Collective Time

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Universal invariance is shown to offer a plausible alternative to special relativity's conceptions of universal covariance, four-vectors, spacetime symmetry, etc. This alternative, supported by a conception of time similar to Newton's (here termed "Collective Time" and patterned on GPS time) provides a mathematical basis particularly helpful in analyzing the many-body problem. Both particle mechanics and electromagnetism fit with this radically new way of formulating a relativistic description. A crucial experiment is advocated, requiring accurate measurement of stellar aberration to second order by means of the VLBI system.

1. Introduction

The Global Positioning System (GPS) successfully employs a method of timekeeping that can readily be generalized to provide physics with a universal "frame time" that (unlike Einstein's version of frame time) has properties of invariance under inertial transformations, signifying compatibility with a relativity principle, as well as possession of an exact differential. These attributes make it particularly useful for treating distant simultaneity, the many-body problem, and extended structures of the sort with which special relativity theory (SRT) has had great difficulty (to judge by the numerous "paradoxes" that keep turning up). I have given this new type of invariant frame time the name Collective Time, and will here describe some of the properties that reveal its usefulness.

Let us begin with GPS time, which furnishes the model for Collective Time. The GPS clocks may be in any arbitrary state of motion. If left to run without correction, they would measure Einstein's proper time τ, and thus would run at different rates when in different states of motion. Instead, each GPS clock is corrected, before being launched into orbit, so that all run at the same rate. This correction takes into account both the effect of motion change and the effect of gravity change on clock running rates, so that the rate variabilities produced by both these environmental effects are nullified or canceled out.

Since this correction, as I say, involves changing the running rates of clocks, the resulting GPS clocks are not Einstein clocks and do not fit with SRT. One can see this at once from the fact that GPS clocks will not in general measure light speed as having the numerical value *c*. The only clocks that measure c are (uncorrected) Einstein clocks, which by definition always tell proper time, regardless of environment, as long as their motions are inertial. (Frame-time clocks in SRT are a special class of proper-time clocks that share a state of inertial motion. Never in SRT is the running rate of any clock tampered with to alter its "natural" proper-time running rate.) A clock that runs at a different rate from its proper-time rate must measure a different light speed, and GPS clocks in general have had their running rates deliberately tampered with. This is true because in any given light-speed measuring apparatus, when everything else except the clock rate stays the same, a change in the clock rate must alter the ratio of measured length to measured elapsed time – hence the quotient, being *c* for Einstein clocks, is necessarily not-*c* for GPS clocks. Consequently, the latter cannot "exist" in SRT because they violate a postulate of the theory. GPS clocks are a total impossibility, inadmissible to SRT, despite all you have been told by SRT's devotees about how GPS timekeeping conforms to and confirms SRT. The supporters of the latter theory have great difficulty recognizing that the GPS is a working, well-engineered system in plain violation of one of SRT's basic postulates.

The foregoing assumes that the actual behavior of light is not in any way altered by changing the state of motion of the measuring apparatus. Quantum mechanics might make one suspicious of such an assumption, in view of the fact that light propagation is a quintessentially quantum process. I was misled on this point when I wrote my 2006 book [1]. On the assumption just mentioned, I predicted there that a GPS (corrected) clock in orbit would measure light speed *c*, and a proper-time (Einstein) clock in orbit would consequently measure not-*c*. I have subsequently retracted that prediction, because it fails to take into account an effect on light speed predicted by my own theorizing. Thus the first three chapters of my book [1] were devoted to developing a Galilean invariant alternative to Maxwell's electromagnetism, which I attributed to Heinrich Hertz. I went on to assure invariance by introducing an invariant time parameter τ_d, which was the proper time of the field detector. In Maxwell's equations the partial time derivatives were replaced by invariant total time derivatives with respect to τ_d. Hence the wave equation became $\nabla^2\vec{E}-\frac{1}{c^2}\frac{d^2\vec{E}}{d\tau_d^2}=0$, with wave-speed solution (when time is measured as the proper time of a clock co-moving with the field detector)

$$u_\tau = \frac{\omega}{k} = \pm c \tag{1}$$

Several significant departures of such neo-Hertzian theory from Maxwell's formulation were demonstrated[1]. An example was that when the wave equation is re-expressed in terms of laboratory time a phase velocity dependent on v_d is predicted, where v_d is the detector or "sink" velocity with respect to the inertial observer's frame or his field point at rest in that frame. [The relationship between frame time and proper time total derivatives needed to prove this is given by Eq. (10b), below.] The appearance of a sink velocity parameter to match the source velocity explicitly described by Maxwell's field equations demonstrates the superiority of neo-Hertzian over Maxwellian theory in respect to ability to describe the known physical attribute of source-sink reciprocity.

