SPECIAL APPENDIX

REMARKS ON THE FOUNDATIONS OF SPECIAL RELATIVITY

At variance with a largely shared opinion, both the foundation and the logical structure of Special Relativity **(SR)** have substantially been laid by Hendrik Lorentz[1] and by Henri Poincaré[2], not by Albert Einstein. Yet, the mathematical generalisation of SR comes from Hermann Minkowski[3], who in 1907 proposed the *spacetime* reference frame in its current notation, though the first mathematical formulation and use of a *spacetime* reference frame was clearly made by Poincaré[4] in June 1905. ("Spacetime" is also referred to as "chronotope").

As pointed out by Hermann Weyl[5]**:**

"One of the interesting historical aspects of the modern relativity theory is that, although often regarded as the highly original and even revolutionary contribution of a single individual, almost every idea and formula of the theory had been anticipated by others. For example, Lorentz covariance and the inertia of energy were (arguably) implicit in Maxwell's equations. Also, Voigt formally derived the Lorentz transformations in 1887 based on general considerations of

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[1] Hendrik Antoon Lorentz, Dutch scientist (1853-1928)**:** ***Versuch einer Theorie der elektrischen und optischen Erscheinungen in bewegten Körpern***, Brill, Leiden 1895**;** ***Electromagnetic phenomena in a system moving with any velocity smaller than that of light***, Proceedings of the Academy of Science, **1**, Amsterdam 1904.

[2] Henri Poincaré, French mathematician and physicist (1854-1912)**:** ***La théorie de Lorentz et le principe de réaction***, Archive Néerlandaise des Sciences Exactes et Naturelles, **5** (1900), ***Les relations entre la physique expérimentale et la physique mathématique***, Revue générale des sciences pures et appliquées, 11 (1900), ***L'état actuel et l'avent de la physique mathématique***, Bulletin des sciences mathématiques, 28 (1904), and ***Sur la dynamique de l'électron***, Comptes Redus **140,** June 1905

[3] Hermann Minkowski, Lithuanian-German mathematician (1864-1909)**:** ***Die Grundgleichungen für die elektro-magnetischen Vorgänge in bewegten Körpern***, Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen, Mathematisch-Physicalische Klasse (1907)

[4] H. Poincaré, ***Sur la dynamique de l'electron*** (reprint), Rendiconti del Circolo Matematico di Palermo, **21** (June 1905).

[5] Hermann Weyl, German mathematician and historian of science (1885-1955)**:** ***Space, Time, Matter***, Methuen & Co., London 1922; Ch. II, Para. 21-22

the wave equation. In the context of electro-dynamics, Fitzgeral, Larmor, and Lorentz had all, by the 1890s, arrived at the Lorentz transformations, including the peculiar time dilation *and* length contraction *effects (with respect to the transformed coordinates) associated with Einstein's special relativity. By 1905, Poincaré had clearly articulated the principle of relativity and many of its consequences, had pointed out the lack of empirical basis for absolute simultaneity, had challenged the ontological significance of the ether, and even demonstrated that the Lorentz transformations constitute a* group *in the sense as do Galilean transformations. In addition, the crucial formal synthesis of space and time was arguably the contribution of Minkowski in 1907, and the dynamics of special relativity were first given in modern form by Lewis and Tolman in 1909".*[6]

Of a particular interest is also the book of another mathematician and historian, Edmund Whittaker, who, in a chapter titled "*The Relativity of Lorentz and Poincaré* ", credited Poincaré and Lorentz for developing SR, while attributing almost no importance to the 1905 paper on relativity published by Einstein. According to Whittaker[7], the famous "mass-energy equivalence" formula $E = mc^2$ must also be attributed to Poincaré.[8]

The preceding annotations are a due premise to the analysis that follows, in which I intend to account for the difference existing between SR as is nowadays practiced and Einstein's SR. In my view, this implies also a distinction between Einstein's SR and the set of the major concepts on relativity formulated by his predecessors. Such a distinction is unusual within the academic world, but is instead necessary to understand the weakness of the foundation of Einstein's SR.

(i) Questions of consistency

Along with my old doubts about the determination of Newtonian gravitation constant *G*, as recalled in Part II of this essay on "*Vacuum,*

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[6] In this connection it is also worth considering that the paper on relativity published in 1905 by Einstein (***Zur Elektrodynamik bewegter Körper****,* Annalen der Physik, **17**) contains no mention of the *spacetime* concept, which was at that time not yet part of Einstein's thought. Only later Einstein became acquainted (arguably through Minkowski) with Poincaré's work concerning the *spacetime* identified by Lorentz transformations.

[7] Sir Edmund Taylor Whittaker (1979-1956), English mathematician: ***A History of the Theories of Aether and Electricity***, Nelson, London 1952-1953.

[8] H. Poincaré, in analysing the characteristics of electromagnetic fields, could show that the energy (*E*) of an electromagnetic wave is like that of a fluid medium whose mass density is proportional to E/c^2. ***La théorie de Lorentz et le principe de réaction***, Archive néerlandaise des sciences pures et appliquées, 11, 1900 (*op.cit.*)

Vortices & Gravitation", other doubts do ever since harass me concerning the way in which Lorentz and Poincaré first, and Einstein later, laid the foundations of the theory of special relativity.

Lorentz pointed out the need in physics for a clearer definition of "time" in describing observed events. He began focusing on the need to define "operationally" what we should consider as "simultaneity", when the same event is observed from two different points in space, say point A and point B located at any distance r from each other in a Euclidean space. In Lorentz-Poincaré's view, the assessment of the speed of any object moving from A to B (or *vice versa*) implies the synchronisation of two clocks, of a same standardised type, one placed in A and the other one in B.[9] Lorentz proposed the analysis of events observed from two different systems in uniform motion with respect to each other.

Suppose that in two distinct fixed points A and B, belonging to the same system S, there are two different observers, one in A and the other in B, who use an identical type of clock to record the passage times of an object P in a uniform motion along the straight line that connects A to B. Object P may be viewed as a different system in a linear uniform motion with respect to S.

Lorentz remarks that when P is seen in A by the local observer it cannot yet be seen by the observer in B, for the light – the speediest signal in nature – takes an amount of time $\tau = r/c$ to reach B from A, if r is the distance between the two observers and c is the speed of light. Lorentz excludes the possibility of synchronising two clocks in A and then taking one of them to B. Another important assumption, which was later turned into a postulate by Einstein's theory of special relativity, is that speed of light c is a universal constant, whatever its propagation direction, irrespective of any physical reference frame. Therefore, the passage of P recorded in A by the local observer at time t_A is "simultaneously" recorded by the observer in B at time $t_B = t_A + \Delta t = t_A + r/c$.

Substantially, though *not explicitly* - and apart from c = *universal constant* - a special assumption made by Lorentz seems to be the following: *Within any system, the "yard-sticks" used to measure distances are rigid, i.e., they do not change their length if moved around for measurement purposes, whereas any kind of clock may in general change its pace if it moves from any point to another of the system.*[10]

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[9] Simultaneity *in itself* seems rather a conventional concept. In principle, synchronisation can never be ascertained for separate clocks.

[10] From a mere logical standpoint, *rigid* yard-sticks moved inside any system for measurement purposes are in a substantial contradiction with Lorentz transformation Formula **[2]** shown in subsequent Page 212.

[By this incidental note I wish to stress why this point seems incompatible with the other Lorentz equation concerning *relative* lengths and distances.

I deem it worth recalling here the origin of the so-called "Lorentz factor", as expressed by $\gamma = 1/\sqrt{1-\frac{v^2}{c^2}}$, which is the "brand" of special relativity.

