Ether, Time, and Energy (August 5, 2006).

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Notes.

On Monday, August 5, 2006, the following version of *Ether, Time, and Energy* [*ETE(8-5-06)*] was submitted to *Classical and Quantum Gravity*. The submission was processed on Monday, August 7, 2006, the date at the top of the submitted manuscript.

ETE(8-5-06) contains what are, to the author's knowledge, two historic results:

In section 4, Figure 11 depicts a universe accelerating an expansion, away from a temporally frozen state, with section 7 later stating, "Recent observations indicate that our universe is accelerating an expansion [54, 55]. As depicted in Figure 11, gravitational time dilation causes observers peering back through time, from lower energy density, to perceive such an acceleration, as the universe begins expanding away from its gravitational radius. The effect is opposite to that of gravitational collapse; instead of light cones closing, they open." Thus, *ETE(8-5-06)* solves the problem of accelerating cosmic expansion, without hypothesizing anything physical, such as Dark Energy, or modifying the formalism of General Relativity, such as by a cosmological constant.

Furthermore, section 7 states, "By observation and theory, there is only energy to influence rest. Energy motion influences rest motion, as manifested in ether drag, while energy amount and distribution set the rate of rest clocks. These influences of energy, on ether, provide the proper understanding of issues explored by Mach [50].", from which section 7 concludes, "Therefore, barring some consideration, external to the observed universe, that causes a flat FRW-proximate universe to have a nonzero total (possibly angular) momentum, the comoving frame is the free-space ether frame, in any FRW-proximate universe [recall that we saw this to be true, for curved FRW-proximate universes, in subsection 5.1]. Our universe is approximately FRW, assuming the Cosmological Principle [32c], so our free-space ether frame is seen in the stars." Thus, from frame drag, which is ether drag and has been observed, *ETE(8-5-06)* infers our free-space ether frame.

ETE(8-5-06) also contains other points of interest, some possibly impacting priority.

However, *ETE(8-5-06)* contains two major errors: The introduction states that *ETE(8-5-06)* uses the formalism of General Relativity; while section 5.2 claims that ether drag makes the ether observable, in effectively asymptotically flat space, with section 5.3 then claiming that waves of ether drag might make the ether more easily observable, both of which are untrue under the formalism of General Relativity.

Moreover, *ETE(8-5-06)* contains other lesser errors.

Because of the errors, the author suggests that readers consult his latest works, which are listed at http://vixra.org/author/kenneth_m_sasaki.

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Ether, Time, and Energy.

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Abstract.

This work establishes three properties of classical space-time: The first is smoothness, which holds since gravitational time dilation, at sufficiently high energy densities, gravitationally confines energy in frozen stars and frozen universes, preventing singularities. The second is the relationship between ether and energy, which allows practical experiments to observe the ether. And the third is causal consistency, assuming not more then current observations. Some associated points of interest are also discussed.

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1. Introduction

Physical theory has two components: There is the "formalism", or mathematics; and there is the "interpretation" that connects the formalism to observation [1,2a (for usage)].

The "Standard Special Relativity" that Einstein initially propounded, that textbooks teach, and that the vast majority of physicists today imagine, has an interpretation that relativity is an inherent property of space [3,2a,4a]. Observations, particularly from the Michelson-Morley experiment [5,2b,4b], are widely held to preclude an ether rest frame.

However, there is an "Ether" interpretation that relativity is a quality of observation, in trivial flat space-times, but not an inherent property of space [6,7,2a,4c]. As discussed further, below, an ether rest frame is hypothesized; although the question of a luminiferous "medium" is left open. Einstein later recognized this interpretation as related to his ether interpretation of General Relativity [3]. And, in fact, this interpretation has been shown to be correct, for universes of varying generality [8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18].

We define "ether" to be space with the property of rest (there are other formulations). We will call "ether flow" any relative motion of rest, at different spatial points.

The best candidate formalism for classical Gravity is that of General Relativity. Therefore, we take this formalism as our model, to aid in understanding phenomena, like gravitational collapse and frame drag, for which observation is tenuous.

In the context of our model formalism, we will consider observations that would create reference frame paradoxes, under the Standard Relativity interpretation. Best-known is the "Standard Twin Paradox" [2c,4d], in trivial flat space-times, although this has no observational consequences. However, the other paradoxes we will consider would be observational, either locally or globally, were Standard Relativity to hold.† We will thus find that observation forces the Ether interpretation on our model formalism, which combination we will call classical "Ether theory", or simply "Ether".

Although we rely on the formalism that most likely applies to our universe, in understanding the observational phenomena of interest, our results apply to any universe or theory exhibiting such phenomena, since it is the phenomena that establish our results.

With one exception, we will assume continuous ether hypersurfaces of simultaneity (the ether is "continuous") and continuous world lines. We will discuss discontinuities, in detail, when we make the exception.

† "Global" will reference either entire universes or at least nontrivial subspaces; context should make clear which. "Local" will reference finite trivial subspaces. And "large-scale" will be the scale, should such exist, just above which the spatial curvature of any distinct energy systems becomes insignificant. The following exemplifies this terminology: The locally large-scale-flat n-tori, T^n, have global curvatures, defined by the circumferences of their incontractible circles.

This work has been organized to maximizing the development of intuition, for the necessity and nature of the ether [see Appendix A for a history of this work].

Section 2 discusses the modern ether, in trivial flat space-times. We first review how assumptions for light velocity, in clock synchronization, lead to the Ether and Standard interpretations of the Special Relativity formalism, and explain that photon propagation produces length contraction. We will see that Ether theory's light velocity assumption is correct, with the ether frame uniquely reflecting reality. We then explain that Standard Special Relativity's incorrect light velocity assumption leads to the Standard Twin Paradox. And then we present new postulates for the flat-space-time Ether theory. We end the section with some kinematics that are useful in understanding the ether.

Section 3 establishes space-time smoothness. We first show that gravitational potentials do not cause ether flow. We then present the process by which gravitational collapse leads to energy confinement, keeping space-time smooth. We discuss this as our first major result, partly because there is already some recognition, among relativists, that gravitational collapse forces a reference frame choice [19a].

Section 4 presents a geometrical condition that would allow direct observation of light velocity, in some cases without clock synchronization. Special case cylindrical space-times have been well studied [8,9,10,11,12,13,14,15,16,17,18]. However, we undertake an extensive treatment that most clearly shows an ether reference frame providing a uniquely correct view of reality (which was originally demonstrated by Peters [9]).

Section 5 discusses the relationship between ether and energy, which allows local observation of rest motion. Although these are our most important results, in proving the ether, they are also the most difficult; so we discuss them after the earlier sections, in the interest of first building intuition.

Section 6 discusses causal consistency. First, for no-backward-time-travel, we establish minimal assumptions that are consistent with current observations. We then suspend our assumptions of ether and world line continuity, and demonstrate causal consistency, assuming not more then current observations.

And section 7 contains general conclusions and directions for future research.

Sections 8 to 10 are, respectively, appendices, acknowledgements, and references.

2. The Ether, in Trivial Flat Space-times

2.1. Light Propagation, Clock Synchronization, and Length Contraction

Both Poincaré (essentially) and Einstein gave the following definition for the synchronization of any two clocks, A and B [20, 21]: A light beam leaves A, when A reads t_1; arrives at B and is reflected back towards A, when B reads t_2 and arrives back at A, when A reads t_3.‡ A and B are *defined* to be synchronized if:

$$t_2 - t_1 = t_3 - t_2 \tag{1}$$

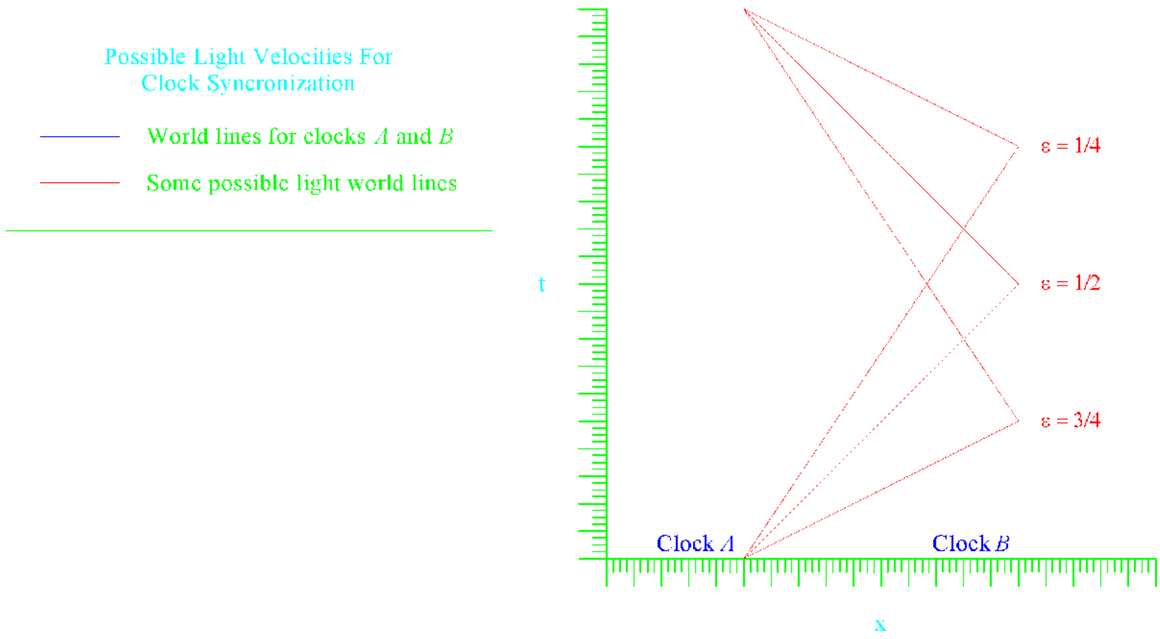

Figure 1. Here are pictured the world lines for two clocks, A and B, along with those for some light beams corresponding to three possible values of ε that might apply to a synchronization of the clocks.

But the above synchronization procedure only measures the round-trip average light speed, for the beam traveling between the clocks, with which an infinite number of one-way speed combinations would be consistent [22a] (see [23] for a further discussion). Figure 1 shows a space-time diagram, with the world lines of two clocks, A and B, in blue, and, in red, some of the possible light signal world lines that would be consistent with the synchronization procedure. With $0 < \varepsilon < 1$, all possible synchronizations are expressed by Reichenbach's ε definition of synchronization [22a,23]:

$$t_2 = t_1 + \varepsilon(t_3 - t_1) \tag{2}$$

The ε's, for the light velocities depicted in Figure 1, are shown on the right.

Standard Special Relativity assumes that light always travels with equal velocity, in both directions, relative to all observers, making ε universally equal to one half and reducing equation (2) to equation (1) [22b,23]. Assuming ε to universally equal any other number, between zero and one, produces similar interpretations.

However, one could alternatively say that ε equals one half, only in an ether rest frame. Light velocities, in any other frame, would be equal to the light velocity, in the

‡ All particles that can serve as vehicles for synchronization give consistent results, when symmetrically employed, which is, in fact, the foundation of all extrinsic symmetries and resulting conservation laws, such as those for energy and momentum.

ether frame, plus the velocity of the ether frame, relative to the other frame. Time dilation would occur just so to create the perceived universal light speed. This is equivalent to saying that the rates of clocks and the lengths of objects are as they appear in some particular (ether) frame of a Minkowski diagram. In all other frames, the values are illusory, because ε only actually equals one half, in the ether frame [as is most clearly illuminated in section 4]. This is Ether.

The FitzGerald Deformation Hypothesis [24] is correct. Photons must travel shorter average lengths, between rest particles of a given proper separation, then between non-rest particles of the same proper separation, not only in synchronizing clocks, but also in mediating the electromagnetic force. The resulting fields make bodies traveling through the ether correspondingly shorter, without appearing shorter. This is why the Michelson-Morley experiment is ineffective in identifying the ether.

2.2. The Ether Resolution to the Standard Twin Paradox

The Standard Twin Paradox [4d] follows from the incorrect assumption that light always travels one-way at its round-trip speed, relative to all observers (which is, itself, incomprehensible).

The Standard Twin Paradox "resolution" [4d], of asymmetry from one twin accelerating, resolves nothing, unless Special Relativity reflects a single reality only when the twins are together. Barring Ether theory, either Special Relativity is incorrect, while the twins are apart, with no reference frame completely reflecting reality (one frame doing so is Ether), in which case we have no theory describing particles with both different positions and velocities, or there is a different reality associated with each reference frame and thus state of motion. Both circumstances are extremely unhappy.

Ether theory has no twin paradox, since only the ether frame provides a correct view of reality, showing twins and other clocks as they truly age and move. So also does Ether avoid, most satisfyingly, that most troublesome Standard interpretation for length contraction. Thus do the Lorentz transformations indicate the existence of rest.

Ether theory has had the problem of the ether being supposed unobservable and thus superfluous. However, as stated above, this work demonstrates ether observability (we will see, in section 3, that the ether would be consequential even were it unobservable).

2.3. New Postulates for Flat-Space-Time Ether Theory

The following postulates create a classical flat-space-time Ether theory that is viable in all geometries and from which the correct classical gravity theory can be built:

a) For any flat space-time, there is a unique rest frame, in which the vacuum-speed of light and gravity is c.

b) Galilean relativity holds, observationally, in any trivial flat space-time.

Einstein's postulates [21] are recovered by b), which implies a perception of invariant speed c, for light and gravity in a vacuum.

In postulate a), c can be replaced by anything else that relates space to time uniquely in the rest frame. For example, c is inherent in Maxwell's equations. Therefore, Maxwell's equations relate space to time uniquely in the rest frame, and can replace c, in a), as they can be analogously used in the formulation of Standard Special Relativity.

2.4. Some Useful Kinematics

The following kinematics help in understanding the necessity and nature of the ether.

Figures 2 and 3 depict *reference frames* RF1 and RF2, respectively, each with two synchronized strings of clocks, one blue and one red. The blue clocks remain stationary in RF1, throughout. The red clocks begin in RF1 and then accelerate into RF2. The accelerations are simultaneous in RF1 but not in RF2. If the red clocks maintain RF1 synchronization, after they accelerate, an observer associated with them will continue to see the separations of clocks in both strings as identical, with the red clocks reading the same proper time, each time they pass respective blue clocks. If RF1 is the ether frame, then the red clocks maintain a truly constant separation, through the acceleration.

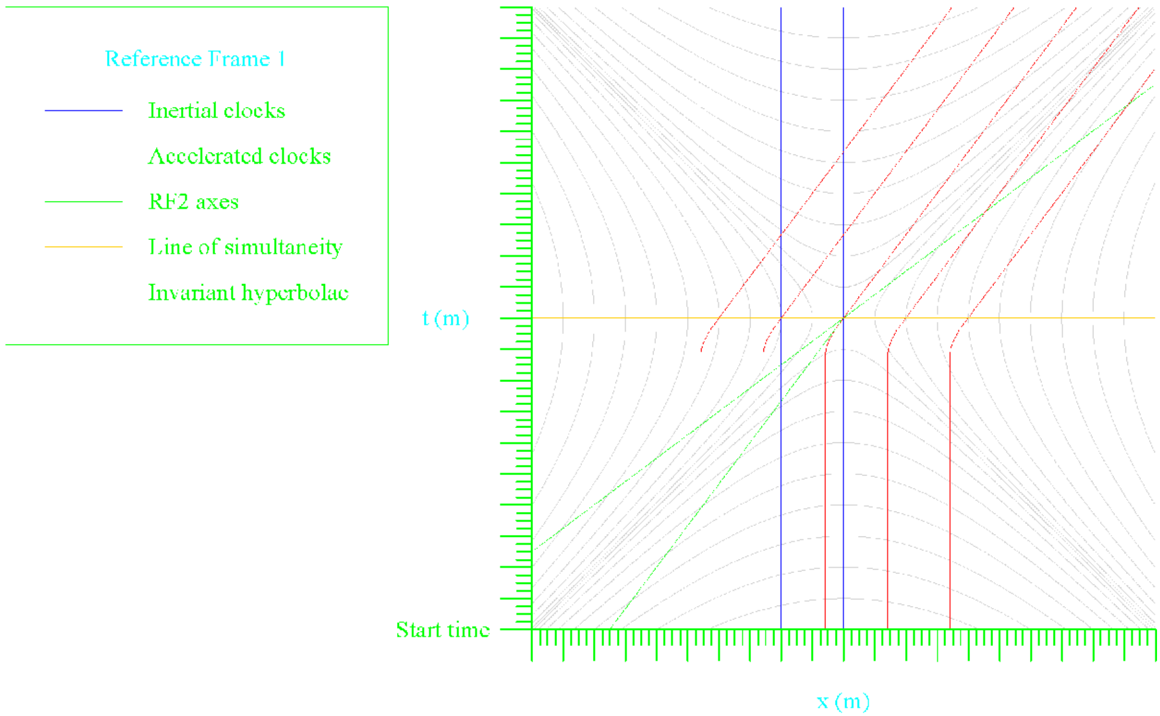

Figure 2. Here, in RF1, blue clocks are intertial, while red clocks are percieved to accelerate simultaneously.

