Back to Newtonian time?

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***Abstract*:** An alternative approach to relativistic physics is reviewed, based on an invariant formulation of electromagnetic field theory due to Hertz. Both electromagnetism and mechanics are shown to be subject to reformulation whereby true invariance replaces "universal covariance." The invariant feature of Einstein's theory, proper time, is retained, but is supplemented for convenience in describing many-body motions by a generalized form of frame time termed "collective time" (CT), patterned on Global Positioning System (GPS) time. CT resembles Newton's absolute time in regard to environmental independence, but is shown to satisfy a form of relativity principle. A crucial experiment is described involving accurate measurement of stellar aberration at second order by means of the Very Long-Based Interferometry (VLBI) system. This would decide definitively between the Hertz and Maxwell-Einstein formulations of electromagnetism. Another experiment that I proposed earlier,[3] involving in-orbit light speed measurement, is disavowed, since I now recognize it as not crucial. This paper sums up a half-century of my dissident thinking in physics and forms a concluding testament.

***Résumé* :** Une approche alternative à la physique relativiste est passée en revue, basée sur une formulation invariable de la théorie de champ électromagnétique attribuée à Hertz. L'électromagnétisme et la mécanique sont sujets à la reformulation par lequel l'invariance réelle remplace « la covariance universelle. » L'attribut invariable de la théorie d'Einstein, le temps réel, est retenu, mais est complété pour la convenance en décrivant des mouvements à N corps par une forme généralisée du temps « collectif » nommé (CT), basé sur le temps du système de localisation mondial (GPS). Le CT ressemble au temps absolu de Newton en rapport avec l'indépendance environnementale, mais démontre une forme du principe de la relativité. Une expérience cruciale est décrite, comportant la mesure précise de l'aberration des étoiles au deuxième ordre, au moyen du système radiointerférométrie à très longue base (VLBI). Ceci trancherait définitivement entre les formulations de Hertz et de Maxwell-Einstein au sujet de l'électromagnétisme. Une autre expérience que j'ai proposée plus tôt,[3] comportant la mesure de la vitesse-lumière en orbite, est désavouée, puisque je la considère maintenant comme non cruciale. Ce document résume un demi-siècle de ma pensée dissidente sur la physique et produit un testament concluant.

Key words: Relativity, Inertial Transformation, Neo-Hertzian Electromagnetism, Proper Time, Collective Time, GPS Time, Newtonian Time, Invariance, Covariance.

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I. INTRODUCTION

When "progress" in what is called normal science (meaning the science pursued during intervals between "scientific revolutions") evolves unidirectionally for a sufficient length of time there is danger that any mistakes occurring in different sub-areas will induce further mistakes that become mutually reinforcing. Should this occur, the damage will become increasingly insidious and irreversible as time goes on, leading to a drift away from real progress. The result will be long-lasting systematic error almost undetectable by established means.

Normal science possesses no natural defenses against systematic error. Science-by-consensus affords no protection against error-by-consensus. There is nobody in the "profession" of physics, for example, whose job it is to look for error of any kind – much less the subtle kind arising from multiple misconceptions that mutually support one another. The only protection is what used to be called common sense … which has, however, been largely driven from all fields of science by the dominant encroachment of ever-increasing mathematization, not to mention computerization. I suggest that this is not an imaginary problem. Even the trend toward axiomatization merely intensifies it, since axioms can serve as cosmetics to hide underlying misconceptions. Axioms do not banish error – they provide it a respectable up-town dwelling place behind a manicured front lawn.

In this paper I am going to suggest that there has arisen during the past century an unholy alliance of misconceptions, stemming primarily from Maxwell's equations, that has brought the progress of basic physical understanding to a virtual halt in our time. If true, this is bad news. The traditional reaction to bad news is to kill the messenger. I ask only that such a termination be delayed until the message has been delivered.

Let us start with the concept of *inertial motion* of a pointlike object. The Galilean transformation (GT) describes the location of this object in primed and unprimed inertial systems by means of

$$\mathbf{r}' = \mathbf{r} - \mathbf{v}t \tag{1}$$

$$t' = t\,, \tag{2}$$

where $\mathbf{v}$ is a constant vector, the relative velocity of the two systems. This GT was discarded early in the twentieth century in favor of the Lorentz transformation (LT), which in the special case of motion parallel to an x-axis takes the form

$$x' = \gamma\left(x - vt\right), \qquad \gamma = 1/\sqrt{1-\left(v/c\right)^2}\,, \tag{3}$$

$$y' = y, \qquad z' = z\,, \tag{4}$$

$$t' = \gamma\left(t - vx/c^2\right). \tag{5}$$

Such an altered vision of physical inertiality is strange on the face of it – not to say disturbing. For at first order in $\left(v/c\right)$ Eq. (5) reduces to

$$t' = t - vx/c^2\,, \tag{6}$$

a form unsupported by empirical evidence, yet never challenged by physicists. One is tempted to ask this consensuspede how it walks. Are physicists empowered to temper *first-order* physics to the winds of fashion? If on Monday first-order inertial motion is described by (2), shall it be described by (6) on Tuesday? If on Monday we say Newton's physics is right at first order, shall we say on Tuesday that it is wrong at first order? If so, what do we plan to replace it with at first order? Is finding an answer to this a top priority, a first order of business? Evidently not, for no attempt has ever been made to improve on Newton at first order or to justify (6) as physics. On the contrary, what evidence there is seems to refute (6); for it implies, *e.g.*, that at short times $t \sim vx/c^2$, of the order of femtoseconds, atomic resonant oscillations should exhibit phase shifts detectable on the scale of laboratory distances. These are not reported. Similarly, at large distances $x \sim c^2 t/v$, of the order of several thousand light years, optical phase shifts (of annual period in step with the earth's orbital motion) should be exhibited by astronomical sources. These also are not reported. No known physical facts speak for the LT as a descriptor of inertial motion. It is clear, then, that some compulsion other than empiricism lies behind the universal adoption of the LT. What could it be?

To answer this, one must consult history. The choice of the LT was a move forced by the shared determination of physicists not to improve on Maxwell's equations in any way. That determination dominated the thinking of Einstein. He could have followed H. R. Hertz[1] in improving Maxwell's equations at first order to make them invariant under the GT – thereby *effectuating a relativity principle without any first-order tampering with the definition of inertial system*. Taking that course requires formal replacement of the non-invariant operator $\partial/\partial t$ everywhere in the electromagnetic field equations by the GT-invariant form

$$\frac{d}{dt} = \frac{\partial}{\partial t} + \left(\mathbf{v}_d \cdot \nabla\right), \tag{7}$$

where $\mathbf{v}_d = \mathbf{v}_d\left(t\right)$ is a new non-constant velocity-dimensioned parameter unrelated to the constant $\mathbf{v}$ of the GT. Instead, Einstein elected to stick with Maxwell's non-invariant field equations in rigorously unaltered form. To support this, since something had to give, he (and Lorentz) adopted a loosened concept of form preservation, known as "covariance," to over-ride and replace the old idea of invariance. Thus, Maxwell's equations were not invariant under anything, but were covariant under the LT. Such were, and remain, the LT's sole physical credentials. In fact it has no genuinely "physical" credentials, but only such conceptual ones as inhere in resistance to change of Maxwell's equations. To certify where we stand, let us formalize definitions of these two rival types of form preservation:

Invariance: An expression is invariant under a stipulated transformation of symbol meanings if the transformation maintains in place each symbol entering the expression, without altering the formal relationships among symbols and without introducing nontrivial changes of symbol definition.