Lorentz was a convinced and systematic theorist of the cosmic ether, which he considered as the immobile basic essence of the physical space. Lorentz's dynamics developed assuming the ether as an absolute reference frame. To prove the existence of the ether, Michelson and Morley (M-M) designed experiments aimed at assessing the influence of a "wind of ether" on the speed of light. According to those designs, the speed of light propagating in parallel to the ether's stream should be different from the speed of light that propagates in the direction orthogonal to the ether's stream line. In M-M experiments the *exact* theoretical difference between the light's go-and-back times along two paths of identical length s (i.e., the parallel and the orthogonal paths, with respect to the ether's wind) is given by

$$Dt = t_1\text{-}t_2 = \frac{2s}{c}\left(\frac{1}{1-v^2/c^2} - \frac{1}{\sqrt{1-v^2/c^2}}\right).$$

After the "failure" of M-M experiments, through which no evidence of the existence of the ether could be exhibited, Lorentz formulated the **hypothesis** that the M-M interferometer's segment parallel to the ether's wind direction undergoes a contraction during its windward relative motion, the contraction being precisely given by

$$Ds = (1-\gamma^{-1})\cdot s = (1-\sqrt{1-\frac{v^2}{c^2}})\cdot s$$

so that $t_1 = t_2$ and $Dt = 0$. Thus, any motion of a 'yard-stick' for measuring distances should imply a 'contraction' of the instrument.

In this connection it is also right to remember that, in subsequent years, a number of physicists interested in the subject carried out reviews of M-M experimental data to conclude that the currently accepted reading and interpretation of those data shall be considered as inaccurate. To cite just one of the recent studies of the kind, Italian physicist Fabio Tabanelli writes: "*A detailed historical analysis of interferometer observations (1887-1924) shows that early experimental procedures were faulty but that observed fringe shifts were real, albeit much smaller than expected. Diurnal variation speed-versus-azimuth and speed versus Earth's orbital position are real and are not caused by experimental artefact: Which appears to eliminate the need for Lorentz transformations. We are faced with unequivocal evidence of the non-existence of experimental proof that can be used as a basis for the theory of relativity*".[11] **]**

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[11] F. Tabanelli, ***Coherence and Continuity of Non-Null Experimental Results by Michelson-Morley and Miller***, Proceedings of the International Conference

As to Lorentz, the only operational possibility of synchronising clocks is keeping them steady in each observation point of the system considered, and using electromagnetic signals (light) for synchronisation purposes.

In that context, the reason for assuming/postulating the physical "impossibility" to move any clock from *A* to *B*, after synchronising the clocks in *A*, is not clear to me. It might have been suggested to Lorentz by the fact that the pace of clocks like pendulums depends on gravity acceleration, and gravity acceleration varies from point to point of the Earth not only in relation to the latitude and altitude, but also at different points of equal latitude and altitude because of not fully explained reasons, as shown by the long lasting use of gravimeters across the world.[12]

The oscillation period T of a pendulum, for small oscillations, is expressed by $T = 2\pi\sqrt{l/g}$, in which l is the length of the pendulum's rod or wire, and g is the local gravity acceleration. One has to consider that all clocks and watches – up to the first three or four decades of the 20th century – were regulated with reference to sample pendulums [13]. Clearly, this fact is not sufficient to explain Lorentz's assumption about clocks. Nevertheless, if one moves clocks from one point to another of any physical system does also give the clocks accelerations that – while modifying their speed and physical state – might also modify their pace, albeit no analogous criterion Lorentz applies to the yard-sticks to be used within the same system, otherwise one could never know any reliable measurement of the distance between points of the system.

"Galileo Back in Italy", Bologna 1999. (As probably known, there is an impressive amount of other papers aimed at confuting special relativity).

[12] In 1672, during his stay in Cayenne, French astronomer Jean Richer could observe that the oscillations of his pendulum were slower than in Paris. At tropical latitudes gravity acceleration *g* is lower than elsewhere, and the Earth's rotation speed is higher than at temperate latitudes. Thus, at the latitude of Guyana, both gravity and kinetic energy of pendulums contribute to increase their oscillation period *T* with respect to the oscillation period observed in Paris. (See also Footnote 50, Page 67, PART II of this essay).

[13] Together with pendulums, clock hands were also set in motion by sort of contrivances based on weights and counterweights obviously moved by gravity. Though the use of metallic springs to activate clocks began in the 16th century, it must be noted that the pace regulation and repeated re-adjustment to these clocks had always to refer to the regularity of given sample pendulums. (The formula for pendulum period *T* given above is only an approximation adopted for small oscillations. More complex general equations describe the oscillations of pendulums).

For one reason or another, as pointed out by Poincaré, Lorentz paved the way to get rid of clocks whose pace may be influenced by their physical state or local environmental conditions, in order to refer to time-measuring devices consistent with the specific state of any system. In simpler words, Lorentz's assumption about synchronisation had provided a first operational criterion to get rid of Newtonian *absolute time* in physics. In dealing with physical events occurring within any physical system in uniform motion with respect to another reference system, the use of only one reference clock of any kind is sufficient to assess how the time runs inside the other systems observed, since the motion of the reference clock is compared only to the universally uniform motion of light.

Lorentz's assumption about synchronisation has heavy implications. The first of these is the way in which, from a given reference system *S*, the time relevant to another system *S′* in relative uniform motion must be accounted for. The relation between time *t′* in *S′* and time *t* in *S* is expressed by the following well-known Lorentz transformation formulas:

[1] $$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}}, \quad \text{or else} \quad t' = t \,/ \sqrt{1-\frac{v^2}{c^2}}, \quad \text{if } x = 0\,;$$

in which $v = r/t = constant$ is the speed of S' with respect to S, x is any abscissa in *S* along the motion direction; r is the distance between S and *S′*; while c, as usual, is the speed of light.

The *relative time* defined by **[1]** is tied to the other well-known transformation formula that Lorentz introduced as a hypothesis to explain the "failure" of Michelson-Morley experiment:

[2] $$x' = \frac{x - r}{\sqrt{1-\frac{v^2}{c^2}}}$$

in which x' expresses the unit length as measured in and from *S′* with respect to the unit length *x* as measured in and from *S*.

Therefore, according to Formulas **[1]** and **[2]**, both time and distances, measured from *S*, reveal shorter than measured from *S′*, in a way that depends on the relative speed *v* and on its ratio to the speed of light c. The greater the speed *v* the greater the delay of *t* with respect to *t′*, and the shorter length unit x with respect to length unit x'. Not to forget, however, that the situation referred to *S* becomes symmetrical if referred to *S′*.

The ambiguity of this point has been stressed by Herbert Dingle seriously.[14]

If relative recession speed is $v = 0$, also $r = vt = 0$, then time and length measurements are identical in *S* and *S′*, whereas the formulas above make no physical sense if $v = c$.

Let's also remember that at Lorentz's time the conviction of most physicists was that the physical space was everywhere permeated with a special substance, the ether, whose only tested property is to allow the propagation of light and all electromagnetic waves at constant speed *c*.

In an analogy with the speed of sound in the air, Lorentz assumed that – *with respect to the ether* – the speed of any electromagnetic signal does not depend on the speed of either the signal's source or receiver. Similarly, for two birds that fly in the atmosphere the speed of their mutual call *across the air* is constant and does not depend on the relative speed of their flight. Moreover, as discussed in Paragraph 3.3 of PART II, time – for most purposes in physics – can be considered as the ratio of any studied motion to a different uniform motion taken as a reference. With a view to avoiding the recourse to Newtonian absolute time, Lorentz thought that there is no better reference motion than that of the light across the ether. Formulas **[1]** and **[2]** are two consequences of assuming the motion of light across the ether as a basic reference motion in physics; and ambiguities concerning the interpretation of these formulas may partly vanish if one thinks that Lorentz's assumptions are viewed as a way to consider the ether as an absolute reference frame.