Figure 4 shows another situation for our blue and red clocks. This time, the red clocks follow the invariant hyperbolae, so as to maintain a constant proper distance between them, as they accelerate from RF1 into RF2 [25].

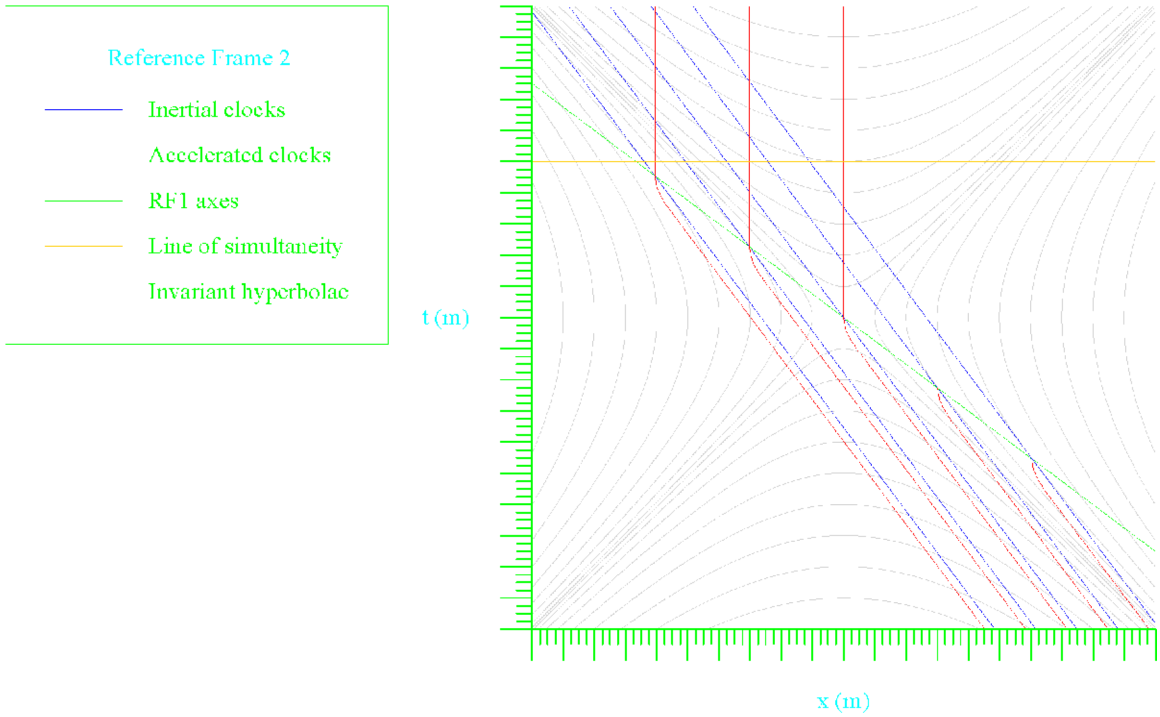

Figure 3. Here, in RF1, blue clocks are intertial, while red clocks are percieved to accelerate simultaneously.

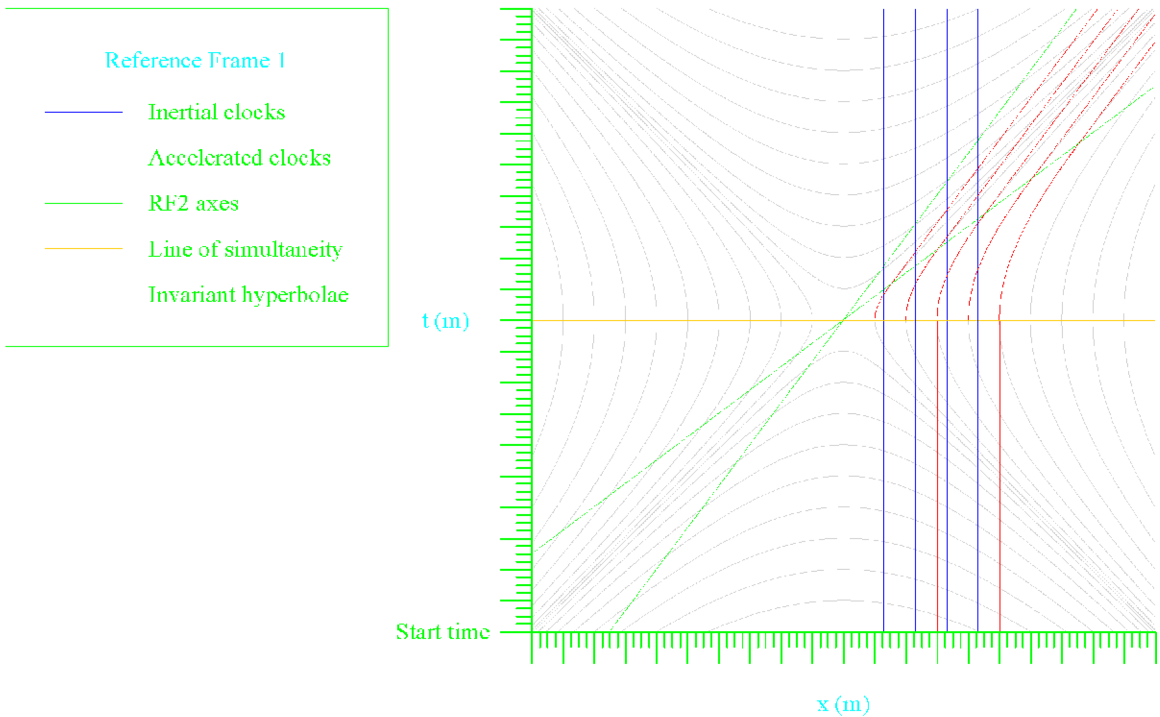

Figure 4. Here, blue clocks are inertial, while red clocks accelerate so as to maintain a constant proper distance between them.

3. Space-time Smoothness

3.1. The Ether in Gravitational Potentials

The Earth's gravity has been observed to cause gravitational time dilation, with clocks holding at higher potentials having faster rates then those holding lower [26,27,28, 29a]. By the definition of a potential, all gravitational potentials must cause such time dilation. This and symmetry allow us to understand the ether in gravitational potentials.

Consider a massive *ball*, B_1, that is stationary with respect to a remote free-space ether. Suppose that B_1 has a small central chamber, in which space-time would be essentially flat, with rest clocks running slower then those in free-space.

Now, suppose that gravitational potentials cause time dilation, in whole or in part, by creating ether flow, as implied, for example, by Eddington-Finkelstein [29b,19b] and Kruskal-Szekeres [29c] coordinates, which have reference clocks in relative motion. Clocks stationary with respect to B_1, but moving relative to the ether, would run slower then those at rest. However, the ether must then flow nonuniformly in B_1's central chamber, which is impossible in flat space-time. Therefore, assuming ether flow to cause a consistent proportion of time dilation, the flow must be zero. Gravity thus causes time dilation strictly by slowing the rates of all clocks at lower potentials, while leaving the ether static, as indicated by Schwarzschild coordinates [29d].

The following experiment would be a good test of gravitational potentiality and time dilation: Drill a hole to the center of a geologically dead *ball*, B_2, such as the Moon. Lower two synchronized clocks to the center. Bring one of the clocks up to free space and then hold it stationary with respect to B_2. Wait well more then the length of time to surmount clock imprecision and then bring the second clock up to the first. The clocks should show time passing slower at B_2's center, assuming B_2 is not creating too much frame drag with motion relative to the free-space ether [see subsection *5.2*].

3.2. Gravitational Confinement

Gravitational collapse greatly troubled many physicists, from the 1920's through the 1960's [19c]. Remote free-space observers would see a collapsing body "freeze", at its gravitational radius, while infalling observers, for example on the body surface, were presumed to fall all the way down to a singularity [29e,19d]. Most physicists rationalized away the Standard Twin Paradox, while ignoring the ether. But many of these balked at a paradox that seemed to involve time stopping verses time continuing [19c].

Starting in 1958, first the Eddington-Finkelstein and later the Kruskal-Szekeres ether-flow coordinates were almost universally adopted as reflecting reality [29b,29c,19b] (though the former is paradoxical [29f]). These coordinates conform to the idea that remote observers would see a collapsing body freeze, while the body, itself, would actually fall to a singularity [29b,29c,29e,19b]. The conflicting Schwarzschild coordinates have since been almost universally held as "illusory" [19a].

The defining act of creating an ether theory is choosing a particular set of coordinates as uniquely correct. Eddington-Finkelstein and Kruskal-Szekeres coordinates are generally not held to be uniquely correct. But their almost universal acceptance, by relativists, to the exclusion of the Schwarzschild coordinates, does set a precedent for choice, showing some recognition, among relativists, that choice is necessary. Unfortunately, the choice almost universally made is incorrect.

The problem with ether-flow coordinates, for the Schwarzschild geometry, is not manifest, if a singularity exists. Ether-flow coordinates cover the whole geometry, minus the singularity, with no central flat space-time to expose the problem. However, careful examination of collapse shows that energy confinement prevents singularities. The key is that the outer Schwarzschild coordinates never reach the gravitational radius.

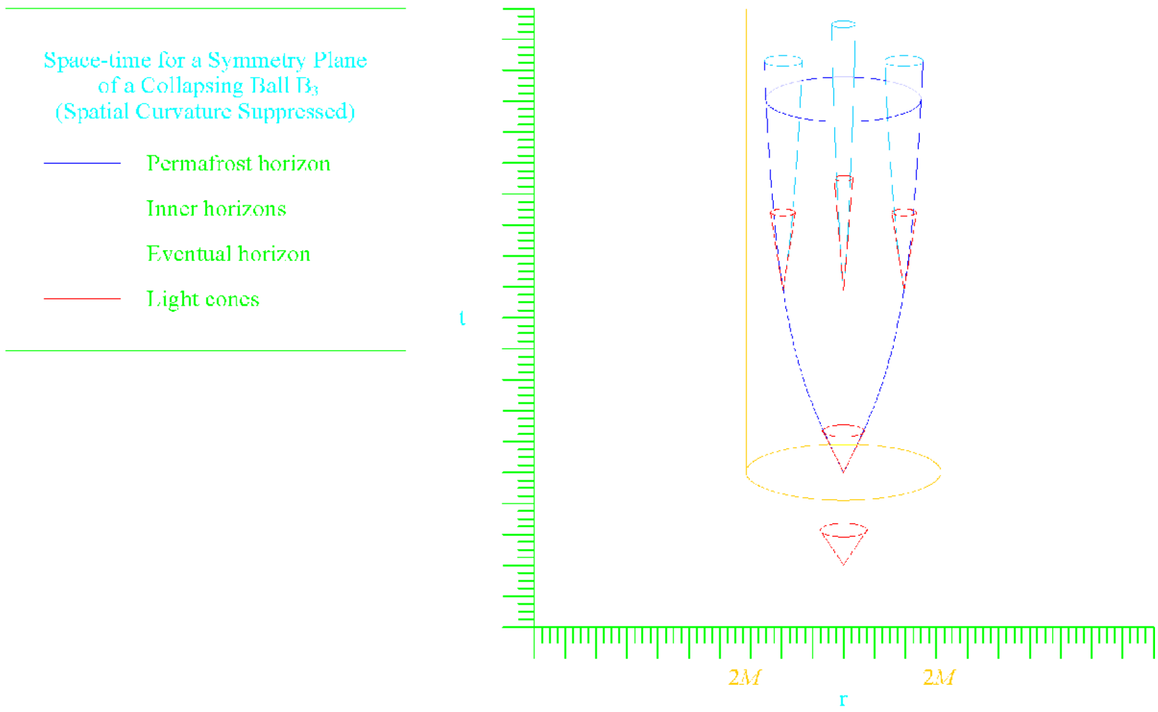

Figure 5. Here are depicted the light cones and world lines for a collapsing ball B_3

Figure 5 shows a space-time diagram for a symmetry plane of a collapsing *ball*, B_3, of *mass* M and radially decreasing density (spatial curvature is suppressed). As the red light cones close up, from B_3's center out, the energy required to escape B_3's potential increases. When B_3's center reaches the tip of the dark blue asymptotic surface, any signal sent from there will encounter light cones that narrow as fast as light can move out, and thus will require infinite energy to reach free space (classically). Light emitted radially outward, from this outer horizon, will travel along the horizon. As B_3's center moves within the outer horizon, its light cone continues to narrow, and so also at all other points within the outer horizon, trapping particles in progressively smaller and disjoint inner horizons, some of which are depicted in light blue. As the amount of mass within an arbitrarily *small radius*, r_S, around B_3's center, approaches $r_S/2$, the slopes of the generating lines, for the light cones just outside r_S, approach infinity, asymptotically slowing mass concentration within r_S and preventing the amount of mass from reaching $r_S/2$. Thus B_3's center never achieves the energy density to create the singularity at the tip of an absolute event horizon [30a,19e].

Thus do collapsing bodies lead to frozen stars, keeping space-time smooth.

{Trapped surface [31,30b] nonexistence precludes intended parts of the singularity existence theorems (see [31,30c], which discuss earlier results).}

Just as velocity boosts cannot infuse particles with energy enough to stop time, so also gravitational collapse cannot concentrate energy enough to stop time.

The clock experiment from the last subsection could, in principle, be used to directly observe temporal slowing, at the center of a collapsing body, confirming the end result.

We name the outer horizon of a collapsing body the "permafrost horizon" and the region within the "permafrost". Time never stops in the permafrost; but its asymptotic slowing does restrict particles, in analogy to the restriction of water molecules in ice.

The permafrost horizon never exactly reaches the gold surface, at radius $2M$, so the gold surface never becomes an *event* horizon. However, the permafrost horizon will *eventually* get close enough to the gold surface for any measuring device to read zero separation. Therefore, we rename the gold surface the "eventual horizon".

Cosmological singularities [32a] are similarly precluded by gravitational confinement [see Figure 11, below, for an example cosmology involving confinement].

4. s-Spheroids and Direct Observation of Velocity

Let U be any *universe*, at some moment in time; {L} the set of all *loops* in U; C_L the *circumference* of L; and $\mathbb{R}$ the *real* numbers. $L_0 \in \{L\}$ is "stationary" if, for every continuous parameterization $L(r) : \mathbb{R} \to \{L\}$, $L(r_0) = L_0$, with corresponding differentiable $C_L(r) : \mathbb{R} \to \mathbb{R}$, $C_L(b) \leq C_L(a)\ \forall\ a < b \in \mathbb{R}$:

$$\left.\frac{dC_L(r)}{dr}\right|_{r=r_0} = 0 \tag{3}$$

The idea here is that L_0 is either incontractible within U, or must be finitely varied to some other loop in U, for its circumference to be diminished to first order, within U.

Our definition of stationary for loops, which are 1-dimensional spheroids, generalizes to n-dimensional spheroids, with spheroid volume the generalization of circumference.

We will represent "stationary", in prefix, with "s-", as in s-spheroid.

Unless otherwise stated, we will assume s-spheroids to be unaffected by significant energy currents, and thus frame drag, which will be dealt with in subsection *5.2*.

s-Spheres, or s-S^n, $n \geq 1$, are central to this section, because particles can inertially circumnavigate any s-S^n great circle.

Figure 6 shows a number of s-S^n, in red, as parts of exemplary spatial structures. The 2δ-width neighborhood, around the s-S^1 encircling the right wormhole, is locally flat, as depicted by the enlarged flat subspace. The s-S^2 is a universe unto itself, as is the locally flat 2-dimensional torus, T^2. The squarish s-L, which exists in varying

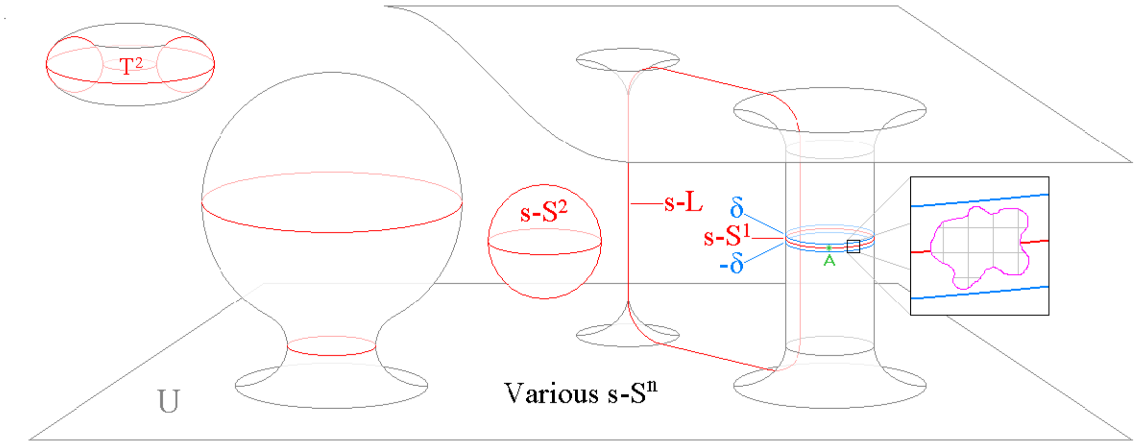

Figure 6. Here, in red, are various s-S^n. Spatial symmetry makes the s-S^1's inertial paths. The s-L loop is not circular, but will appear so, over a sufficiently short time interval, to a given measuring device. And the structure composed of the large semi-sphere, left wormhole, and lower plane, exemplifies the existence of s-S^n in trivial spaces.

dimensions, is not spherical, but will appear so, in the absence of significant frame drag, during a sufficiently short time interval, for a given measuring device. And the structure composed of the large semi-sphere, left wormhole, and lower plane, demonstrates that s-S^n can exist in trivial spaces.