Specifically, the predicted phase velocity (light speed), measured in terms of frame time, was found to be

$$u = \sqrt{c^2 - v_d^2} + \frac{\vec{k}}{k}\cdot\vec{v}_d = c/\gamma_d + \cdots, \tag{2}$$

where the first-order term in $\vec{k}\cdot\vec{v}_d$ must be neglected (for a reason embodied in Potier's principle [1], known in the nineteenth century, and responsible for the first-order non-detectability of an ether wind). The upshot is that, according to neo-Hertzian electromagnetism, light speed is actually physically slowed, when the measuring apparatus is given speed v_d, by a factor $\gamma_d = 1/\sqrt{1-v_d^2/c^2}$, where v_d is light detector speed (in orbit) relative to the observer (at rest on the Earth's surface).

When this anticipated light-slowing effect is taken into account, the predictions I published [1] in 2006 are exactly reversed. That is, I now predict that an Einstein proper-time clock in orbit will measure light speed *c* [in agreement with Eq. (1)], and a GPS clock (which has been corrected to run faster than a proper-time clock) in the same conditions will measure speed $c/\gamma_d < c$. Since this is also what Einstein would predict, the experiment is not crucial, and I am forced to withdraw my claim to the contrary. If I am right, and Hertz, rather than Maxwell, is right about electromagnetism, the measurement of light speed in orbit would not tell us anything not expected on the basis of SRT. Thus the only crucial experiment I have to offer is the other one proposed [1] in 2006, namely, accurate measurement of stellar aberration to second order in v/c, by means of the Very Long Baseline Interferometry (VLBI) system. That, I am convinced, should be definitive.

2. Collective Time

In practice the GPS is confined to orbital motions of its clocks, usually at roughly constant heights and gravity potentials. This makes it feasible to determine the necessary approximate running rate corrections in advance of launching the satellites into orbit. When such anticipatory rate alterations are made to a GPS clock while still at rest on the Earth's surface, the clock, so altered (speeded-up), obviously cannot measure light speed c there. As we have just seen, when the clock is placed in a new (orbital) environment, two distinct types of physical effects are anticipated: (1) Clock running-rate effects occur (slowing due to motion, speeding-up due to Earth's gravity decrease). (2) The neo-Hertzian prediction is that the actual light speed will decrease, so that the orbiting GPS clock will measure light speed slowed by a γ-factor. This light-speed slowing is a separate effect from the clock running-rate slowing due to motion, which also occurs. The corrected GPS clock, when placed in orbit, will measure by Eq. (2) light speed c/γ, neglecting gravity. This implies, as noted above, that an uncorrected (slower-running, hence measuring fewer seconds between any two events) proper-time clock, in the same physical conditions of inertial motion, will measure light speed c, as called for by Eq. (1). Relativists interpret this famous constancy attribute as a (postulated, rather mysterious, fundamentally unexplained) stability feature of physical light speed; but I see it as a compensation of clock-rate slowing by physical light-speed slowing, each by a γ-factor, and both associated with a change of clock motion state.

Let us quantify the GPS corrections. The compensation factor *f* by which a clock's running rate must be increased to cancel its proper-time slowing due to motion at speed v (relative to an initial inertial system *S* serving as fiducial referent) is

$$f = \frac{d\tau}{dt_0} = \frac{1}{\gamma} = \sqrt{1-(v/c)^2} \tag{3a}$$

where t_0 is a variety of frame time to be discussed presently. The factor *f* is applied in the following way to compensate an atomic clock so as to speed up its running rate: If N_0 is the number of atomic oscillations per second used to define the second of time when the clock is running at its "natural" or proper-time rate, then $N_0' = f N_0$ is the corrected running rate of the clock, based on redefining the "second" as N_0' oscillations. Since $f<1$, this decrease in number of oscillations per defined "second" accomplishes an increase in the running rate of the clock, meaning increasing by a γ-factor the number of (shortened) "seconds" it counts between any two events occurring at the clock.

