Ether, Time, and Energy (November 29, 2006).

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Notes.

On Wednesday, November 29, 2006, the following draft of *Ether, Time, and Energy* [*ETE(11-29-06)*] was created; and at 12:29 AM, on Thursday, November 30, 2006, it was e-mailed to Carl Brans, a physics professor at Loyola University in New Orleans.

ETE(11-29-06) is essentially the same as a draft of *Ether, Time, and Energy* [*ETE(11-21-06)* which is at viXra:1704.0127] that was e-mailed to Professor Brans, on November 21, 2006, except that *ETE(11-29-06)* has a new figure which is now Figure 2.

ETE(11-29-06) contains what are, to the author's knowledge, two historic results:

Firstly, *ETE(11-29-06)* identifies how Special Relativity and General Relativity violate observation. Subsection 2.2 states, "Now, at each space-time point, different light cones would allow different world lines for physical clocks, as depicted in Figure 2. Here, even the blue Frame 2 reference clock is superluminal, and thus nonphysical, according to the red Frame 1 light cone. But the Lorentz transformations preserve physical clocks; so all coordinates based on physical reference clocks share a unique light cone, at each space-time point. Thus the Lorentz transformations again indicate the existence of rest." Subsection 2.2 goes on to state, "The assumption of a universal light velocity has led to the use of different light cones, with different coordinates, in General Relativity, as we will see in section 4. Ultimately, it is this use of nonphysical coordinates that has confused the study of space-time." The mentioned section 4 states, "Near the gravitational radius, even the ingoing Eddington-Finkelstein and Kruskal-Szekeres reference clocks are superluminal, and thus nonphysical, according to the Schwarzschild coordinate light cones, forcing a coordinate choice. Figure 2 exemplifies this, with Frame 1 the Schwarzschild coordinates, and Frame 2 the ingoing Eddington-Finkelstein or Kruskal-Szekeres coordinates." The discussed reference clocks are those relative to which the local light speed is isotropic, as implied by whichever coordinates are chosen.

In Figure 2, the tilted light cone is actually neither Eddington-Finkelstein nor Kruskal-Szekeres. Eddington-Finkelstein light cones, in particular, always have ingoing, radial, null rays of slope $\Delta t/\Delta r = -1$. However, Figure 2 still illustrates how Special Relativity and General Relativity violate observation. The Figure 2 line of simultaneity is valid for both depicted clocks; and in Relativity, light speed is isotropic relative to both clocks; therefore, in Relativity, both light cones must exist, violating observation.

Moreover, section 4 shows how three observations indicate that space-time is smooth. In particular, building on the result that decreasing gravitational time dilation causes our cosmic expansion to accelerate, from *Ether, Time, and Energy (August 5, 2006)* [*ETE(8-5-06)* which is at viXra:1704.0032], section 4 explains how our observations of accelerating cosmic expansion are also observations that time slows at the center of any imploding star, preventing any imploding star from collapsing to a singularity. Beyond this, section 4 also considers two theoretical indications that space-time is smooth. No quotation from section 4 appears here, because all of section 4 is worthwhile reading.

In addition, *ETE(11-29-06)* contains what is, to the author's knowledge, another historic result from *ETE(8-5-06)*: From ether drag, which is frame drag and has been observed, the first paragraph of section 7 infers our free-space ether frame.

ETE(11-29-06) also contains other points of interest, some possibly having priority.

However, *ETE(11-29-06)* contains two major errors: The introduction states that *ETE(11-29-06)* 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 may make the ether more easily observable, both of which are untrue under the formalism of General Relativity.

Furthermore, *ETE(11-29-06)* contains other lesser errors.

In subsection 4.2, two references are incomplete. The first was later removed, while the second became a referral to pages 744-747 and 771-774, of [28]. Also, in the reference section, reference 36 is incomplete. The first instance of [36], in the text, later became a referral to pages 111-112 of [38], and page 712 of [28]; while the second became a referral to pages 459-464 and 616-618, of [33], and pages 750 and 770, of [28].

Because of the errors, and because the author has since vastly improved his results, the author suggests that readers consult his latest works, which are listed at http://vixra.org/author/kenneth_m_sasaki.

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Abstract This work demonstrates that observation and theory support three properties of classical space-time: The first is smoothness, which holds since gravitational time dilation, at sufficiently high energy densities, gravitationally confines energy, 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 only the physical laws of current observations. Some associated points of interest are also discussed.

Keywords Ether Theory · Relativity Theory · Singularities · Energy · Causal Consistency

PACS 03.30.+p · PACS 04.20.-q · 04.20.Cv · 04.20.Dw · 04.20.Gz · 04.25.Nx · 04.90.+e

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;

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although the question of a luminiferous "medium" is left open. Einstein later recognized this, in his words, "ether of Lorentz" [3], as related to his "ether of the general theory of relativity" [3] (though clearly he did not understand all of the ramifications).

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 Theory 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 pathologies of the "Standard Relativity" interpretation, including reference frame paradoxes. 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.[1] 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.

This work has been organized to maximize the development of intuition for the necessity and nature of the ether.

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. Then, by reconsidering the Standard Twin Paradox and the limitation light cones set on physical clocks, we illuminate a message in the Lorentz transformations, telling us that Ether theory's light velocity assumption is correct, with the ether frame uniquely reflecting reality. We then present new postulates for the flat-space-time Ether theory. We end the section with some kinematics that are useful in understanding the necessity and nature of the ether.

Section 3 presents a geometrical condition that would allow direct observation of velocity, in some cases without clock synchronization. Special-case cylindrical space-times have been well studied [8–18]. However, we undertake an extensive treatment that most clearly shows an ether reference frame pro-

[1] "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.

viding a uniquely correct view of reality (which was originally demonstrated by Peters [9]).

Section 4 establishes that observation and theory indicate gravitational potentials to not cause ether flow, and thus that gravitational collapse keeps 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 5 reveals the relationship between ether and energy, which allows local observation of rest. These are our most difficult results, for which the intuition from sections 2 and 3 will be most important.

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 (as well as one other), and demonstrate causal consistency, assuming only the physical laws of 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 and Clock Synchronization.

Both Poincaré (essentially) and Einstein gave the following definition for the synchronization of 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.[2] A and B are *defined* to be synchronized if:

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

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 velocity 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 results. 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.

[2] 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.