The s-S^3 universe and s-S^2 wormhole center might apply to our 3-dimensional space.

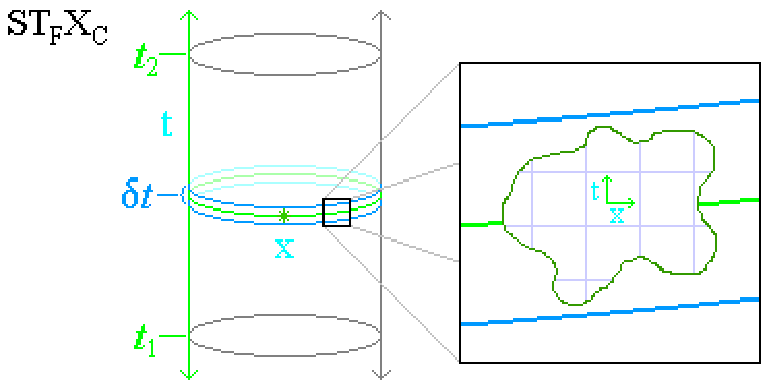

Figure 7. The space-time, ST_FX_C, is locally flat, as depicted by the enlarged local subspace.

Consider now s-S^1 × R^1. Identify a *circular* space, X_C, with s-S^1, and time with R^1, forming a locally *flat space-time*, ST_FX_C, as pictured in Figure 7, with the enlarged subspace depicting local flatness.

{Actually, ST_FX_C is valid for any energy-current-free *smooth* loop, L_S, over a time of negligible geodesic deviation.}

Clearly X_C has at least one reference frame (*ether*), RFE, in which global observations are consistent. That is, there is at least one global inertial observer.

Figure 8 shows a tiled space-time of RFE, in which blue Twin 1 and red Twin 2 start at x = A, travel with opposing constant velocities, and yet meet again [8, 10, 11, 12, 13, 14, 15, 16, 17, 18]. RFE axes are shown in green. Here is a "Circular Twin Paradox" with no asymmetry from one twin accelerating to allow the Standard Twin Paradox "resolution" [8, 10, 11, 12, 14, 15, 16, 17, 18].

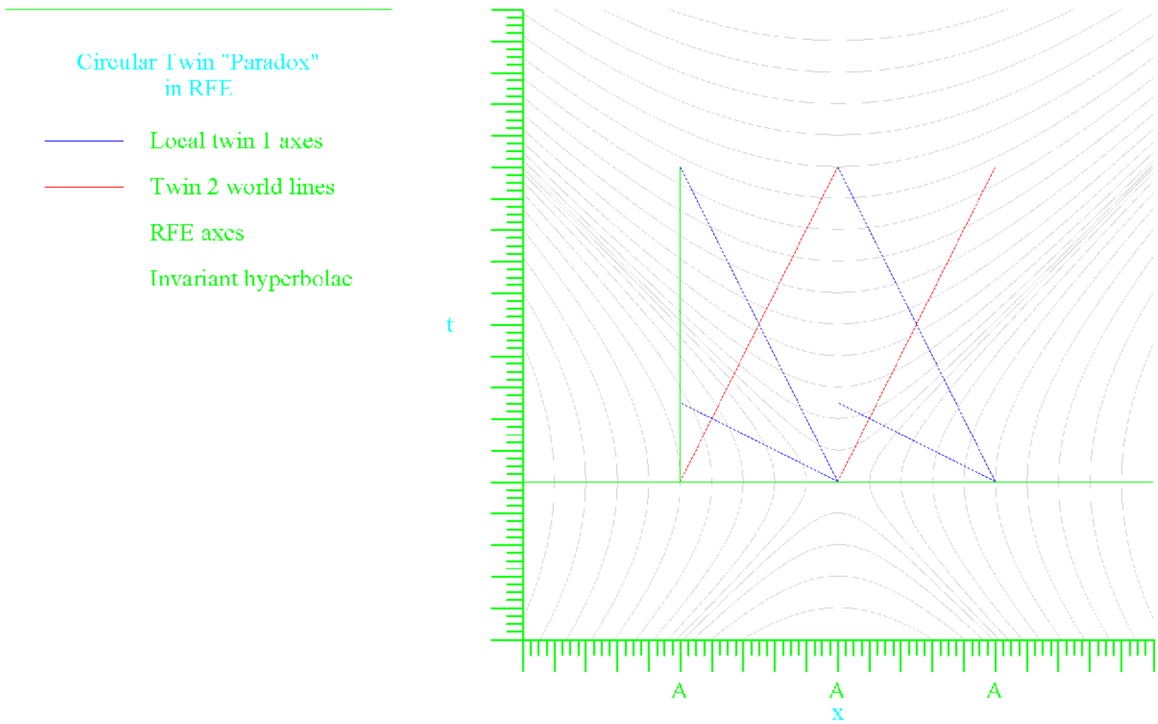

Figure 8. Here, in RFE, is a tiled space-time picture of a Circular Twin Paradox, with no asymmetry from one twin accelerating to allow the Standard Twin Paradox "resolution" [8, 10, 11, 12, 14, 15, 16, 17, 18].

Figure 8 also shows discontinuous lines of Twin 1 simultaneity, in blue, demonstrating that global simultaneity is problematic for reference frames other then RFE [8, 9, 10, 11, 12, 15, 18]. For example, if we identify the first and fifth clock pairs in Figure 2, we get a tiled picture of our blue and red clocks, in RFE. However, this identification causes a problem for Figure 3. Since the red clocks do not accelerate simultaneously, in this frame, the identified red clock has not a unique time of acceleration. Identifying the first and fifth clock pairs from Figure 4 causes a similar problem, this time indicating that global proper distance is also problematic, for frames other then RFE.

To resolve the above issues, we distort Figure 8, with a horizontal shear, making the Twin 1 world line perpendicular to the RFE space axis, as depicted in Figure 9. We will call this reference frame, comoving with *Twin 1* but having *RFE* synchronization, RFET1. In Figure 2, if RF1 is RFE, then the red clocks constitute such an observer, after they accelerate, so long as they do not resynchronize. In RFET1, the light cone is asymmetric, since light and gravity do not travel with velocity c; and, instead of invariant hyperbolae, there are hybrid functions of motion and synchronization. Twin 1 would thus see two beams of light or gravity, fired in opposite directions around X_C, come back at different times [8, 9, 10, 13, 14], preventing any global synchronization of clocks to the standard Twin 1 frame [8, 9, 15, 18], as expected from tiling Figure 3.

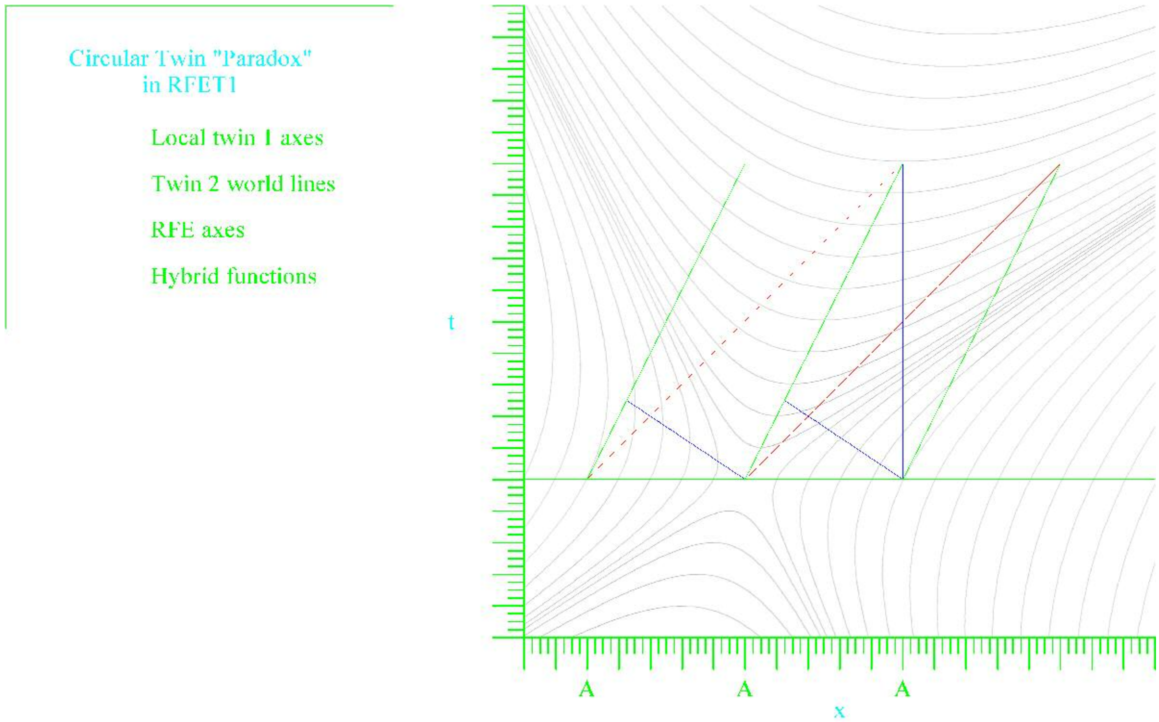

Figure 9. Here, again, is the Circular Twin Paradox, this time shown in RFET1, the referece clocks of which move with Twin 1 but have RFE synchronization.

But RFET1 is not associated with easy algebra, so we apply a vertical shear, producing Figure 10. This is, locally, the *standard Twin 1* reference frame, RFST1, with restored invariant hyperbolae. The boosted, yet continuous, RFE space axis indicates that spatially separated events may be viewed as boosted, relative to one another [9, 10, 11, 15, 16, 18]. The temporal lengths, between the discontinuous lines of RFST1 simultaneity, are the time boosts, for boosted iterations of Twin 1.

Let l_{maxE} be the X_C circumference and v the Twin 1 velocity, as seen in RFE. The unboosted time and space intervals $(0, l_{maxE})$ then define the RFE space axis. The boost values for the RFST1 space axes [9, 10, 15, 18] are in the Lorentz boost equation:

$$\begin{pmatrix} \gamma & \nu\gamma \\ \nu\gamma & \gamma \end{pmatrix} \begin{pmatrix} 0 \\ l_{maxE} \end{pmatrix} = \begin{pmatrix} \nu\gamma l_{maxE} \\ \gamma l_{maxE} \end{pmatrix} \tag{4}$$

Our distortion exercises show that calculations using the boosts [9, 10, 14] are really calculations in RFE, just using a different picture. Figures 8 through 10 are all valid representations of RFE, each giving a different insight into the nature of $ST_F X_C$.

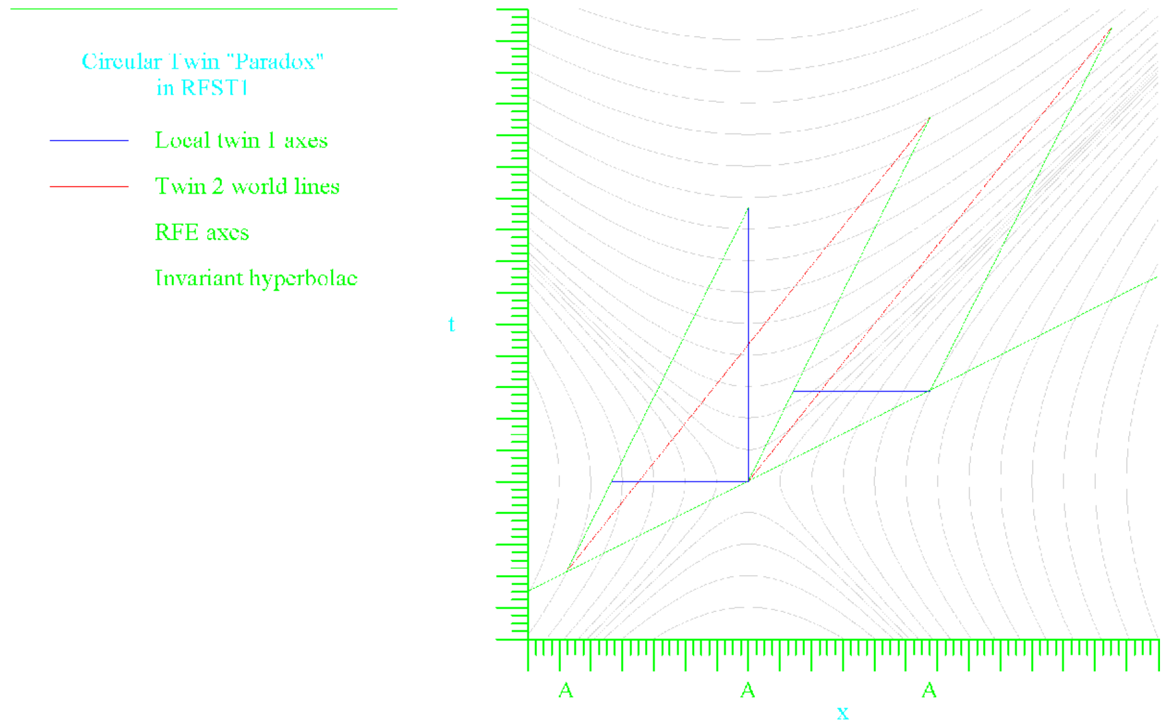

Figure 10. Here, yet again, is the Circular Twin Paradox, now shown in RFST1, which is, locally, the standard Twin 1 referece frame.

As seen in Figures 8 through 10, the globally consistent coordinates of a global inertial observer exist only for RFE [8, 9, 14]. Non-RFE coordinates have space axes that are discontinuous at the arbitrarily located tile boundaries (unlike the continuous RFE space axis), creating discontinuous global lines of simultaneity [8, 9, 10, 11, 12, 14, 15, 18].

Since we assume ether continuity, RFE is the ether frame for $\mathrm{ST_F X_C}$.

For an RFE temporal interval, t_E, the corresponding non-RFE temporal intervals are $(1/\ \gamma)\ t_E$ [10, 13, 14, 15]. Thus, RFE clocks exclusively run fastest [8, 10, 11, 13, 14, 15, 16, 18].

The RFE space axis defines absolute simultaneity, making simultaneity not relative.

Objects comoving with non-RFE frames appear to be a factor of γ longer, in those frames, then they appear to be, in RFE. As seen in equation (4), this includes the $\mathrm{X_C}$ circumference, γl_{maxE}, which is the maximal spatial length on which a non-RFE frame can have consistent coordinates (see primarily [9], and also [15, 18]).

As discussed above, RFE provides the only correct view of reality, in $\mathrm{ST_F X_C}$. Non-RFE observers perceive RFE clocks to progress slower, when they actually progress faster! Along with an $\mathrm{X_C}$ circumference of γl_{maxE}, they also perceive RFE clocks to be simultaneously located in multiple places, with each iteration having a different age [see the RFE time axes in Figure 10] [9, 18]! These illusions result from the incorrect light velocity assumption of Standard Relativistic non-RFE clock synchronization.

Specifically considering the Michelson-Morley experiment, suppose Twin 1 has an interferometer, with one arm parallel to its motion through the ether. The time for light to travel parallel to the motion was expected to be γ times that for perpendicular travel. Most physicists discarded the ether, at least in part, because this γ factor was not seen [5,2b,4b]. But the boosted length, between the Twin 1 world lines in Figure 10, shows that the actual parallel length that light travels is $1/\gamma$ times the length Twin 1 perceives, explaining the null results.

However, non-RFE observational inaccuracies are not locally detectable, in flat subspaces (see section 5 for geometries allowing local detection of RFE). As we have seen, everything related to local observation, in flat space-times, including all observational references, such as light speed, is subject to the same frame-dependent variation. In theoretical terms, local experiments cannot determine any inherent slope, to any reference frame space axis, in a flat subspace [see again Figure 10].

All of the above issues are now resolved. The asymmetries of non-RFE reference frames resolve both the Circular and Standard Twin "Paradoxes" [11, 16, 17]; and the global simultaneity and global proper distance problems, in tiling Figures 3 and 4, are merely manifestations of incorrect non-RFE coordinates.