Experience with the GPS confirms Eq. (3a) only to the order $(v/c)^2$. There are many ways (on the side of theory) to proceed with higher-order developments capable of compensating for gravity as well as for motional effects. A typical one, which I happen to endorse, is the following: The quantity γ can be expressed in terms of the mechanical energy (rest plus kinetic energy), associated with mass m_0, by means of the well-known formula

$$E_{mech} = \frac{m_0c^2}{\sqrt{1-(v/c)^2}} = m_0c^2\gamma \tag{3b}$$

or

$$\frac{1}{\gamma} = \frac{m_0c^2}{E_{mech}}. \tag{3c}$$

Now we recognize that such "mechanical" energy could also include the gravitational potential energy $V = m_0\Phi$ of the same mass m_0. Thus we are led to generalize plausibly by making the successive replacements

$$f \to \frac{1}{\gamma} \to \frac{m_0c^2}{E_{total}} = \frac{m_0c^2}{E_{mech}+|V|} \to \frac{m_0c^2}{m_0c^2\gamma - m_0\Phi} = \frac{1}{\gamma - \Phi/c^2}. \tag{4}$$

Observe that m_0 has canceled. In (4) the sign of V is chosen to ensure that total energy E_{total} is a definitely positive quantity (in order that *f* be assured of being positive). Φ is assumed to be non-positive, as in Newtonian mechanics. (For instance, $\Phi = -GM/r$ for the gravity potential at distance *r* from a point mass *M*.) The first-order [in $(v/c)^2$] approximation to (4) is

$$f = \frac{1}{1+v^2/2c^2 - \Delta\Phi/c^2+\cdots} = 1 - \frac{v^2}{2c^2} + \frac{\Delta\Phi}{c^2} + \cdots \tag{5}$$

where $\Delta\Phi = -\frac{GM}{r} + \frac{GM}{R}$, the change of potential associated with transfer of the clock from an initial separation *R* from the mass center *M* to a (greater) final separation *r*, has been substituted for

Φ (to avoid having to fix an arbitrary gauge for the potential). Similarly, "v" in (5) is the change of velocity effected by putting the clock in orbit. This first-order expression (5) is known to be valid for the GPS, with the understanding that M is the mass and R the radius of the Earth and G is Newton's universal gravitational constant. The higher-order allegation, Eq. (4), is speculative and not in agreement with various formulas to be found in the literature. It is just my best guess. I doubt that there is a true "consensus" about any of the rival formulas.

Fortunately, the exact higher-order formula is not very important. What matters is that some formula can be found that will "adequately" describe the clock-rate compensation factor f needed to correct any environmental influences that may be discovered. Eq. (4) treats explicitly two influences on clock rate, motion and gravity. If clock rate research in the future turns up other influences, we may similarly suppose them to be "adequately" compensated. Moreover, in applying Eq. (4) or any other expression for f, we must suppose that, as time passes, any changes of the relevant physical factors (motion, gravity, etc.) in the clock's vicinity are continually compensated for each clock, so that all clocks stay in synchronism at all times. In other words the definition of the "second," given for each clock by $N_0' = f N_0$, must be continually altered in a manner independent of the other clocks, so that every clock measures the same number of "seconds" between any two events. Thus f is in general a function of time, and a function evaluated with different numerical parameter values for each clock of an Einsteinian "clock gas," the values being descriptive at all times of each clock's unique environmental conditions. It seems likely that the quantity f^{-1} serves as a generalization of the quantity γ in our previous discussion [just above Eq. (3a)] of light-speed constancy via compensation of clock-rate changes by light-speed changes. But this needs empirical study.

If we suppose space to be filled with a clock gas, the individual members of which are in arbitrary states of motion, then the fact that all measure the same number of "seconds" between any two events means that they all "tell time" at the same rate. But what shall we say about that rate? We need some way of assuring ourselves that the rate of telling "seconds" is uniform. This we may accomplish by placing one clock in a state of Newtonian inertial motion and designating it as Master Clock, with which all "slave" clocks are compensated so as to keep them constantly in step. I emphasize Newtonian inertial motion, meaning uniform straight-line motion at constant or zero gravity conditions. (If the straight-line motion causes the Master Clock to experience variable gravity conditions, those gravity effects are to be compensated out, so that this Master Clock measures seconds ("runs") at a uniform rate. Einsteinian (General Relativistic) inertial motion, represented by free fall in a gravity field, is not straight-line motion, and so is excluded from allowed motions of the Master Clock.