In connection with the preceding notes it's worth observing that Special Relativity shows a theoretical gap. Formulas like **[1]** or **[2],** together with any other one that involves the square root factor $1/\sqrt{1-v^2/c^2}$, give imaginary values for relative speed $v > c$; which has led to state that nothing can travel faster than the speed of light. However, considering that uniform speed *v* is *relative* to any reference frame, there is an unanswered question as to the fate of quantities such as lengths, masses and times, when two physical systems move along opposite directions at a

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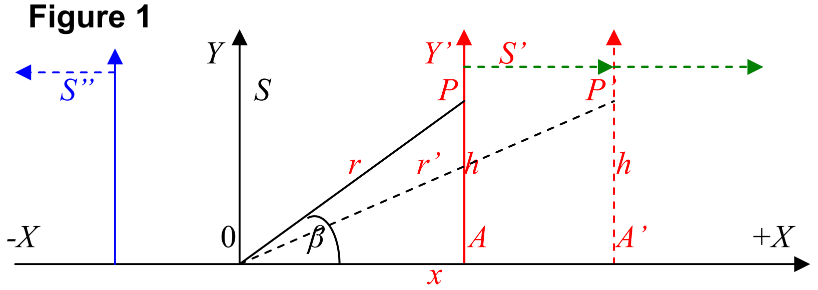
14 "*The theory* [Einstein's Special Relativity] *unavoidably requires that* A *works more slowly than* B *and* B *more slowly than* A *...which requires no super-intelligence to see is impossible*". Page 17 of ***Science at the Crossroads***, by Herbert Dingle, M. Brian & O'Keeffe, London, 1972. Dingle, English physicist and professor at Imperial College, after being a militant relativist, found reasons for changing his mind concerning Einstein's Special Relativity. See also ***The Case against Special Relativity***, Nature **119,** 1967.

relative receding speed that exceeds the speed of light but doesn't exceed c with respect to the ether. According to Einstein's SR this is impossible, but it's not difficult to show that it's instead thinkable. Einstein's special relativity claims that no transmission medium of light can be assumed as an absolute reference frame, but Einstein's postulate – according to which the speed of light doesn't add with the speed of either the light's source or detector – is an implicit assumption that the transmission medium of light is the absolute reference frame. Actually, in the second half of his life, Einstein felt impelled to recognise this fact**;** in this connection, see also the *Attachment* to PART I. Two different systems can be thought of as moving with respect to each other at a speed that is higher than the speed of light.

Figure 1



$v = h \cot\beta/(t - h/c\sin\beta) = constant$; $x = vt = c\,t\,h\cos\beta/(c\,t\sin\beta - h)$.

A way for measuring the relative speed between « inertial systems in *linear* uniform motion » is using the size of « image h » of the system observed.

Let's imagine a source of light, placed in the origin O of the reference frame S of **Figure 1** above, which sends a continuous electromagnetic signal in all directions. Moving from point O, and along the same axis X, two other different systems, S' and S'', move in opposite directions, i.e., one following the positive X, the other one along the negative X. Even in Special Relativity, there is no conceptual impediment to thinking that both systems S' and S'' can move at a speed, with respect to the source of light O in S, not too far from c, say 200,000 km/sec. If so, this also means that, with respect to each other, the two systems, S' and S'', travel now at 400,000 km/sec (or more) recession speed, which is remarkably greater than the speed of light. Obviously, no direct electromagnetic connection is possible between S' and S'', albeit they could in principle communicate through S, since each of them is still in condition to catch the signals from O and to send signals to S.

In this thought example the theoretical framework of Einstein's SR shows its logical limits, since statements such as the *impossibility* of travelling faster than the speed of light loose scientific significance, if one claims to generalise the concept, while no credible explanation can be provided as to the *physical fate* of systems like the two S' and S'' imagined above. In that case, the relativistic composition of velocities makes no sense: the sum of the velocities (v for S' and $-v$ for S'') with respect to S would be nil [the relativistic composition is $w = (v-v)/(1- v^2/c^2)$].

I deem it is licit to think that the young Albert Einstein, as it may happen to any committed science amateur, prepared his first published paper on special relativity by use of not well defined basic concepts, most of them being actually rejected by him in founding his subsequent theory of general relativity. To corroborate this opinion of mine, there are also significant sentences in a book written by astronomer Erwin Freundlich, and endorsed by a *Preface* signed by Einstein himself, concerning the foundation of general relativity. For example, in discussing difficulties inherent in the interpretation of "the law of inertia", Freundlich writes:

"*The inner ground of these difficulties is without doubt to be found in an insufficient connection between fundamental principles and observation*. As a matter of actual fact, we only *observe* the motions of bodies *relatively* to one another, and these are *never* absolutely rectilinear nor uniform. *Pure inertial motion is thus a conception deduced by abstraction from a mental experiment – a mere fiction*"; [The *Italic* font in the original text].[15] Therefore, anybody can imagine what credit should deserve Einstein's special relativity.

(ii) Inertial relative motion

In Lorentz-Poincaré relativity, the consideration of the ether as an absolute reference brings in itself reasonable answers to the issue concerning the two systems S′ and *S″*, for the composition of relative velocities is independent of the speed of light to the extent that all velocities refer to the ether. In Einstein's SR, instead, the problem becomes complicated due to the two postulates that characterize his theory.

First of all, Einstein's SR accounts only for *inertial systems*. An "inertial system" may be defined as a set of physical objects each of which is in a *rest state* with respect to all the other ones, none of them being subject to any kind of acceleration. *No absolute intrinsic force* can be detected within an inertial system, apart from testing *the bodies' local inertia*. Any inertial system may be considered as either at absolute rest or in motion at a "linear uniform speed", since no *absolute reference* is allowed for.

Instead, what matters in Lorentz-Poincaré SR transformations **[1]** and **[2]** is only the speed relative to the ether, so that motion can also occur in presence of forces like, for example, those of either gravity or gravitation. It's a very important difference, which makes Lorentz-Poincaré SR a

[15] E. Freundlich, ***The Foundations of Einstein's Theory of Gravitation***, Cambridge University Press, 1920, p.22, *op. cit.*

theory with its own pertinent dynamics, always bearing in mind that theory of Lorentz's relativity develops with respect to the ether.

Einstein's SR does *postulate* (Einstein's *relativity principle*) that electromagnetic laws do not change their form with respect to any *inertial* reference frame[16]**.** The second postulate of Einstein's SR is that the speed of light is constant in all directions and *independent of the motion of any systems*. On this basis, Einstein's SR arrives at the same relativistic formulas proper to Lorentz-Poincaré relativity, including Formulas **[1]** and **[2],** as well as at the other important equation which expresses *mass* as a function of its "relative" speed, *i.e.*:

[3]
$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

in which m is the mass that moves with "relative" speed v, whereas m_o is the same mass "at rest" with respect to the relevant reference frame. Equation **[3]** (actually regarding the "transverse mass" of a body in relative motion) is due to Lorentz, and it appears also in the definition of kinetic energy formulated by Einstein in analysing the motion of an electron.[17]

In my opinion, all the ambiguity associated with relativistic formulas like **[1], [2]** and **[3]** depends on three facts, which are not accounted for by the theories of special relativity:

(a) There is no way to assess the absolute speed of any inertial system with respect to the ether**;**

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16 Should this regard electromagnetic laws only, Einstein's postulate would simply be obvious and useless, since Maxwell's *original* field equations *must* be corrected and expressed in vector notation, as per Heaviside's specific contribution to vector calculus through the innovative introduction of operators "rotor" (Δx" or "curl") and "divergence" ("*div*"), which make it evident that the laws of electromagnetism are *per se* independent of any reference frame, be this inertial or not. Actually Maxwell's equations *in their initial form* are ever since tested as in contrast with *non-inertial* terrestrial reference frames, and that did actually confuse physicists of the time, Einstein included, **who used only *those* original equations**.

17 A. Einstein, ***Zur Elektrodynamik bewegter Körper**,* Annalen der Physik, 1905, *op. cit.,* Para. 10. The formula for kinetic energy is there given by $E_k = (m - m_o)c^2$, where $m = m_o /(1-v^2/c^2)^{1/2}$ as per Equation **[3]** . When considered within Lorentz's paradigm, Equation **[3]** for (*transverse*) mass does not necessarily refer to *linear* uniform *velocity*.

