Commentary on the Work of Thomas E. Phipps, Jr. (1925-2016)

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The following discussion presents a critical survey of the writings of Thomas E. Phipps, Jr. dealing with the two subjects of relativity theory and electrodynamics. It is a challenge to give a suitably comprehensive description of his work in these fields because it is distributed over a huge number of scientific publications. This includes two books [1,2], the second of which appeared in two editions. It is easy to find one unifying principle, however, namely his opposition to Einstein's Special Theory of Relativity (STR) [3]. He was deeply skeptical of its conclusion that two observers in relative motion must each find that the other's clock runs slower than his own (symmetric time dilation). This symmetry principle applies to all measured quantities according to STR, and is the consequence of the Lorentz transformation (LT), which is the cornerstone of Einstein's theory. It bothered Phipps tremendously that there should be such a subjective character for physical measurements (lengths, masses, energies and anything else), and so this STR prediction (Einstein's Symmetry Principle or ESP) is a good point at which to begin this survey.

The LT relates values of elapsed times and distances between two events that are measured by two observers O and O' who are both moving at constant speed and direction. The observers are assumed to move along their mutual x,x' coordinate axis with relative speed v. The LT then gives the following relationship between their respective elapsed times Δt and $\Delta t'$:

$$\Delta t' = \gamma\left(\Delta t - vc^{-2}\Delta x\right) = \gamma\eta^{-1}\Delta t \,. \tag{1}$$

In this equation, Δx is the distance separating the two events that is measured by O and c is the speed of light in free space (299792458 ms^{-1}); $\gamma = \left(1 - v^2c^{-2}\right)^{-0.5}$ and $\eta = \left(1 - vc^{-2}\dfrac{\Delta x}{\Delta t}\right)^{-1}$. Unlike the case with the classical (Galilean) space-time transformation (GT), in which $\Delta t = \Delta t'$, the coordinates of space Δx and time Δt are mixed in the LT. The concept of space-time mixing has become dogma for theoretical physicists and is believed by them to be an essential feature of relativity theory in general. In the present context, the key point is that eq. (1) can be used directly to derive [3,4] the phenomenon of time dilation according to the formula given below:

$$\Delta t' = \frac{\Delta t}{\gamma} \,. \tag{2}$$

The derivation is made from the standpoint of the rest frame of observer O. Because the LT conforms to the Relativity Principle (RP), it follows that a corresponding equality must also hold when the tables are reversed and the comparison of elapsed times is determined from the standpoint of the other observer (O'). Formally, this result is obtained by reversing the primed and unprimed subscripts and changing the sign of v, a procedure referred to as Galilean Inversion. The LT therefore also leads to the relationship given below:

$$\Delta t = \frac{\Delta t'}{\gamma} \tag{3}$$

A useful way to express this result is to point out that in both eqs. (2) and (3), it is the "moving" clock that runs slower. It is easy to show that eq. (3) is not the true inverse of eq. (2), however. Multiplication by γ on both sides of the latter gives as result: $\Delta t = \gamma\Delta t'$, not eq. (3). Phipps railed against this inconsistency in STR for decades and he was certainly not the only one who held this position. The problem is that mainstream physics insisted, and continues to insist to the present day, that anything that can be derived from the LT must be correct. Therefore, if you want to be a member in good standing in the theoretical physics community, you must swear that both eqs. (2) and (3) are correct at the same time.

The accepted way to verify a theory is to demonstrate that it holds in experiment, and more importantly, that it is never contradicted by one. An obvious way to test whether symmetric time dilation, and therefore the ESP in general, is correct is to have observers exchange light signals emitted from a standard source. The frequency ν emitted or absorbed by a light source serves as a standard clock in the proposed experiment. Therefore, according to eqs. (2) and (3), if the light source is moving with speed v relative to the observer, the relationship between the emitted frequency (ν_{em}) and that measured (ν_{obs}) in the observer's rest frame must be [5]:

$$\nu_{obs} = \frac{\nu_{em}}{\gamma}. \tag{4}$$

In other words, the clock in the moving rest frame should run slower than that in the laboratory in which the observer makes his measurement and so he should find a shift to lower frequency (red shift) relative to the standard value.

The first experiment of this kind was performed by Ives and Stilwell in 1938 [6]. The light source consisted of excited hydrogen atoms that were accelerated in the laboratory. Einstein had predicted [3] that there would be a transverse Doppler effect for the emitted radiation. In order to eliminate the conventional first-order Doppler effect, the light source was accelerated in opposite directions with the same speed v. The authors reported that the experiment indeed found that there is time dilation in the rest frame of the light source which is quantitatively consistent with eq. (2), and their result was hailed as a stunning verification of STR. The experiment has since been repeated with much higher accuracy [7], thereby strengthening belief in the validity of the theoretical interpretation.

There are two important aspects of the Ives-Stilwell experiment that need to be kept in mind, however. First, it was only a "one-way" experiment since results are only obtained in the rest frame of the laboratory. Secondly, frequencies are not directly measured, but rather *wavelengths* of the emitted light. Accordingly, the following relationship was found:

$$\lambda_{\mathrm{obs}} = \gamma \lambda_{\mathrm{em}}, \tag{5}$$

i.e. the wavelength λ measured in the laboratory is γ times larger than the standard value.
In order to arrive at the prediction of time dilation, it is necessary to assume that Einstein's postulate for the speed of light holds, and therefore that $\lambda_{\mathrm{obs}} \nu_{\mathrm{obs}} = \lambda_{\mathrm{em}} \nu_{\mathrm{em}} = \mathrm{c}$; the γ factors in eqs. (4) and (5) exactly cancel as a result of this assumption.