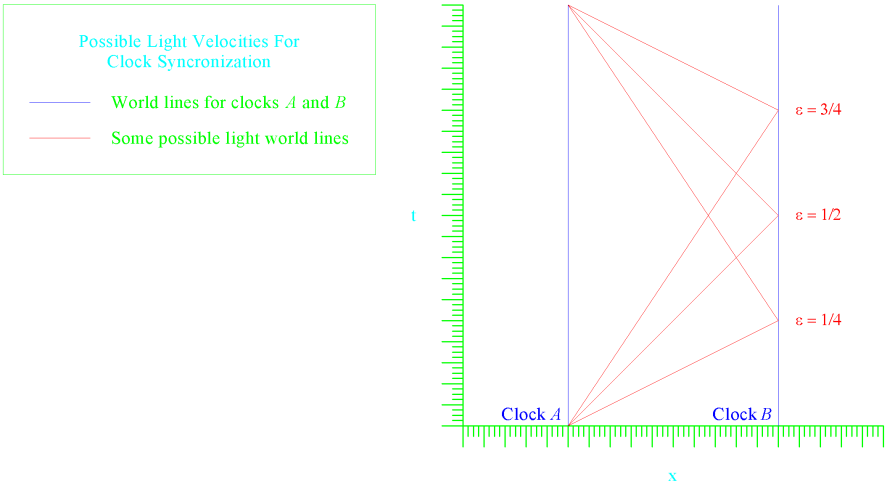

Fig. 1 Here are pictured the world lines for two clocks, A and B, along with those for some light beams corresponding to three possible values of ε that might apply to a synchronization of the clocks.

Standard Special Relativity assumes ε to universally equal one half, in all directions, relative to all observers, reducing equation (2) to equation (1) [22b,23].

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 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 3). This is Ether.

2.2 A Message in the Lorentz Transformations.

The Standard Twin Paradox [4d] follows from the incorrect assumption of a universal light velocity, for all observers, in all directions (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.

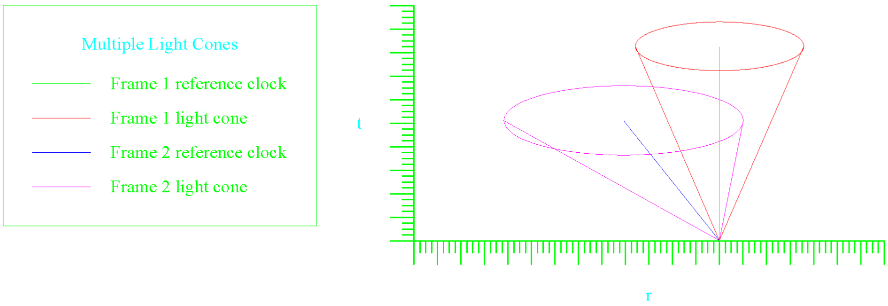

Fig. 2 Here, each light cone allows a different set of physical clocks, with even the Frame 2 reference clock superluminal, and thus nonphysical, according to the light cone that is symmetric with respect to Frame 1.

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 Relativity interpretation for length contraction. Thus do the Lorentz transformations indicate the existence of rest.

Now, at each space-time point, different light cones would allow different world lines for physical clocks, as depicted in Figure 2. Here, even the blue Frame 2 reference clock is superluminal, and thus nonphysical, according to the red Frame 1 light cone. But the Lorentz transformations preserve physical clocks; so all coordinates based on physical reference clocks share a unique light cone, at each space-time point. Thus the Lorentz transformations again indicate the existence of rest.

The assumption of a universal light velocity has led to the use of different light cones, with different coordinates, in General Relativity, as we will see in section 4. Ultimately, it is this use of nonphysical coordinates that has confused the study of space-time.

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.

In trivial flat space-times, 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 truly relates space to time, in the rest frame. For example, c is inherent in Maxwell's equations.

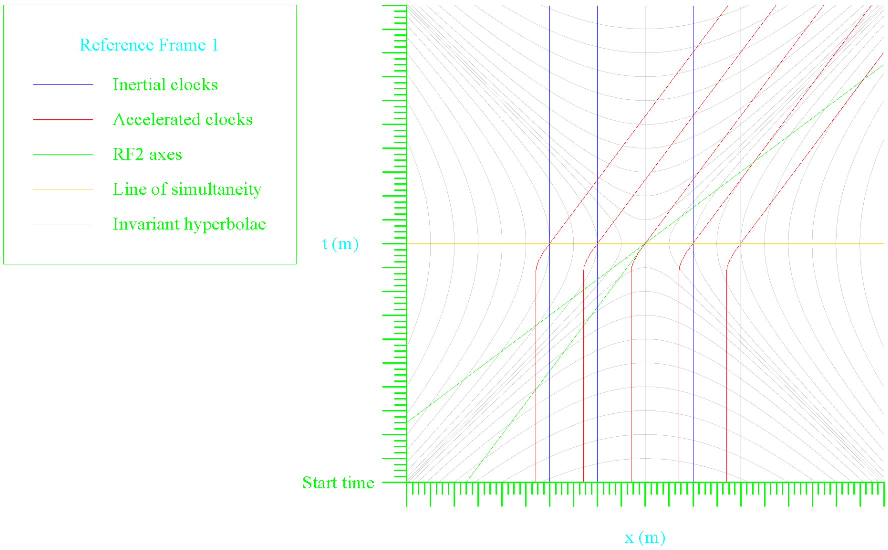

Fig. 3 Here, in RF1, blue clocks are inertial, while red clocks are perceived to accelerate simultaneously. If RF1 is the ether frame, then the red clocks maintain a truly constant separation, through the acceleration.

Therefore, Maxwell's equations truly relate space to time, 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.

Figures 3 and 4 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 all reading identical proper times, 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 5 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 separation between them, as they accelerate from RF1 into RF2 [24]. In this case, the separation between the red clocks is not truly constant, as is evident if RF1 is the ether frame.