(b) There is no clear indication of how it is possible for *S* to assess the relative speed of *S′* (or *vice versa*), when the two systems are isolated in the cosmic space.

Moreover, in Einstein's relativity, the concept of "inertial system"seems quite metaphysical (*also to Einstein himself, as already remarked above*)**:** not only is there no way to imagine a physical system totally free from external forces, but also the concept of "mass" itself escapes all physical significance, considering that within an inertial system there is no means for assessing *locally* the absolute "rest mass" m_o.

[Moreover, Einstein's physical moving system and annexed clock start accelerating with respect to the "*stationary reference system*", as Einstein dubs it. The Author does not attach any physical consequence for the moving system when this attains the mentioned constant uniform speed, which is by definition different from the uniform linear speed of the reference "stationary" system. This difference in speeds does necessarily imply different kinetic energy contents in the *physical bodies* of the two physical systems considered by the Author. My personal question is: should such a difference be considered as negligible in Einstein's analysis? If yes, why? Whatever the difference between the two different kinetic energies, it seems obvious to me that such differences, at any difference in speed, do actually entails different physical states of the two different clocks (only *initially* taken for identical to each other and synchronized in their mutual "stationary" state), implying different time measurement by the clock in relative motion with respect to the stationary one. Is this remark of mine negligible in Einstein's Special Relativity? If yes, why? I deem instead it's a grave basic flaw in the theory's building].

(c) There is confirmed experience that two identical clocks, after initial synchronisation and whatever their working mechanism, display different times at the end of any sort of "round trip" made by one of them at a high relative speed with respect to the other one.

In Lorentz-Poincaré relativity, instead, relative motion *does not* necessarily imply *inertial systems.* Consider – for instance – a terrestrial artificial satellite moving with uniform speed along a circular orbit with respect to a fixed reference frame having its origin in the Earth's center. This orbital motion is planar, uniform in speed but not in *velocity*, since the velocity vector of the satellite (the *direction* of its speed's intensity) changes continuously. In association with the varying velocity vector, the satellite is constantly subject to a pair of equal and opposite forces (the gravity centripetal force and the corresponding centrifugal force), which put the material body of the satellite under a permanent tension stress. Lorentz, in fact, had to consider any mass moving with a uniform speed along a plane *non linear route* as characterized by two *mass-components* relevant to the varying *longitudinal* and *transverse velocity* components, with the respective acceleration components (while the *speed* may or not remain a scalar constant). In the paradigm of Lorentz relativity, *mass* is basically interpreted as a *vector,* and in that paradigm Equation **[3]** describes there the *transverse mass.* This, however, cannot be considered as pertinent also to Einstein's special relativity, which is constructed upon the linear and uniform motion of "*inertial* system", in which *transverse* and *longitudinal mass* should intrinsically exclude any relevant acceleration**.**

The SR formulated by Einstein disregards point (a) above, after considering that no absolute reference frame is necessary to the internal consistency of the theory.

As to point (b), there are at least two ways to assess the relative speed of any inertial system S' in a linear uniform motion with respect to another inertial system $S,$ taken the latter as the reference one, though the theories of relativity do not provide any specification as to this issue. The most obvious way of the two can be illustrated by the aid of **Figure 1** above.

It must be supposed that the two systems considered, S and S', are objects of at least one dimension measured along axis Y of a Cartesian reference frame, otherwise S' would be invisible from $O.$

Suppose also that S' is seen from S as in receding motion from S along co-ordinate $X,$ and that a length h on co-ordinate Y' of S' is known. Then, a couple of measurements are sufficient to assess the recession speed v of S' and whether v is a constant speed. In fact, by optical measurement of the angle β in O formed by $r = OP$ with $X,$ the distance $x = OA$ is given at time t in O by $x = h \tan\beta,$ while distance OP is given by $r = h/\sin\beta.$

However, at instant t, when r is recorded in $O,$ system S' (its point A in particular) has moved ahead during the travel of the light received in O from $P,$ which took a time $\tau = r/c = h/c\sin\beta.$

Therefore, the value of speed v is expressed by

$$v = \frac{h}{(t - \frac{h}{c\sin\beta})\tan\beta} = \frac{ch\cos\beta}{ct\sin\beta - h} = const.;$$

whence one derives the actual distance $x = OA$ at time t in $O,$ i.e.,

[4]
$$x = vt = \frac{cth\cos\beta}{ct\sin\beta - h} \quad .$$

Analogous operations can be repeated at any time $t + \Delta t$ to verify the constancy of speed $v.$

It seems obvious that quite symmetrical operations are possible if one considers system S as receding from S', after placing the observation point in *A*. Whatever the clocks used, either in *S* or in *S′*, the values calculated in *S′* for both speed *v* and distance *x cannot* differ from the relevant values calculated in *S.*

If one considers inertial systems, the symmetry of the situation described is total, for there is no *a priori* way to establish which of the two systems is in motion, or whether *both* of them are in motion or not. Moreover, it is difficult to recognise the need for any synchronisation of clocks in *S* with clocks in *S′* in describing physical events with either reference to *S* or *S′.* Let alone the other question that I, for the sake of mathematical precision, ask myself about the physical meaning of the "**+**" and "**–**" signs, which I didn't write but *should* instead be associated with the square root operations shown by relativistic Equations **[1]** and **[2].**

In simpler words, it seems to me that the problem of synchronisation is a false problem, and the attempt to resolve it through the relativistic approach recalled above leads to the formulation of questionable conclusions. In particular, the reason why clocks cannot be moved from one point to another of the same inertial system has been left unexplained by special relativity. This point has been either omitted or ambiguously addressed by various authors of texts on special relativity. Let's see just a few examples amongst the many possible ones: Christian Møller, a renowned Danish physicist, wrote:

"*Any other method* [different from the relativistic one] *for synchronising the two clocks* [placed one] *in A and* [one] *in B, like for instance the transport of a third clock from A to B, clashes against the same fundamental difficulty*" [18];
albeit one cannot identify, in that entire text by Møller, any "***same fundamental*** *difficulty*" which could work as something at what Møller hints. Even Born's arguments for justifying the relativistic assumptions about synchronisation seem tottering, thus strengthening the impression that Equations **[1]** above should be considered as an assumption rather than a thesis of relativity.[19] Amongst other authors and more recently Massimo Brighi wrote**:**

"*…in* [space-]*ship A we synchronise two identical clocks and then we send one to space-ship B. The main problem of this solution is that - according to relativity itself - any clock in motion slows its pace down; and this is not only a theoretical prediction, but a true fact which has clearly been proven by*

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[18] Christian Møller, ***Relatività***, Enc. del Novecento, VI, Page 74, Istit. Enc. Ital., Roma 1982.

[19] Max Born, ***Einstein's Theory of Relativity,*** Dover Publications, 1962, Chapter 6. However, also Joseph Larmor (1857-1942), before Lorentz and Einstein, gave a reasonable *physical* explanation for time dilatation relevant to matter in motion, in his book ***Aether and Matter****,* Cambridge Univ. Press, Cambridge 1900.

experiments carried out with atomic clocks. Therefore, clocks transported [from *A* to *B*] *at different speeds would result in different synchronisations*" [20] ;
this is – on the one hand – a classical example of *petitio principii,* in that which is to be demonstrated is taken for granted, and is – on the other hand – also an example of how one can introduce theses in the lucky wait for any later relevant corroboration/confirmation**;** which nowadays turns Lorentz's and Einstein's thesis into a sort of self-evident truth for Brighi. When Lorentz and Einstein formulated their relativistic theories no reference to such self-evidence would have been possible. The fact recalled by Brighi, however, appears more as something still to be properly explained, rather than a clear confirmation of Special Relativity.

Another method for assessing the mutual recession speed, either from *S* or from *S′*, is endowing both *O* of *S* and *A* of *S′* with an identical source of light that sends a continuous electromagnetic signal at a given frequency ψ in all directions.