Hay et al. [8] devised an experiment over 20 years later that is capable of answering many of the questions about time dilation that were left open by the Ives-Stilwell results. They placed an x-ray source and the corresponding absorber on a rotor at different distances from the axis. For one thing, their method measures light frequencies instead of wavelengths, so time dilation can be demonstrated without making any assumption about light speeds. In addition, the source and absorber can be mounted on the rotor in a way that guarantees that only radiation emitted *transverse* to the direction of the x-ray absorber is detected, thereby effectively removing the existential problem caused by the first-order Doppler effect that was of paramount concern in the Ives-Stilwell study. Hay et al. reported that their experimental data were in complete agreement with STR. They also noted that their results could be successfully interpreted by using Einstein's Equivalence Principle (EP) by relating the effects of kinetic and gravitational acceleration.

The rotor study had another distinct advantage, however; it could serve as a two-way experiment. This can be arranged by interchanging the positions of the source and absorber, which information suffices for a definitive test of whether time dilation is symmetric or not. Hay et al. stated that the expected fractional shift Δν/ν is given by the formula below, which is determined solely on the basis of the EP [9]:

$$\frac{\Delta \nu}{\nu} = 0.5\ \mathrm{c}^{-2} \left(\mathrm{R_a}^2 - \mathrm{R_s}^2 \right) \omega^2, \tag{6}$$

where ω is the rotational frequency of the rotor and R_a and R_s are the respective distances of the absorber and source from the rotor axis. However, the critical question of how eq. (6) is related to eq. (4) of STR is not further discussed in their paper.

A short time later, an analysis of the Hay et al. transverse Doppler experiment was published by Sherwin [10] which did discuss the role of STR explicitly. Parenthetically, Phipps had worked with Sherwin at some point in his career. The address for Sherwin's paper is the University of Illinois in Urbana. Phipps published many papers from his home address, also in Urbana. The fact that Phipps did not have other than his home address to list on his papers caused him considerable difficulty in getting them published in certain venues such as the Cornell archives.

Sherwin pointed out that the result of the transverse Doppler experiment "might be regarded as being trivial" when analyzed in an inertial frame of the light source. From that vantage point all that is found is that the accelerated clock associated with the x-ray absorber is subject to time dilation [11,12], in agreement with eq. (4). Since the absorber clock runs slower, it counts more photons per second than does the clock located in the rest frame of the light source so that a blue shift $\left(\frac{\Delta\nu}{\nu} > 0\right)$ is recorded. This is the result expected from eq. (6) because R_a is greater than R_s in the experiment. Sherwin then goes on to say: "When, however, this problem is analyzed in a reference frame attached to the traveling clock ... the problem is far from simple." What is meant in the context of the rotor experiment is that from the vantage point of the x-ray absorber, the clock associated with the light source runs *faster* than that which is stationary in the absorber's rest frame. This is a clear violation of eq. (4). Sherwin summarizes the situation as follows: "It is the completely unambiguous nature of the result in the 'clock paradox' which is, perhaps, its most unique feature." He continues: "The result is completely unambiguous: One particular clock certainly runs fast, and the other certainly runs slow." One can also see this from eq. (6) itself, since interchanging the positions of the light source and absorber leads to a change in the sign of the frequency shift. At the very least, Sherwin's arguments show that the conclusion of Hay et al. [8] that their experimental results for the transverse Doppler effect are in agreement with STR is not correct; not just oversimplified, but simply false.

One might think that this was the end of belief in symmetric time dilation and a complete vindication for Phipps and his many like-minded colleagues, but that assessment would not be correct. Sherwin was a staunch defender of STR and so he continued with his analysis with the following statement [10]. "By contrast, in experiments involving uniform translation ... the clock rates are ambiguous, that is, the observers in each frame measure the *other* clock to be running slow." In other words, there is a two-tiered interpretation of STR according to Sherwin, a symmetric version holding only for pairs of inertial systems, and the other coming into force for any other situation in which one of the rest frames is being accelerated. It needs to be emphasized, however, that no reference is given for the "experiments involving uniform translation." The reason is simple; there were *no such experiments* up to that point of time. Moreover, there have been none in the succeeding years up to the present day. In short, Sherwin's statement is a fabrication. It was clearly intended to convince the reader that the "ambiguity" totally lacking in the rotor experiments [8,11,12] was routinely observed in other applications of STR.

Two paragraphs later, Sherwin notes that "the effect is uniquely associated with the fact that acceleration has occurred, but it is quantitatively related not to the acceleration, but to the average speed." That conclusion is evident from the relationship [8] given in eq. (6) which states that the frequency shift is completely independent of the acceleration for either clock. This has been verified in time dilation experiments in which the particles have been subjected to extremely large g forces [13]. Consider then the example of the absorber clock in the rotor experiment moving with very high speed relative to the axis so that $\gamma=1000$ in eq. (4), but with *infinitesimally small acceleration.* According to Sherwin's two-tiered interpretation of STR, the clock at the x-ray source should run roughly 1000 times *faster* than the absorber clock under these circumstances. Now apply a minimal force to the absorber so that it moves in a purely translational state. One can now safely apply STR from the viewpoint of the absorber, from which one concludes that the source clock suddenly runs 1000 times *slower* than the absorber clock. Can there really be such a tremendously large change in the relative rates of the two clocks caused only by a miniscule applied force on one of them? One has to be out of his mind to believe this, but that is the inescapable consequence of combining Einstein's EP with STR.