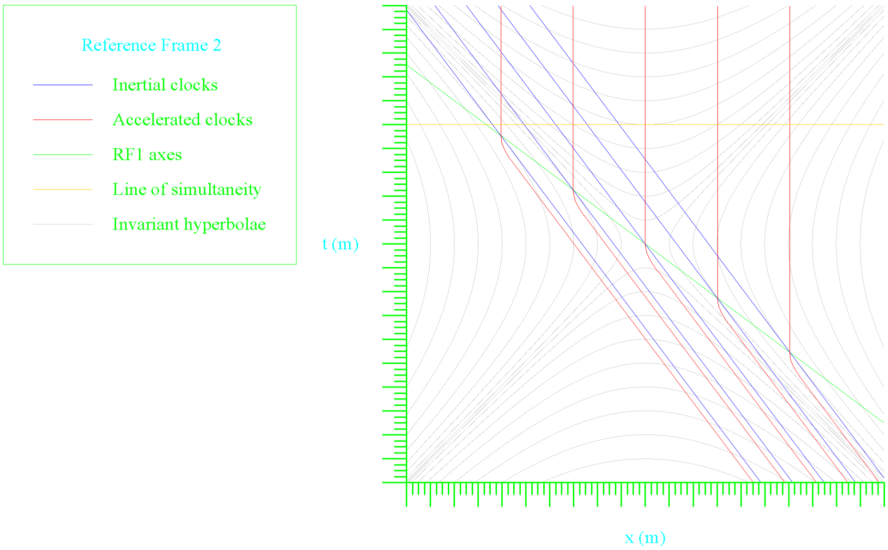

Fig. 4 Here, in RF2, the blue clocks are again inertial, but the red clocks are not perceived to accelerate simultaneously.

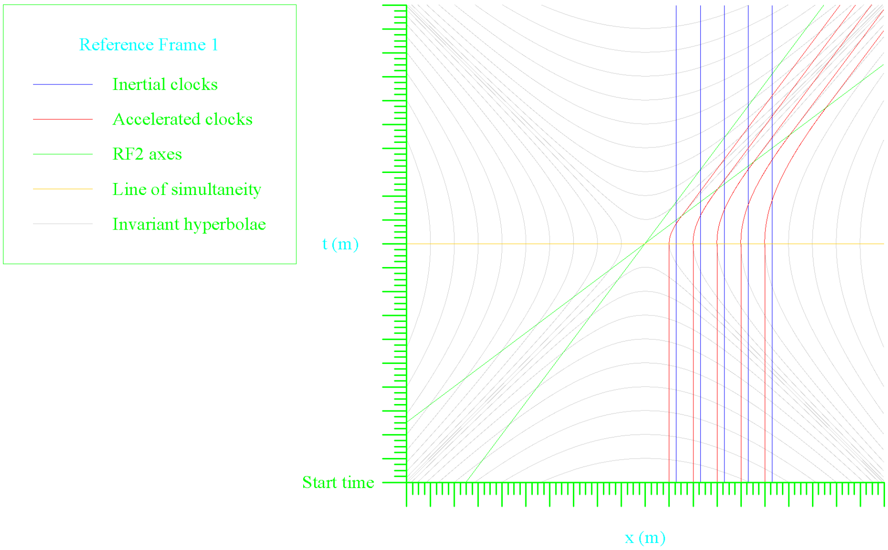

Fig. 5 Here, blue clocks are inertial, while red clocks accelerate so as to maintain a constant proper distance between them. In this case, the separation between the red clocks is not truly constant, as is evident if RF1 is the ether frame.

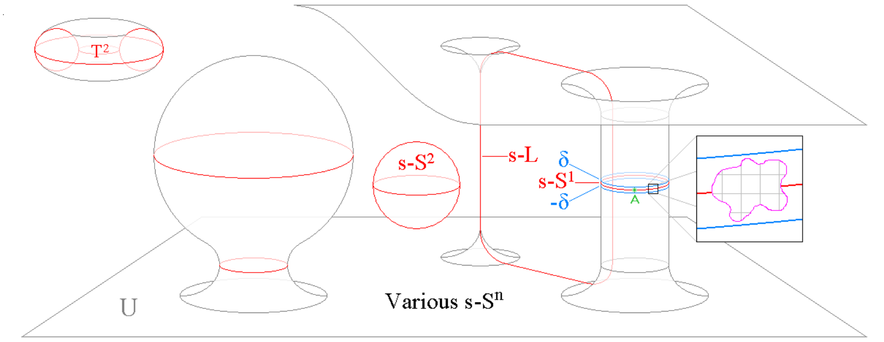

Fig. 6 Here, in red, are various s-S^n. Spatial symmetry makes the s-S^1's inertial paths. The s-L loop is not circular, but will appear so, over a sufficiently short time interval, to a given measuring device. And the structure composed of the large semi-sphere, left wormhole, and lower plane, exemplifies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

3 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 R the *real* numbers. $L_0 \in \{L\}$ is "stationary" if, for every continuous parameterization $L(r) : R \to \{L\}$, $L(r_0) = L_0$, with corresponding differentiable $C_L(r) : R \to R$, $C_L(b) \le C_L(a)\ \forall\ a < b \in R$:

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

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 1-dimensional spheroid loops, 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, $n \ge 1$, 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 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.

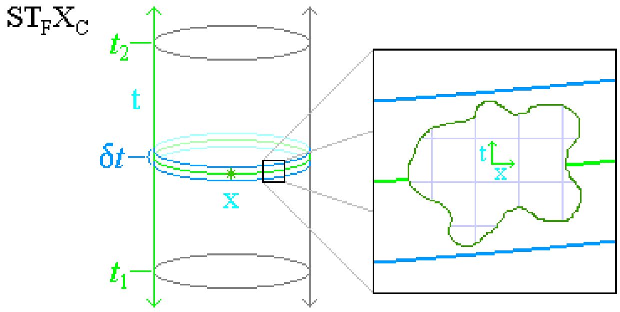

Fig. 7 The space-time, ST_FX_C, is locally flat, as depicted by the enlarged local subspace.

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

Consider now $R^1\times$ s-S^1. Identify time with R^1, and a *circular* space, X_C, with s-S^1, forming a locally *flat space-time*, ST_FX_C, as pictured in Figure 7.

{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 [8,10–18]. 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" [8,10–12,14–18].

Figure 8 also shows discontinuous lines of Twin 1 simultaneity, in blue, demonstrating that global simultaneity is problematic for reference frames other than RFE [8–12,15,18]. For example, if we identify the first and fifth clock pairs in Figure 3, we get a tiled picture of our blue and red clocks in RFE. However, this identification causes a problem for Figure 4. 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 5 causes a similar problem, this time indicating that global proper distance is also problematic for frames other than RFE.