The mutual recession speed can in this case be measured through the Doppler effect associated with the recession motion of any source of light. In the cosmic space, at any given relative recession speed v of any source of light, whose proper emission frequency is ψ, there is a corresponding frequency ψ_v perceived by the observer of the recession, as expressed by the following simple relation

[5] $$\psi_v = \psi \ (1 - \frac{v}{c}),$$

which gives – in the case of recession motion – a measurement of the so-called *red shift.* The red shift is a constant value if recession speed v is constant; otherwise it varies with v.
Thus, speed v is immediately determined by

[6] $$v = c\,(1 - \frac{\psi_v}{\psi}) \quad \text{together with distance} \quad x = \ t\,c\,(1 - \frac{\psi_v}{\psi}).$$

If $v = constant$, the values for v and x calculated in *S* are the same as in *S′*, irrespective of the clocks used in each system. From the first of the above relations one gets

[6a] $$(1 - \frac{\psi_v}{\psi}) \ = \ \frac{v}{c} \quad .$$

It's however important to remark that v is in general considered with respect to the speed of light, which also means with respect to the plenum (or ether)**:** Equations **[5]** to **[6a]** do not exclude the physical possibility of a

[20] Massimo Brighi, ***Simultaneità relativistica***, in "La natura del tempo", edited by F. Selleri, Dedalo, Bari 2002, Pages 230 on.

mutual recession speed which exceeds the speed of light, though – in such a case – the same equations would make no sense. In the above analysis, which is based on relative speeds detected through the transmission of electromagnetic signals, the same equations are significant as far as electromagnetic connection between systems in motion is possible.

As to the last point **(c)** listed in preceding page 216, I wish to remark that one thing is to express the concept of "time" in terms of abstract kinematics; a quite different thing is the *physical measurement* of time in physics, which is based on dynamic phenomena and operations. If experience proves that alterations occur in the behaviour of clocks in different dynamic states, this should not necessarily prove that the only plausible explanation for that is provided by Relativity. Similarly, Ptolemaic system could with a high precision predict eclipses, but this fact has not been sufficient to establish that the Ptolemaic system is the only adequate theory to explain eclipses.

Clocks are material contrivances that undergo the effects of changes in their physical state**;** such an obvious statement doesn't seem to require a general and universal explanatory theory. Nevertheless we could try to approach the issue in a simple manner, allowing for *not unreasonable* examples about what clocks are in practice.

(iii) When the relative recession motion is accelerated

For the sake of simplicity, let's now suppose that the two systems S and S' of **Figure 1** are initially in an identical inertial state, characterised by any linear uniform speed v, so that points *O* and *A,* shown in **Figure 1**, are not in motion with respect to each other.

At a certain moment t, system S' starts receding from system S with any acceleration a; therefore, the two systems are in a relative accelerated recession motion, *but the effects of the acceleration can be detected only in* S', the objects in this system being now subject to a force whose strength is the product of their mass and the acceleration undergone.

S' is no more an inertial system. The force generated by the accelerated motion of S' could - for instance - set a pendulum in motion, whereas this is still not possible in system S, which hasn't changed its inertial state.

Yet, the mutual recession speed can – instant by instant – be assessed through the Doppler effect, though the situation is now asymmetrical**:** at each different value assessed for recession speed v_r - from either S or S' - different dynamic states must be considered for the two systems. Whatever constant speed v of inertial system S, its kinetic energy remains constant with time, whereas the kinetic energy of system S' increases with time as long as its acceleration lasts.

We can also suppose that initially, when S and S' are in the same inertial state, time is measured inside each system by identical caesium clocks. Caesium clocks exploit the very high regularity of the oscillations of the metal's atoms when these are excited by a controlled beam of microwaves. The use of this kind of high-precision clocks is possible also in absence of gravity, but one is not allowed to think that these clocks are insensitive to changes in their speed.

The cubic crystal lattice of caesium compels the atom of this metal to make highly constrained and regular oscillations about its oscillation centre. However, as it is of any atom in any material, the atom's oscillation amplitude and frequency undergo the effects of changes in the material's pressure or temperature or any other changes in the metal's physical state. The oscillation keeps the atom under a central force that can schematically be described by the harmonic motion equation**:**

[7] $$m\,\frac{d^2 s}{dt^2} + ks \;=\; 0$$

in which m is the atom's mass, s is the elongating distance of the centre of mass of the atom from the oscillation centre, and k is the specific elasticity constant of the material.

As known, the solution of Equation **[7]** is given by

[8] $$s\; = D\,\mathbf{cos}(\,t\,\sqrt{\frac{k}{m}} \pm \phi\,),$$

in which D is the oscillation amplitude, i.e., the maximum distance (or elongation) of the atom's mass centre from the oscillation centre, and ϕ is the integration constant that indicates the oscillation phase. Elongation s is the oscillation amplitude D when $t\sqrt{k/m} + \phi = 0$, and $t = T/4$, i.e., when

[9] $$T \;=\; \pm\, 4\phi\,\sqrt{m/k}$$

in which T is the oscillation period.

Let's now imagine that system S', once achieved a certain speed V at any distance r from S, stops its acceleration and continues moving at speed $V = constant.$ Every mass unit of S' has at that moment acquired an increment in its kinetic energy which, remembering Equations **[6]** - and for mass m in particular - can be expressed by

[10] $$\Delta E'_m = \frac{m(V^2 - v^2)}{2} \;=\; \frac{mc^2(1 - \frac{\psi_V}{\psi})^2}{2}$$

in which ψ_V is the frequency of the electromagnetic signal detected by both *S* and *S′* in relation to the mutual recession speed *V* (whereas the initial relative speed *v* is nil). One can now express the new situation in *S′* *as if* every mass unit of *S′* has been augmented by an amount

[11] $$\Delta m' = \frac{\Delta E'_m}{c^2} = \frac{m(1-\frac{\psi_V}{\psi})^2}{2} \ ,$$

which reflects on the atom's oscillation period, according to the following relations (remember also **[6a]** above):

[12] $$T'_V = \pm 4\phi\sqrt{\frac{m+\Delta m'}{k}} = \pm 2\phi\sqrt{\frac{2m\cdot[2+(1-\frac{\psi_V}{\psi})^2]}{k}} = \pm 2\phi\sqrt{\frac{2m\cdot(2+\frac{V^2}{c^2})}{k}},.$$

This relation shows there is an expansion of the atom's initial oscillation period *T*, which means a lowering of the atom's oscillation frequency, as a consequence of the intervened quantity $\Delta m' = m\,(1-\psi_V/\psi)^2/2 = m\,V^2/2\,c^2$ that adds with the atom's mass in *S′* (see **[11]** above). Therefore, a slowing down of the clock's tick pace in *S′* occurs – during and after its acceleration – with respect to the clock's pace at its initial speed v.

Once *S′* has achieved its new uniform speed *V*, the delay expressed by $\Delta T = T'_V - T$ doesn't change further, as it remains constant together with *V = constant.* It should now be clear that in this situation the clocks in *S* differ from the clocks in *S′***:** the difference in their ticking pace means that *the times they display do now refer to different measurement systems.* [21]

(iv) Measurement of speed and energy

From the preceding simple analysis, one may infer that the delay shown by clocks in motion at uniform relative speed does ultimately depend on the effects of different initial accelerations undergone by the relevant systems, and does not depend on their relative speed. In other words, if one doesn't know which of the systems has undergone an acceleration with respect to the other, the uniform relative speed as such is

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[21] Slower clocks in *S′* do not *per se* imply that people in system *S′* slow their aging down. In the two different systems age is measured by different time units. In this connection, it's also worth considering that "the twins' paradox" does not pertain to Einstein's special relativity, for such a case involves relative accelerations, whereas Formulas **[1]** in Einstein's special relativity regard inertial systems only.

not sufficient to make one establish in which system the clocks delay and whether they delay or not in any one of the systems.