There is another way to consider the behavior of freely translating clocks that can shed further light on this problem, namely with reference to Newton's Laws of Kinematics. His First Law states that an inertial body such as a freely translating clock will continue moving indefinitely with constant speed and direction. It seems reasonable therefore to assume that the properties of the clock, including its rate, will also not change over time. A second such inertial clock may move with a different direction and speed relative to the same origin as the first, but it seems equally plausible that its rate will also remain constant as long as no unbalanced force is applied to it. To believe otherwise is to deny the Law of Causality. The rates of the two clocks may well be different, just as their velocities are not the same, but consistency demands that the *ratio* of the two rates must also have a constant value. One is therefore led to an alternative relationship between the elapsed times of two inertial clocks to those given in eqs. (2) and (3), namely:

$$\Delta t' = \frac{\Delta t}{Q}, \tag{7}$$

where Q is the above ratio of clock rates. It is independent of the relative speed of the two clocks, depending instead on the speeds of each clock relative to some standard rest frame.

The clocks in the rotor experiment are not inertial, but eq. (6) holds in the limit of null acceleration for constant speeds $v_a = R_a\omega$ and $v_s = R_s\omega$, so it is possible to convert the frequency shift formula to one that is directly compatible with eq. (7). By denoting $\nu_s = \nu$ and $\nu_a = \nu + \Delta\nu = \nu'$, one obtains, with a corresponding change in notation for the clock speeds:

$$\frac{\nu_a}{\nu_s} \equiv \frac{\nu'}{\nu} = 1 + 0.5c^{-2}\left(v'^2 - v^2\right) \approx \frac{\gamma(v')}{\gamma(v)}. \tag{8}$$

Frequencies are the inverse periods of the radiation or elapsed times Δt and Δt', so eq. (8) can be reformed into a relationship for elapsed times:

$$\frac{\Delta t'}{\Delta t} = \frac{\gamma(v)}{\gamma(v')}. \tag{9}$$

Comparison with eq. (7) then gives an explicit value for the proportionality constant Q inferred from Newton's First Law, namely

$$Q = \frac{\gamma(v')}{\gamma(v)}. \tag{10}$$

The above two equations are not only consistent with Newton's First Law and the Law of Causality, but also with Einstein's EP. Note, however, that the $0.5\, v^2 c^{-2}$ terms in eq. (8) are replaced by $\gamma(v) - 1$ in each case, thereby allowing eqs. (9) and (10) to be at least potentially applicable for speeds close to the relativistic limit, something that is not at all guaranteed by the EP itself. Because Q is assumed to have a definite constant value, it is clear that the relationship between clock rates implied thereby guarantees the "non-ambiguity" characteristic noted by Sherwin [10].

The RP demands that the inverse of eq. (7) be obtained by Galilean Inversion, with the result:

$$\Delta t = \frac{\Delta t'}{Q'}. \tag{11}$$

Unlike the situation for the STR eqs. (2) and (3), one finds that the corresponding eqs. (7) and (11) are related by a straightforward algebraic operation so long as $Q' = \frac{1}{Q}$. This relationship is made explicit by applying Galilean Inversion to eq. (10):

$$Q' = \frac{\gamma(v)}{\gamma(v')}. \tag{12}$$

The measurement of elapsed times and clock rates becomes *completely objective* in this formulation, unlike the purely subjective approach demanded by the STR version. As a result, it is convenient to look upon the parameter Q as a *conversion factor* between the units of time in the two rest frames. Accordingly, the conversion factor in the reverse direction (Q') is just the reciprocal of that in the forward direction. It is obviously impossible to speak of conversion factors in STR when one is not even sure which of two clocks runs slower.

The erroneous prediction of symmetric ("ambiguous") time dilation was only the tip of the iceberg as far as Phipps was concerned. He concluded that the root cause of the problems with STR is the Lorentz transformation (LT) itself, the cornerstone of Einstein's theory [3]. There are plenty of other examples to cite in this regard. The LT predicts unequivocally that the lengths of objects in a moving rest frame contract by a factor of γ along the radial direction, while those in a parallel direction remain the same (FitzGerald-Lorentz length contraction or FLC). Of course, by virtue of the RP the effect is also claimed to be symmetric. Consider then an experiment in which the speed of light is measured by the observer in the moving rest frame. He measures L for the distance traveled by a light pulse and T for the corresponding elapsed time, and on this basis calculates the speed of light to be $\frac{L}{T} = c$, in agreement with the standard value. He finds exactly the same results independent of the direction in which the light pulse takes. The other observer assumes from the FLC that lengths are shorter in the other rest frame by a factor of γ when the light pulse travels in the radial direction. He therefore concludes that the distance traveled by the light based on his measuring device was only $\frac{L}{\gamma}$. He also assumes from eq. (2) that there is time dilation in the other rest frame, so he concludes that the elapsed time on his clock was γT, i.e. greater than measured in the moving rest frame. Dividing these two values he calculates the speed of light in the moving rest frame to be $\frac{(L/\gamma)}{\gamma T} = \gamma^{-2}\frac{L}{T} = \gamma^{-2}c$, in contradiction to Einstein's light speed postulate [3] which states that the two observers must agree that the speed of light in free space is c independent of the rest frame of the light source.

Combining the FLC and time-dilation predictions of STR along the parallel direction also leads to a contradiction. In this case the FLC states that the two observers agree on the distance traveled by the light pulse. They also must agree on the speed of the pulse, and yet they disagree on the corresponding elapsed time because of time dilation in the "moving" rest frame. This STR contradiction has been referred to as the clock riddle [14]. Phipps [15] has referred to this result as specific proof of the unsuitability of the LT. The result of the clock riddle has sometimes been criticized because it supposedly ignores the fact that a light pulse must travel in a diagonal direction to reach the position in the moving rest frame and therefore will take longer to do so. This position overlooks the fact that the LT states explicitly that the two observers agree on the values of all distances perpendicular to the direction of their relative motion ($\Delta y = \Delta y'$) no matter how they go about measuring their respective values. Sherwin also dealt with this question in his work [10], stating: "Since this effect is observable without dependence either on the propagation properties of light, or upon any measurement operation using meter sticks, it cannot be dismissed as an 'apparent effect' having to do somehow with the processes of determining what happens at distance points." The underlying problem of STR in this regard is that it treats distance, time and velocity as three independent variables. It has a separate relationship for each of them (FLC, time dilation and light-speed constancy), thereby belying the fact that the value of any one of the three is determined unequivocally by the values of the other two.