To find resolution, we distort Figure 8, with a horizontal shear, making Twin 1's 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 3, if RF1 is RFE, then the red clocks constitute such an observer, after they accelerate, if they do not resynchronize. The RFET1 light cone is asymmetric; 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 [8–10,13,14], preventing any

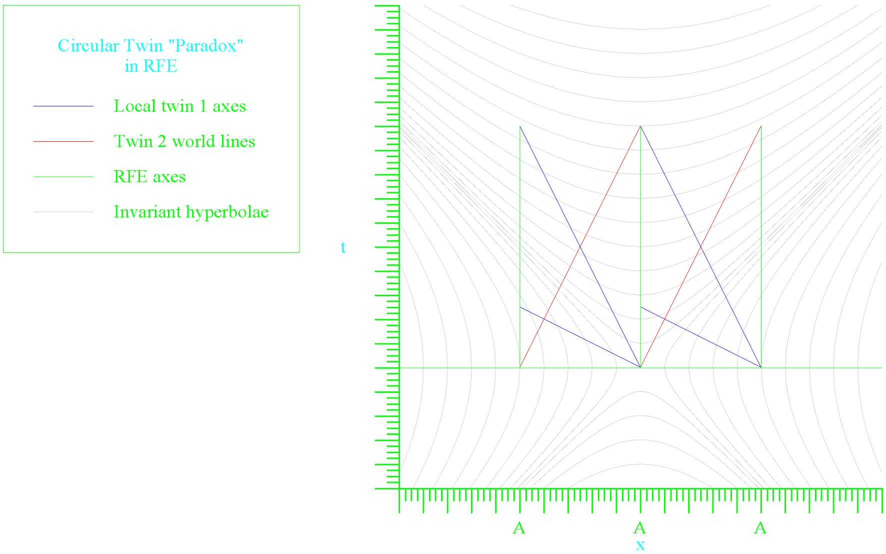

Fig. 8 Here, in RFE, is a tiled space-time picture of a Circular Twin Paradox, with no asymmetry from one twin accelerating to allow the Standard Twin Paradox "resolution" [8, 10–12, 14–18].

global synchronization of clocks to the standard Twin 1 frame [8, 9, 15, 18], as expected from tiling Figure 4.

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 [9–11, 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 $\mathrm{X_C}$ circumference and $\boldsymbol{v}$ 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 $\mathrm{ST_F X_C}$.

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 globally discontinuous lines of simultaneity [8–12, 14, 15, 18].

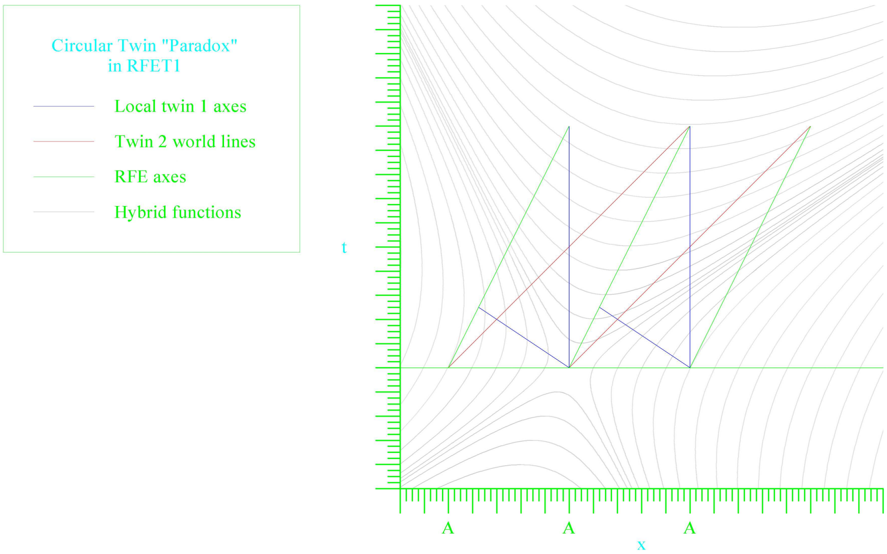

Fig. 9 Here, again, is the Circular Twin Paradox, this time shown in RFET1, the reference clocks of which move with Twin 1 but have RFE synchronization.

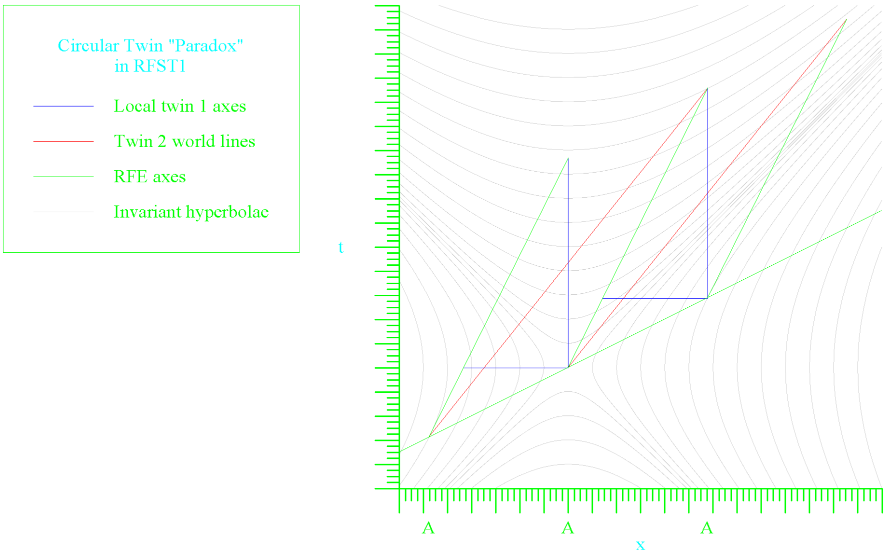

Fig. 10 Here, yet again, is the Circular Twin Paradox, now shown in RFST1, which is, locally, the standard Twin 1 reference frame.

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

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

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

Objects comoving with non-RFE frames appear to be a factor of γ longer, in those frames, than they appear to be, in RFE. As seen in equation (4), this includes the $\mathrm{X_C}$ circumference, γl_{maxE}, which is the maximum spatial length over 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 Special Relativistic non-RFE clock synchronization.

However, non-RFE-synchronization illusions are not locally identifiable in flat subspaces (see section 5 for geometries allowing local detection of RFE). As we have seen, everything related to local observation in flat spacetimes, 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].

Suppose Twin 1 has a Michelson-Morley 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 light travels is $1/\gamma$ times the length Twin 1 perceives, explaining the null results.

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 4 and 5, 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, through direct observation of velocity, as a result of geometry.

In sections 5 and 7, we will see that, barring some consideration external to the observed universe, the comoving frame is the free-space ether frame, in any Friedmann-Robertson-Walker (FRW) [25a] proximate universe; however, this is not related to the global observations discussed here, as argued in [18] [see Appendix A for an analysis].