In the light of the preceding analysis, one might conclude that the *cause* of the tick alteration in clocks *after* acceleration is the same as the cause of their tick alteration under gravity effect, for in both cases differences in time measurement depend on the *effect* of acceleration, i.e., on changes in speed. In this connection, it must be pointed out that changes in the clock's tick pace *are not a function* of the acceleration *itself*, but only of the acceleration's effect, which consists in the change in the kinetic energy of the clock's oscillating masses. In proper terms, the tick pace changes because of the change in the clock's speed, which entails a change in the kinetic energy of the clock. The clock's *acceleration* may have an identical intensity because of either an increase or *decrease* of its speed, but the effects of the acceleration are different in the two cases. If the speed increases, the clock slackens its pace**;** if the speed decreases, the clock hastens its pace.

As to the effect of gravity on the tick pace of clocks, one should consider that gravitational forces entail motion in every case, at either macro or micro scale. In one way or another, matter subject to gravity moves along trajectories/paths with either constant or variable speed, often according to the effects of other possible forces that combine with gravity.

By definition, gravity accelerations are inevitably associated with orbital speeds, so that the mass of any material body affected by gravity has its intrinsic content of kinetic energy due to the gravity field only. This particular energy content may be viewed either in the macro-motion of the whole body with respect to the gravity centre or in the summation of the micro motions of its elemental components (molecules, atoms, etc.) with respect to the physical space, *i.e.*, with respect to the plenum.

Beside the preceding remarks, it's appropriate pointing out, in particular, that the kinetic energy of any particle of matter in an orbital motion depends *only* on its speed along the orbital path. For example, a stable *identical central acceleration* regime may be maintained by any particle in a circular motion *under different conditions of uniform circular motion/speed*, according to appropriate choices of the radiuses and periods of the relevant circular trajectories.

For example**:** consider two bodies, both of mass m, at *different uniform speed*s, V and v, on two different circular gravitational orbits whose radiuses are R and r, respectively, T and t being the respective orbital periods**. If** $V = vT/t = v(R/r)^{1/2}$, then the two bodies – which are vehicles of different kinetic energies – are subject to an identical and constant central acceleration. This example means that the ticketing pace of clocks in motion depends *only* on their speed in space, in no case by the accelerations that might affect them. In fact, if the two orbiting bodies are two identical clocks, the clock at speed $V > v$ is late with respect to the other one.

Once again to conclude that also within gravity fields mass oscillation frequency depends on the relevant kinetic energy, be this constant or variable. **Thus, clocks might be used in a comparative mode to assess also relative differential speeds with respect to the plenum.**

Experiments have been carried out or are still in progress to better understand how time is measured by clocks in different relative motions as well as how the life-time of atomic elements modifies under various dynamic conditions.[22] It must be said that much uncertainty prevails as to the conclusions to be drawn from the findings of those researches, because in no case one can neglect that any material object, in order to achieve any final speed, must first undergo acceleration. Discussions are in fact recorded on whether or not – or in which cases – acceleration should be accounted for in assessing the behaviour of clocks in motion.

(v) Mass energy

Finally, it seems worth observing that one may consider the energy E_m of any mass unit m – in whatever physical state – as expressed by the sum of the *actual* kinetic energy of the mass in motion, at any speed V **with respect to the ether/plenum**, and the *minimum* kinetic energy of the mass in its absolute minimum motion with respect to the plenum/ether ("rest mass m_o").

Let us consider that any material particle is a source of radiation because of its *thermal* vibration, with which a conventional "rest state" frequency ψ_o can be associated. This means assuming that the rest state of any mass *is* its oscillation around a fixed point of the plenum, since the frequency ψ_o of the relevant radiation wave depends on the particle's temperature, *i.e.,* on the average content of *"rest-state"* kinetic energy intrinsic to the particular oscillatory state of the particle.

Let's now imagine that the particle, whose "rest mass" is m_o, moves with respect to the plenum at any speed V, so acquiring – together with additional kinetic energy – that sort of *active mass* proper to the intrinsic oscillation of any particle in motion with respect to the plenum, as already described in addressing the atoms of caesium clocks.

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[22] A useful synthesis concerning the state of the research in this field has been written by Michele Barone, ***Ritardo degli orologi in moto*** [The ticking delay of clocks in motion], in "La natura del tempo" [*The Nature of Time*] ed. by F. Selleri, *op. cit.,* Pages 101 to 110.

Considering **[11]** and **[6a]** above, the *active mass*, *i.e.*, the "*additional mass*" (denote it with m_V), which *seems adding* with the particle's "rest mass" because of the motion across the plenum, is expressed by

[13] $$\Delta m_0 = m_V = \frac{m_0}{2}(1-\frac{\psi_V}{\psi_0})^2 = \frac{m_0}{2}\left(\frac{V}{c}\right)^2,$$

in which ψ_V is the particle's radiation frequency perceived from any system not in motion with respect to the plenum. *Instead*, the radiation frequency ψ_v - perceived from any system moving across the plenum in the same direction of the particle at a relative speed v with respect to the same particle - marks an *active mass* of the particle as given by

[14] $$\Delta' m_0 = m_v = \frac{m'_0}{2}(1-\frac{\psi_v}{\psi'_0})^2 = \frac{m'_0}{2}\left(\frac{v}{c}\right)^2,$$

where m'_0 and ψ'_0 are the particle's "rest mass and rest-mass radiation frequency", respectively, within the system travelling at relative speed v.

Therefore, with respect to the moving reference system, the particle's total mass can be expressed by

[15] $$m = m_v + m'_0 = m'_0\left(1+\frac{v^2}{2c^2}\right).$$

After multiplication of this equation by c^2, one obtains

[16] $$m\, c^2 = (m_v + m'_o)c^2 = m'_o v^2/2 + m'_o c^2.$$

The meaning of this equation is here obvious: It expresses the kinetic energy $E_k = m'_o v^2/2$ of any mass summed with an intrinsic "original" mass energy $E_0 = m'_o c^2$ that may be associated with any particle of matter in its *physical* "rest state", with respect to any reference frame. Thus, the *total energy* of the material particle, in any motion condition and with respect to any reference frame, can be expressed as

[17] $$E_m = m\, c^2,$$

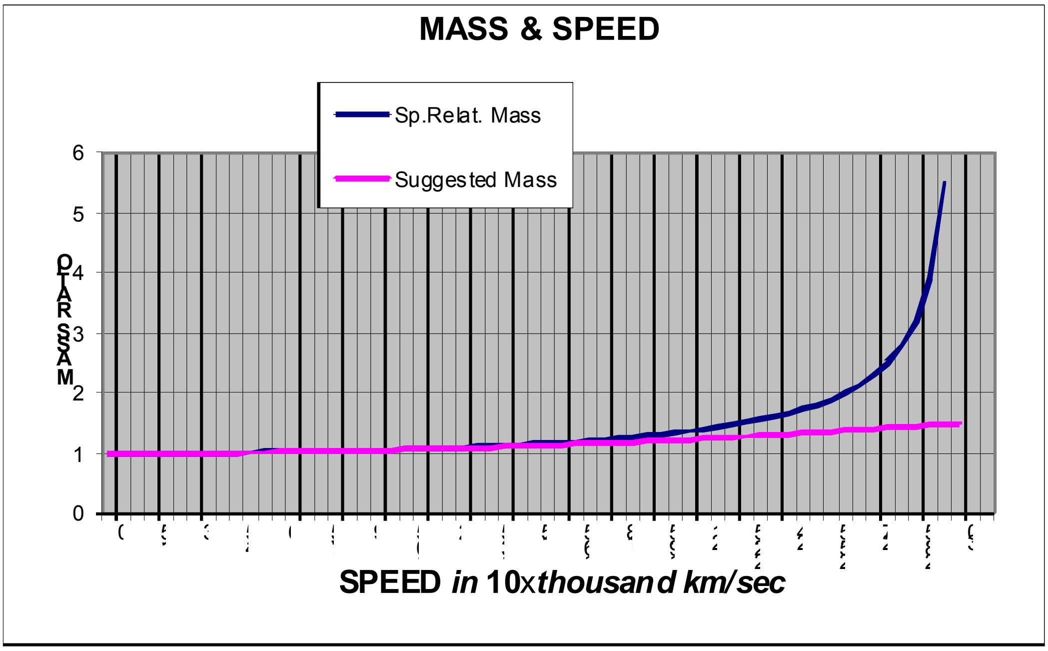
in which m indicates any mass in any state of motion with respect to any reference frame.