Probably the most straightforward way to prove that the LT is invalid is to directly compare two of its most well-known consequences for timing measurements. On the one hand, its eq. (1) leads to the inescapable conclusion that events which are simultaneous for one observer *cannot* be so for another who is moving relative to the first. If both v and Δx have non-zero values in this equation, it is impossible for both Δt and $\Delta t'$ to have null values for the same pair of events. As a result, "remote non-simultaneity" has long been a key principle in STR [16]. Accordingly, one observer can find a null time difference ($\Delta t = 0$) while the other measures a non-zero value ($\Delta t' = 0$). However, the STR prediction of time dilation, as has already been discussed at length, demands that both eqs. (2) and (3) hold under all circumstances, i.e. Δt and $\Delta t'$ must always be *strictly proportional* to one another. These two claims clearly do not mesh with one another. Multiplying zero with a non-zero constant such as γ gives a zero result, and so if $\Delta t = 0$, so must $\Delta t'$.

A popular example of remote non-simultaneity involves two lightning flashes striking a moving train. It is discussed in detail by Phipps in one of his books [17]. The LT is used to supposedly prove that a platform observer will not observe the flashes to arrive at the same time at the midpoint of the train even though his counterpart on the train does. Along the way one is asked to believe that the speed of light measured by the platform observer is also not the same at the two ends of the train. What happened to the light-speed postulate? Why doesn't it hold in this case? More directly to the point, if one believes in proportional time dilation ala eqs. (2) and (3), the only possible conclusion is that if the observer on the train measures the same time T for the arrival of the two flashes at its midpoint, then the platform observer will obtain corresponding values of $\frac{T}{\gamma}$ in each case, and therefore agree that the two flashes indeed do occur simultaneously.

Despite the many clear contradictions inherent in the LT, it must be said that Phipps failed in his campaign to eradicate it from theoretical physics during his lifetime. The main reason can be summed up in two words: *Einstein's legacy*. Every graduate physics program worth its salt devotes at least some substantial part of its curriculum to praising the virtues of STR, including first and foremost its reliance on the LT as its centerpiece. When someone espouses a theory, he begins in a real sense to "own" it. It is therefore very painful to his/her self-esteem to have to admit at some point that the theory was actually wrong. More often than not, the reaction to a colleague's attempt to refute such a cherished belief is to become angry at the bearer of the unwelcome news. The mind closes, never to open again.

Nonetheless, one is reminded of the experience with Bell's Inequalities. Einstein had argued strongly against the prevailing probabilistic interpretation of quantum mechanics and had collaborated with Podolsky and Rosen to buttress his position in the form of the EPR Paradox. Bell was able to find a straightforward mathematical argument to show that Einstein was wrong on this point and this criticism ultimately carried the day. However, the belief in the LT seems to be far more embedded in the psyche of the average physicist than to allow it to be overturned by mere logical argumentation. The normal reaction of mainstream journals when a manuscript which calls the legitimacy of the LT into question is submitted to them is to refuse to send it on to competent referees for their evaluation. For example, the journal Science recently rejected one such manuscript without outside review since in the editorial board's opinion it would not be as interesting to its readers as many others currently under consideration by them. They emphasized that their decision was not in any way a reflection on the accuracy of the paper's claims. It is not difficult to see how disingenuous this judgment is. All one has to do is to imagine the level of excitement that would be generated for physicists when they see a paper appearing in a mainstream journal which proves that the LT is self-contradictory. The real reason the manuscript was not sent out for review was that the editors recognized that they were confronted with a very controversial claim which is supported by rock-solid arguments. Other journals within the authors' personal experience reacted similarly. One said the arguments did not contain "enough new mathematics" to be of interest to their readers. Another insisted that the manuscript be sent to some journal that "specializes in relativity."

The above examples demonstrate that journals are useless when it comes to resolving such issues. They don't see it as their problem to adjudicate existential details of Einstein's relativity theory. That duty belongs exclusively to experts in the field, but attempts to reach them by direct correspondence are either met with total silence or with dismissive replies. What has at least the potential of eliminating the impasse is to have generally accepted experts reply in public to one or another concrete questions. For example, can any one of them see a way for remote non-simultaneity and symmetric time dilation to both be correct predictions of the LT, i.e. can $\Delta t = 0$ but $\Delta t' \neq 0$ when the two quantities are strictly proportional to one another? Failing to answer that question, can they nonetheless justify retaining the LT as a valid space-time transformation?

Fortunately, the capacity for carrying out more definitive tests of relativistic predictions has continued to improve. The introduction of the atomic clock a few years before the rotor experiments had been reported contributed mightily to this objective. One of the key innovators in this development was Norman Ramsay, who was Phipps's doctoral thesis advisor at Harvard. The atomic clock could be used to measure elapsed times of events taking place over long periods. Hafele and Keating [18] took advantage of this capability in 1971, roughly ten years after the Hay et al. study, by placing cesium beam atomic clocks on aircraft which circumnavigated the globe in opposite directions. The authors noted in their introductory remarks that there was still considerable disagreement among physicists as to whether Einstein's clock paradox is a real effect. What they found was that the clock flying in the easterly direction returned to the airport of origin with less elapsed time than that on its counterpart that was left behind there, whereas the westward flying clock showed more elapsed time than either of the others. The HK results therefore confirmed again that time dilation is asymmetric, that it is completely "unambiguous" which of two clocks runs slower. Nonetheless, they argued that their experiment was perfectly consistent with STR predictions, again claiming with Sherwin [10] that the LT can only be legitimately applied from the standpoint of a particular inertial system, in this case that of the earth's center of mass (ECM). This argument is even less plausible in the present case than in the rotor study because a cruising airplane is very close to being an inertial system, existing in an environment which is almost completely free of unbalanced forces. At the same time the ECM and the earth's poles are constantly changing their velocity relative to the sun, so their rest frames are certainly not inertial in any strict sense.