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

Each great circle of an s-S^n is an 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-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 $S^1 \subseteq$ s-S^n, $n \geq 2$, including S^1's existing in small essentially flat subspaces, will thus correspond to the angular (and locally translational) rest of any s-S^n great circles existing in hyperplanes not perpendicular to that of the S^1 (we will simply say that such circles are "not perpendicular"). For example, under the Sagnac effect [26], a nonrotating clock near the Earth advances faster than one carried around the Earth [27], allowing the determination of RFE for any s-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 for any s-S^n great circle not perpendicular to the surface.

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

Time-independent rest for dynamic s-S^n is apparent, since the distances between rest clocks vary proportionally. In the next section, we will show that gravitational potentials do not cause ether flow; so all s-spheroids have uniform time-independent rest.

Any s-spheroid that exists long enough to allow a global observation would allow direct observation of velocity. It is fascinating that velocity measurement at a single point might be achieved by sending signals around a universe [13].

4 Space-time Smoothness.

4.1 A Coordinate Choice.

According to the ingoing Eddington-Finkelstein [28a,19b] and Kruskal-Szekeres [28b] coordinates, gravitational time dilation [27,28c] involves the tilting in of light cones. Stationary clocks near a gravitating body would move, relative to similarly located infalling reference clocks, and thus would keep dilated time. This implies that a gravitationally collapsing *ball*, B_1, of *mass* M, would fall to a singularity [28a,19b].

However, according to the Schwarzschild coordinates [28d], gravitational time dilation involves only the narrowing of light cones. All clocks near a gravitating body thus would keep dilated time. This implies that, under "Schwarzschild collapse", the fall of B_1's surface would asymptotically slow near B_1's gravitational radius, $r = 2M$ [29,30].

Figure 11 shows a space-time diagram for a symmetry plane of B_1 undergoing Schwarzschild collapse (spatial curvature is suppressed). As the red light cones close up, from B_1's center out, the energy required to escape B_1's potential increases. When B_1's center reaches the tip of the dark blue asymptotic surface, any signal sent from there will encounter light cones that

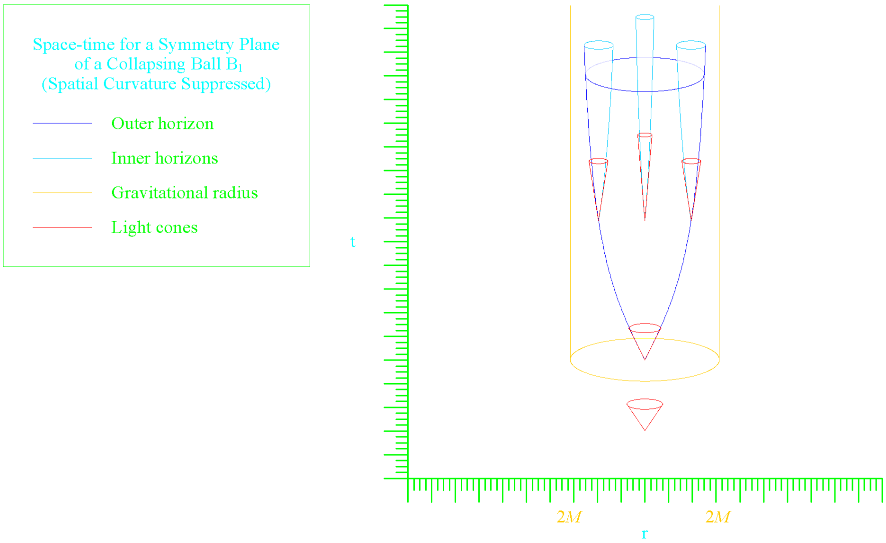

Fig. 11 Here are depicted some light cones and horizons for a ball, B_1, undergoing Schwarzschild collapse.

narrow as fast as light can move out. Light emitted radially outward, from this outer horizon, will travel along the horizon. As B_1'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_1'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_1's center never achieves the energy density to create a singularity; and the outer horizon never reaches r $= 2M$, so the gold surface never becomes an event horizon.

Near the gravitational radius, even the ingoing Eddington-Finkelstein and Kruskal-Szekeres reference clocks are superluminal, and thus nonphysical, according to the Schwarzschild coordinate light cones, forcing a coordinate choice. Figure 2 exemplifies this, with Frame 1 the Schwarzschild coordinates, and Frame 2 the ingoing Eddington-Finkelstein or Kruskal-Szekeres coordinates.

If an outer Schwarzschild geometry were to extend to its gravitational radius, the geometry there would be smooth; and all coordinates would show the same finite proper-time fall through the gravitational radius, for clocks falling from a finitely greater radius; yet the Schwarzschild coordinates would diverge at the gravitational radius [28e]. As a result, the ingoing Eddington-Finkelstein and Kruskal-Szekeres coordinates, which are respectively better-behaved and well-behaved at the gravitational radius, have been almost universally adopted as reflecting reality [28a,28b,19b], while the Schwarzschild coordinates have been held as pathological [28e] and illusory [19a].

But McCrea [29], and later Rosen [30], observed that the outer Schwarzschild coordinates never reach the gravitational radius, during Schwarzschild collapse; so they are well-behaved. The Schwarzschild coordinate boundary and all observers that fall behind follow a sequence of positions that converge to the gravitational radius; but the sequence does not contain that limit point. The rate of rest clocks tends to zero, forcing all other clock rates towards zero even faster. Thus an infalling observer never reaches the gravitational radius, while always having a finite proper time. The observer would not perceive time slowing, since the clocks of his mind would be among those slowing.

{Note that Zeno's Dichotomy "Paradox" and its resolution [31] have no relevance here, since they involve uniform time and space, whereas our situation does not.}

Also, many believe in singularities because of the "singularity theorems" (see [32], which discusses earlier results). However, the theorems for local gravitating systems assume trapped surfaces [32], which, in turn, assumes in-tilted light cones.

4.2 Observation and Theory.

We now establish that the Schwarzschild coordinates are the best explanation for gravitational time dilation, by three observational and two theoretical considerations.

Consider a geologically dead *ball*, B_2, such as the Moon, with a Schwarzschild geometry. Drill a hole to the center and there create a small chamber. Lower two synchronized clocks to the chamber and then bring one up to essentially free space. Wait 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.

First observation: The above experiment and symmetry tell us that the light cones in B_2's small essentially flat chamber are narrowed but not tilted.