Naturally, the Master Clock could be a notional one – and is in fact purely notional in the case of the GPS, where it is imagined to be at rest on the axis of a non-rotating Earth. (The Earth's orbital departures from a straight line are ignored, because of the extended time scale on which they occur. Even more so, for the motional curvature of the solar system's barycenter.) The state of motion of the Master Clock may further be considered a fiducial state, with reference to which all "velocities" v are reckoned. In other words, it defines the "zero kinetic energy" state. This arbitrarily fixes the velocity gauge.

It will be recognized that the Newtonian inertial system S in which the Master Clock is at rest can be called a "frame," and that the Master Clock consequently tells the "frame time" of S. I shall call this Collective Time (CT) and designate it as t_0. The other ("slave") clocks of the clock gas associated with this Master Clock in general do not share the latter's state of motion. That is, they can move (all differently and arbitrarily) in S, but must be individually compensated to keep them all telling time in step with the Master. So, clearly, CT is a sort of "frame time" associated with S; but not Einsteinian frame time, which requires all clocks to be at rest in S and all to run at the identical "natural" proper-time rate.

Thus Einstein's approach is to let clocks, strictly on their own, decide what "time" means – in other words, never to tamper with what (idealized) clocks themselves want to do. The GPS, in contrast, comes much closer to what Newton sought to make "time" mean: When and where the environment affects clock-running, that influence is deliberately cancelled (by tampering with the clock running rate) in order to ensure a uniform and universal rate of time-telling (measurement of "seconds"), just as Newton had it. Restoring to physics a Newton-like form of time restores many of the amenities physicists had to give up in order to conform to the Einstein model. Thus, things like "center of mass" of a collection of mass particles, "rigid body," etc., and other simplifications of many-body description, which had to be banished from Einsteinian physics, are restored through collective time-keeping.

How does it happen that CT simplifies many-body description? This comes about principally because the CT differential dt_0 is exact. By contrast, the differential $d\tau$ of proper time is inexact. It is precisely Einstein's insistence that all clocks run at their proper-time rates that forces relativists to use a different time parameter for each individual particle, thereby immensely complicating the description of the motion of more than one body. Indeed, the many-body problem in SRT is something most textbook writers prefer not to discuss at all. When we have, instead of Einstein's presuppositions, a set of mutually synchronized clocks, each of which exhibits co-motion with one of a set of many arbitrarily-moving bodies, we have a way of systematically "time"-tabulating events occurring at those bodies, in terms of a shared time-measuring parameter. Thus we attain a simplified many-body description completely inaccessible to Einstein and basically of no more complexity than that of classical mechanics. A side benefit is restoration of the Galilean transformation to describe inertial motion. Let us see how this works.

3. Inertial Transformations

The Lorentz transformation, supposed in SRT to describe inertial motions in the absence of gravity, has a time part that is approximated to first order in v/c by

$$t' = t - vx / c^2 . \qquad (6)$$

The Galilean transformation, in contrast, replaces this time transformation with the exact (to all orders) invariance assertion

$$t' = t \tag{7}$$

Which is physically correct? It really is a question of physics, although, oddly enough, no physicist approaches it in that spirit. The modern physicist, instructed by generations of teachers mentally paralyzed under the spell of consensus, subscribes without question to the dogma of "universal covariance," so, instead of looking outward to the physical world for validation of (6) he looks inward to the mathematical world, with resulting hermetically sealed circularity of reasoning, if any.

The mathematicians who have taken over physics consider (6) to be (at first order the time part of) the definition of "inertial system." And, of course, definitions are the mathematicians' own mental creations, so any challenge would amount to disputing their constitutional right to free exercise of the human imagination. ("Die Gedanken sind frei.") Glancing back over a century of relativism, we can say that not once, to as many as one relativist, has it occurred to consult nature directly regarding the validity of (6). Does a physically real clock in uniform inertial motion spontaneously shift its phase as it is moved to distant x-values? Is that what we want to mean by inertiality? It seems an incredible proposition … yet neither scientific curiosity nor the ancient defining tradition of empiricism in physics has acted to challenge the faith conferred by purely theoretical rumination. Thus physics is no longer an empirical science, and relativism can take the credit for pioneering that evolution.