Example: Newton's second law, $\mathbf{F} = md^2\mathbf{r}/dt^2$, is invariant under the GT, Eq. (1)-(2), from unprimed to primed coordinate symbols, it being understood that $m' = m$ and $\mathbf{F}' = \mathbf{F}$ (all symbols retaining their physical meanings in primed and unprimed inertial systems – such changes of symbol *physical association* being characterized as "trivial" definitional changes).

Covariance: An expression is covariant under a stipulated transformation of symbol meanings if the transformation maintains in place each symbol entering the expression, without altering the formal relationships among symbols, but *with* allowed nontrivial changes of symbol definition (formally compatible with the changes defined by the transformation itself).

Example: Maxwell's field equations are covariant under the LT, Eq. (3)-(5), whereby the field-component symbols F_μ undergo redefinition according to a rule of linear combination, $F_\mu' = \sum_\nu a_\mu^\nu F_\nu$, which mimics the LT coordinate linear transformation rule, $X_\mu' = \sum_\nu a_\mu^\nu X_\nu$, referring to $X_\mu = (\mathbf{r}, ct)$ and employing the same coefficients a_μ^ν, $\mu, \nu = 1, \cdots, 4$. (This ignores the distinction between contravariance and covariance, which is not relevant to the present discussion.)

Thus we see that covariance is a looser expression of the form preservation idea than invariance. Why does this loosening of rigor appeal to the mathematical mind? I can think of no reason except that it is slightly more complicated, hence intellectually more challenging, and possessed of the elegance associated with generalization. Elegance is the mathematician's Lorelei, and there are few theorists alive today in the physics profession who are not misplaced mathematicians. Traditionally, the "invariant" has been seen as what correlates with the "real" in the external world. The willingness of physicists (or mathematicians) to drop this tradition and to relax standards by accepting the dictum of "universal covariance" can only be read as testimony to the spell cast upon them by the transcendent elegance of Maxwell's equations. Lorentz-Einstein's preservation of those equations came like manna in the desert. Physicists did not have to think a single new thought about electromagnetism … what a relief! All empirical evidence bearing on inertiality spoke for the GT and against the LT, but ignoring that was a small price to pay for a providential escape from the threatened necessity of thought. That's history. (But you will not find it so bluntly expressed in any history of science written in the twentieth century.)

The irony is that the hard part, the thinking, had already been done. Well before his death in 1894 – more than a decade before Einstein's *annus mirabilis* – Heinrich Hertz had discovered and published a formalism for electromagnetism[1] that was honestly invariant under the GT, as mentioned above. Not only did Hertzian invariance better correspond at first order to the traditional idea of reality, but his was a formal mathematical *covering theory* of Maxwell's electromagnetism [inasmuch as setting $\mathbf{v}_d = 0$ in (7) reduces the one theory identically to the other]. Why, then, did Einstein and all other physicists pay no attention to Hertz? To answer this in the light of history, one must recognize the vast difference between physical theory and mathematics, *sang pur*. The latter needs only the right symbols in the right relationships, whereas the former needs also the right physical interpretations of the symbols. It was there that Hertz went fatally astray, as he sought to build physical theory on an interpretation of his new $\mathbf{v}_d$ symbol in terms of ether wind, the trendy thing of his day. (How many modern physicists resist the trendy thing of their day?) That led eventually – after Hertz's death – to disagreement with observation[2], so history dropped his theory like a hot potato.

A century later, not one physicist in a hundred can tell you that a Galilean invariant formal theory of electromagnetism ever existed or could exist. But the fact is that there was nothing wrong with Hertz's theory that could not be cured by fixing his unlucky interpretation of $\mathbf{v}_d$, plus some tweaking of the "time" concept, to be discussed below. Hertz's formalism was splendid, better than Maxwell's, because it was a formal covering theory. What was and is needed is to discern a valid physical definition of $\mathbf{v}_d$; *viz.*,

Definition: In field theory the parameter $\mathbf{v}_d$ in (7) is the velocity of the field detector with respect to some fiducial reference state of inertial motion, such as the inertial frame of the laboratory or "observer." The field detector's position in that frame at the instant of detection is (by definition) the "field point" – *detection* being conceived in field theory, in relativity theory, and in quantum theory, as a point (localized) event.

One can confirm the plausibility of this definition by any number of common-sense considerations. For example, given the stated definition, the covering theory requirement $\mathbf{v}_d = 0$ describes a condition in which the field detector is permanently at rest at the observer's field point. But this is precisely the condition that characterizes Maxwell's theory – the latter being a special case of the Hertzian covering theory. That is, since detector *motion* is not parameterized in Maxwell's theory, the field detector must be at rest (motionless) somewhere, if it exists at all … and the only useful or rightly conceivable place for it is at the field point. Maxwell's field equations parameterize source motion (via the Maxwell source current $\mathbf{j}_s$), but do not parameterize sink (absorber, detector) motion. How serious is such an omission? In a theory that claims source-sink *reciprocity* (and also purports to be compatible with a relativity principle) one might see it as quite serious, indeed … but physicists have always chosen to view Maxwell's field theory as an Immaculate Conception, hence as incapable of error (even though "Maxwell's equations" were never written nor seen by the great man himself). More significantly, the advent of quantum theory places special emphasis on the act of detection or "measurement" as the crux of what is physically real about the "field" (and possibly *all* that is real about it). So, in a sense it is at least as important to parameterize sink motions as source motions – in any theory legitimately entitled to describe reality. Field theorists (nature's linguists) are deathly serous about such entitlement … they assure us most earnestly that field theory speaks the "language of nature." Strange, then, that their poster child, Maxwell's theory, does not speak to the act of *field detection* at all.

The manifold superiorities of Hertzian over Maxwellian theory have barely been touched on here. In the weak-field (one-photon) limit, to adduce a prime example, Maxwellian covariance fails completely, since it requires *each inertial observer* to be equipped with his own field detector at rest at his field point. If two or more of these macro instruments compete to detect the given field quantum, only one can succeed. The other must register *zero*. Hence, the relations demanded by the Lorentz transformation among measured field components between two inertial observers (whose field points coincide at the instant of detection) cannot be satisfied. The "zero" will not fit. But in Hertz's invariant theory there is present only a single detector, viewed by a plurality of observers (each with detector-relative velocity parameterized by $\mathbf{v}_d$); so no such problem of multi-detector mutual interference arises. And so on. This is more thoroughly discussed elsewhere.[3]

With this introduction, and before more can be attempted toward reconstructing theoretical physics to improve its conformity to reality through invariance, it is necessary to broaden our conception of "time." This we shall do in two stages.