What is beyond dispute, however, is that the circumnavigating clock results are completely consistent with eq. (9) that was derived above in connection with the discussion of the transverse Doppler studies [8,11,12]. In this case the speeds to be inserted in the γ factors are determined relative to the ECM, whereas the corresponding rest system in the former case is the rotor axis. The reason that the eastward-flying clock runs the slowest in the HK study is because its moves in the direction of the earth's rotation, whereas its westward flying counterpart moves in the opposite direction. The measured elapsed time Δt for a given portion of its flight is inversely proportional to the $\gamma(v)$ factor recorded for each clock, in quantitative agreement with eq. (9). The same equation holds for Einstein's original speculation [3] regarding a hypothetical clock attached to an electron traversing a closed path, in which case the rest frame from which acceleration has occurred is to be used to compute the pertinent value of γ. The ECM also serves as the corresponding rest frame from which the speeds of the Equator and North Pole are to be computed in Einstein's other example [3] for the rates of clocks located in these positions. There are no known exceptions to eq. (9) and thus it is appropriate to refer to it as the Universal Time-dilation Law (UTDL) [19]. To apply it, one must specify a definite rest frame from which to compute the $\gamma(v)$ factors. The latter has been designated as the objective rest system (ORS) in previous work [20]. One can speculate that the ORS for a clock orbiting the moon would be the latter's center of mass, for example.

The effects of the gravitational red shift also had to be taken into account in the airplane experiment [18]. Einstein [21] used the EP to predict that clock rates decrease in the neighborhood of massive objects such as the sun. The effect had been verified in terrestrial experiments by Pound and coworkers [22] and was also observed in the HK study. The EP was also used to derive eq. (8) in the transverse Doppler studies [8, 10, 11], as has been discussed above.

The two applications of the EP in the same experiment raises another point, however, namely are gravitational and rotational acceleration really equivalent, as Einstein claimed with his well-known Gedanken experiment (Einstein's elevator)? According to his 1907 paper, the speed of light should increase with gravitational potential, and this prediction has been borne out in experiments carried out by Shapiro et al. with radar signals passing close to Jupiter [23]. Yet, it was assumed in the original Ives-Stilwell experiment [6] that the speed of light is the same in the rest frame of the accelerated light source as it is in the laboratory. This assumption is of course in accord with Einstein's light-speed constancy postulate of STR [3]. In other words, the speed of light is *independent* of the source when it is accelerated, but it *changes* when its position in a gravitational field is altered. Therefore, contrary to what Einstein claimed with the EP, it is indeed possible to distinguish between gravitational acceleration and that induced by application of an outside force [24].

Theoretical discussions aside, what the HK airplane study indicates in practice is that there are two distinct effects determining the relative rates of clocks. One depends only on the speeds of the two clocks relative to their common ORS, while the other is purely gravitational. The latter requires knowledge of the locations of the two clocks in a gravitational field but is completely independent of their respective states of motion. A single parameter Q defined in eq. (10) is all that is required to compute the desired ratio in the first case, whereas another completely distinct parameter (S [25]) performs the same function for the gravitational red shift, in which case the respective altitudes of the two clocks are all that is needed to compute its value. The engineers who developed the Global Positioning System (GPS) were keenly aware of these relationships. They use the above two parameters to "pre-correct" the rates of satellite clocks prior to launch [26,27] so that the effects of time dilation cause them to have the same values once they achieve their orbital trajectory as clocks located on the earth's surface. The success of this procedure in enabling accurate measurements of distances therefore amounts to a continuous affirmation of the fact that time dilation is a strictly asymmetric phenomenon, unlike what is expected from the LT.

Phipps decided that STR should be discarded because of its clear deficiencies and undertook a long campaign to develop a thoroughly revamped version of relativity theory which could replace it. He began his second book [2] with a chapter outlining various problems with Maxwell's Equations, suggesting that they could be removed by substituting total derivatives for partial ones wherever they appear. The resulting theory is referred to as "Neo-Hertzian" because of its reliance on Hertz's alternative form of Faraday's Law. Going into detail about the distinguishing characteristics of Neo-Hertzian electrodynamics is beyond the scope of the present survey, except for one subject to be considered subsequently, and so the reader is invited to look further into the general subject by carefully reading the Second Edition of Phipps's second book [2].

Instead, the author will concentrate on a far less complicated issue that is of utmost importance to relativity theory, namely the task of finding a space-time transformation to replace the LT. Phipps concluded that Einstein's second postulate of relativity is incorrect. He did not believe that the speed of light in free space has a constant value (ignoring gravitational influences) independent of the states of motion of both the light source and the observer. An accurate method for determining the speed of light is to measure the frequency ν and wavelength λ of the emitted radiation and multiplying them to obtain the required value. The various transverse Doppler studies provide quantitative results for both quantities as a function of the speed v of the light source relative to the observer. The result for λ is given by eq. (5), which indicates within experimental error [6,7] that wavelengths *increase* by a factor of γ(v) in the accelerated rest frame. On the other hand, the rotor experiments [8,10,11] indicate that the corresponding frequency is given by eq. (4), i.e. that the observer in the laboratory (located at the rotor axis) finds that the frequency ν emitted from the accelerated clock of the x-ray absorber is *smaller* by the same factor of γ(v) [11]. The actual experiments were carried out for different light sources, but their results are assumed to both be valid for any relative speed v. In both experiments it is assumed that the observer is stationary in the rest frame of the laboratory, with no restriction on the location of the latter. In agreement with Einstein's postulate, and in disagreement with Phipps's opinion on the matter, the product of the frequency and wavelength values is seen to be the same in both rest frames because of the cancellation of the γ factors in eqs. (4) and (5).