Actually, Eq. (6) does not withstand the most cursory attempt at empirical verification. That equation says that a spontaneous time shift of clock reading by an amount $\Delta t = v\Delta x / c^2$ will occur if the clock is relocated to a large distance Δx from the observer, or if the clock is permanently at rest on the x-axis at distance Δx in a "Lorentz inertial frame," the origin of which is located near the Earth. That is, co-moving synchronized clocks are progressively desynchronized by a mere increase of their separation distance. This happens as a result of the "nature of time," or maybe the nature of fiddlesticks. If there is any physical mechanism to account for it, it must amount to a self-resetting of clock phases. It sounds like magic.

The universe offers an adequate "laboratory" to test this bizarre hypothesis. A fractional change of clock-time reading $\Delta t / T$, occurring in time T, implies an equivalent fractional change of frequency, $\Delta f / f = \Delta t / T$, of any oscillatory phenomenon taking place at distance Δx during the time interval Δt. The Earth's orbital motion causes it to be continually switching inertial systems in which it is instantaneously at rest. Consequently, the relative velocity "v" of a chosen uniformly-moving distant light source (with respect to the Earth) changes its sign every $T =$ six months, so $\Delta t = v\Delta x / c^2$ changes sign with the same period. A spectral line shift of a given atomic resonance line produced by such a distant light source [changed from its frequency in the earthly laboratory to a frequency "Lorentz-shifted" by the fraction $\Delta f / f = \Delta t /$(six months)] should be detectable, provided the Lorentz transformation has anything to do with physics.

Of course, it doesn't, since no such effect has been reported by astronomers. When numbers are put in, it is found that a distance Δx of 5000 light years suffices to produce during an elapsed time interval of six months a fractional frequency shift of 100%, corresponding to the relative velocity sign reversal $\pm v$. Since many light sources visible to the astronomer are located at far greater distances, it is clear that we are not dealing with a small effect. But we are dealing with a ludicrous one, that does not in fact exist. There is no mistaking this hypothetical Lorentz shift for the "expanding universe" (Doppler) frequency shift, because the latter does not show an annual periodicity – although it must show a small annual modulation due to Earth's orbiting.

Needless to say, Eq. (7) passes the empirical test just described. No location-dependent frequency shift of spectral lines is predicted, just as none is observed, regardless of the distance of the light source. This means that nowhere is there a magical self-resetting of clocks of the sort demanded by universal Lorentz covariance. What are we to think, then, of generations of savants, gracing numberless departments of physics in every corner of the Earth, who (as in all instances of science by "consensus") have never thought critically about this nor voiced a caveat? Dare a sober person rely on any of the teachings of such a physics?

4. The Relativity Principle

The principle of relativity, valid in Newtonian physics, as in SRT, asserts that the "laws of nature," as expressed by suitable mathematical equalities, are invariant under changes of inertial reference system. We should expect this principle to retain its validity for any legitimate definition of time, including the present CT. Of course, "inertial reference frame" demands a physically valid concept of inertiality. Thus it depends on what mathematical transformation (Galilean or Lorentz) one chooses to associate with the physics. In the present treatment the Galilean transformation is assumed (with respect to CT, in the absence of uncompensated gravity or the presence of compensated gravity) for reasons already suggested.

Each of a plurality of notional space-filling CT clock "systems," patterned on the GPS, and defined by synchronism with a Master Clock that is in one of the infinitely-many possible states of uniform Newtonian inertial motion, has its own characteristic rate of clock-running. For this reason one might expect the rate of physical happenings to vary with choice of the Master Clock's inertial system and thus to violate the relativity principle. This, however, is not the case, as can be seen in several ways.

First, the "laws of nature" do not depend on the running rate of clocks. A clock may measure many or few "seconds" between two events, but that will alter neither the events nor their "structural" relationship. Secondly, and equivalently, the laws of nature do not depend on the definition of the time unit, the "second." (Newton was the first to call attention to this freedom of units choice, through his Principle of Similitude [2].) Thirdly, replacing t by $t' = \alpha t$ in any of the formal equations of physics, expressing "laws of nature," merely affects the definition of units. For example, if this replacement is made in the relativistic law of particle motion,

$$\vec{F}_{lab} = \frac{d}{dt}\left(m_0 \gamma \frac{d\vec{r}}{dt} \right) \tag{8}$$

the effect is merely to multiply the laboratory force $\vec{F}_{lab}$ by the constant α^2; so, with a force units adjustment, the law remains invariant.