II. FUNDAMENTAL ROLE OF INVARIANT PROPER TIME

Our Introduction suggested reinstating the theme of true *invariance* as central to the description of physical reality. It is time now to recognize a serious vulnerability of all classical physics in this regard, in that Newton's "time" parameter *t* has been considered since Einstein to be non-invariant. Thus, under the GT, Eq. (1)-(2), we find, together with the easily proven $\nabla' = \nabla$, that

$$\frac{\partial}{\partial t} = \frac{\partial x'}{\partial t}\frac{\partial}{\partial x'} + \frac{\partial y'}{\partial t}\frac{\partial}{\partial y'} + \frac{\partial z'}{\partial t}\frac{\partial}{\partial z'} + \frac{\partial t'}{\partial t}\frac{\partial}{\partial t'} = \frac{\partial}{\partial t'} - \mathbf{v}\cdot\nabla \neq \frac{\partial}{\partial t'}, \tag{8}$$

which shows the non-invariance of the partial time derivative operator appearing in Maxwell's equations. By contrast, as previously noted, the total time derivative operator is Galilean invariant,

$$\left(\frac{d}{dt}\right)' = \left(\frac{\partial}{\partial t} + \mathbf{v}_d\cdot\nabla\right)' = \frac{\partial}{\partial t'} + \mathbf{v}_d'\cdot\nabla' = \left(\frac{\partial}{\partial t} + \mathbf{v}\cdot\nabla\right) + \left(\mathbf{v}_d - \mathbf{v}\right)\cdot\nabla = \frac{\partial}{\partial t} + \mathbf{v}_d\cdot\nabla = \frac{d}{dt}, \tag{9}$$

where we have applied (7) and made use of Galilean velocity addition, $\mathbf{v}_d' = \mathbf{v}_d - \mathbf{v}$.

In his special relativity theory what did Einstein do about the non-invariance of Newton's *t*? First, he identified *t* with the "frame time" of an inertial frame, thus acknowledging the special physical status of inertial motions. He then assigned it the inferior status of fourth component of a four-vector. Next, he introduced a new kind of time, associated with a single particle and termed "proper time" τ, which was invariant, in the sense that all observers (in whatever states of motion) had to agree on it. There was a simple operational definition: τ was the "pocket-watch time" of an observer co-moving with the particle. In view of this definition and its associated invariance there can be no doubting the *reality* of τ. Since Newton's *t*, in contrast, involves a definition of distant simultaneity, there is an element of conventionality about it that denies it a direct correlate in nature, so it lacks the unqualified reality of proper time. When there is a choice, it is reasonable that greater reliance be placed on parameters more strongly correlated with reality. Hence the basic equations of electromagnetism, Newton's mechanics, and the rest of physics, need to be reformulated in terms of the invariant τ, in order to make sure of getting them physically right.

Unfortunately, Einstein went on to invent a conception of "spacetime symmetry," consonant with his four-vectors and perhaps suggested by the symmetry of partial derivative operators $\left(\frac{\partial}{\partial x},\frac{\partial}{\partial y},\frac{\partial}{\partial z},\frac{\partial}{\partial t}\right)$ in Maxwell's field equations. We have seen that a demand for strict invariance rules out Maxwell's equations and calls instead at first order for the GT-invariant Hertzian equations that employ space-time *asymmetrical* operators $\left(\frac{\partial}{\partial x},\frac{\partial}{\partial y},\frac{\partial}{\partial z},\frac{d}{dt}\right)$. Since space-side and time-side operators can be considered separately invariant [*cf.* our results $\nabla' = \nabla$ and (9)], an invariant reality affords at first order no physical basis for Minkowski's space-and-time amalgamation inherent in "spacetime symmetry." A symmetry absent at first order is certainly not going to make an appearance at higher orders. Consequently, the Einstein-Minkowski postulation of a supposedly invariant "proper space" interval $d\sigma$ to match $d\tau$ was a blunder of historic proportions – one that has become deeply embedded in the corpus of subsequent physics. To this day there exists not a shred of empirical evidence to support it (or its spawn, the "Lorentz contraction"), and of course $d\sigma$ has no possible operational definition.

Indeed, the existence of an operational definition for $d\tau$ is persuasive evidence against $d\sigma$ invariance, since the reality of $d\tau$ in the mathematical sense of being representable by a real number implies that $d\sigma = icd\tau$ is an imaginary number, hence unsuited to describe physical reality. All the *world-structural* claims of Einstein's relativity theory rely upon alleged $d\sigma$ invariance and are surely, without exception, spurious. In profound contrast, the *on-particle-trajectory* claims of that theory, deriving from $d\tau$-invariance, are empirically verified and form the sole objective basis for physicists' reliance on relativity theory. There can be no more damning proof of the folly of deciding science by consensus than the fact that for a century consensus has unhesitatingly backed Einstein in the matter of $d\sigma$ invariance. Rather than argue further a topic that has acquired all the attributes of scriptural doctrine, I shall drop it here and leave the orthodox reader to deploy his own defenses of his indefensible belief.

If we seek a genuinely invariant formulation of the electromagnetic field equations, with the aim of improving field theory, it will evidently be necessary to replace the Newtonian *t* in Hertz's equations by the invariant τ. The resulting field equations have been termed[3] "neo-Hertzian." With respect to a given inertial frame *S* they take the following form in vacuum (**E**,**D** and **B**,**H** distinctions being disregarded). We may express this as a

Postulate:

$$\nabla\times\mathbf{B}-\frac{1}{c}\frac{d\mathbf{E}}{d\tau}=\frac{4\pi}{c}\mathbf{j}_m\,, \tag{10a}$$

$$\nabla\times\mathbf{E}=-\frac{1}{c}\frac{d\mathbf{B}}{d\tau}\,, \tag{10b}$$

$$\nabla\cdot\mathbf{B}=0\,, \tag{10c}$$

$$\nabla\cdot\mathbf{E}=4\pi\rho\,. \tag{10d}$$

Note the use of the total time derivative. In (10a) the current $\mathbf{j}_m$, invariantly measured by a current meter co-moving with the field detector, is

$$\mathbf{j}_m = \mathbf{j}_s - \rho \mathbf{v}_d\,, \qquad (11)$$

$\mathbf{j}_s$ being the Maxwell source current, and the additional convective effect of detector motion being taken into account by the term $-\rho\mathbf{v}_d$. Also, in (10)

$$\frac{d}{d\tau} = \frac{\partial}{\partial\tau} + \mathbf{V}_d \cdot \nabla, \qquad \mathbf{V}_d = \frac{d\mathbf{r}}{d\tau} = \frac{dt}{d\tau}\frac{d\mathbf{r}}{dt} = \gamma\mathbf{v}_d, \qquad \gamma = \gamma_d = \frac{1}{\sqrt{1-\left(v_d / c\right)^2}}\,. \qquad (12)$$

The proper-time parameter τ entering (10) and (12), to repeat, is the "pocket-watch time" of the field detector, the latter being idealized as a mathematical point passing through the field-point position designated $\mathbf{r}$ at the moment of detection. (Recall that at that moment the field detector is *by definition* coincident with the field point.) The field quantities in (10) are Hertzian invariant ones, obeying $\mathbf{E}' = \mathbf{E},\ \mathbf{B}' = \mathbf{B}$, not Maxwell fields. This requires explanation, suggested above and given more fully elsewhere.[3] To review, Maxwell's fields are operationally defined by a plurality of detectors, one at rest at the field point of each independently-moving Maxwellian inertial observer. When these field points coincide, the field component readings of the various detectors are related covariantly, by the Lorentz transformation. In contrast, the Hertzian field is defined by the readings of a single detector, whose motion with respect to the field points of various inertial observers is described by different values of the parameter $\mathbf{v}_d$. Since these various observers read the *same numbers* from that single detector at the shared instant when their field points coincide with it, *numerical invariance* follows trivially. With the help of the following additional postulate, the Galilean *form invariance* of the neo-Hertzian field equations (10) is easily shown:[3]

Postulate: Object length is a physical invariant.