Since $\mathrm{X_C}$ might occur in any topology, its ether is not topology-related, as stated in other recent works [15, 17, 18]; rather, its ether is observable as a result of $\mathrm{X_C}$ geometry.

In sections 5 and 7, we will see that the comoving frame is the ether frame, in any Friedmann-Robertson-Walker (FRW) [33a] proximate universe; however, this is not related to the global observations discussed here, as argued in [18] [see Appendix B for a presentation and analysis of this argument].

{Since $\mathrm{ST_F X_C}$ is valid for any $\mathrm{L_S}$, over a sufficiently short time, all $\mathrm{L_S}$ have momentary rest frames.}

Consider next the s-S^n, n $\geq$ 2, analogies to $\mathrm{X_C}$, and the corresponding s-$\mathrm{S^n} \times \mathrm{R^1}$ analogies to $\mathrm{ST_F X_C}$.

Each great circle of an s-$\mathrm{S^n}$ is an $\mathrm{X_C}$, with its own RFE. By symmetry, these RFE's, together, constitute a single time-independent state of rest, with the ether having no flow.

In s-$\mathrm{S^n}$, all motion is rotational, including that which would locally be perceived as translational, with the ether defining zero rotation on all circles, great and lesser. The angular rest of every $\mathrm{S^1} \subseteq$ s-$\mathrm{S^n}$, n $\geq$ 2, including $\mathrm{S^1}$'s existing in small essentially flat subspaces, will thus correspond to the angular (and locally translational) rest of all s-$\mathrm{S^n}$ great circles existing in hyperplanes not perpendicular to that of the $\mathrm{S^1}$ (we will simply say that such circles are "not perpendicular"). For example, under the Sagnac effect [34, 35], a nonrotating clock near the Earth advances faster then one carried around the Earth [26], allowing the determination of RFE for any s-$\mathrm{S^n}$ great circle not perpendicular to the Earth's great circles. And, as per Newton, a bucket of water with a level surface establishes RFE on any s-$\mathrm{S^n}$ great circle not perpendicular to the surface.

However, establishing s-$\mathrm{S^n}$ existence requires observation of spatial curvature. Therefore, flat-space-time observations of angular rest do not, alone, constitute observations of any translational rest; the observed rest may or may not become translational in remote and unobserved space.

Time-independent rest, for dynamic s-S^n, is apparent. The distances between all uniformly moving clocks vary proportionally, through time, with clocks defining a global inertial observer at one moment, so continuing. Furthermore, since the ether does not flow in gravitational potentials, all s-spheroids have time-independent rest.

Any s-Spheroid that exists longer then its circumference divided by c would allow direct observation of one-way velocities. It is fascinating that velocity measurement at a single point might be achieved by sending particles around a universe [13].

Figure 11 depicts the *curved* space-time, ST_CX_C, for one spatial dimension of an expanding and then recollapsing finite universe. The longitudinal lines depict time, while the latitudinal rings depict X_C through time. Any sufficiently small temporal slice, like that between t_M - δ and $t_M + \delta$, will measure as identical to a time slice of ST_FX_C. Momentary inertial frames continually change with time; yet there is a unique space-time direction, along which clocks mark time maximally [16, 17]. This cosmology resembles the Big Bang/Big Crunch cosmologies [32a], but differs from them in that the earliest and latest times, depicted in blue, do not involve singularities but rather a universe frozen at its gravitational radius. What event would initiate the expansion is a mystery.

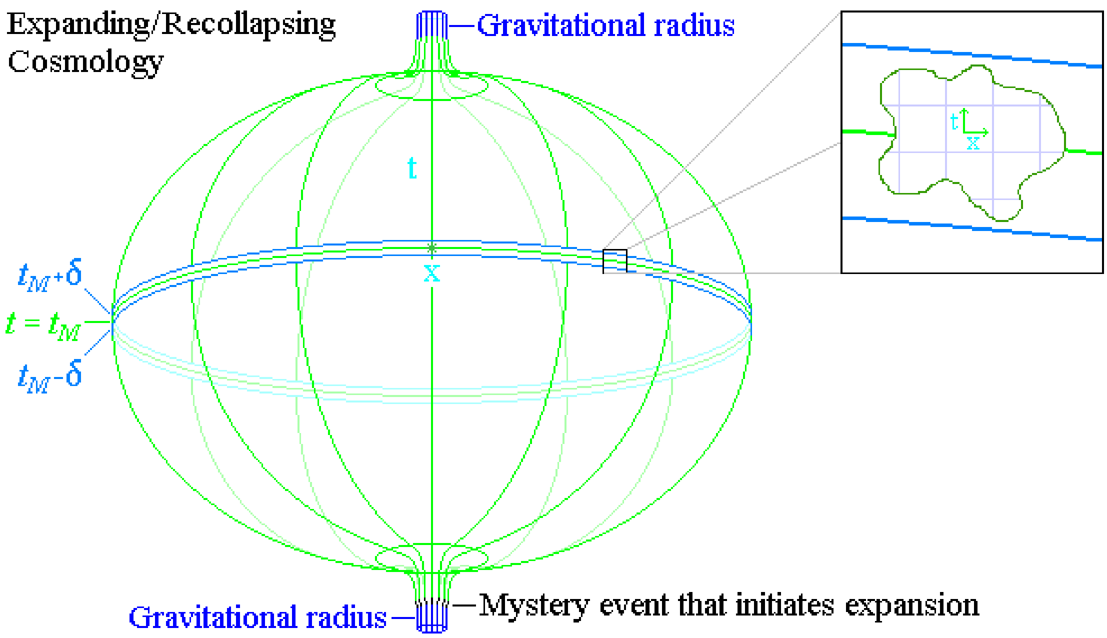

Figure 11. Here is ST_CX_C, for one dimension of an Expanding/Recollapsing cosmology. Clocks marking time the fastest travel longitudinal world lines, through momentary rest frames of thin latitudinal time slices. At the earliest and latest times, the universe is frozen at its gravitational radius. What event would initiate the expansion is a mystery.

5. The Relationship Between Ether and Energy

5.1. Large-Scale Curvature

For all s-S^n, $n \geq 2$, clocks at rest will only geodesically deviate with s-S^n size, while clocks initially translating through the ether, along parallel paths, will additionally geodesically deviate due to s-S^n spatial curvature. Resolution of such an s-sphere's curvature will thus locally determine rest. Similar considerations allow local observation of rest for any s-S^1 surrounded by nonzero large-scale curvature. In particular, the isotropy of curved FRW-proximate universes demands that their comoving frames be the free-space ether frames.

Since we assume all s-S^n to be free of significant energy currents, they must have most of their mass at rest, making rest easily observable, once curvature is established.

Now, since these considerations of large-scale curvature are local, rest motion will be observable with any non-zero large-scale curvature, regardless of topology, in the absence of significant energy currents.

5.2. Ether Drag

There is a "Maxwell" form of the low-velocity weak-field approximation to General Relativity [36, 37, 38, 39] that is helpful in understanding this subsection (the earliest such result known to the present author, [36], contains some small errors [37]).

Schiff has observed that energy currents, such as rotating balls or rings, "drag" inertial frames, in patterns similar to those created by bodies moving in a viscous fluid [40]. But this does not imply that particles or fields will behave as if dragged in a fluid, as pointed out by Rindler [38], who objects to the characterization "dragging" [see Appendix C for an answer to these objections].

As noted in the introduction, frame drag observations are currently tenuous; however, the Gravity Probe B experiment [40, 41, 42] is currently under way, to study the Earth's Lense-Thirring effect [43], and should shortly provide the first direct observation.

At first glance, frame drag might not seem like a big deal for our ether discussion, since local inertial frames can move and even accelerate, relative to one another, in asymmetrical geometries, without the ether flowing. But, as we will see, frame drag does not merely involve inertial frames in relative motion - it involves rest frames in relative motion. Energy moving through the ether alters rest, causing the ether to flow. Frame drag is, therefore, a matter of particular interest for us, as it is, in fact, ether drag.

Consider a massive *ball*, B_4, at rest in the ether of an essentially asymptotically flat space. Far from B_4 is a *remote* ether reference frame, RFE_R. Any *circle*, L_C, centered on B_4, has a non-inertial cylindrical space-time that looks like ST_FX_C, with an angular rest frame, RFE_C, corresponding to RFE_R [44].

Now, suppose that B_4 starts rotating, with L_C in the symmetry plane. RFE_C would then rotate prograde, with respect to RFE_R, in proportion to B_4's angular momentum and in inverse proportion to L_C's circumference [44].

A *remote* inertial *observer* on B_4's rotational *axis*, O_{RA}, could still see L_C clearly. Information carriers, such as light, would spiral out, creating a picture that is merely rotated. For example, suppose mirrors are held motionless, with respect to RFE_R, so as to guide light around L_C, each with a beacon that flashes, when light hits the mirror. From the beacons, O_{RA} would observe light circling L_C faster prograde then retrograde.

On any local segment of L_C, clocks that are motionless with respect to RFE_R could be synchronized. But, due to the asymmetrical light propagation, relative to RFE_R, the resulting space-time would appear to RFE_R like RFET1, in Figure 9. Imagine laying RFET1 onto the RFE of Figure 8; the hybrid functions would not match the invariant hyperbolae, even accounting for gravitational time dilation [see also Figure 12 B, below, with the pictured blue mass as part of B_4's equatorial surface].

Therefore, the ether is dynamic.

If B_4 were rotating in an otherwise s-S^n, then the state of zero rotation, around L_C, would not coincide with that in other parts of the otherwise s-S^n.

The drag created by each constituent particle of a rotating body is translational, in each small space-time subspace containing the particle, as seen most clearly with thin rotating rings. The local ether drag produced by a rotating ring encompassing an s-loop provides intuition for the time-dependent drag of translationally moving local bodies.

Ether drag preserving the symmetry of translational motion would constitute yet another paradox. We now demonstrate how ether drag breaks the symmetry of translational motion, assumed in Relativity, allowing local observation of the ether.

Figure 12 A shows four uniformly moving green clocks, which could have any velocity, relative to the static ether of a space in which the only significant mass, pictured in blue, is at rest. Here, identify the mass as a segment of an essentially infinite dust column (as noted above, the mass could also represent part of B_4's equatorial surface). In a sufficiently small space-time subspace, the clocks can use light signals to synchronize consistently, along all of the violet light paths, forming an inertial observer.

Figure 12 B again shows our clocks, this time uniformly moving with any velocity, parallel to a dust column that is, itself, moving axially through the ether, creating significant ether drag. Now the clocks can achieve consistent synchronization either along the upper three paths, as pictured, or the lower three. However, the upper and lower coordinates will each appear asymmetrical to the other, like RFET1 in Figure 9. Since this synchronization anomaly is independent of clock velocity, parallel to the dust column, it can be used to establish rest (nonparallel velocities would produce other anomalies, among all clocks).

Finite bodies, like the Earth, will produce synchronization anomalies analogous to those created by an infinite column, in propagating through the ether. Clocks and other particles near such bodies will respond to curls in the ether, in conserving momentum and angular momentum, behaving differently from those around similar bodies at rest.

Figure 13 depicts the Earth, in blue, translating with velocity v and rotating with angular velocity ω, relative to the ether. The pictured experimental apparatus translates

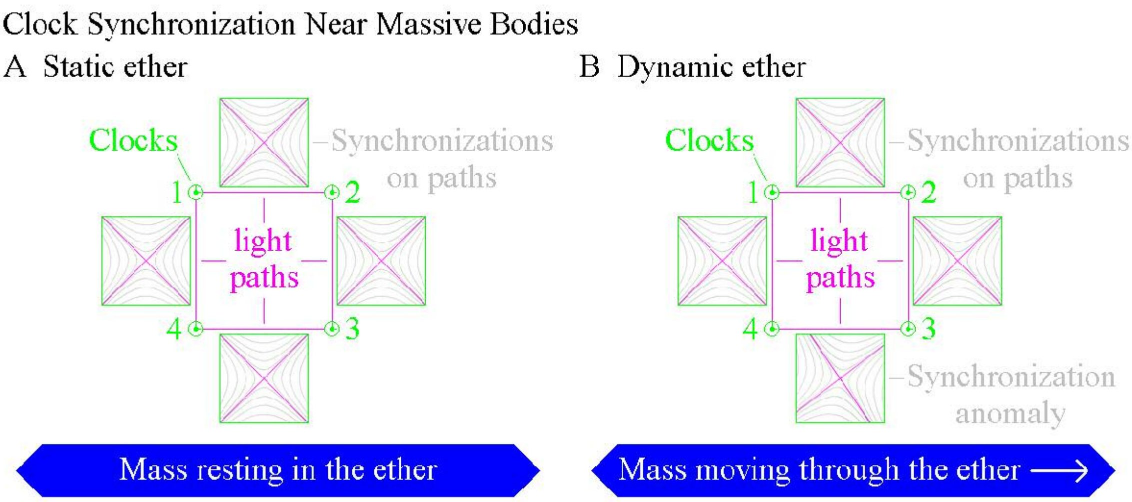

Figure 12. In A, four clocks uniformly move with arbitrary velocity, near a mass resting in the ether. In a sufficiently small space-time, these clocks can synchronize consistently, along all depicted light paths, to form an inertial observer. In B, the same clocks cannot synchronize consistently, because the mass, itself, is moving axially through the ether, creating significant ether drag. At best, consistent synchronization can be achieved on the upper three paths, as depicted, or the lower three; but the upper and lower coordinates will each appear asymmetrical to the other.

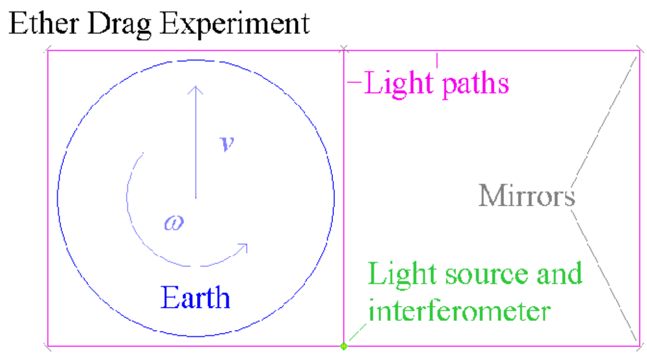

Figure 13. In this ether drag experiment, the light source sends beams along all violate light paths, which are created by mirrors at the square corners. An interferometer reads the fringes of recombined returning beams. The left square measures ether drag due to Earth's rotation, while the right measures ether drag due to translation.

with the Earth. A light source sends beams along all violet light paths, which are created by mirrors at the square corners. An interferometer reads the fringes of recombined returning beams. The left square measures the ether drag due to Earth's rotation, in a type of experiment proposed in [45], while the right measures the changing ether drag due to Earth's seasonal rest velocity.

Ether dragging astrophysical systems can also infuse light with rest information. For example, a galaxy translating across the line of sight from Earth to a light source will shift the source spectrum, depending on both the galaxy's internal angular momentum

[46] and momentum. Dragged light can be compared with direct light, to observe rest. Also, glowing jets emitted from regions around frozen stars, and glowing disks of matter, such as galactic and accretion disks, will all shape according to momentum conservation.

5.3. Ether Waves

With ether defined as space with the property of rest, all gravitational waves [29g,32b,33b,39] are ether waves, which are composed of two "hyperpolarizations", respectively parallel and perpendicular to the ether dimensions. Time-dependent ether drag creates ether waves that oscillate parallel to ether and carry rest information. Time-dependent gravitational potentials create ether waves that oscillate perpendicular to ether. Ether waves would evolve according to any large-scale curvature through which they travel, thus carrying any associated rest information [recall subsection *5.1*].

Binary systems are very common and useful theoretical ether wave sources. Figures 14 A and B show two binary systems. A's rotational axis is at rest in the ether, while B's translates, such that each body periodically comes to rest, in a manner similar to that of points on the edge of a rolling wheel. Both bodies of binary A disturb the ether continuously. However, when one of binary B's bodies is momentarily at rest, the system's ether disturbance is entirely due to the other body. So, the ether waveforms produced by our two binaries are different and thus carry observable rest information.

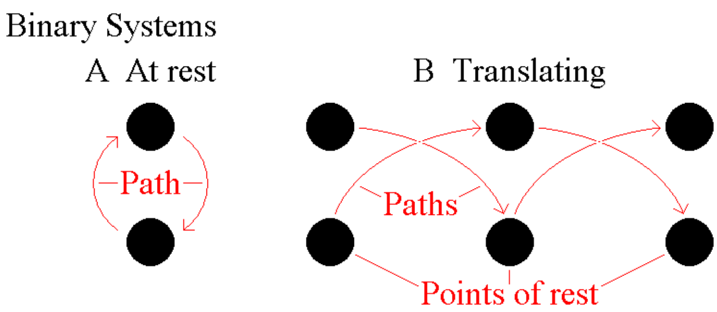

Figure 14. Here are two binary systems. A's rotational axis is at rest, while B's is translating through the ether, such that each body periodically comes to rest, in a manner similar to that of points on the edge of a rolling wheel. The ether waves produced by these binaries are distinct and thus carry rest information.