Another confirmation comes from the Fresnel light-drag experiment. The speed of light is shown to have the following dependence on the refractive index n of a transparent medium through which it travels :

$$c(v) = \frac{c}{n} + v\left(1 - \frac{1}{n^2}\right). \tag{13}$$

Extrapolation of n to its free-space value of unity leads to the conclusion that $c(v) = c$ for this special case. This is a concise statement of Einstein's second law of relativity, and therefore a verification thereof.

The GPS technology is often cited as a counterexample, however, as is discussed in Phipps's second book [2]. When a distance D between the satellite and the ground is measured, it is necessary to know the relative speed of the satellite v used for this determination. The elapsed time T required for a light pulse to travel this distance is given by

$T = \frac{D}{c - v}$ if the satellite is moving away from the ground or $\frac{D}{c+v}$ if it is moving toward it. This state of affairs is *not* proof of a violation of the light-speed constancy postulate, however, but rather yet another verification of it. Use of this procedure simply recognizes that during the time T, the satellite does not remain in its original position. The actual distance to be traveled by the light pulse to "catch up" with the satellite is therefore not D but rather $D \pm vT$ depending on the direction in which the satellite moves. One must therefore assume according to the light-speed postulate that $cT = D \pm vT$, which upon solving for T leads to the above result. The analogous situation exists for analyzing the results of the Sagnac effect for light pulses traveling in opposite directions around a disk. The two pulses do not travel the same distance before interfering and thus the rotational speed of the disk needs to be taken into account, which again only makes it appear that the speed of light is not equal to c in both directions.

The main reason that Phipps rejected the light-speed constancy postulate seems to have been his strong belief in the Neo-Hertzian theory since it stipulates that lengths are invariant. Since he was also convinced by experiment that clocks slow down when accelerated, he concluded on this basis that the light speed would be *overestimated* by an observer traveling with the clock. He had no problem ignoring the FLC on this point since he argued that any prediction based on the LT was of no value.

If one accepts Einstein's light-speed constancy postulate instead, one is faced with the question of how the LT which is derived on this basis could be anything but correct. There is a straightforward answer to this question, however. One only has to go back and look at Einstein's derivation of the LT [3]. He agreed with Lorentz [28] that there was a free parameter (φ) whose value needs to be fixed before a satisfactorily relativistic space-time transformation can be unambiguously determined. He "solved" this problem by stating that φ can only depend on the relative speed v of the two inertial systems in question (see p. 900 of

Ref. 3). He gives no justification for this assumption. In fact, he doesn't even acknowledge that it is an assumption. Textbooks almost universally agree with Einstein on this point. Yet, it is clearly an assumption that needs to be tested experimentally. Einstein [3] then goes on to show that the only value consistent with this functional dependence is $\varphi = 1$ and this in turn leads directly to the LT and its eq. (1). Should anyone be surprised that this assumption turns out to be wrong? It leads, for example, to separate predictions of remote non-simultaneity and strictly proportional time dilation that no one can deny are self-contradictory.

Nonetheless, the LT possesses a symmetric character that has long been assumed to be essential if Einstein's first postulate, the RP, is to be satisfied. Squaring and adding its four equations leads to the following relationship referred to as Lorentz invariance:

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = x^2 + y^2 + z^2 - c^2 t^2 . \tag{14}$$

There is a different way to satisfy both of Einstein's postulates, however. One merely has to insist that eqs. (7) and (9) be included as an integral part of relativity theory by virtue of the fact that they are consistent with all relevant experimental timing measurements. This condition is achieved [29] by making another choice than $\varphi = 1$ in defining the space-time transformation, namely:

$$\varphi = \frac{\eta}{\gamma Q}, \tag{15}$$

using the same definitions for η and γ given above after eq. (1). Multiplying the right-hand sides of each of the LT equations by this value of φ leads to the following transformation [30]:

$$\Delta t' = \frac{\Delta t}{Q} \tag{16a}$$

$$\Delta x' = \left(\frac{\eta}{Q}\right)\left(\Delta x - v\Delta t\right) \tag{16b}$$

$$\Delta y' = \frac{\eta \Delta y}{\gamma Q} \tag{16c}$$

$$\Delta z' = \frac{\eta \Delta z}{\gamma Q}. \tag{16d}$$

For example, multiplying the right-hand side of eq. (1) of the LT with the above value for φ leads to eq. (16a), which in turn is the same as eq. (7). Since speeds are ratios of space and time intervals, it is clear that the same relativistic velocity transformation (RVT) results from eqs. (16a-d) as for the LT because φ is simply cancelled out in each of the corresponding divisions. The light speed postulate is therefore also satisfied as a result.