Such invariance refers to measurements made by observers in arbitrary states of relative motion. This extra postulate is an obvious first option to try, once spacetime symmetry is discarded. It proves entirely viable and reliable[3] at all orders of approximation.

The neo-Hertzian field equations, (10), and the evaluation of γ in (12), use the Einstein formal definition of proper time τ,

Definition: $$d\tau^2 = dt^2 - dr^2 / c^2, \qquad dr^2 = dx^2 + dy^2 + dz^2\,, \qquad (13)$$

which is fundamental to all valid "relativistic" considerations. In fact, I take the radical position that (13) is the only part of special relativity theory worth saving, because it is the only part that correlates directly with reality. Note that the two event points delimiting the interval $d\tau$ lie on the trajectory of a single particle (specifically, a "clock particle") and are continuously connected by its motion and timekeeping ability. Such terminal event points do not make or delimit *connections between the trajectories* of any two different particles – such being, instead, the hypothesized mission of the spurious Einstein-Minkowski spacelike "invariant" $d\sigma$. Nothing in nature corresponds to that kind of imagined connection. The *world* built upon such "world-structural" ideas does not exist … it fades to mere shadows. The physics experimenters of the actual world have had a century in which to prove the contrary. It is time to admit their unrelieved failure. The same applies to the unsupported expression of religious faith that says we live "in" Minkowski space.

Applying to particle mechanics the same demand for formal invariance as is embodied in Eqs. (2.3) for electromagnetism, we are led to postulate a modified ("covering") form of Newton's second law wherein τ replaces *t*, *viz*.,

Postulate:
$$\mathbf{F}_{inv} = \frac{d}{d\tau}\mathbf{p}_{inv} = \frac{d}{d\tau}\left(m_0 \frac{d}{d\tau}\mathbf{r}\right), \tag{14}$$

m_0 being the invariant rest mass of the particle described. From (14), with the help of

$$\mathbf{F}_{inv} = \gamma \mathbf{F}_{lab} \tag{15}$$

(the justification of which is discussed elsewhere[3]), and of $\frac{d}{d\tau} = \gamma \frac{d}{dt}$ from (12), we obtain

$$\mathbf{F}_{lab} = \frac{d}{dt}\left(m_0 \gamma \frac{d\mathbf{r}}{dt}\right), \tag{16}$$

which expresses the force measurable in the laboratory in terms of lab-frame time *t*. This is probably the empirically best-confirmed prediction of special relativity theory. It describes the motion of a single point particle at position **r**. Such evidence solely validates the invariance of $d\tau$, not of $d\sigma$.

Similar formal manipulations on the side of quantum mechanics lead[3,4] to Dirac's equation for the electron. One gets the operator equations of ordinary quantum mechanics, which we need not reproduce here, by postulating the following formal operator replacements[5] in the classical canonical mechanical equations of motion – an application of the "Correspondence Principle" to the Hamilton-Jacobi formalism:

Postulate:
$$\mathbf{p} \equiv (\nabla S) \rightarrow (\nabla S) + S\nabla , \quad H \equiv -\left(\frac{\partial S}{\partial t}\right) \rightarrow -\left(\frac{\partial}{\partial t} S\right) - S\frac{\partial}{\partial t}, \quad S \rightarrow \frac{\hbar}{i}. \tag{17}$$

(These correspondences express the Heisenberg postulate in a possibly unfamiliar form, $p_j q_i - q_i p_j \rightarrow \frac{\partial}{\partial q_j} S q_i - q_i \frac{\partial}{\partial q_j} S = \left(\frac{\partial S}{\partial q_j}\right) q_i + S\delta_{ij} + S q_i \frac{\partial}{\partial q_j} - q_i \left(\frac{\partial S}{\partial q_j}\right) - q_i S \frac{\partial}{\partial q_j} = S\delta_{ij}$ $\rightarrow \frac{\hbar}{i}\delta_{ij}$. They further imply the more familiar quantum operator definitions $\mathbf{p} \equiv \frac{\hbar}{i}\nabla$,

$H \equiv -\frac{\hbar}{i}\frac{\partial}{\partial t}$, which entail an implicit operand.) We have here covered electromagnetism and particle mechanics with reference to invariant formulations in terms of $d\tau$, and have touched on quantum mechanics, which submits to a similar formal "relativization." Presumably the rest of physics can follow suit and thus express *universal invariance*, a far nobler and less compromised ideal than universal covariance, which has dominated physics for the past century, anointed by the holy consensus.

III. GPS OR COLLECTIVE TIME (CT)

The best way to look at "time" depends on what fish one has to fry. If one wants to know how individual clocks or biological specimens age, then invariant proper time offers the only qualified option. But for other purposes this has severe drawbacks. Proper time applies to only a single body, being different for each of a collection of differently-moving bodies, so τ is poorly adapted to treating the many-body problem or the description of extended structures. Also, the differential $d\tau$ is inexact, so τ is inappropriate for use as a coordinate in geometrical representations. Such deficiencies are readily corrected by recognizing $dt = \gamma d\tau$ [from Eq. (13)] as a *Pfaffian form*,[6] wherein γ serves as an integrating factor to render *dt* exact. This exactness enables *t* to serve as a geometrical coordinate, as well as a shared descriptor of many-body collections. Even in treating a single body, *t* is useful [as in Eq. (16)] to describe the motions observable in a laboratory frame. Such description, let it be re-emphasized, does not tell us how the particle "ages." It just tells us how it moves. That is the fish we most often need to fry in practical problems. Once the *t*-description of the motion is known, the τ-description can be deduced from it by integrating (13).