Binary system constituent bodies often possess the properties of astrophysical objects discussed in the last subsection, and so infuse light with ether wave rest information. The time-dependent ether disturbances of binaries may make their rest information more easily observable then that from isolated astrophysical bodies.

Eventually we will not need to look very far to detect ether waves. The Earth and Moon form a binary system, the ether waves of which will be detectable, with sufficiently sensitive gyroscope or interferometer experiments.

6. Causal Consistency

6.1. Minimal Assumptions For No-Backward-Time-Travel

Hawking coined the "Chronology Protection Conjecture" [47,19f], "*The laws of physics do not allow the appearance of closed timelike curves.*" This conjecture has been prominent in the study of causality, so we will meet or exceed its original standards.

We have already seen that Ether theory is correct. However, we here independently demonstrate that any proper study of chronology protection requires Ether theory.

Poincaré showed that, with increasing superluminal travel, from light speed to infinity, the range of ε, in equation (2), can be observationally narrowed, from the interval (0,1), down to a point [48] (see also Capria [23], who cites [48], providing details and some English translation). Superluminal travel would thus make Standard Relativity nonviable. This method of ether observation can be realized, using translational ether drag, since light can travel faster then c, relative to the remote free-space ether. In a sense, the narrowing of the ε range generalizes the ether demonstration for $\mathrm{ST_F X_C}$, in section 4. Any observer in $\mathrm{ST_F X_C}$ can be thought of as being in two places at once, as in the tiled representations, and able to self-send instantaneous signals.

Hawking states [47], "Of course, in the theory of relativity, time travel and faster-then-light space travel are closely connected. If you can do one, you can do the other. You just have to travel from A to B faster than light would normally take. You then travel back, again faster than light, but in a different Lorentz frame. You can arrive back before you left." (Here, time travel refers specifically to backward time travel.)

Thus (backward) time travel eliminates Standard Relativity theory. Therefore, any proper study of chronology protection requires Ether Theory.

In his treatment, Hawking assumed real-time Lorentzian metrics [47], in which "...the light-cone structure forces one to travel at less then the speed of light and forward in time in a local region." Hawking made this assumption in the context of Standard Relativity; however, we can relax it into one suitable for demonstrating no-backward-time-travel and thus chronology protection.

Exclude only backward time travel in any trivial essentially flat ether frame. This assumption allows greater observed velocities, in all frames, then does Hawking's.

No-backward-time-travel requires three locally untestable assumptions: Exclude universes over which time uniformly repeats, making all future immutable past. Nothing important is lost with this assumption, since uniformly repeating universes are causally consistent (as discussed further in the next subsection). Also, recall our assumptions of ether and world line continuity. Some discontinuities are consistent with current observations (as also discussed further in the next subsection); but the continuity assumptions are reasonable, given our current observational capabilities, since any discontinuity that is consistent with current observations must be locally unobservable.

No-backward-time-travel in any essentially flat ether frame and continuity guarantee no-backward-time-travel past any ether hypersurface of simultaneity.

Furthermore, any traversable closed world line must be two-way traversable, since any one-way traversable closed world line would require the type of event horizon that we have demonstrated does not exist. In particular, any closed world line involving wormholes would have to be two-way traversable.

No-backward-time-travel past any ether hypersurface of simultaneity then restricts closed world lines to individual ether hypersurfaces of simultaneity (instantaneous travel, in effect, allows clocks to be spread over arbitrary volumes).

Therefore, there is no backward time travel, implying chronology protection.

[See Appendix D for specific refutation of two well-known prescriptions, for closed timelike curves, that try to use multiple reference frames.]

6.2. Causal Consistency, Assuming Not More Then Current Observations

Zel'dovich and Novikov realized that closed timelike curves could be causally consistent [49]. However, to demonstrate causal consistency, assuming not more then current observations, we must account for all locally unobservable backward time travel, which may involve repeating world lines that are not closed timelike curves.

From the assumptions of our result in the last subsection, locally unobservable backward time travel can only occur from ether or world line discontinuity, and in uniformly repeating universes. However, all locally observable phenomena must be representable by continuous world lines, in continuous coordinates.

Therefore, allow uniformly repeating universes. World line repetition only violates causal consistency if it is created or destroyed, necessarily by something with a different repetition frequency. Uniformly repeating universes are thus causally consistent.

Also allow time-independent ether discontinuities that create purely temporal separations of uniform magnitude, in ether hypersurfaces of simultaneity, but do not affect clocks. These "allowed" discontinuities can be represented by space-times like Figure 15, in which the green ether axes have discontinuous lines of simultaneity; however, we emphasize that they would not be mere characteristics of any ether coordinates, but rather of the ether, itself. Clock world lines would be continuous, across the allowed discontinuities, as exemplified by both of the blue non-ether axes (allowing for superluminal travel). Such allowed discontinuities would be locally unobservable.

Our allowed ether discontinuities would also be unobservable, simply by a global synchronization. Any discontinuity they would produce, in ether coordinates, would depend on where the synchronization procedure begins and ends - no longer is there a unique observable ether frame - and there would be continuous non-ether coordinates, like the blue axes in Figure 15, that would be indistinguishable from continuous ether coordinates [compare Figure 15 with Figure 10].

However, a discrepancy between locally observed ether coordinates and globally continuous coordinates would indicate a discontinuous ether. This can only happen in multiply connected spaces. In simply connected spaces, any repeating curve must cross any allowed ether discontinuity, in both directions equally, preventing any discrepancy. In any case, the locations of any allowed discontinuities would still be unobservable.

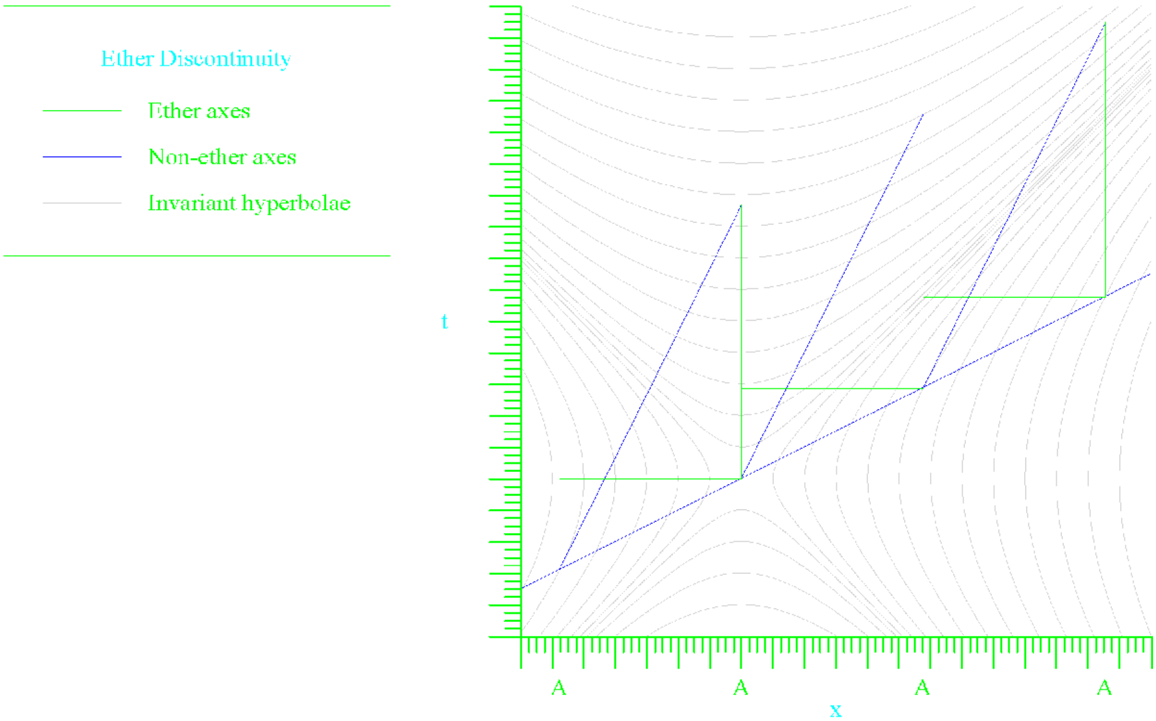

Figure 15. Here is a tiled space-time with ether discontinuities and a globally continuous non-RFE frame.

Unlimited superluminal travel, around multiply connected spaces with allowed ether discontinuities, would allow repeating world lines. Even with locally observable travel restricted to the forward light cones, world lines could still repeat, if the magnitude of any allowed discontinuity were to equal or exceed the smallest s-spheroid circumference.

However, any universe with allowed ether discontinuities would have an ether reference frame covered by infinitely repeating diagonally placed tiles. Therefore, causal consistency would hold, with the associated backward time travel.

If we imagine distorting Figure 15, with a horizontal shear, making the blue non-ether space axis vertical (this retains an ether synchronization), the resulting space-time would appear to depict a uniformly repeating universe, clarifying the causal consistency of universes with allowed ether discontinuities. (An actual superluminal observer is unnecessary for our purposes. In any case, one can be mimicked by continually adjusting the assignment of spatial coordinates to clocks at rest in the ether.)

There are infinite possibilities for ether and world line discontinuities that would create locally unobservable backward time travel, but all must be observationally equivalent to our allowed ether discontinuities. For example, if we imagine sliding space-time back and forth, along an allowed ether discontinuity, we get an infinite number of observationally identical combinations of ether and world line discontinuities.

Therefore, there is causal consistency, assuming not more then current observations.

{Blau has examined superluminal travel in $\mathrm{ST_F X_C}$ [14], essentially concluding that there are no closed timelike curves. Although he does not consider ether or world line discontinuity, or the ramifications of superluminal travel for synchronization [48, 23].}

7. General Conclusions and Directions for Future Research

By observation and theory, there is only energy to influence rest. Energy motion influences rest motion, as manifested in ether drag, while energy amount and distribution set the rate of rest clocks. These influences of energy, on ether, provide the proper understanding of issues explored by Mach [50].

Therefore, barring some consideration, external to the observed universe, that causes a flat FRW-proximate universe to have a nonzero total (possibly angular) momentum, the comoving frame is the free-space ether frame, in any FRW-proximate universe [recall that we saw this to be true, for curved FRW-proximate universes, in subsection *5.1*]. Our universe is approximately FRW, assuming the Cosmological Principle [32c], so our free-space ether frame is seen in the stars.

Gyroscopic and laser technologies have advanced to the point where ether drag and ether wave experiments, such as that presented in subsection *5.2*, should soon directly measure rest motion, establishing rest time to widely accepted theoretical standards (by which, for example, we accept the theoretically described nature of elementary particles).

Ether wave experiments may soon detect waves created by frozen stars. These waves would be distinct from those thought to be created by singularities.

Longstanding concerns about singularities, leading to, for example, the "Cosmic Censorship Hypothesis" [51,52,19g] and the "Ignorance Principle" [53], are no more.

Total energy determines gravitational radius and thus maximum energy density. Therefore, the universe must be finite, unless there is either a violation of the Cosmological Principle or negative energy.

Recent observations indicate that our universe is accelerating an expansion [54, 55]. As depicted in Figure 11, gravitational time dilation causes observers peering back through time, from lower energy density, to perceive such an acceleration, as the universe begins expanding away from its gravitational radius. The effect is opposite to that of gravitational collapse; instead of light cones closing, they open. The cleanest and most intuitive way to theoretically account for this would be with the radial scale factor, while referencing time to our point of observation.

The search for a unified theory of nature should focus on gravity as a confining agent at high energy densities. Confined elementary particles, in nucleons and other composite particles, might manifest gravity's role in the quantum realm.

Gravitational confinement involves a minimum volume for a given amount of energy and energy is associated with particle wavelength; so there is a minimum particle wavelength for RFE, which is the Planck length, l_p (see [56] for a pertinent l_p derivation).

As discussed in subsection *2.1*, clock synchronization requires two signals, the longer wavelength of which is a lower bound for the separation of reference clocks in the resulting frame. l_p is thus the minimum observable length in RFE.

But an l_p minimum wavelength, in RFE, will be Doppler shifted into direction-dependent minimum wavelengths, in any reference frame, RFB, having non-RFE synchronization. Let $\boldsymbol{v}$ be the velocity and *gamma* the Lorentz boost factor, relative to RFE, associated with the RFB synchronization, and let θ_E be the angle between $\boldsymbol{v}$ and any RFE signal velocity. The wavelength Doppler shift formula for RFB is then:

$$\lambda_B(\theta_E) = \frac{1}{\gamma}\lambda_E\left(1 - \frac{v}{c}\cos\theta_E\right)^{-1} \tag{5}$$

Therefore, the best resolution in RFB, along the direction of $\boldsymbol{v}$, is γl_p, with both synchronizing signals having $\cos\theta_E$ equal to v/c (in RFB, both signals would appear to travel perpendicular to $\boldsymbol{v}$). The ether is thus additionally observable.

Moreover, the minimum wavelength gives the vacuum energy [57a] rest information. Wavelength-limited vacuum-energy particles will cause vacuum-energy friction and corrections to the Casimir Effect [58,59,57b]. Within decades, such effects might be within reach of ultra-boosted nanotechnology laboratories.

Associated with l_p is the maximum energy, E_p. With this natural cutoff, Gravity theory's nonrenormalizability [57c] is no problem. Since the cutoff is a real physical quantity, renormalization is not appropriate for Gravity theory (or really needed for any other theory). In fact, with cutoff-dependent phenomena, like those in the last paragraph, Gravity theory would be problematic if it was renormalizable.

These considerations serve as signposts, pointing the way to a unified theory of nature. Construction of a unified theory should be eased, with only one reference frame to consider and heretofore-problematic infinities out of the way.

Causal consistency has no ramifications for foreseeable observation. However, it is theoretically comforting to know that causal inconsistencies will not arise, unless time becomes like space, with continuous movement in both directions, causing space-time, itself, to break down, in a catastrophic failure of all the most fundamental patterns in perceptions, by which we understand and cope with our universe.

Acknowledgments

Great thanks go out to Dr. Michel L. Lapidus for encouraging my studies. Many thanks go to Dr. Ben-Li Young, Dr. Xiao-Song Lin, Dr. Jose Wudka, and Dr. Bill Strossman, for contributing to the development of this work. And many thanks also to Dr. Kip Thorne, Dr. Angelo Tartaglia, Dr. John Baez, and Dr. Bahram Mashhoon, for physics advice.

Most of all, I thank my Father, Peter J. Sasaki, and Mother, Chiyoko Sasaki, for their support and good wishes, during my time working on this project, and to whom this work is dedicated.

Appendix A. A Partial History of This Work

Ideas showing the incompatibility of Special Relativity and all multiply connected spaces were developed between October 12, 1999, and October 31, 2000. Axial observation of rotational frame drag was disclosed to Dr. Bahram Mashhoon, in an April 21, 2005 telephone conversation, and later, in an April 26, 2005 e-mail. Most of the material in the present work was the subject of a talk, given by the author, on December 22, 2005, which was attended by Dr. Bill Strossman. The associated paper was submitted to *Physical Review D*, on December 30, 2005. Over the years, this work has been disclosed, in varying degree, to numerous other physicists, most of whom were in Southern California. The present paper was completed and submitted to *Classical and Quantum Gravity*, on August 5, 2006.

Appendix B. A Problematic Argument for a Comoving Ether Frame

Barrow and Levin have argued that monotonically expanding finite universes, supporting an FRW line element everywhere, must have the preferred topological frame (RFE) coincide with the frame comoving with the cosmological expansion [18].

With x' denoting a comoving frame that is not the preferred topological frame, and $a(\tau')$ the homogeneous and isotropic FRW scale factor, they construct the line element:

$$ds^2 = a(\tau')^2(-d\tau'^2 + d\overrightarrow{x'}^2) \tag{B.1}$$

[$a(\tau')$ should only apply to the spatial components of the line element.]

With L the size of the universe, in the preferred topological frame, and b the velocity parameter, relative to the preferred topological frame, they then assert that the scale factor has the boundary condition:

$$a(\tau') = a(\tau' + L \sinh b) \tag{B.2}$$

They note that this condition is impossible, in a monotonically expanding universe, and conclude that the comoving frame must be the preferred topological frame.

To be a valid boundary condition, equation (B.2) must be based on valid coordinates. But the comoving coordinates are globally inconsistent and generate observations that do not reflect reality. In particular, they tell us that any physical clock, in the comoving frame, exists in the same state, at both τ' and $\tau' + L$ sinh b. This is obviously impossible. Yet we do not conclude that the physical clock is impossible. Neither should we conclude that a time-dependent scale factor, which is just a theoretical clock, is impossible. The comoving coordinates thus generate a false boundary condition, nullifying the argument.

Appendix C. The Characterizations "Frame Drag" and "Ether Drag"

Rindler has objected to the characterization "frame dragging", based on predicted post-Newtonian effects that involve geodesic particles and electromagnetic fields [38].