If we introduce a two-stage correction of CT clocks, such that the first stage brings them all into synchronism with some Master Clock in any arbitrary state of inertial motion, and the second stage brings that Master Clock (mimicked by all its slave clocks) into synchronism with some other (fiducial) Master Clock, whose rate we choose arbitrarily to view as "correct" for the entire universe or for all states of motion, or to match some favored system of time units; then application of this two-stage procedure achieves a genuine invariance or universality of "absolute" timekeeping, matched to any chosen predilections. Thus there exists a version of CT that can be identified precisely with Newton's absolute time. This variety of CT obeys a fortiori a relativity principle.

We shall herein denote CT, of whatever variety, by the parameter t_0. In treating the many-body problem it proves immensely useful that the CT time parameter possesses a related property; namely, that dt_0 is an exact differential. The reason is that quantities possessing exact differentials can serve as coordinates in geometrical representations, whereas inexact differentials, such as that of proper time, $d\tau$, are not generally useful as coordinates. This failure of inexact differentials can be recognized, for instance, from the fact that a different numerical value must be assigned to the proper time of each individual particle, when different particles move differently. As a result of this multiplicity of parameterization, no single "space" can permanently contain more than a single particle, and the attempt to give a geometrical representation to a collection of particles, not all in the same state of motion, must fail. In contrast, the classical conception of "frame time" serves very well for many-body description and geometrical representation, because the differential of frame time is exact and all particles of a collective can share the same numerical value of frame time. (This is why Minkowski space "works." That it works mathematically does not mean, however, that it has anything to do with physics.) We have already noted that CT is a variety of frame time (most conveniently associated with the inertial frame of the Master Clock); hence, dt_0 is an exact differential, and CT provides a basis for geometrical representation, or for consistent parameterization, of many-body collectives.

Verification of the exactness of dt_0 proceeds from the definition of proper time,

$$d\tau^2 = dt_0^2 - dr^2 / c^2 = \text{ invariant,} \tag{9}$$

which holds because t_0 is a variety of frame time. Hence Eq. (9), with t_0 so interpreted, is just a variant of Einstein's original definition of τ. It implies the Pfaffian form[3]

$$dt_0 = \gamma_0 d\tau, \quad \gamma_0 = 1 / \sqrt{1-\left(dr / dt_0\right)^2 / c^2}\ , \tag{10a}$$

wherein γ_0 plays the role of an integrating factor to render dt_0 exact, $d\tau$ being recognized as inexact. In this connection a useful alternative way of writing (10a) is

$$\frac{d}{d\tau} = \gamma_0 \frac{d}{dt_0}\, . \tag{10b}$$

The integrated form of (10a),

$$\tau = \int \left(1/\gamma_0\right) dt_0\ , \tag{10c}$$

provides a way of calculating the elapsed proper time interval ("aging") between any two events on the trajectory of a chosen particle, the timekeeping of which is recorded by one or more CT clocks.

The geometrical advantage of CT is that it is shared among all particles of the universe, so that a single 3-space representation, $\left(x_i(t_0), y_i(t_0), z_i(t_0)\right)$, $i = 1, 2, \cdots$, or a 4-space representation, $\left(x_i(t_0), y_i(t_0), z_i(t_0), t_0\right)$, can accommodate the entirety of physical description. These representations, of course, also fit with 3- and 4-space Euclidean geometries. CT's other advantages, as we have noted, include obedience to a relativity principle and possession of an exact differential. Einstein's proper time, in contrast, has no capability of sharing. In practice, Einstein must fall back on frame time to accommodate many bodies. And his version of frame time, although it has an exact differential dt, does not obey a relativity principle (ct being the fourth component of a four-vector), so his description is permanently crippled. The many paradoxes[4] of SRT, associated in the most unanswerable cases with the description of extended structures, have their origin in these facts, as well as in the attempt to base "world structure" on the falsely-identified "spatial invariant," $d\sigma = icd\tau$. The latter is an imaginary number, if $d\tau$ is real; hence is unqualified to represent anything real, and (unlike $d\tau$) lacks any possibility of operational definition. The present work defines the spatial invariant of kinematics to be length, as operationally defined by a tangible object, a meter stick.