For such reasons it becomes desirable to take a much closer look at "frame time" in general. SRT dismisses it as non-invariant, *i.e.*, as nothing more than one component of a four-vector – the fourth leg of a quadruped. Don't believe it. We are launched upon a different paradigm, which eradicates spacetime symmetry, hence four-vectors. So rid your mind of all that and try to think about the physics. Consideration of the Global Positioning System (GPS) will help. Recall that the clocks of that system are rate-adjusted so that all run in step, regardless of environmental differences such as their states of motion and gravity potentials. Thus they are emphatically not "Einstein clocks," for which no such rate adjustments are permitted. In the accepted view of relativists, "time" itself (reified in their imaginations) is directly affected by such environmental influences. Its flow rate is objectively altered. That is, whenever a clock is transferred from a given inertial system and brought to rest in a relatively moving system, its rate, hence time itself, is slowed by a $\gamma\left(v^2\right)$-factor – wherein v^2 measures the speed (squared) of the relative motion. In contrast to this Einsteinian approach, the GPS, prior to the transfer of a clock into orbit, redefines that clock's "second" (decreasing the specified number of atomic oscillations per second) by a γ-factor, so that after transfer the resulting objective clock-slowing due to relative motion (physical decrease of atomic oscillation rate) is *compensated*. That is, it is canceled out. Hence the "moving" clock in orbit subsequently runs (counts seconds) at exactly the same rate as the "stationary" one on earth … and all match their rates to that of some (real or conceptual) fiducial reference clock, serving as a Master Clock in an inertial state of motion. (In the GPS, the fiducial clock is a conceptual one at rest on the non-rotating axis of the earth.) Once rate synchrony is established in this way, actual clock synchronization is easily accomplished for arbitrarily moving clocks. So "distant simultaneity" in terms of GPS time becomes an entirely feasible concept.

This is true within any one GPS. But what about some other hypothetical GPS wherein the fiducial reference clock is at rest in a different (non-earthly) inertial system? Where there is relative motion between two fiducial Master Clocks, their natural running rates will differ by some constant factor α – constant since both are in inertial motion, hence in uniform relative motion – and the "times" in the two systems will be related by $t' = \alpha t$. This difference can be eliminated by adjusting time units in one or the other of the two systems. Or it can be left unaltered and the validity of a relativity principle can be asserted in the following form:

Relativity Principle: The laws of nature are invariant under changes of inertial reference system.

A typical "law of nature" is Newton's second law, expressible as a differential equation. From Eq. (16) we see that replacement of *t* by $t' = \alpha t$ merely alters the definition of force by a constant factor α^2, so with a force-units change the "law" remains invariant. Newton's Principle of Similitude (*Principia*, Prop. 32), indeed, assures us quite generally that the laws of nature are independent of the units chosen for physical description. The adjusting of units to make all inertial system measurements compatible is merely a convenience that facilitates agreement on the quantitative aspects of description. Among these aspects, let us accept that time units can be adjusted in different inertial systems so as to impart operational definability to that perennially-vexed concept, distant simultaneity, to allow universal agreement on it and on the "time" number assigned to any given event.

The same is true of what has been termed *frame time*. Universal agreement on it is feasible through the same units adjustments that impart respectability to distant simultaneity. That is, "seconds" can be so defined, and clocks so adjusted, that all inertial observers agree on whatever time readings those of any chosen GPS settle on. Since this implies that no particular spatial framework in an inertial state of motion is "preferred," it is somewhat inappropriate to tie *time* to such a framework via the terminology "frame time." Elsewhere,[3] I have suggested the name "collective time" (CT), meaning a generalized frame time of GPS pedigree, whereby the fiducial reference for all timekeeping, the Master Clock, may be in any location and in any state of *inertial motion* – the "second" of time being adjusted to fit any chosen preconception. Since special relativity has prejudiced physicists against viewing frame time as invariant, a new name for it may bypass that mind-set. Through suitable choices of time units (given any inertial state of motion of the Master Clock), all timekeeping issues, as well as distant simultaneity, can by reference to CT be agreed on by all observers. This is true because all observers, regardless of their states of motion, must at any given event read the same numbers from any of the (arbitrarily-moving) CT clocks – an evidence of the non-locality of CT. And the laws of nature will be agreed on regardless of the units chosen. Thus both CT invariance and a form of Relativity Principle can be considered to hold (under inertial transformations).

It is important to be fully aware of the difference between CT and Einstein's frame time. The latter pictures a space-filling set of *co-moving* clocks, all in a shared state of inertial motion. In contrast, CT pictures a space-filling set of arbitrarily-moving clocks, not in general co-moving, but all corrected to run (tell time) in step with a fiducial Master Clock, which is a uniformly-running proper-time clock in a given environmental state (of inertial motion and gravity potential – possibly, but not necessarily, corrected to zero gravity conditions). Thus "frame time" is a specialized form of CT in which all clocks share the same inertial state of motion. Inertiality is intimately connected with timekeeping in both cases; but for CT *only the fiducial clock* has its motion restricted to inertiality, other clock motions throughout extended space being disassociated from any "frame." *Collective time* is therefore essentially divorced from *frame*, the mechanism of spatial mensuration. This exposes the foolishness of "spacetime" … space (extension) and time (duration) having nothing inherently to do with each other.

Because of the arbitrariness of clock running rates and phase settings, there is obviously nothing "absolute" about physical time, conceived as what is measurable by clocks. Apart from this, it is apparent that CT possesses all the principal attributes traditionally ascribed to Newtonian "time." Those are invaluable attributes … as their loss during the past century should amply testify. Let the measure of CT be designated t_0. There is no reason not to think of t_0 as *invariant* under changes of the observer's motion state, or under changes of the Master Clock's inertial state, provided we are willing to adjust time units as necessary. If we then picture a hyperplane of constant t_0 in a Euclidean four-space whose orthogonal space coordinates are (x, y, z), it can be supposed that there is instant action-at-a-distance on that invariant t_0-hyperplane, that Newton's third law (equality, simultaneity, and collinearity of distant action-reaction) holds on it, that gravity, electricity, and other *forces* act instantly at a distance on it, and that quantum non-locality of action is described by it – given redefinition of the *t*-time parameter in (13) and (17) as the invariant t_0. We could formalize a postulate to that effect, although at present there is no empirical evidence to confirm or disconfirm it. Changing the Master Clock's inertial state (without adjusting time units) merely replaces the t_0 measure of time by αt_0, and thus alters no law of nature, nor any of the instant-action considerations just mentioned. For whatever happens in elapsed time interval $\Delta t_0 = 0$ happens also in elapsed time interval $\Delta(\alpha t_0) = \alpha \Delta t_0 = 0$.

This last observation resolves the famous "conflict" between quantum mechanics and field theory. (Quantum non-locality describes an instant action-at-a-distance incompatible with field theory's supposedly universal retardation of distant action at speed *c*.) The resolution depends on replacing Maxwell's version of field theory with Hertz's.

Physically, it is necessary to recognize that the retardation described by field theory refers to radiation alone, not to force actions. Admittedly, this is a controversial contention – since most physicists nowadays take it for granted that all *force* acts retardedly at speed *c*, although the wave equation descriptive of speed-*c propagation* has never purported to describe force. I submit that there is no empirical evidence to support the force-retardation assumption, its possible laboratory testing being on too small a physical scale to distinguish speed *c* from ∞. What little extra-terrestrial testing can be done relates mainly to the action of gravity. All of that evidence is compatible with speed ∞, without exception. (For example, LaPlace showed that the solar system would come apart in a couple of hundred million years – about one trip around the galaxy – if gravity acted at speed *c*. All other empirical evidence indicates that it has made many such trips without dissolution.) The physicists' decision to give zero weight to such evidence is a purely ideological one. Physics is ruled by ideology, but that is another fact you will not learn from physics textbooks. In order to confirm it you must read with a disenchanted eye the history of the science.