Second observation: Gravitational time dilation depends strictly on potential and not on the strength of gravity. Light cone phenomena involved in gravitational time dilation should have the same dependence. The best explanation, then, is that the light cones are also narrowed but untilted, at places equipotential to B_2's center but of nonzero gravity.

We turn to cosmology for our third and strongest observation.

The gravitational collapses of bodies and cosmologies [33a] are related. With potential-in-tilted light cones, nothing would prevent a collapsing universe from a singularity. The gravitational radii of individual bodies would offer no barrier. But with potential-narrowed light cones, a finite universe has its own gravitational radius.

Figure 12 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 +

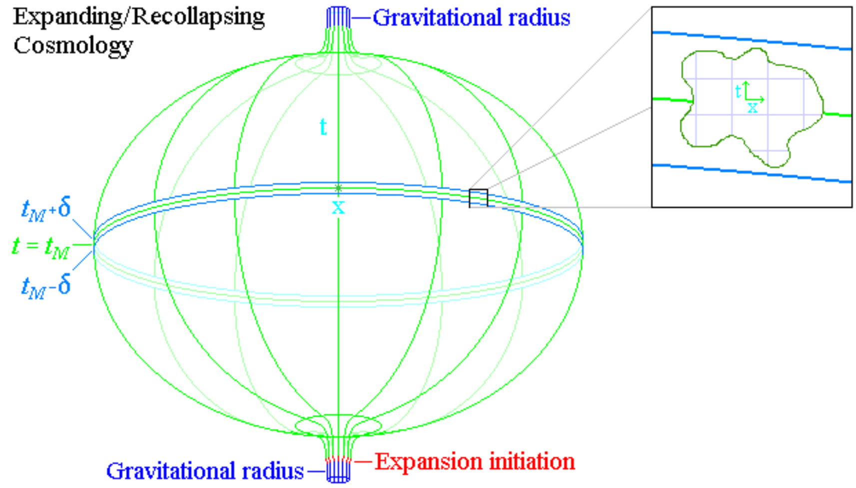

Fig. 12 Here is ST_CX_C, for one dimension of an Expanding/Recollapsing cosmology. Clocks marking time the fastest travel longitudinal world lines, through momentary rest frames of thin latitudinal time slices. At the earliest and latest times, the universe is confined near its gravitational radius.

δ, would measure as identical to ST_FX_C. Momentary inertial frames continually change with time; yet clocks mark time maximally along the shortest path through space-time [16, 17]. This cosmology resembles the Big Bang/Big Crunch cosmologies [33a], but differs in that the earliest and latest times, depicted in blue, do not involve singularities but rather a universe confined near its gravitational radius. The temporal variation is allowed under our gravity formalism [Wein], and the FRW radial scale factor can account for it, with time referenced to our point of observation.

Third observation: Our universe is accelerating an expansion [34, 35]. The best explanation, requiring no artificial modification of our gravity formalism, is that 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, as depicted in Figure 12.

To accommodate universal acceleration, the Big Bang scenario requires a cosmological term [mtw,Wein], for which we have no physical explanation.

The Cosmic Microwave Background (CMB) is touted as observational evidence of a Big Bang [36]. But this is only with respect to the steady state alternative [36]. The CMB does not, in principle, favor universal expansion from a singularity over universal expansion from a gravitational radius.

Theoretical considerations that suggest potential-in-tilted light cones are nonphysical: Firstly, the resulting physical singularities are conceptually difficult, prompting, for example, the "Cosmic Censorship Hypothesis" [37,38,19c] and the "Ignorance Principle" [39]. With potential-narrowed light cones, information and associated entropy can become trapped behind horizons, but there is no breakdown in predictability, since space-time is smooth. Secondly, we will see, in section 6, that the type of horizon created by potential-in-tilted light cones would make conceivable backward time travel and causal inconsistency, while such paradoxes are not possible with potential-narrowed light cones.

Finally, out-tilted light cones, such as those of the outgoing Eddington-Finkelstein coordinates [28a], explain gravitational time dilation as effectively as in-tilted light cones, but would not allow singularities. Those who would argue for tilted light cones and the existence of singularities must explain why the tilt must be in.

Therefore, light cone narrowing is the best explanation for gravitational time dilation. From this, we conclude that gravitational potentials do not cause ether flow and that gravitational collapse keeps space-time smooth.

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

5 The Relationship Between Ether and Energy.

5.1 Large-Scale Curvature.

In 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 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 will be locally 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 [40–43] that is helpful in understanding this subsection (the earliest such result known to the present author, [40], contains some small errors [41]).

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 [44]. But this does not imply that particles or fields will behave as if dragged in a fluid, as pointed out by Rindler [42], who objects to the characterization "dragging" [see Appendix B for an answer to these objections].

As noted in the introduction, frame drag observations are currently tenuous; however, the Gravity Probe B experiment [44–46] is currently under way, to study the Earth's Lense-Thirring effect [47], and should shortly provide the first reliable 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, of particular interest for us, as it is, in fact, ether drag.

Consider a massive *ball*, B_3, at rest in the ether of an essentially asymptotically flat space. Far from B_3 is a *remote* ether reference frame, RFE_R. Any *circle*, L_C, centered on B_3, has a non-inertial cylindrical space-time that looks like ST_FX_C, with an angular rest frame, RFE_C, corresponding to RFE_R [48].

Now, suppose that B_3 starts rotating, with L_C in the symmetry plane. RFE_C would then rotate prograde, with respect to RFE_R, in proportion to B_3's angular momentum and in inverse proportion to L_C's circumference [48].

A *remote* inertial *observer* on B_3'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 than 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 13 B, below, with the pictured blue mass as part of B_3's equatorial surface].

Therefore, the ether is dynamic.

If B_3 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, as assumed in Relativity, would constitute yet another paradox. We now demonstrate how ether drag breaks the symmetry of translational motion.

