes a simple understanding of other gravitational effects, an understanding available in the present theory. For example, in the present theory clock slowing is a simple consequence of light slowing, according to $c \to c' = c / n = c / (1 + |\Phi|/c^2)$. By contrast, in GRT clock slowing is something mysterious, a “distortion of time itself”. This author regards such mysticism as not much removed from paradox!

But let us proceed to perihelion advance. This effect can be understood as follows: Since the parameter c is itself affected by n, the expression $n = 1 + |\Phi|/c^2$ is clearly only a first-order approximation. One step of iteration gives $n \to n' = 1 + |\Phi|/(c/n)^2 = 1 + \frac{|\Phi|}{c^2}\left(1 + \frac{|\Phi|}{c^2}\right)^2$. This can be written $n' = 1 + |\Phi'|/c^2$ with modified potential $\Phi' = \Phi(1 + |\Phi|/c^2)^2$. That implies an effective orbit radius $r' = r / (1 + |\Phi|/c^2)^2$. The classical Kepler’s law relates orbit radius r and orbit frequency Ω according to the power law $r^3\Omega^2 =$ constant. If r is replaced by $r' = r / (1 + |\Phi|/c^2)^2$, then Ω has to be replaced by $\Omega' = \Omega(1 + |\Phi|/c^2)^3$. This is approximately $\Omega' = \Omega(1 + 3|\Phi|/c^2)$. It implies that the perihelion advances in the sense of the orbit by the fractional rate of $3|\Phi|/c^2$ orbit per orbit. This simple prediction matches both GRT and the observed non-Newtonian part of Mercury's perihelion advance.

Einstein's formula for the rate of perihelion-advance, $3\,|\,\Phi\,|\,/c^2\,(1-\varepsilon^2\,)$, includes orbit eccentricity ε. The Galilean theory has not yet been developed to the point of including the effect of ε. For Mercury, the ε is very near zero and plays little role in the believed confirmation of GRT. Getting the $3\,|\,\Phi\,|\,/c^2$ part right was considered a big triumph for GRT, but clearly now that triumph is *not* unique to GRT.

So at present, we have *nothing at all* uniquely supportive to GRT.

Summary and Conclusions

The two-step model for light propagation reproduces SRT qualitatively - length contraction, time dilation, *etc*. But it does so without any paradoxes, and it does so with wider scope, unambiguously including rotation and acceleration. Furthermore, it quantitatively fits experimental results, such as the so-called anomalous electron magnetic moment. The two-step model for light propagation also reproduces trophy results from GRT, such as light-ray bending and perihelion advance, but with simplicity of calculation. The two-step model for light propagation also fits well with QM; for example, because of its non-locality.

It is this author's belief that with two-step light propagation, we have a good basis to start raising questions about, and offering revisions to, current-day understandings of both SRT and GRT.

SRT as we know it today puts much emphasis on the mathematical group properties of Lorentz transformations and rotations. This emphasis may be misplaced. Consider that with an understanding of two-step light propagation, the Twin Paradox, the Ehrenfest Paradox, and the other paradoxes of SRT are really just **optical illusions**. They are caused by force-fitting a **one-step** model to a **two-step** propagation process. SRT creates the optical illusions because it involves time coordinates that have to be **inferred**, and which are inferred **incorrectly**. All this means that compiling multiple Lorentz transformations may be analogous to compiling multiple **illusions of illusions**.

GRT as we know it today is about mind-boggling, even computer-boggling, **complexity**. That is why only a **few testable predictions** have been extracted from it. The possibility that the predictions can also be understood in terms of two-step light propagation suggests that GRT may be so mathematically complicated only because it is unnecessarily **confounding** two fundamentally simple things: **mechanics** and **optics**. Newtonian mechanics and classical optics were at least more computable, and hence more testable, than GRT. This author thinks we should leave the descriptions of optics and mechanics separate, according to their required order of iteration in a more complete theory of light, a theory that acknowledges **two-step propagation**. We may thereby recover the more computable, testable situation that we had classically, and possibly put ourselves in a better position for reconciliation with QM.

Acknowledgment

The work presented here represents the latest stage in a long and difficult development process aimed ultimately at producing a book. At each step along the way, the earlist incarnation has been presented before the Natural Philosophy Alliance in the United States. The author thanks the Natural Philosophy Alliance for the opportunity to forge and test ideas on an attentive and sympathetic audience.

Apologies for a very Utilitarian Theory:

- It has no paradoxes; it requires no **Faith**.
- It has no speed limit; it offers no **Mystery**.
- It has no space-time symmetry; it lacks **Beauty**.
- It has no space-time curvature; it has no **Poetry**.
- Its simple math is pedestrian; there is no **Music**.
- It criticizes SRT and GRT; it shows no **Charity**.
- Sorry! But maybe at least it offers **Truth**.
- Also, maybe **Hope**. That's the best I can do.

MASS INCREASE

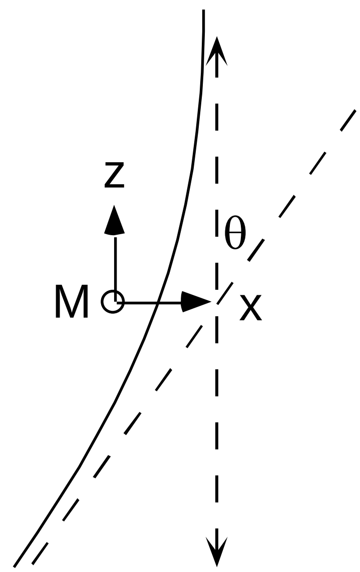
Applied in a particle accelerator, the Lorentz force law generally says

$$m_0 V\omega = evB \tag{8}$$

where m_0 is rest mass, ω is circulation frequency, e is charge, and B is magnetic field. Because V is bigger than v, the frequency ω used for any energy boosts has to be "chirped" down to compensate. In the case of SRT, the particle is presumed to travel at speed v, and the scale factor from v to V is regrouped with the m_0 to form a mass parameter m that increases with v. This is called "relativistic mass increase". It is believed to be physically real.

LIFETIME EXTENSION

In similar situations, charged particles that decay (*e.g.* mesons) are found to live longer than expected, in the sense that they travel a distance greater than expected before they decay. This is called "relativistic lifetime extension". It is believed to be a real, physical effect. But those mesons may age less than expected because they travel faster than believed. The distance they travel is consistent with velocity V rather than v. In the new theory, the meson is simply recognized to travel at V, so there is no surprise about its lifetime.



The angular deflection is... $\theta = 2|\Delta v| / c$

where by integration $\Delta v = \dfrac{2GM}{xc} = \dfrac{2|\Phi|}{c}$

so $\theta = 4|\Phi| / c^2$.