IV. LIGHT-SPEED MEASUREMENTS

We next address the relationship of the time parameters τ and t_0 to field theory. The electromagnetic field equations (10), being formulated in terms of invariant proper time, give rise to a fundamental neo-Hertzian wave equation of the form

$$\nabla^2\mathbf{E} - \frac{1}{c^2}\frac{d^2\mathbf{E}}{d\tau^2} = 0 . \tag{18}$$

The phase-speed solution of this equation has been shown[3,5] to take the form $\pm c + \mathbf{V}_d \cdot \mathbf{k}/k$, where $\mathbf{V}_d$ is given by (12) and $\mathbf{k}$ is a propagation vector. The *observable* part (see below) of this solution is

$$u_\tau = \frac{\omega}{k} = \pm c , \tag{19}$$

for speed measurement by means of an Einsteinian proper-time τ-clock – that is, a clock allowed to run naturally without environmental corrections. This result applies to all clock locations, all inertial states of clock motion, and all environmental conditions, in full agreement with Einstein's second postulate.

Let us see how the same thing looks from the viewpoint of collective time. Since CT t_0 is a variety (generalization) of frame time, its differential is related to $d\tau$ by (13), with t_0 for *t*; namely,

$$\frac{d}{d\tau} = \frac{dt_0}{d\tau}\frac{d}{dt_0} = \gamma_0 \frac{d}{dt_0} , \qquad \gamma_0 = \frac{1}{\sqrt{1-\left(dr/dt_0\right)^2/c^2}} , \tag{20}$$

where d/dt_0 is given by (7) with t_0 for *t*. Hence (18) can be rewritten as

$$\nabla^2\mathbf{E} - \frac{1}{c^2}\gamma_0 \frac{d}{dt_0}\gamma_0 \frac{d}{dt_0}\mathbf{E} = 0 . \tag{21}$$

This possesses a wave solution[3,5] with phase speed

$$u_{t_0} = \pm\sqrt{c^2 - v_d^2} + \frac{\mathbf{k}}{k}\cdot\mathbf{v}_d\,, \tag{22}$$

the speed being calculated with respect to t_0 as time parameter, $\mathbf{v}_d = d\mathbf{r}/dt_0$, etc., $\mathbf{r} = \mathbf{r}_d$ being the position vector of the field detector. The same follows alternatively from (18) by the use of

$$\frac{d}{d\tau} = \frac{\partial}{\partial\tau} + \left(\mathbf{V}_d \cdot \nabla\right) = \gamma_0\frac{\partial}{\partial t_0} + \left(\gamma_0\mathbf{v}_d \cdot \nabla\right), \tag{23}$$

a result in agreement with (12) and (20), and proven elsewhere.[3] The vector $\mathbf{v}_d$ in (22) describes the t_0-velocity of the light detector (used to measure light speed) relative to the fiducial inertial state of motion – the rest state of the Master Clock.

So far in this Section we have paid no attention to the physics, just reviewed some mathematics. Let us try to discern what it means. To begin with, the first-order term in (22), $\frac{\mathbf{k}}{k}\cdot\mathbf{v}_d$, like that in the solution of (18), lacks physical significance. That is, it is not directly observable, for the same reason an *ether wind* is unobservable. If one works out the wave-speed solution of the traditional wave equation in the presence of an ether wind of velocity $\mathbf{V}_e$, one finds an additive term of similar form, $\frac{\mathbf{k}}{k}\cdot\mathbf{V}_e$. It was proven[3,5] in nineteenth-century physics ("Potier's Principle") that a term of this form produces no effects measurable by laboratory means, such as interferometry, diffraction, etc. Since $\mathbf{v}_d$ plays the same role formally as $\mathbf{V}_e$, the $\mathbf{k}\cdot\mathbf{v}_d$ term in (22) is unobservable and can be ignored. (Alternatively, since $\mathbf{V}_e$ can be assigned an arbitrary value without affecting anything observable, one could imagine an ether wind $\mathbf{V}_e = -\mathbf{v}_d$ to be blowing, which formally cancels the first-order term.) Consequently, from (22), the higher-order speed of light *measurable* with respect to collective time t_0 is

$$\left|u_{t_0}\right| = \sqrt{c^2 - v_d^2} = c/\gamma_d\,. \tag{24}$$

Thus, according to neo-Hertzian electromagnetism, the light speed measured by a moving detector is slowed by a factor $\gamma_d = \gamma_0$ [defined in Eq. (20)], provided CT is the measure of time. This prediction describes an objectively verifiable physical light-speed slowing, independent of detector motion direction. *The effect is measurable only by a collective-time (CT) clock.* A proper-time clock, in contrast, measures always light-speed *c*, according to Eq. (19). The reason for the difference is that the two types of clock are set to run (measure seconds) at different rates, the t_0-clock running γ_d times faster than the τ-clock. (Here only motional effects, not gravitational, are considered.) Hence, when a t_0-clock measures the time interval between any two events (as of emission and absorption or reflection in a light-speed measuring apparatus) it counts more "seconds" elapsed between those two events than does the corresponding τ-clock; so, while the length numerator stays invariant (by our postulate), the denominator of the light-speed quotient is increased and the "speed" measured is decreased by the γ_d-factor in (24).

To repeat, this all refers to the compensation of *motion* effects only. In CT timekeeping and in its GPS counterpart (at first order in potential difference $\Delta\Phi$ and in v^2), gravity effects are compensated (removed), as well as, *and independently of*, motion effects, in applying the corrections that define t_0. The result of these separate corrections is that the effects of motion on t_0 can be analyzed at the observable first order (and have been analyzed here) independently of gravity effects, as if the latter did not exist. The gravity corrections[3] are interesting, and often are in the opposite sense from the motional corrections, but will not be treated in the present paper. (Relativists sometimes credit the theory responsible for operation of the GPS to general relativity, but in practice only the lowest-order treatments of time dilation and the Newtonian gravity potential suffice.)