Figure 13 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_3's equatorial surface). In a sufficiently small space-time subspace,

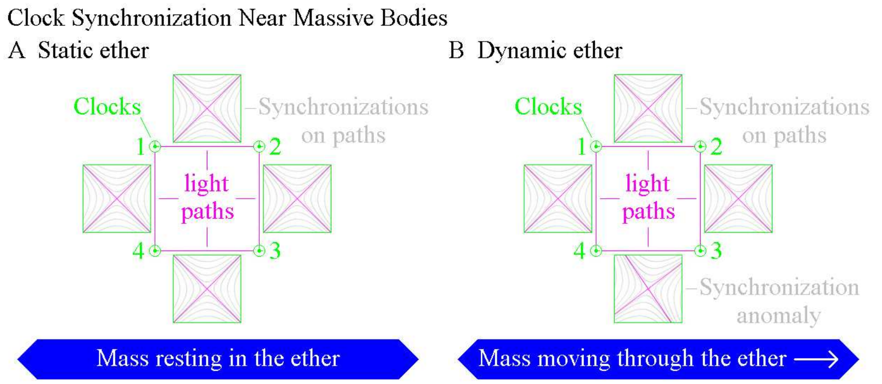

Fig. 13 In A, four clocks uniformly move with arbitrary velocity, near a mass resting in the ether. In a sufficiently small space-time, these clocks can synchronize consistently, along all depicted light paths, to form an inertial observer. In B, the same clocks cannot synchronize consistently, because 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.

the clocks can use light signals to synchronize consistently, along all of the violet light paths, forming an inertial observer.

Figure 13 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 14 depicts the Earth, in blue, translating with velocity v and rotating with angular velocity ω, relative to the free-space ether. The pictured experimental apparatus translates 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 [49], 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

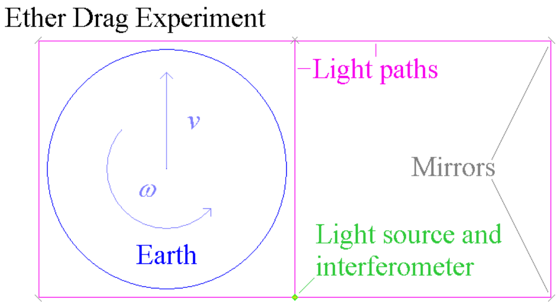

Fig. 14 In this ether drag experiment, the light source sends beams along all violate light paths, which are created by mirrors at the square corners. An interferometer reads the fringes of recombined returning beams. The left square measures ether drag due to Earth's rotation, while the right measures ether drag due to translation.

galaxy's internal angular momentum [50] 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, gravitational waves [28f,33b,25b,43] and ether waves are the same. Ether waves are composed of two "hyperpolarizations": Time-dependent ether drag creates ether waves that oscillate parallel to ether and carry rest information. Time-dependent gravitational potentials create ether waves that have components both parallel and 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 15 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.

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 than that from isolated astrophysical bodies.

We may soon detect ether waves created by systems containing frozen stars, which would be distinct from those thought to be created by systems containing singularities. But, eventually, we will not need to look so far to

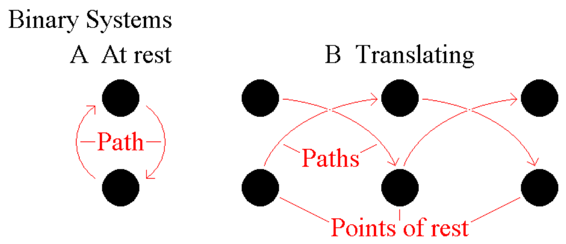

Fig. 15 Here are two binary systems. A's rotational axis is at rest, while B's is translating through the ether, such that each body periodically comes to rest, in a manner similar to that of points on the edge of a rolling wheel. The ether waves produced by these binaries are distinct and thus carry rest information.

detect ether waves. The Earth and Moon form a binary system, the ether waves of which will someday be detected.

6 Causal Consistency.

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

Hawking coined the "Chronology Protection Conjecture" [51,19d], "*The laws of physics do not allow the appearance of closed timelike curves.*" This conjecture has been prominent in the study of causal consistency, so we will meet 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 [52] (see also Capria [23], who cites [52], providing details and some English translation). In a sense, this generalizes the ether demonstration for $\mathrm{ST_FX_C}$, in section 3. Any observer in $\mathrm{ST_FX_C}$ can be thought of as being in two places at once, as in the tiled representations, and able to self-send instantaneous signals. Superluminal travel would thus eliminate Standard Relativity.

This method of ether observation can be realized, using translational ether drag, since light can travel faster than c, relative to the remote free-space ether.

Hawking states [51], "Of course, in the theory of relativity, time travel and faster-than-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.

Hawking assumed real-time Lorentzian metrics [51], in which "...the light-cone structure forces one to travel at less than the speed of light and forward in time in a local region." He made this assumption in the context of Standard Relativity, but we can make it suitable for a discussion of no-backward-time-travel and thus chronology protection.

Assume that, in any trivial essentially flat ether frame, observationally, one must travel at less than the speed of light and forward in time. This assumption allows the same observed velocities, in all local frames, as does Hawking's.

No-backward-time-travel also 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. There could be discontinuities that would only be detectable in multiply connected space, and would thus be consistent with the physical laws of current observation (as also discussed further in the next subsection). But, since any associated backward time travel would be locally unobservable, the continuity assumptions are reasonable, from a practical standpoint.

Restriction of locally observable travel to less than the speed of light and forward in time, in any trivial essentially flat ether frame, and ether and world line continuity, guarantee that real travel is so-restricted, in any ether frame of trivial time dimension.

Furthermore, there exists no one-way traversable world line, through multiply connected space-time, that leads back, past any ether hypersurface of simultaneity, since it would require an ether-flow-generated event horizon, which observation and theory indicate do not exist. This particularly includes closed world lines through wormholes. But two-way traversability would violate travel restriction to the forward light cones. Hence, the time dimension is trivial.

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

{See Appendix C for specific refutation of two well-known prescriptions, for closed timelike curves, that try to use multiple reference frames.}

6.2 Causal Consistency, Assuming Only the Physical Laws of Current Observations.

Zel'dovich and Novikov realized that closed timelike curves could be causally consistent [53]. However, to demonstrate causal consistency, assuming only the physical laws of 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, backward time travel can only occur in uniformly repeating universes, and from ether and/or world line discontinuity. But, in the context of such phenomena, all locally observable phenomena must be representable by continuous world lines, in continuous coordinates.