It's important to remark that Equations **[10]** to **[17]**, *albeit significant only if* $(V, v) \le c$, do not exclude the theoretical possibility for speed V or v to exceed the speed of light, and suggest avoiding any improper generalisation though.

A similar conclusion ($E = m\, c^2$) is usually (and inappropriately) ascribed to Einstein's special relativity, though the same equation – anticipated in

1905 by one of Poincaré's papers[23] - can be obtained through more than one way of reasoning, to mean that it is not an achievement inherent in Special Relativity.

In this connection it is worth remarking that Equation **[15],** by different reasoning and form though for the same purpose, was proposed by Einstein notwithstanding it is incompatible with the equation for relativistic mass expressed by Equation **[3].** Actually - within the strict logic of Einstein's special relativity - all of the inevitable implications of Equation **[3]** are incompatible with the conclusions showed by Equations **[15]** to **[17];** unless additional as well as contradictory assumptions or simplifications are introduced.[24]



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[23] See Footnote 4 in Page 207.

[24] The graph above shows how mass ratio m/m_0 expressed by use of Equation **[15]** varies with speed, in a comparison with the variation relevant to the same mass ratio obtained by use of SR Equation **[3]**. Up to about $v \approx 0.60c$, the two curves are substantially coincident. For $v = c$ the relativistic curve indicates an infinite value for mass, whereas the other curve shows that the value achieved by mass at speed c is finite and equal to $m_c = 1.5m_0$.

As to physics, the "relativistic mass" seems senseless, and its definition conflicts with Equations **[14]** to **[17],** as these equations are also considered as achievements of Einstein's special relativity. Actually, Equation **[14],** as obtained by Einstein**,** is an "accidental hypothesis", whereas the same equation is here derived analytically. On this subject, see the comment in the next page.

Before Einstein, Lorentz had formulated Equation **[3]** to define the relativistic "transverse mass" [*i.e.*, $m = m_o /(1-V^2/c^2)^{1/2}$]. Einstein came to the same definition in Paragraph 10 of his 1905 paper on special relativity with no mention of Lorentz's equation. In that paragraph of his paper, Einstein defined also the *kinetic energy* of an electron in motion with the following equation

[18] $$E_K = m_o c^2 \, [(1-\beta^2)^{-1/2} - 1] = (m - m_o)\, c^2 \, ,$$

in which $\beta^2 = V^2/c^2$, and m is the "relativistic transverse mass" recalled above.

Still in 1905, a few months after his paper on relativity, Einstein published another very short paper, ***"Ist die Trägheit eines Körpers von seinem Energieinhalt abhängig? "*** (*Does the Inertia of a Body Depend upon its Energy Content?*), Annalen der Physik, September 1905. In that paper Einstein made his first attempt to propose the mass-energy equivalence.[25] For the purpose, he introduced a drastic simplification, by replacing Lorentz's factor $1/(1-\beta^2)^{1/2}$ (where $\beta = V/c$) with the relevant series[26] *cut at the second order term*, thus **assuming** $\mathbf{1/(1-\beta^2)^{1/2} = 1+\beta^2/2}$; with the result of writing an equation equal to my Equation **[15]** or – equivalently – to my Equation **[16].**

If the same "simplification" is allowed for in the relativistic definition of Lorentz's *transverse mass* used by Einstein in Equation **[18]**, Einstein's relativistic definition of *kinetic energy for the electron* becomes

$$E_K' = m_o V^2/2 \, ,$$

which is only the classical definition of kinetic energy. Thus, Einstein's Equation **[18],** because of such a tricky "simplification", would remain with no logical justification and physics without Einstein's special relativity.

The preceding remarks lead me to the following conclusion:

(a) If one considers the equation $E = mc^2$ as an experimentally well tested equation, then the Lorentz transformation factor $1/(1-\beta^2)^{1/2}$ involved by special relativity has no physical significance;

(b) In an alternative, if one considers the Lorentz factor as a basic achievement due to Special Relativity, then this theory cannot be credited

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[25] By the way, in PART II, Paragraph 0.7 of this essay I have already observed that Einstein makes the concept of inertia coincide with the concept of mass, which is against Newton's concept of inertia and, perhaps, also one of the sources of a certain subsequent conceptual confusion in physics.

[26] Lorentz factor $1/(1-\beta^2)^{1/2}$ can also be expressed by means of the following series: $1+\beta^2/2 + 3\beta^4/8 + \ldots + 1\cdot 3\cdot 5\cdot \ldots \cdot(2n-1)\beta^{2n}/(2\cdot 4\cdot 6\ldots \cdot 2n)$, in which $n \rightarrow \infty$.

with the real achievement of the mass-energy equivalence principle expressed by $E = mc^2$, which shall instead be viewed as a separate definition, or hypothesis, or thesis, formulated in various ways both by Einstein and by some of his predecessors or by other physicists. Such an assumption or hypothesis or thesis, however, does certainly conflict with the *logical paradigm* of Einstein's special relativity.

(vi) The "space-time"

In 1907, the advent of the "space-time", with Poincaré-Minkowski-Tolman interpretation of Lorentz's relativity, had created quite a new theoretical situation, in which every previous hypothesis or intuition stating the mass-energy equivalence could transform *naturally* into one of the *axioms* of the new paradigm. The traditional Euclidean three-dimensional space that physics uses in association with "time" to describe phenomena, is transformed by the *space-time* into a *quasi-Euclidean four-dimensional space* where "time" is a fourth additional linear dimension (represented by product $ic{\cdot}t$) **measurable in imaginary length units**, homogeneous to the other conventional three dimensions.

In the *spacetime* the "physical dimensions", *i.e.*, the intrinsic character-ristics of physical quantities undergo a dramatic change. For example, "speed", whose "physical dimension" is conventionally the *ratio of a length (or distance) to a time*, in the space-time becomes *the ratio of a length to a length,* which means a *pure number***;** thus, speed is no more a *physical* quantity, since it has no *physical dimension*. Therefore, in such a formal context the concept of "**energy**", which is dimensionally thought of as *a mass multiplied by a square speed*, turns into the concept of *a numerical multiple of a mass* (in the same sense as one states - for example - that two tons are two thousand times one kilogram).

Analogously, also the *physical dimension* of "**momentum**" is equivalent to the dimension of "mass". In simpler words, in the spacetime "energy", "momentum" and "mass" become *axiomatically* nothing more than three different terms for identifying one same *type* of physical quantity, the *mass*, in three different "conceptual" states, two of which (mass, energy) are *scalar* quantities and one (momentum) is a *vector* quantity. It is also a way to state that in the space-time the three traditional physical dimensions *Length, Time* and *Mass* coagulate in the dimensional couple of *Length* and *Mass* only (or, equivalently, *Length* and *Energy* only). Nevertheless, it is worth pointing out that while "speed" is a scalar quantity also in the spacetime, "velocity" is still a vector quantity, which affects any mass in motion in determining the relevant vector momentum.

Of some interest is also considering that in Minkowski's spacetime the physical dimension of *acceleration* (and of *central acceleration* in particular) is the inverse of a "length", *i.e.*, the dimension of a "curvature", while the concept of *force* (and of *central force,* in particular) may be viewed as dimensionally expressed by *mass* times a *curvature*.

(vii) Superluminal motion [27]

In the absence of viable cosmological alternatives, scientists feel compelled to stick to the relativistic conclusions of Lorentz-Einstein's theories as to the "impossibility" of any superluminal motion. Nowadays, it's common belief that "nothing can travel faster than the speed of light".