The problem with these objections is that "dragging" appropriately refers to inertial frames, not particles or fields. For example, near a ball rotating in three dimensions, there are only momentary inertial frames, existing with unlimited precision in at most two dimensions. Geodesically traveling particles must pass through successive inertial frames, bringing with them properties such as momentum and angular momentum. So it is not surprising that particles or fields would not appear to be dragged. But dragging clearly fits the effect of energy currents on coordinate systems, most particularly rest frames, justifying the characterization "frame drag", and even more so "ether drag".

Appendix D. Two Well-know Prescriptions for Closed Timelike Curves

Various rotating systems have been thought to have circles, along which the light cones are sufficiently tilted, by frame drag, to create closed timelike curves [60, 61, 62].

But tilted light cones show a relation between two reference frames, at most one of which is the ether frame {as in Figure 9 and the Eddington-Finkelstein diagram of [29b]}. Like B_4, in subsection *5.2*, the rotating systems would continuously alter rest, dragging the ether prograde; but, relative to the ether frame, the only frame that matters, the light cones would be symmetric.

Frame dragging systems thus cannot be time machines.

Morris, Thorne, and Yurtsever have put forth a well-known prescription for wormhole time machines [63,19h], which has previously been argued against by Konstantinov (see most recently [64]). This supposes a nearly flat space, with a wormhole handle. One of the wormhole mouths is taken on a near-light-speed journey, through the nearly flat space, away from and back to the other mouth, while the spatial length through the wormhole is kept short. It is asserted that two observers, just outside the opposing mouths, would see this process take a longer time by watching each other through the wormhole, then by watching each other across the nearly flat outer space [19h]. Thus is time dilation asserted to create a time differential across the wormhole.

But here again, we immediately see the trick of switching reference frames, this time depending on whether one is looking through the wormhole or across the outer space. Both observers would age according to their motion relative to the ether.

Wormholes thus cannot be time machines.

References

[1] This is fairly standard terminology (see [2a], for an example of usage). It is most commonly met while studying the philosophy of Quantum Mechanics, in which numerous interpretations are more commonly discussed then is the case, these days, for gravity theory. One may also come across an equivalent formulation, with the term "philosophy" replacing "interpretation".

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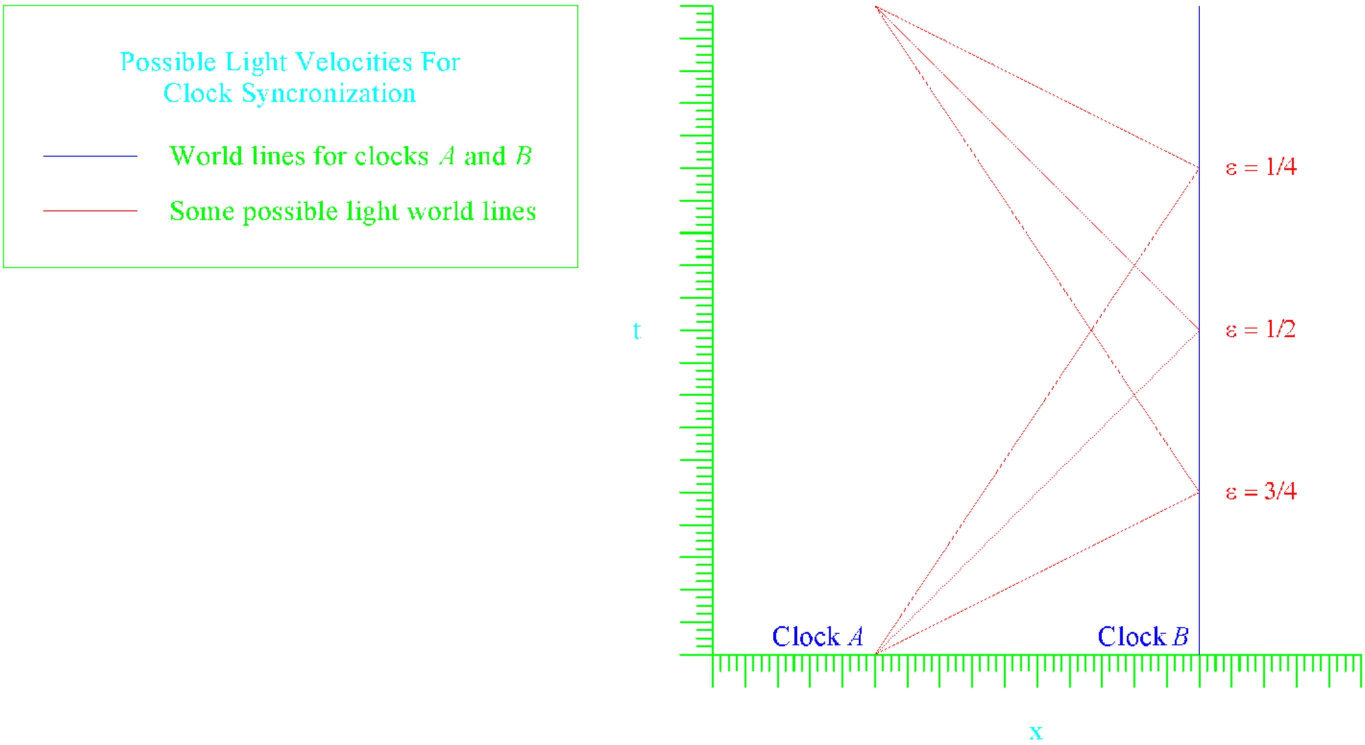

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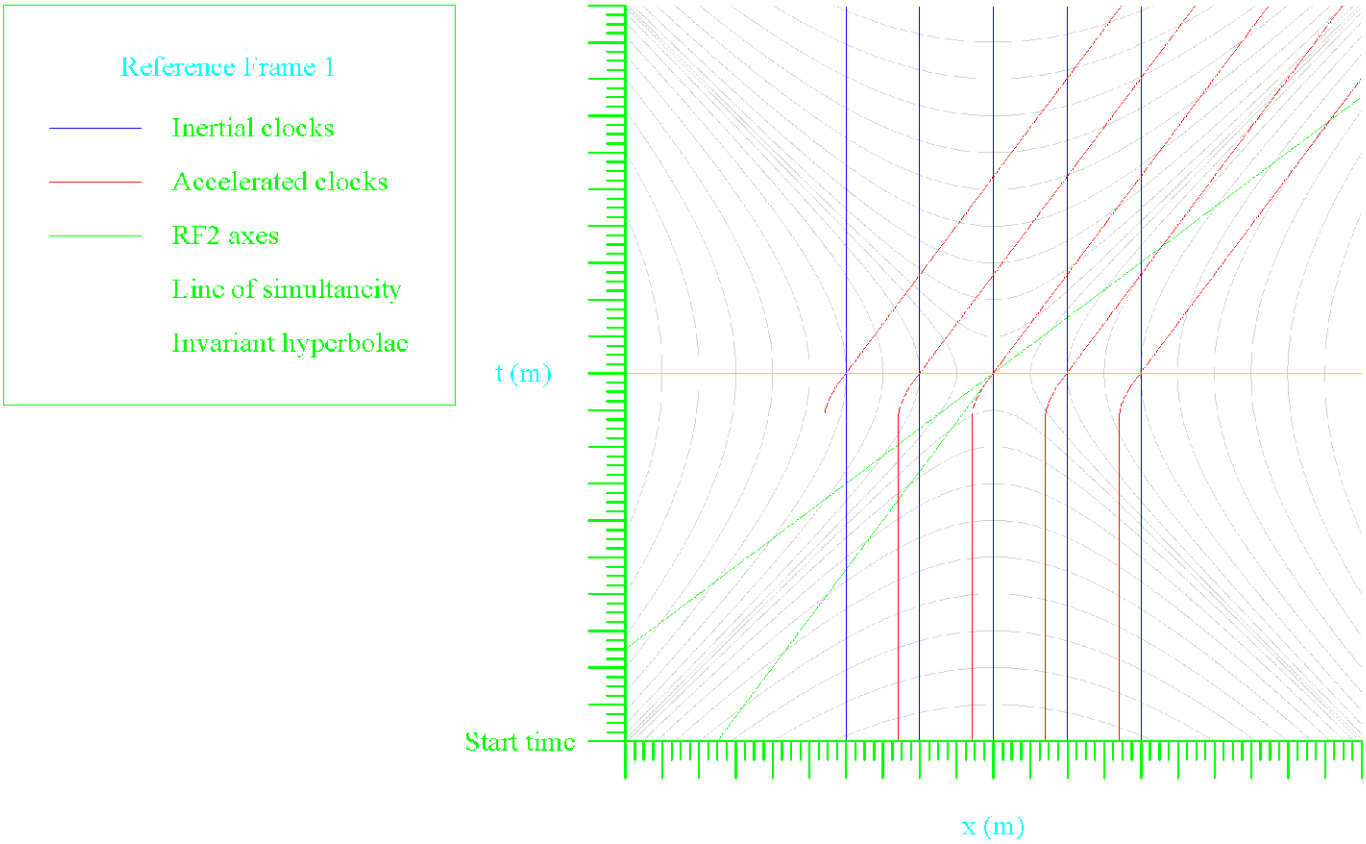

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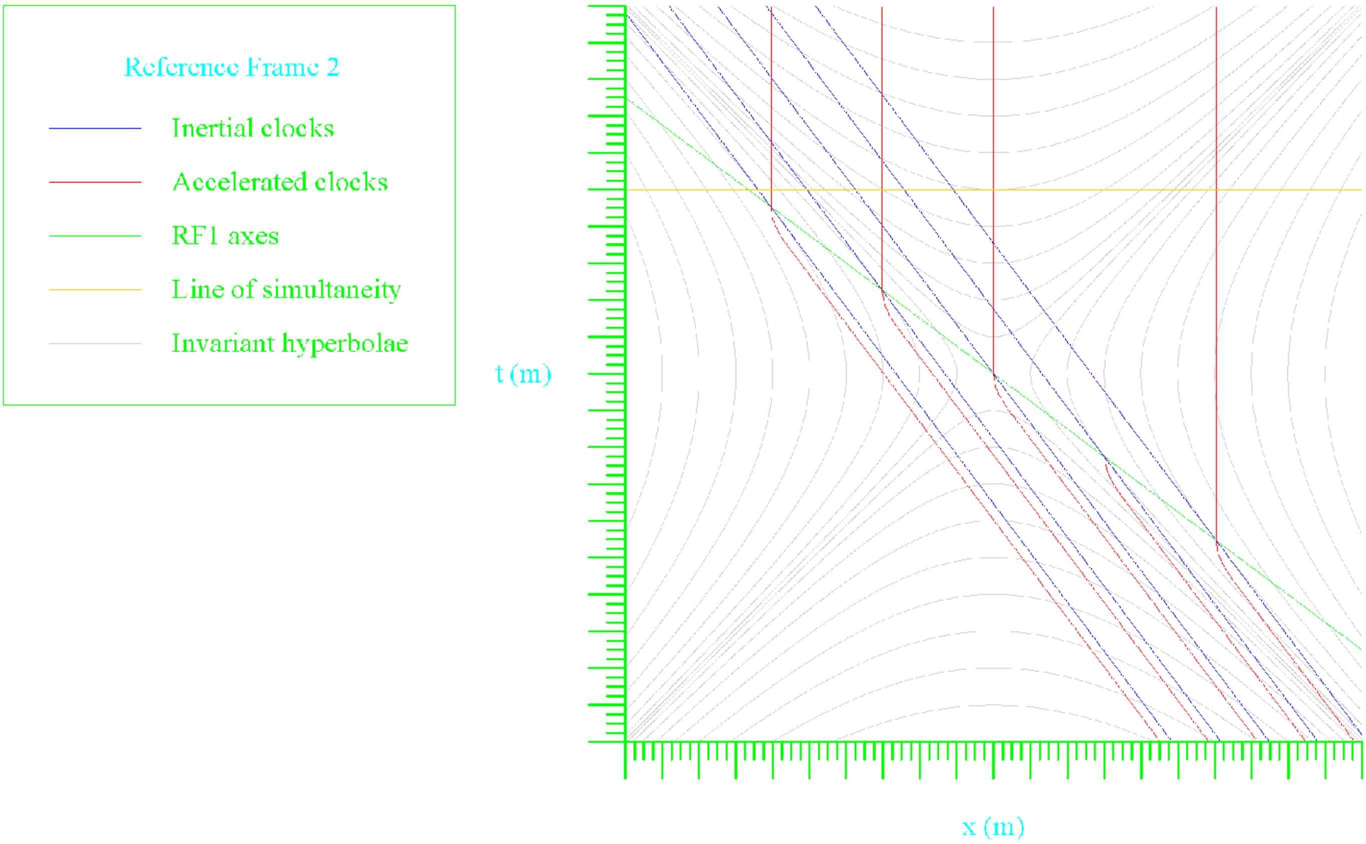

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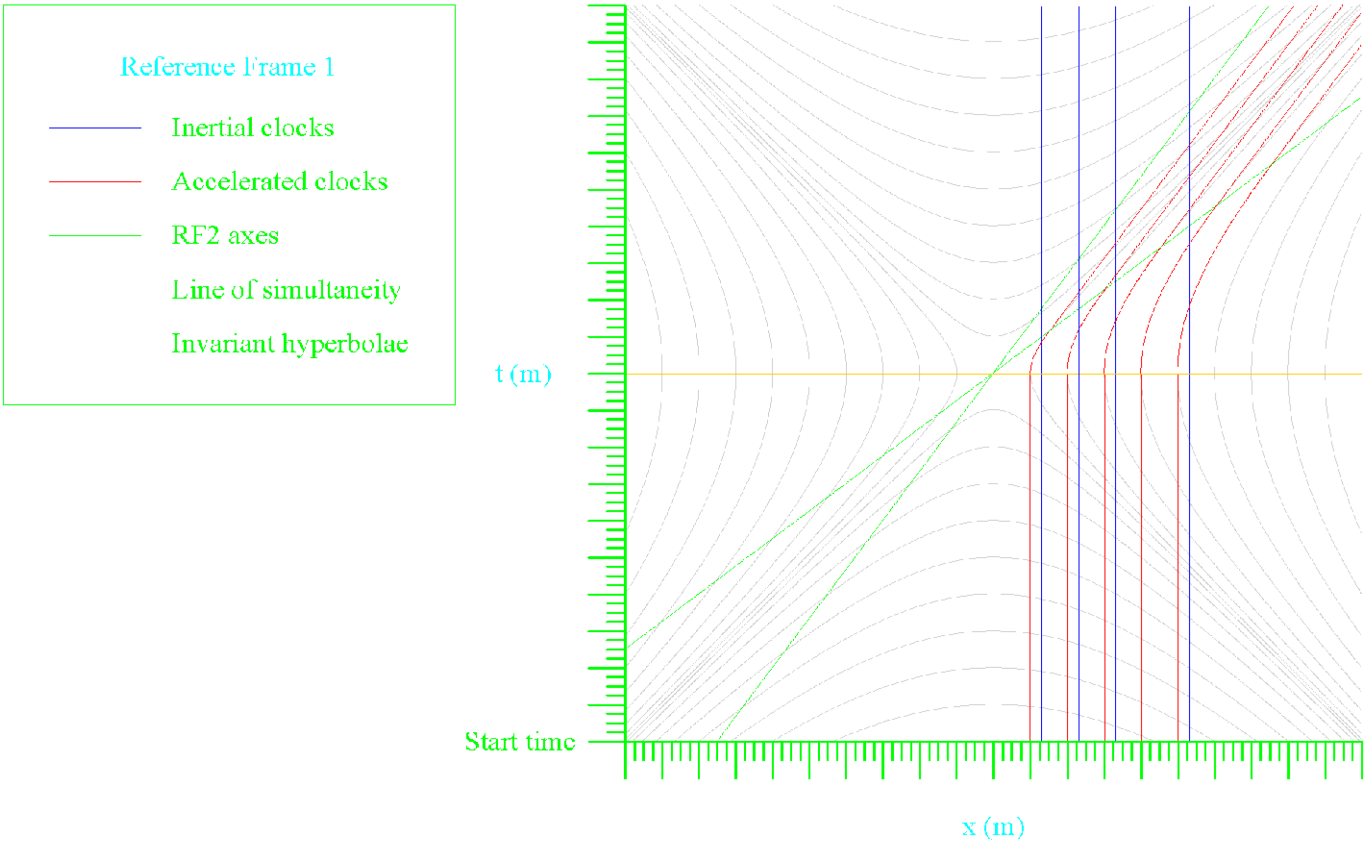