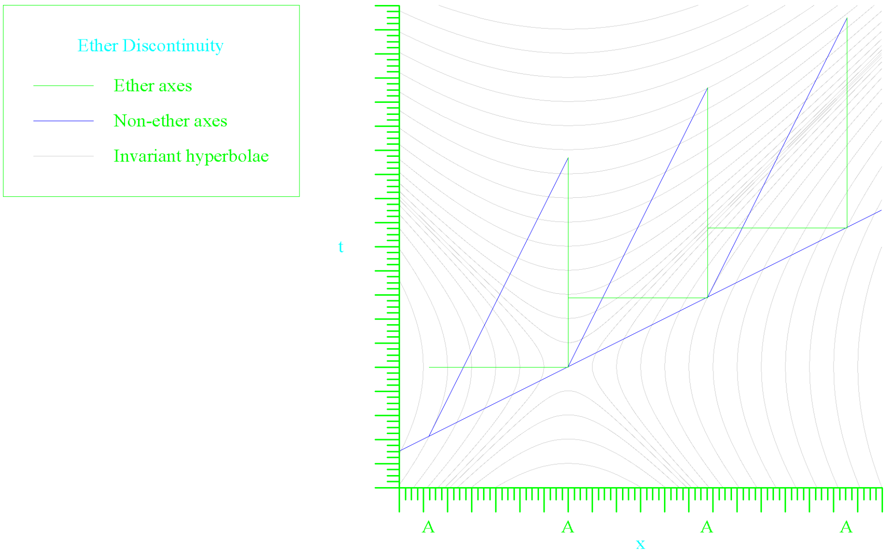

Fig. 16 Here is a tiled space-time diagram with ether discontinuities and a globally continuous non-RFE frame.

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 in diagrams like Figure 16, 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; so 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 16, that would be indistinguishable from continuous ether coordinates [compare Figure 16 with Figure 10].

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

With locally observable travel restricted to the forward light cones, world lines through multiply connected ether could still be closed, if the magnitude of any allowed discontinuity were to equal or exceed the smallest s-spheroid circumference of a multiply connected structure. 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 such backward time travel.

If we horizontally distort Figure 16, making the blue non-ether space axis vertical, the resulting diagram would appear to depict a uniformly repeating universe. This is nonphysical, but the unbroken repetition common to uniformly repeating universes and universes with allowed ether discontinuities clarifies the causal consistency of the latter. All tiles represent the same space, so nothing can occur in any to break the repetition.

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

Therefore, the physical laws of current observations are causally consistent.

{Blau has examined superluminal travel in $\mathrm{ST_FX_C}$ [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 [52, 23].}

7 General Conclusions and Directions for Future Research.

By observation and theory, there is only energy to influence rest (and vice versa). Energy motion influences rest motion, through ether drag, while energy amount and distribution set clock rates. This is the proper understanding of issues Mach explored [54]. Therefore, barring some consideration, foreign to observation and theory, that causes an essentially flat universe to have a nonzero total (possibly angular) momentum, the comoving frame is the free-space ether frame, in any FRW-proximate universe [as we already saw for curved FRW-proximate universes, in subsection 5.1]. Our universe is approximately FRW, assuming the Cosmological Principle [33c], so our free-space ether frame is seen in the stars.

Energy amount and distribution determine gravitational radius and thus maximum energy density. Therefore, the universe must be finite, unless there is negative energy or a violation of the Cosmological Principle.

The FitzGerald Deformation Hypothesis [55] is correct. Photons must travel shorter average lengths, between rest particles of a given proper separation, than 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.

The horizons of Schwarzschild collapse appear to differ from others only in that we know of no process to keep them from approaching vertical (by comparison, singularity-associated horizons seem quite unnatural). But energy always exists outside any horizon of collapse, upon which depends the horizon size. Collapse (including cosmological) could be reversible, through an as-yet unidentified quantum gravitational process.

The search for a unified theory of nature should focus on gravity as a confining agent, at high energy densities.

Gravitational confinement might give energy its particle nature. Particle creation and annihilation might be a tiny gravitational collapse and re-expansion of wave energy.

The search for a unified theory of nature should focus on gravity as a confining agent, at high energy densities. Gravitational confinement might give energy its particle nature. Particle creation and annihilation might be a microscopic gravitational bounce.

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), setting a maximum particle energy for RFE, which is the Planck energy, E_p.

Clock synchronization, in trivial flat space-times, 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 a lower bound for observable spatial length in RFE; and the Planck time, t_p, is similarly a lower bound for observable temporal length.

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 γ the Lorentz boost factor, relative to RFE, that are 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, γl_p and γt_p (with the analogous period Doppler shift formula) are respective lower bounds for RFB spatial and temporal measurement, along the direction of $\boldsymbol{v}$, with both synchronizing signals limited by $\cos\theta_E$ equal to v/c (in RFB, the limiting signal travel would appear to be perpendicular to $\boldsymbol{v}$). And $(1/\gamma)E_p$ is an upper bound for observable energy. The ether is thus additionally observable.

Let l_{min} and E_{max} respectively be the minimum observable length and maximum observable energy, in any given frame, due to the minimum wavelength. And recall that there is a maximum length, l_{max}, for any given frame of an s-loop, which defines a minimum energy, E_{min}. The ratios $R_{maxl} = l_{max}/l_{min}$ and $R_{maxE} = E_{max}/E_{min}$ are invariant. That is, the universe of measurement varies equally at both scale extremes, with the maximum quantities always composed of the same number of minimum quantities.

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 [58,57b]. Within decades, such effects might be within reach of ultra-boosted nanotechnology laboratories.

With E_p the natural cutoff, Gravity theory's nonrenormalizability [57c] is no problem. Since the cutoff is physical, renormalization is inappropriate for Gravity theory (and unnecessary for any other theory). In fact, with cutoff-dependent phenomena, like those in the last paragraph, our Gravity theory would be problematic if it was renormalizable.

These considerations serve as signposts, pointing the way to a unified theory of nature.

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.

Appendices.

A 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:

$$ds^2 = a(\tau')^2(-d\tau'^2 + d\overrightarrow{x'}^2) \tag{6}$$

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

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

$$a(\tau') = a(\tau' + L \sinh b) \tag{7}$$

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 (7) must be based on valid coordinates. But the comoving coordinates are globally inconsistent and generate unreal observations. 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.

B 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 [42]. 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 unsurprising 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".

C Two Well-know Prescriptions for Closed Timelike Curves.

Various rotating systems have been thought to have closed paths, along which the light cones are sufficiently tilted, by frame drag, to create closed timelike curves [**?**,59,60].

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 ingoing Eddington-Finkelstein diagram of [28a]}. Like B_3, in subsection 5.2, all rotating systems continuously alter rest, dragging the ether prograde; but, relative to the ether, light cones are always symmetric.

Frame dragging systems thus cannot be time machines.

Morris, Thorne, and Yurtsever have put forth a well-known prescription for wormhole time machines [62,19e], which has previously been argued against by Konstantinov (see most recently [62]). 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, than by watching each other across the nearly flat outer space [19e]. 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 respective motions relative to the ether.

Wormholes thus cannot be time machines.

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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 than 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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