The situation of our present scientific knowledge is obviously conditioned by the limits intrinsic to current theories, even against the evidence provided by very significant observations, which should instead induce scientists to doubt what they are used to believe.

At least since 1981,[28] in observing the *strange* very long linear flares, or "jets" orthogonal to galaxy disks and currently associated with the activity of the galactic nuclei, astronomers detected *superluminal* motions in the material particles of which those "jets" consist.

During the last two decades, there have been several attempts to explain the phenomenon, though the given explanations can actually apply under particular conditions only. An initial explanation was accepted for superluminal motions detected in galaxy flares whose alignment is close to (within 19 degree deviation from) the line of sight. However, superluminal motions were later observed also in galaxy flares

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[27] Since a few decades some articles and essays try to question Relativity as to the speed limit (the speed of light) *imposed* on the physical world by that theory. One of the topics addressed for the purpose consists of the discussion-on and the interpretation of the so called "entanglement" described by quantum-mechanics, which involves the generation of pairs of particles whose physical states remain apparently interconnected, irrespective of the distance that may intervene between them. The debate re-proposes, in particular, the physical possibility of *absolute simultaneity*, which was instead ruled out by Special Relativity. It is not my intention to avail myself of such a topic.

Besides, starting from 1967, Gerald Feinberg and followers developed a theory based on "tachyons" (particles speedier than light), picturing a hypothetical world where the speed of light is the unattainable *minimum* speed.

Furthermore, it seems to me that in General Relativity there is no theoretical limit to a possible speed of light exceeding the conventional value of *c*.

[28] See I. J. Pearson & al., ***Superluminal Expansion of Quasar*** *3C273*, Nature, vol. 290, April 1981.

See also R. Porcas, ***Superluminal Motion: Astronomers Still Puzzled***, Nature **28**, April 1983, and R. J. Davis, S. C. Unwin, T. W. B. Muxlow, ***Large scale superluminal motion in the Quasar 3C273***, Nature **354**, Dec. 1991. More recently, J. A. Biretta, W. B. Sparks, F. Machetto, ***Hubble Space Telescope Observations of Superluminal Motion in the M87 Jet***, Astrophysical Journal, vol. 520, Aug 1999.

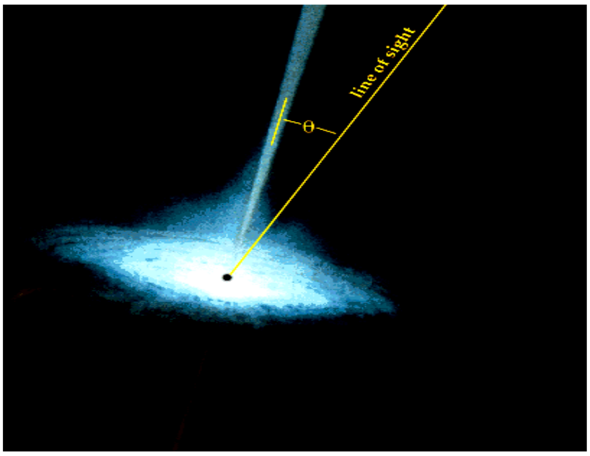
whose alignment is almost perpendicular to the line of sight, and the explanations for the observed phenomenon became insufficient. The "apparent" speed of the superluminal motions observed attains 4 to 9.6 times the speed of light.

In my opinion, there is already enough stuff to question the light's speed limit seriously.

In connection with the arguments presented in the preceding sections of this essay, in particular with a reference to assumptions made in the PART III and in the *Appendix*, the observed superluminal motions can naturally be explained with respect to the *void* (or the *nothingness*) that forms along the linear rotation axis of a ring-vortex as well as in the ring core of ring-vortices.

Part of the analyses and calculations I have carried out in other sections of this essay are based on the hypothesis that the speed of the plenum at the boundary with the vortex nucleus or core (*i.e.*, at the plenum's contact with the void) is more than 2.5 times the speed of light. However, the astronomic observations mentioned above suggest that the maximum speed of the plenum *at its contact with the void* may be much higher than expected**:** Which might remarkably modify a few quantitative conclusions of my analyses based on the hypothesized *source speed* of vortices.

Besides, one can clearly observe the very strong academic resistance against any observation, experiment or data that might lead to question the *academic dogma* that the speed of light is the top limit to physical speed.



*There is no clear explanation for the origin of the galaxy "flares"***:** *These involve extremely high and even superluminal speeds of material particles. This essay provides one of the possible explanations, which is connected with the hypothesis that* ***the "flares" are a visible effect of the action of ring-vortices of "plenum"*** *travelling across the same medium. See the detailed description of the vortex shape, structure and motion in the first "Appendix". Moreover, the length of such "flares" should approximately correspond to the diameter of the "spherical vortex" into which the ring-vortex transforms when moving across the plenum. The picture above shows the inner core of a galaxy with the relevant flare.*

AN INCIDENTAL ASTRONOMICAL ANNEX
The space distribution law of the orbits of solar planets & asteroids

My book and papers about the hypothesis on gravity and gravitation, as due to vortexes of the physical space (the *plenum*), do also entail the consideration of an unceasing formation of undetermined swarms of solar sub-vortices and sub-sub-vortices whose total vorticity[29] equals the value of the vorticity of the solar mother vortex, according to the mathematics of vortex fluid-dynamics theory.

Because of the hypothesized kinetic viscosity of the fluid plenum, there is to hypothesize that zones of major turbulence - as generated by the vortex flux motion - are where both matter and other major vortexes form.

An interpretation of the observations is here that a relative major turbulence in the vortex field external to the body of the solar sphere is particularly active where major planetary vortexes form together with the relevant satellite sub-vortices and intervening asteroid zones. In this connection, a simple correlation, which fits the data rather well, seems to indicate that a sort of turbulence storm occurs in the orbits of the solar system housing the major solar planets and relevant satellite sub-vortices.

The presence of two asteroid orbital zones (Ast.1 and Ast.2), between Mars and Jupiter, together with the farther Kuiper orbital zone (Ast.K) of very massive asteroids – closer to the known system's boundary - have also been accounted for. The position of each orbit, in terms of average distance from the Sun, has been expressed in astronomic units (A.U.). Moreover, according to the exercise's results, an asymptotic distance is shown for the possible further formation of unknown planet or asteroid orbits.

The interpolation function (the "*law*")[30] is a *logistic-like* one, as per the following equation:

$$D = \frac{a}{1 + b * \exp(-k * N)}$$

where ***D*** is the *average* distance in A.U. of the planet or asteroid orbit from the Sun, ***N*** is the relative position in an ordinal sequence (*i.e.,* 1 for Mercury, 2 for Venus, 3 for Earth, etc.), and ***a*** ***,b, k,*** are the parameters calculated by means of the correlation analysis.

The analysis results are as follows:
Maximum allowed number of iteration = 500
Number of observations = 12
Number of iteration performed = 23
Stopped due to relative function convergence
Convergence toleration factor = 1.000000E+000
Final sum of squared deviations = 5.7324924E+000
Final sum of deviations = 2.1893040E+000
Standard error of estimate = 0.798087
Average deviation = 0.638694
Maximum deviation for any observation = 1.15874
Proportion of variance explained (R^2) = 0.9983 (99.83%)
Adjusted coefficient of multiple determination (Ra^2) = 0.9979 (99.79%).
Durbin-Watson test for autocorrelation = 1.743
Parameters:
***a* = 65.3654002** (standard error = 3.663716 ; t = 17.84 ; probab. t = 0.00001)
***b* = 1451.1714** (stand. error = 446.8692 ; t = 3.25 : probab. t = 0.01004)
***k* = 0.706124857** (stand. error = 0.0409344 ; t = 17.25 ; probab. t= 0.00001).
(Future more complete and precise observations will necessary adjust the data set used here)

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29 The *vorticity* of any vortex is expressed by the *angular velocity* (spinning velocity) of the vortex core.

30 A number of astronomers of the past century did variously try – with no success – to identify an exact law for the sequence of the planets' orbital position with respect to the Sun.