Because t_0 has some of the features of an absolute time, the time part of the Galilean transformation, Eq. (7), together with the space part, provides the appropriate representation of the physical inertial transformation,

$$\vec{r}\,' = \vec{r} - \vec{v}t_0, \quad t_0' = t_0\ . \tag{11}$$

It is this transformation, not that of Lorentz, under which the equations of physics, expressing the "laws of nature," exhibit universal invariance. (Contrast with universal covariance[5].)

Proof of invariance of the mechanical equation of motion. Let t_0 be written for t in Eq. (8), and let that equation be multiplied by γ_0. The result [by Eq. (10b)] is

$$\gamma_0 \vec{F}_{lab} = \vec{F}_{inv} = \gamma_0 \frac{d}{dt_0}\left(m_0 \gamma_0 \frac{d}{dt_0}\vec{r}\right) = \frac{d}{d\tau}\left(m_0 \frac{d}{d\tau}\vec{r}\right) \tag{12}$$

This form is obviously invariant under the Galilean transformation (11), provided we recognize (a) that particle proper time τ is invariant under physical inertial transformations, (b) that the Galilean transformations (11) describe such physical transformations, (c) that the invariance of length, implicit in Eq. (11), is acknowledged to be valid physics (the Lorentz contraction never having been observed), (d) that $\gamma_0 \vec{F}_{lab} = \vec{F}_{inv}$ defines an "invariant force," patterned on the Minkowski force of SRT, but referring to the Galilean transformation. [The physics of this is that a proper-time clock co-moving with the mass particle m_0, whose motion is described by (12), runs at a rate differing from that of the laboratory clock by the factor γ_0. That time-factor directly affects the definition of force acting in the laboratory vs. force acting in a system co-moving with the particle.]

Similarly the Galilean invariance of the neo-Hertzian equations of electromagnetism (unlike the Maxwellian equations) can be proven[5]. In fact, there is no reason to doubt that all valid equations of physics, expressing "laws of nature," can be represented in Galilean invariant form by the use of CT. Such an hypothesis will strike relativists as mere whistling in the dark, but it constitutes genuine physics, inasmuch as it allows identification of a crucial experiment[1,5]. The latter, as previously mentioned, calls for the accurate measurement of stellar aberration by means of the VLBI system. Einstein in 1905 made a definite prediction of this phenomenon at second order in (v/c), where v is Earth's orbital speed. The neo-Hertzian electromagnetic theory denies that prediction, claiming instead that only third-order departures from Bradley (first-order) aberration occur. Thus a definite challenge has been issued and a specific alternative theory proposed. The usual maneuver by which relativists dodge the menace of new thoughts, viz., that SRT is the only player in the game, is no longer valid.

5. Conclusion

Optimism is an occupational hazard of innovators. Einstein, one of the truly innovative thinkers of the past century, well illustrates the point. For instance, optimism guided him to the idea of "universal covariance," which amounts to the supposition that certain formal peculiarities of Maxwell's equations color all physics. In reaching this conclusion, he did not examine all physics, but made a grand conjectural leap of the imagination. Similar imaginative leaps led him to Eq. (9), his successful definition of the invariant "proper time" interval, and also to various popular but unsuccessful ideas (as I see them) such as spacetime symmetry and his definition of the "proper space" interval. The allegation of invariance of the latter gave rise to a completely distorted "world structural" view, which has proven the source of endless paradoxes[4] and fruitless apologetics. Einstein's optimism carried him and his followers by successive leaps from one lily-pad of conjecture to another. Some, but not all, of those lily-pads were sinkers.

My own venture into innovation, amounting to an attempt to build by means of Collective Time a "world structure" that reproduces Einstein's agreements with observation, but avoids numerous unverified aspects of his physics, such as the Lorentz contraction, has also fallen victim to the above-mentioned occupational hazard, optimism. I have spoken of a "universal invariance," designed to play exactly the same role and have the same scope as Einstein's "universal covariance." I can claim no better justification than he did, for I have certainly not studied all laws of nature or equations of physics. Rather, like him, I have sampled[5] the equations of two indicative subjects, mechanics and electromagnetism, and have found that they entirely confirm my views regarding invariance. Having also identified a crucial experiment (VLBI measurement of second-order stellar aberration), I feel I have done all that can be expected of one person. If somebody will perform the experiment, I shall rest easy, whether vindicated or refuted.

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