Elsewhere[3] I have discussed the measurement of light speed by a "dual-function" clock capable of measuring both τ-time and t_0-time, placed either on earth or in orbit. (Such a clock employs the same cloud of atoms, cesium or whatever, for its internal oscillatory timekeeping reference, but defines the "second" differently for the two types of time, in terms of different numbers of atomic oscillations.) Previously[3] I concluded *wrongly* that neo-Hertzian theory predicted light speed to be measured in orbit as *c* by the t_0-clock and as $c\gamma_d$ by the τ-clock. [This was based on length invariance coupled with the faster clock running-rate of the orbiting t_0-clock by a γ_d-factor, contrived to compensate for the physical clock rate-slowing due to relative motion. It overlooked the physical light-*speed* slowing prescribed by (24). The latter effect, measured by the t_0-clock, occurs independently of and additionally to the clock running-rate slowing.] *Mea culpa*. I take the present opportunity to retract that earlier claim and now to predict instead, on the basis of the considerations given here, that when a dual-function clock is placed in orbit (considering motional effects only, always setting gravity effects aside) the τ-clock will measure light speed *c* and the t_0-clock (*e.g.*, a GPS clock in orbit) will measure speed c/γ_d. Here the velocity parameter in γ_d refers to satellite speed relative to the GPS fiducial clock (at rest in the inertial system in which the earth's rotational axis is fixed). Once again, obviously, the t_0- and τ-clocks clocks cannot both measure the same light speed, because they run at different rates. Only the "Einstein τ-clock" measures *c*, in agreement with Eq. (19). The CT-measured light speed c/γ_d of Eq. (24) is a "true" (slowed) propagation speed, revealed through the cancellation of objective (factual) clock-rate slowing due to motion in orbit by compensatory clock-rate speeding, and through factual length invariance. This effect of genuine physical light-speed slowing can be measured only with the help of collective time, which, being independent of environment, provides a unique insight into the environmentally-affected physics. The τ-clock, being uncompensated, runs γ_d times slower than the CT clock and thus measures a light speed *c* that is γ_d times greater ($c = \gamma_d \times c/\gamma_d$). Einstein's second postulate thus hides the underlying physics and is valid only for measurements by (uncompensated) τ-clocks. (The foregoing supposes a light-speed-measuring apparatus, *e.g.*, similar in construction to a Feynman "light clock," to be placed in orbit, along with the dual-function clock. Postulated length invariance of the apparatus characterizes all these considerations.)

V. CRUCIAL EXPERIMENT: STELLAR ABERRATION MEASUREMENT

I take this opportunity to reiterate a prediction made several times before,[3,5,7] the reason being that it identifies a rare case that "crucially" distinguishes Einstein-Maxwellian theory from neo-Hertzian theory. Einstein's special relativity theory (SRT), in agreement with Maxwell's theory, unambiguously predicts[3] the angle of stellar aberration to be

$$\alpha_{SRT} = \cos^{-1}\left(1 - \frac{1-\ell^2}{1-\ell v/c}\left(1-\sqrt{1-v^2/c^2}\right)\right) = \sqrt{1-\ell^2}\left(\frac{v}{c}\right) + \frac{\ell\sqrt{1-\ell^2}}{2}\left(\frac{v}{c}\right)^2 + O\left(\frac{v^3}{c^3}\right), \quad (25)$$

where $\ell = -\sin\theta\cos\phi$, θ being the angle made by the downward starlight-propagation vector $\mathbf{k}$ with the normal $\hat{\mathbf{k}}$ to the plane of the ecliptic, and ϕ being the azimuthal angle of earth's orbital motion, reckoned from a direction normal to the plane containing the **k**- and $\hat{\mathbf{k}}$-vectors. The third-order term in (25) is unobservably small, but the claimed resolution of the Very Long-Based Interferometry (VLBI) system is adequate to measure the *predicted non-zero second-order term* – although the actual measurement has never (to my knowledge) been made. That critical term, if it exists, is largest (maximum departure from Bradley aberration) when $|\ell| = 1/\sqrt{2}$, *i.e.*, $(\theta,\phi) = (45°, 0°)$, the condition that the earth is moving to or from a star located at $45°$ from the ecliptic.

We shall suppose, as suggested by Bradley's classic observations (which then agree with SRT at first order), that

$$v = v_{orb}\,. \quad (26)$$

That is, the parameter v descriptive of stellar aberration in Einstein's formula (25) is taken to be independent of any star's (source's) motion and equal to earth's (sink's) orbital speed v_{orb}. It is difficult to reconcile the empirical Eq. (26) with known four-vector theory, because the frequency component of the starlight four-vector $k_\mu =$ $(\mathbf{k}, i\omega/c)$ requires (in order to make physical sense in terms of the Doppler effect) that v be *source-sink relative velocity*, in disagreement with (26). [Relativists sometimes[8] "derive" Eq. (26) by bringing in Sun-earth relative motion, although what the Sun has to do with light propagating from distant stars to earth is never made clear.]

Neo-Hertzian electromagnetism predicts[3,9] a different angle of stellar aberration, *viz.*,

$$\alpha_{neo-Hz} = \tan^{-1}\left(\frac{v_d}{c}\sqrt{\frac{1-\ell^2}{1-(v_d/c)^2}}\right) = \sqrt{1-\ell^2}\left(\frac{v_d}{c}\right) + O\left(\frac{v_d^3}{c^3}\right). \quad (27)$$

Conspicuously missing here is the second-order term appearing in Einstein's result, (25). Let me repeat, for this is the crux of the matter: *Einstein's second-order term is predicted* *to be absent*. If that term were searched for and *not found*, such an outcome would be decisive against SRT and in favor of giving serious consideration to the Hertzian invariant alternative.

Untold billions have been spent in seeking confirmation of various vanishingly-small general relativistic effects. How many peanut bars would it cost to enable the mentors of the existing (already paid-for) VLBI system to sic a few graduate students onto this aberration measurement problem? Ah, but the cost could be vastly greater in presuppositions! (I should not want to be one of those graduate students. Picture the career-blighting effect of a *wrong answer*. But, scientists, like whistle-blowers and *pro bono* lawyers, are interested in truth, not in careers, right?) Note that Einstein's ambiguous *v*-parameter is here replaced explicitly by v_d, the light-detector speed [the same parameter appearing in Eqs. (7), (10), (12), etc.], which is evidently equal to the earth's orbital speed [compare (26)],

$$v_d = v_{orb} . \qquad (28)$$

More exactly, what is observable is changes in telescope tilt angle, described by changes in $\mathbf{v}_{orb}$. (Upon this would be superposed a small diurnal effect of telescope motion due to earth's rotation, as well as an effect of circulation of the solar system around the galaxy, detectable only on a million-year time scale – all due to minor departures from true inertiality of detector motion.) In the Neo-Hertzian analysis of stellar aberration there is from start to finish no relevance of light source speed or source-sink relative speed. All that matters is light detector speed, with no ambivalent four-vectors, no sleight of hand.

This is, I confess, the only crucial experiment I have been able to find to distinguish my ideas from Einstein's … despite the gulf that divides those ideas on the intellectual or ideological plane. Some hint of how this comes about – of the difficulty of discovering observational distinctions – may be obtained by considering again the "simple" topic of light-speed measurement. Einstein's second postulate, the constancy of light speed independently of source motion, is one of the features of modern physics most profoundly baffling to native intuition. It is elucidated in invariant neo-Hertzian analysis by the combination of length invariance and proper-time measurement of "time," whereby it arises as an artifact of speed *measurement* with clocks uncorrected for environmental influences. (Corrected clocks are needed in order to *measure* the light-slowing produced by detector motion and thus to expose the underlying physics.) In Einstein's theory the same thing is not elucidated; it is postulated … and its "explanation" is allowed to depend on a predicted but unobserved anisotropic spatial contortion (the Lorentz contraction). In both theories the observable facts of light behavior are predicted to be exactly the same. So, crucial experiments are not necessarily to be found on every bush. Often the most disparate theories can map onto much the same set of observations. This is why it is vainglorious ever to boast of the successes of theory.