It is less obvious that the new transformation satisfies the RP. It has been shown, however, that the inverse transformation is obtained from eqs. (16a-d) by Galilean Inversion [31]; for this purpose it is necessary to define $\eta' = 1 + vc^{-2} \frac{\Delta x'}{\Delta t'}$ and $Q' = \frac{1}{Q}$ in the latter equations. The identity $\eta\eta' = \gamma^2$ is useful in this connection [32]. The transformation in eqs. (16a-d) is consistent with asymmetric time dilation, unlike the LT, and eliminates any possibility of the symmetric version of time dilation required by the LT. It is therefore directly applicable for the aforementioned "pre-correction" procedure for GPS atomic clocks, hence the designation of GPS-LT in referring to the transformation [30]. It seems fair to say that the reason the physics community has insisted on the LT as a key component of relativity theory, despite its obvious inconsistencies, is because an alternative that satisfies both of Einstein's postulates was assumed to be non-existent. The GPS-LT clearly eliminates any basis for this position, so one can only hope that this state of affairs will eventually be overcome. In this connection, it is interesting to consider Phipps's reaction to the GPS-LT and the accompanying theory. Rather than embracing the idea, he wrote in an e-mail message that he did not like it because it was "too much like Einstein's version of relativity theory." Nonetheless, the new transformation does remove many of the undesirable characteristics of

STR that he has long criticized, such as two clocks both running slower than each other and the non-simultaneity of remote events.

It is important to see that Phipps was not critical of everything that STR predicts. A key example is Einstein's famous $E = mc^2$ formula. The necessity of eliminating the LT from relativity theory is based solely on considerations of space and time. By contrast, mass-energy equivalence is a consequence of the relationship between energy E and momentum **p**. It is possible to derive a similar transformation connecting the E and **p** variables by using Hamilton's equations in connection with the light-speed postulate $\left(\frac{dE}{dp} = \frac{dE'}{dp'} = c\right)$ [33]. This leads to an analogous relation to eq. (14) for these variables:

$$E'^2 - \left(p_x'^2 + p_y'^2 + p_z'^2\right)c^2 = E^2 - \left(p_x^2 + p_y^2 + p_z^2\right)c^2, \tag{17}$$

as well to $E = mc^2$. This does not mean, however, that there is any ambiguity as to which of two particles has the higher energy or momentum. The reason is that Hamilton's equations are derived under the clear assumption that a given particle has been subjected to a constant force applied at a definite position in space. The corresponding velocity is therefore defined relative to this origin, so there is total certainty that the particle moving with the greater speed has the greater energy.

Indeed, exactly the same proportionality constant as for elapsed times in eq. (7) and in the GPS-LT also holds for energies:

$$\Delta E' = \frac{\Delta E}{Q}. \tag{18}$$

This result received experimental verification in Bucherer's study [34] of the dependence of inertial mass on the speed of electrons. Note that the origin of the force in the definition of Hamilton's equations is an example of an ORS required for evaluation of the UTDL in eq. (9). This comparison underscores a key aspect of relativity theory that is almost entirely missing from STR. Its unbending belief in "Einsteinean symmetry" (the ESP) prevents it from assigning a unique set of consequences that the application of force has on the properties of the affected objects, i.e. which mass is greater and which energy is higher.

By contrast, the theory associated with the GPS-LT does not suffer from any such ambiguities. As the speed of an object such as a rocket changes relative to the location (ORS) of an applied force, the rates of its proper clocks decrease. In addition, the energies, inertial masses and momentum of accelerated objects all increase by the same factor. The speed of light emanating from an accelerated source does not change at all, however. This eventuality requires that the distances traveled by the light also *increase* by the same factor (isotropic length expansion accompanying time dilation). None of these changes is "felt" by stationary observers in the same rest frame, i.e. all these properties appear to remain constant to them, consistent with the prescriptions of the RP. Changes are observed, however, when someone left behind in the original rest frame carries out the analogous measurements with his proper measuring devices.

To conclude the present survey, it is important to return to the subject of the relativistic treatment of electromagnetism that was of such great interest to Phipps. A good place to begin this discussion is with the Lorentz Force Law for the action of an electric field **E** and magnetic field **B** on a particle with electric charge q:

$$\mathbf{F} = q\left(\mathbf{E} + c^{-1}\mathbf{vxB}\right). \quad (19)$$

The experience alluded to above with Hamilton's equations is of special significance in this regard. According to the traditional interpretation of this equation, v is the speed of the electron *relative to the observer*. Consider the familiar case of an electric field directed along the x axis ($E_x \neq 0$, but $E_y = E_z = 0$). The corresponding magnetic field does have transverse components, however (B_y and $B_z \neq 0$). From the point of view of a stationary observer located at the origin of both fields, the electron will initially move along the x axis; the magnetic field has no effect since $v = 0$ in eq. (19). As the speed of the electron increases, however, it is observed to veer away from the original path and to follow a curved trajectory. This behavior is quantitatively described by eq. (19) since v is gradually increasing as a result of the applied force.

If the observer is continuously located in the rest frame of the electron itself, the assumption is that the Lorentz Force Law will also hold for him. In that case, however, the speed of the electron is always zero. According to eq. (19), this means that the magnetic field **B** has no effect on the electron precisely because $v = 0$. As a result, the trajectory of the electron is expected to continue indefinitely along a straight-line path. Thus, this traditional interpretation of the Lorentz Force Law leads to the conclusion that the two observers will differ in a fundamental way regarding the electron's path. The question that needs to be asked is whether this difference is at all consistent with reality.