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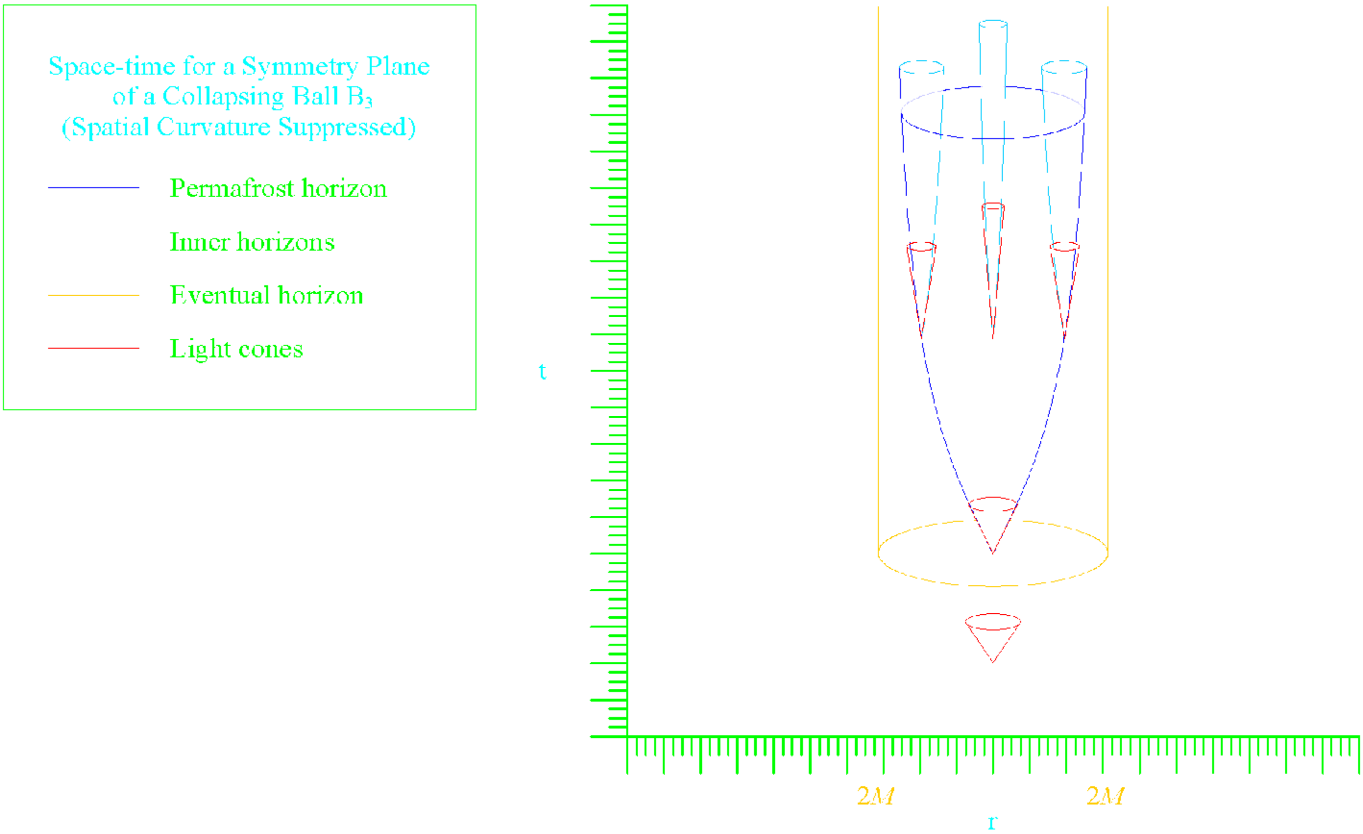

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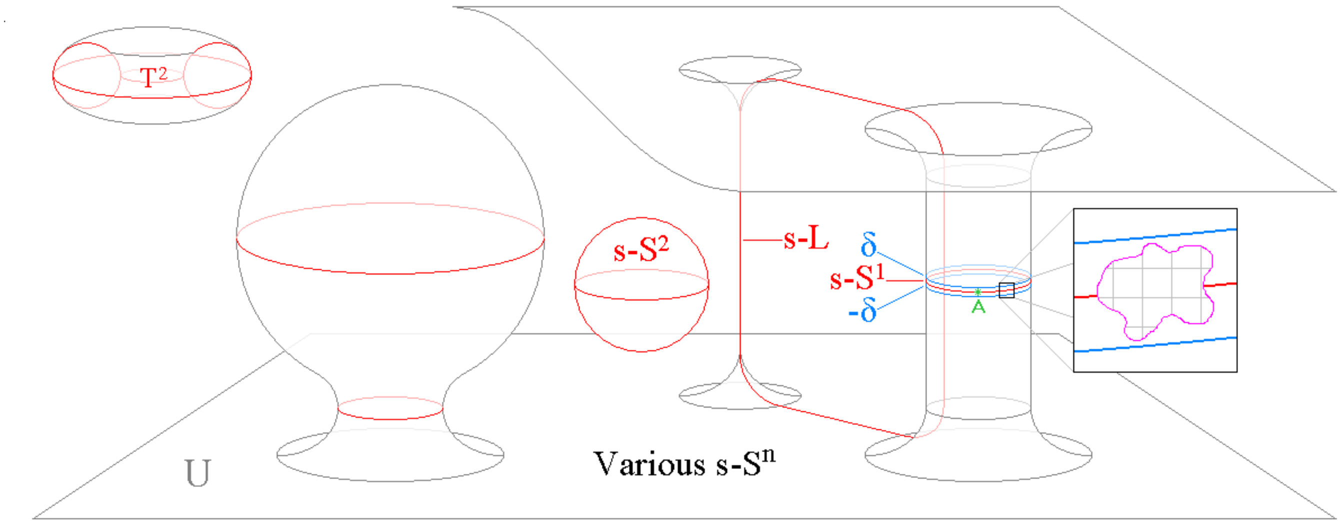

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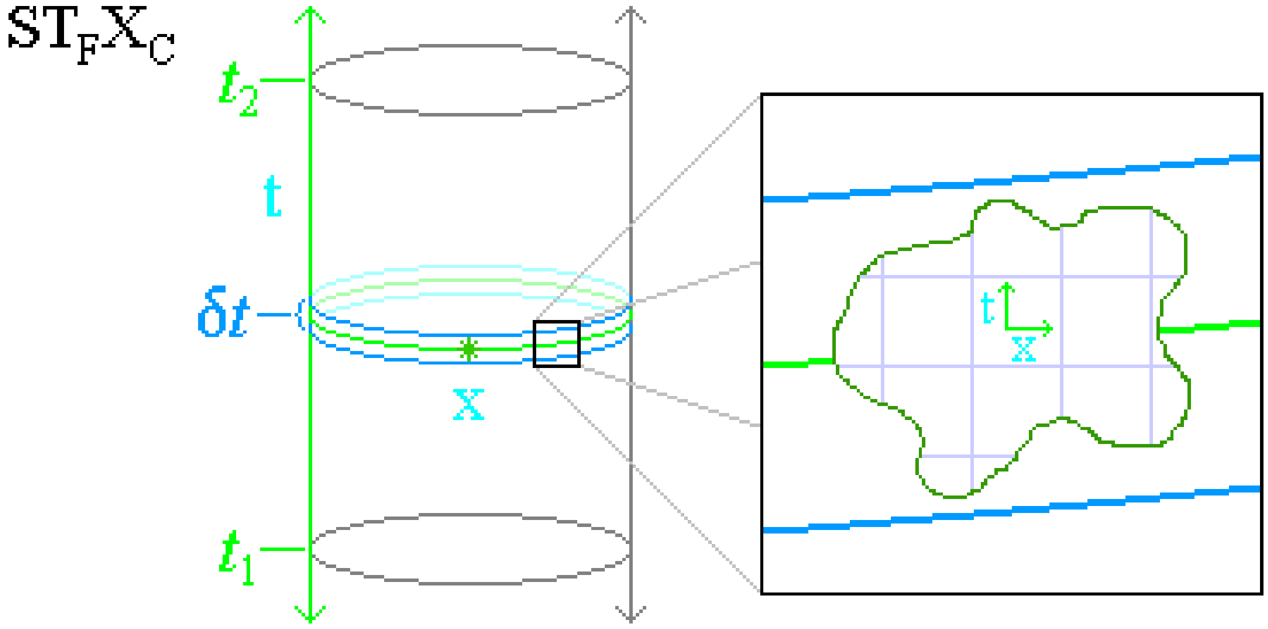

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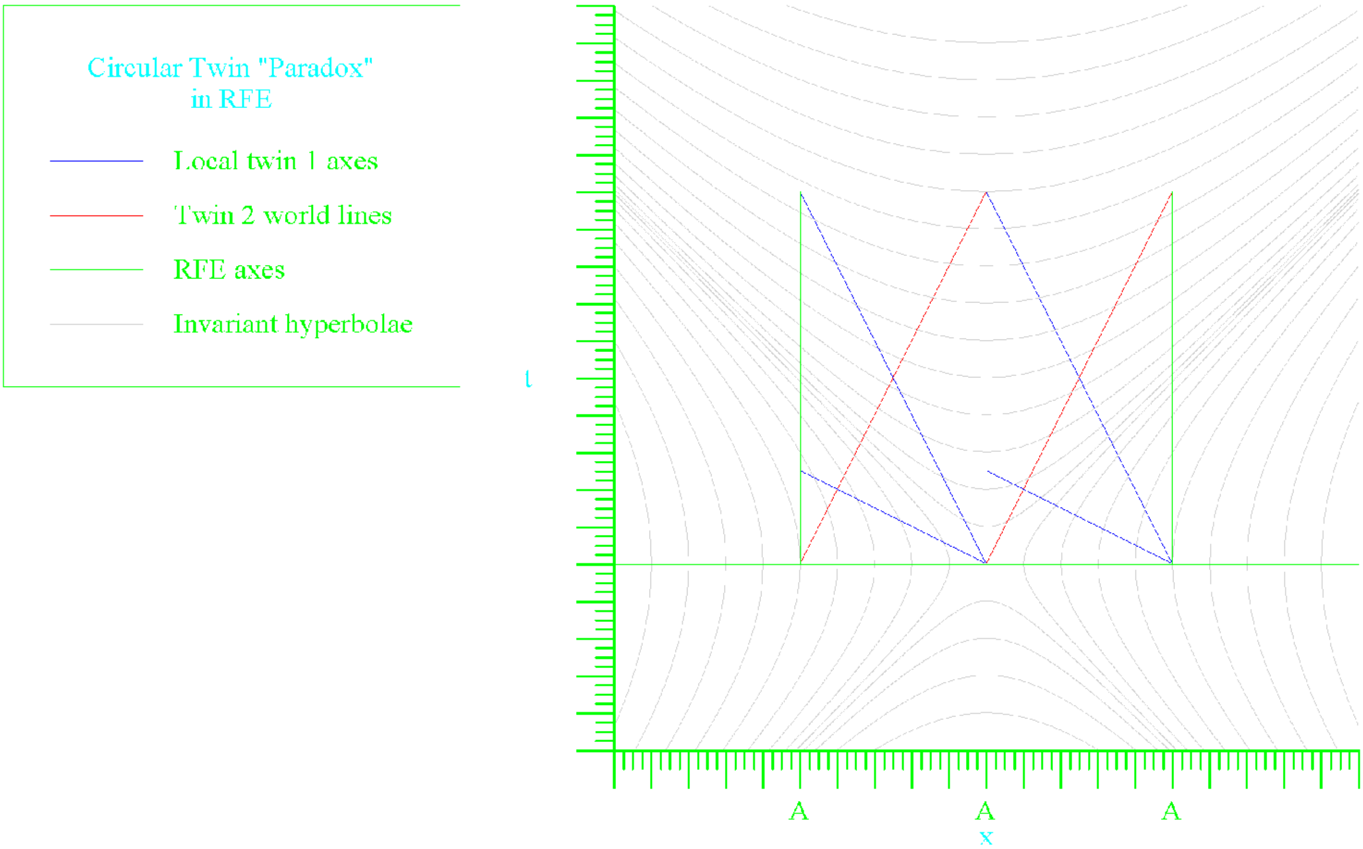

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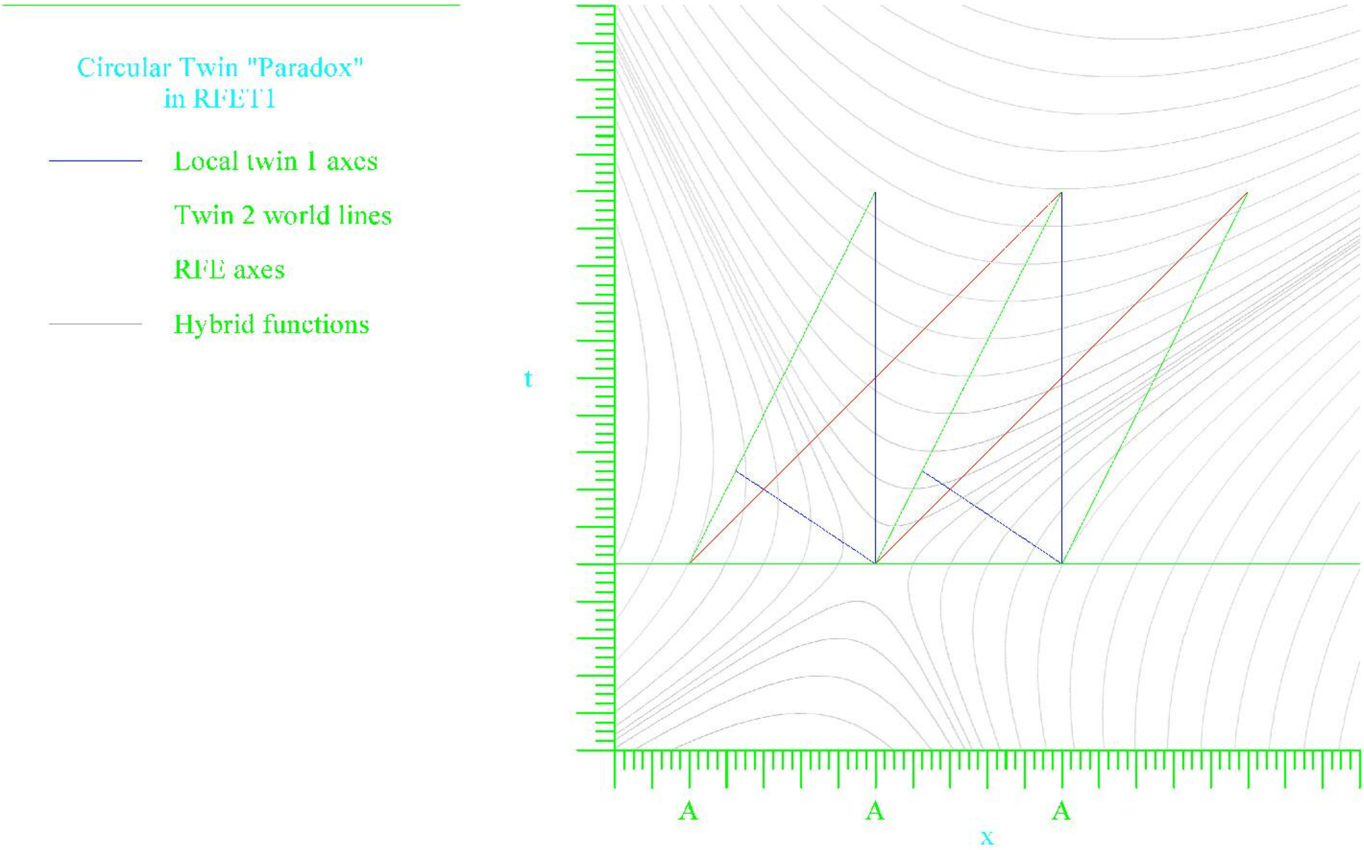