VI. SUMMARY

I have assembled some unconventional postulates and definitions, covering much of the core of contemporary theoretical physics, not with the idea that physics should be axiomatized, nor with the intention of providing a complete set of inputs to any physical theory, but to bring out the main points of distinction that identify the paradigm here proposed and to facilitate checking them for mutual consistency. Critics are reminded that to judge any new paradigm relative to the presuppositions of an old one is logically impermissible. The best way to defeat this particular upstart is not to blow it down with hot air or ignore it to death (the traditional cheap and simple scholastic methods) but to do the cheap and simple VLBI *experiment* identified here as crucial.

To review: Motivations to seek approaches alternative to the *status quo* include

- The Lorentz transformation's first-order description of inertial motion is indefensible. It lacks the support of either plausibility or empiricism.
- Spacetime symmetry has its sole basis not in physical reality but in a parametric deficiency of Maxwell's equations, whereby those equations lack means of acknowledging the field detector's relative motion or even its existence.
- Covariance is an inferior simulacrum of invariance. Its dependence on symbol redefinition disqualifies it from describing physical reality. Its use is as a toy of mathematicians.
- Measured longitudinal contraction of objects in relative motion, as well as the alleged physical invariance of an operationally undefined "proper space interval," are fictions unsupported by plausibility or empiricism.
- Speed-*c* retarded action of forces is without empirical support, as are violations of Newton's third law and related undemonstrated marvels claimed by the Maxwell-Lorentz-Einstein combination-in-restraint-of-progress. If anything physical were able to put the quietus on these figments, quantum non-locality would do it.

For over a century a workable escape from all these difficulties has been available to physicists. The problem of finding a formal first-order *invariant* electromagnetism was solved by Hertz well before 1900. It required only replacement of Maxwell's partial time derivatives by total time derivatives, plus some touching-up of the field-source term, to make the field equations Galilean invariant. That eliminated the need to play games with physical inertiality. The small portion of Einstein's special theory worth saving, embodied in Eq. (13), enables proper time to be recognized as the key to higher-order description in both electromagnetism (proper time of the field detector) and mechanics (proper time of the point particle). Applying these perceptions or prejudices, we arrive at the invariant field equations of vacuum electromagnetism, Eqs. (10), and also derive the basic equations of one-body classical (16) and quantum (17) mechanics (in both of which t is to be replaced by t_0, to achieve invariance and cope with the many-body problem).

In order to take a decisive step toward simplicity in refining our understanding of "time," we must recognize that Einstein's view of proper time as the ultimate quantifier of chronometry is needlessly limiting. Proper time works fine as long as one's interest is confined to the aging rates of individual particles. But, if one seeks dynamical descriptions of many-body collectives, a fundamentally simpler theme is needed. For such a purpose it is advantageous to exploit the exactness of the "frame time" differential

– mathematically by applying the Pfaffian integrating factor γ, physically by taking a tip from the GPS engineers: Instead of supposing that time itself, the over-arching concept, is to be assigned physical qualities (*i.e.*, that time possesses a character of physicality affected by environmental changes), as Einstein did, the thing to do is to *compensate* all environmental effects [*e.g.*, by exploiting known laws such as (13)] so that they cease to disturb the uniform flow of a notional "time." In this way time is deprived of all physical attributes, so that it becomes simply a passive descriptor – a bookkeeping device for labeling events – not itself an active participant in the physics. Only through such temporal neutrality can a fully objective view of the physics itself be obtained. To endow "time" with a physical coloration is to color all the rest of physics. The result of eliminating every form of coloration is here termed *collective time* t_0 (CT), a generalized type of frame time patterned on GPS time and agreed upon by observers in arbitrary states of motion. (In particular, CT can employ the same conventions as does frame time for distant clock synchronization.) Having lost all responsiveness to environment, CT resembles Newton's "absolute, true, and mathematical time" in that it, "without reference to anything external, flows uniformly." And it is invariant, modulo a units multiplier, under inertial transformations. However, it is not "absolute," inasmuch as (a) it obeys a relativity principle, (b) it lacks any objective referent in the external world, and (c) its flow rate is subject to no absolute determination, but varies with the choice of time unit and Master Clock's inertial (and gravity) state. GPS experience provides daily evidence of the practical usefulness of CT for the description of many-body motions.

CT allows simplest description not only of many-body motions but, more importantly, of many-body *interactions* via instant action on hyperplanes of constant CT, governed by the instant action-reaction balance prescribed by Newton's third law. If CT is viewed as non-physical, then this instant action must equally be considered non-physical – nevertheless as immensely *useful* to the analyst, who is less concerned with the (hypothetical) ontological truth of his methods than with their ability to yield right answers. When t_0 is substituted for t in Eqs. (1), (2), the resulting neo-Galilean transformations describe inertial motions to all orders of approximation … and Galilean velocity addition holds when velocity is measured by CT clocks. [Thus, applying d/dt_0 to (1) modified in this way, we get $d\mathbf{r}'/dt_0 = d\mathbf{r}/dt_0 - \mathbf{v}$.] CT is clearly easiest for the analyst (of dynamical motions) to work with, but no implication is intended here that it is the only kind of time useful to the physicist. On the contrary, proper time will be needed unavoidably for describing single-particle aging. Proper time of the individual particle can always be evaluated from a knowledge of CT by a formal process of clock de-compensation (reversal of the compensation procedure used to define CT). One just needs *for each variably-moving particle* to keep a record in memory of how the clock compensations continuously defining CT were done. Then the de-compensation is carried out (apart from allowance for gravity changes – see Chapter 8 of Ref.[3]) for the particle at analytically-representable position $r = r(t_0)$ by integration, using (20),

$$\tau = \int d\tau = \int \gamma_0^{-1} dt_0 = \int \sqrt{1 - \left(dr/dt_0\right)^2 / c^2}\, dt_0 \,. \tag{29}$$

If all velocities are sufficiently small, the distinction between τ and t_0 can be ignored.

It may be worthwhile to add a general observation about alternative theories in physics. There is a tenet of belief, propagated from generation to generation within the halls of higher learning, that alternative theories are received with open-mindedness and weighed according to their merits. In truth, merit is virtually useless as a sieving criterion … its place is in legendry, its role retrodictive-congratulatory. Alas, physicists welcome only innovations originating with the devils they know. That is human nature. The merit system barely qualifies as a joke. Most physicists would not tip their hats to raw merit if they met it in the road. They recognize only the kind well-cooked by the praise of their esteemed colleagues. Therein lies the central fallacy of the "peer review" system. But the trouble strikes much deeper, in that it decisively affects what happens to alternative theories after publication as well as before. Direct editorial power exertion (censorship, suppression) is only a metaphor for the real problem – which is the censorial impulse imbued in all hearts and minds by a higher education. Professional physicists possess such a plenitude of knowledge that they retain little curiosity … knowing so much, they feel no need to learn. It ain't necessarily so, that the truth shall make you free; it is more likely to make you certain, a form of slavery. That's the story of organized religion in a nutshell. Today, established physics has become a variety of organized religion. Is there any solution? No, not for a thousand years. History gives proof: It took that long to rid physics of Ptolemy's astronomy – the mesmerism of the perfect circle, sans beginning, sans end, *so beautiful it has to be right.* Where have we heard that in our own day? Is there an echo in this place?

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