One of the most basic tenets of SRT is that the laws of physics are invariant to the LT. What that means in the present case is that the Lorentz Force Law must be equally valid in all inertial rest frames. This means in particular that the velocity v in eq. (19) must be determined relative to the observer's rest frame, and that therefore $v = 0$ is to be used in evaluating the force on the electron within its own rest frame. What is clear on this basis is that one must be prepared to accept the conclusion that the curvature of the electron's path varies with the rest frame of the observer. To believe this is to believe in utter nonsense. The way to resolve the issue in a rational manner is certainly not to question the Lorentz Force Law (see the discussion of Ampere's law below, however) or its invariant properties. Instead, one only has to go back to Hamilton's equations to see the effects of applying a force to any particle. In that case the speed v is measured relative to the origin of the applied force (the ORS). The faster the particle moves away from this reference frame, the greater is its energy and momentum. The E,p invariance relation in eq. (17) is derived from Hamilton's equations exactly on this basis. The speed v used to evaluate E and p in a given rest frame is always measured relative to the ORS. In this particular rest frame, $v = 0$ and therefore $p' = 0$ and

$E' = \mu c^2$; the latter (rest energy) is the invariant quantity in eq. (17) and $Q = \gamma$ in eq. (18). By contrast, the Lorentz invariance relation in eq. (14) does not agree with the experimental fact of asymmetric time dilation and thus is invalid. In short, the fact that an equation is suitably invariant according to the "rules" of STR is no guarantee whatsoever that its results are physically correct. Applying the same logic to electromagnetic interactions, the conclusion is that the velocity **v** in the Lorentz Force Law of eq. (19) is always measured relative to rest frame (ORS) in which the **E** and **B** fields originate. The clear result is that all observers measure the same curved path for the electron. Their experimental results will differ in the values of elapsed times, however, simply because their respective clocks do not run at the same rate.

In one of his last papers [35], Phipps discussed a controversy that has arisen regarding the Lorentz Force Law that again involves the role of symmetry in relativity theory. He pointed out that Ampère's original law of ponderomotive force action exerted by an infinitesimal element of neutral current $I_2 d\vec{s}_2$ upon another element $I_1 d\vec{s}_1$, has the form [36,37]:

$$\vec{F}_{21(Ampere)} = \frac{\mu_0}{4\pi}\frac{I_1 I_2 \vec{r}}{r^3}\left[\frac{3}{r^2}\left(\vec{r}\cdot d\vec{s}_1\right)\left(\vec{r}\cdot d\vec{s}_2\right) - 2\left(d\vec{s}\cdot d\vec{s}_2\right)\right], \tag{20}$$

where $\vec{r} = \vec{r}_1 - \vec{r}_2$ is the relative position vector of the elements and ($\mu_0 / 4\pi$) is a units factor yielding force in N for current in $A = \frac{C}{s}$. Note that $\mathbf{F_{21}}$ is symmetrical between 1 and 2 subscripts, and is proportional to $\vec{r}$. Thus, it rigorously obeys Newton's third law of equality and co-linearity of action-reaction between current elements, which requires $\vec{F}_{21} = -\vec{F}_{12}$ on a detailed element-by-element basis. It has nonetheless generally been rejected by physicists because of its transformation properties. The Lorentz Force law, when similarly expressed, takes the form [36]:

$$\vec{F}_{21(Lorentz)} = \frac{\mu_0}{4\pi}\frac{I_1 I_2}{r^3}\left[-\left(d\vec{s}_1 \cdot d\vec{s}_2\right)\vec{r} + \left(d\vec{s}_1 \cdot \vec{r}\right)d\vec{s}_2\right] \tag{21}$$

It is asymmetrical in subscripts 1 and 2, and not proportional to $\vec{r}$, so that it disobeys Newton’s Third Law in two ways. More details about this topic may be found in Phipps's original work [35]. The point to be emphasized in the present discussion is that there is no reason to reject eq. (20) on the basis of its lacking of certain symmetry properties. The LT is proof that such properties can actually be a hindrance to providing a valid description of experimental data. In that case, they force one to believe, against all experimental evidence, that two clocks in motion can both be running slower than one another. Phipps points out that Ampère's law in eq. (20) predicts that there are longitudinal electro-dynamic forces associated with currents flowing in closed circuits. Moreover, he presents the results of two experiments which verify the existence of longitudinal forces [35]. The conclusion is that heretofore claims that Newton's Third Law is not universally valid are based on an unfounded belief that the laws of physics must satisfy symmetry principles that are known to be incorrect in the case of the LT.

The above summary of Phipps's work is by no means complete. It does, however, emphasize an issue that was foremost on his mind, namely the need to revise Einstein's theory of special relativity (STR). Specifically, he went to great pains to prove to the world that the Lorentz transformation (LT) is not valid physics. Anyone who disputes his claim needs to reconcile two of its most famous predictions: remote non-simultaneity and proportional time dilation. It is mathematically impossible to believe on the one hand that clock rates in two rest frames are strictly proportional to one another $\left(\Delta t' = \frac{\Delta t}{\gamma}\right)$, while at the same time accepting the inevitable conclusion of STR that Δt can have a null value without $\Delta t'$ doing so as well. One self-contradiction is sufficient to destroy any theory, but there are many other inconsistencies of STR as well.

The problem from the beginning was that no other transformation than the LT seemed to be possible that could satisfy Einstein's two postulates of relativity. This belief was shown to have no basis in fact once the GPS-LT was discovered to replace the LT. As a consequence, predictions of remote non-simultaneity and a symmetric form for time dilation (two clocks each running slower than the other) can no longer be accepted as fact by the physics community. More generally, the supposed inextricable relationship between space and time is shown to be simply the result of an erroneous (and undeclared) assumption made by Einstein in his original work. Newton was right and Einstein was wrong. Instead, one can return to the ancient principle of the *objectivity of measurement*. The only reason two observers can legitimately disagree about the value of a measurement is because they base their results on a different set of units. The parameter Q in the GPS-LT (or some integral power of it) serves as a conversion factor between the units that are operative in the two inertial systems, not only for time, but for every conceivable physical property. It is determined on the basis of the speeds of the two rest frames relative to an ORS such as the ECM in the HK airplane studies, not their speed relative to one another. This prescription guarantees the objectivity of measurement that is generally lacking in STR. Moreover, it indicates that Galileo's Relativity Principle needs to be amended to read: *The laws of physics are the same in all inertial systems but the units in which their results are expressed can and do vary from one rest frame to another.*

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