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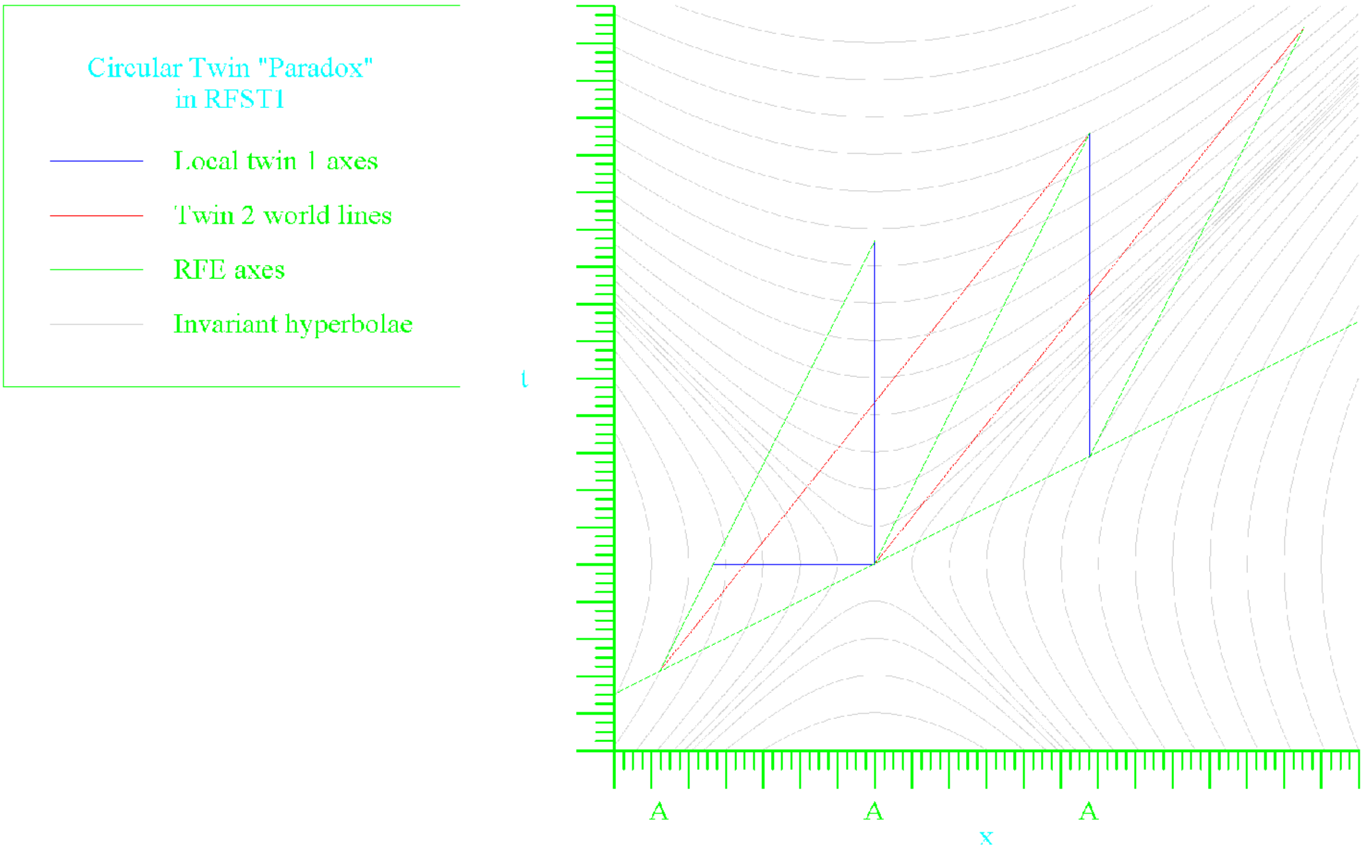

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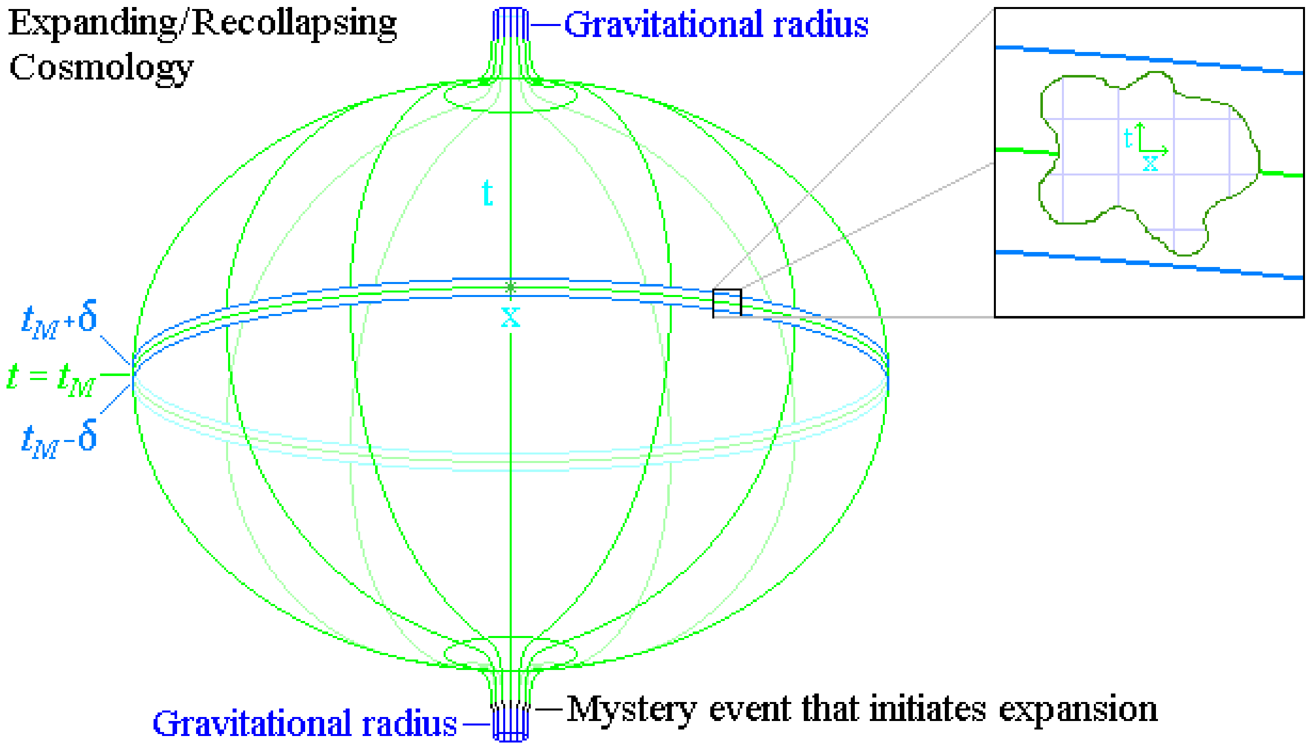

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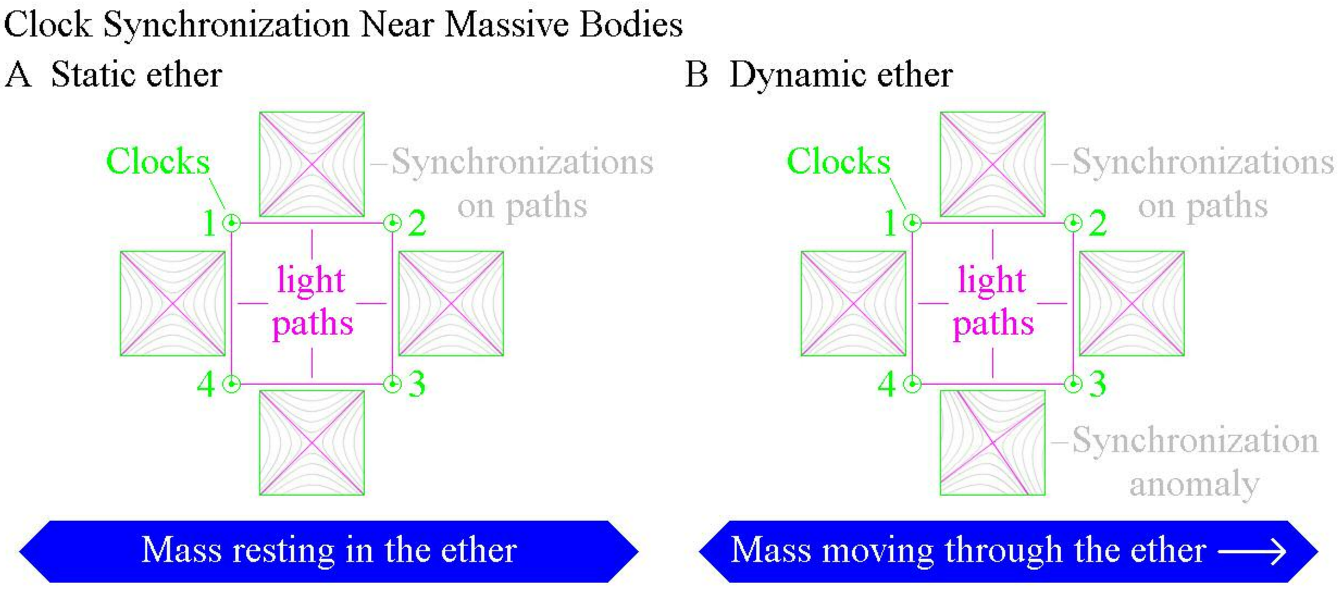

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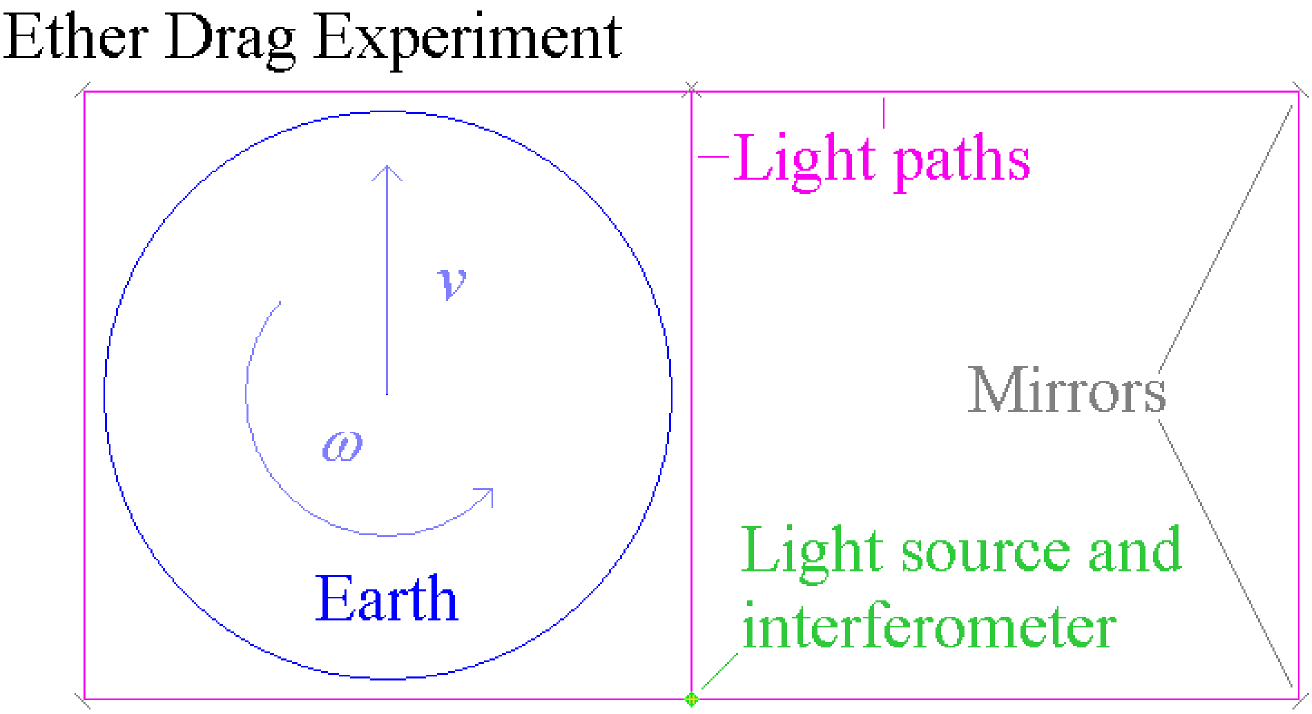

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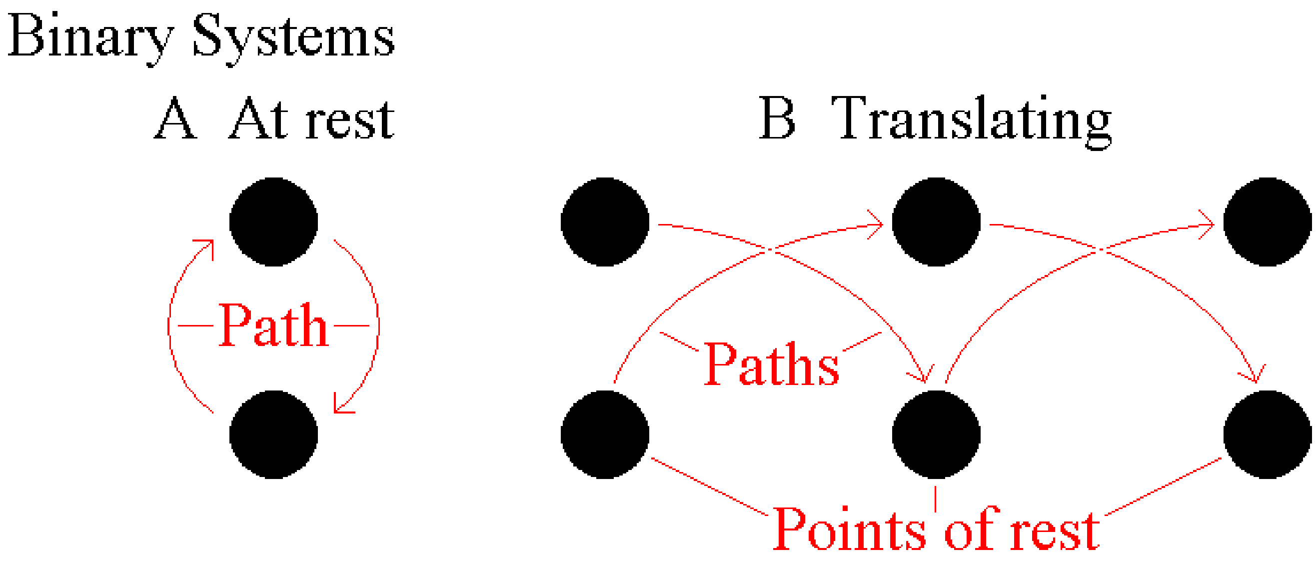

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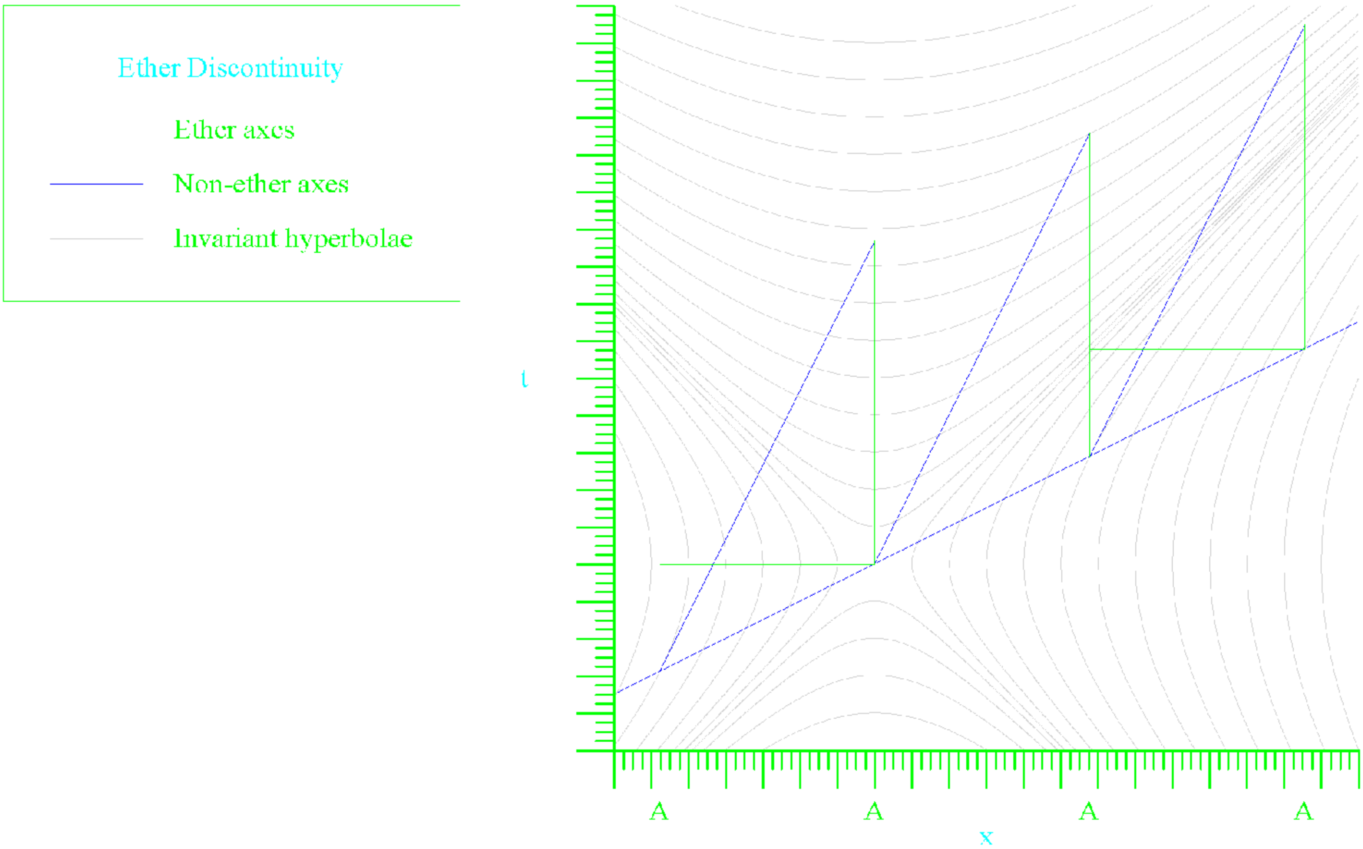

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