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Local Lorentz Invariance and the Distortion of Einstein's Equivalence Principle

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"Science sets itself apart from other paths to truth by recognizing that even its greatest practitioners sometimes err. …"

-- S. Weinberg, Physics Today, November 2005.

I. Introduction

Over the last decade, experiments [1, 2] on the violations of local Lorentz symmetry were conducted. It was specu-lated that the coefficients, which control the degree of Lorentz violation for a given type of particle or field, vanish when Lorentz symmetry holds exactly [3]. In essence, this symmetry says that the laws of physics are the same as required by special relativity for all (local) inertial observers moving through space, regardless of their velocity and orientation.

Many regard a violation of the local Lorentz symmetry as a violation of general relativity. However, this notion ac-tually comes from a distortion of Einstein's equivalence principle by Misner, Thorne, & Wheeler [4] as follows:

"In any and every local Lorentz frame, anywhere and anytime in the universe, all the (non-gravitational) laws of physics must take on their familiar special-relativistic form. Equivalently, there is no way, by experiments confined to infinitestimally small regions of space-time, to distinguish one local Lorentz frame in one region of space-time frame from any other local Lorentz frame in the same or any other region."

They claimed the above as Einstein's equivalence principle in its strongest form [4]. However, one should not take their view seriously since they even obtained, in their eq. (40.14), an incorrect local time of a particle at free fall. [1)]

Moreover, in their book "Gravitation" [4], there is no reference to Einstein's equivalence principle and the re-lated Einstein-Minkowski condition that are stated in his 1916 paper [5] or his subsequent well-known book [6]. In stead, they refer to Einstein's 1911 assumption [7] of equivalence between acceleration and Newtonian gravity and Pauli's version [8] that Einstein pointed out as a misinterpretation [9]. While many admire Einstein's intelligence, it is amazing that they were convinced that the 1916 Einstein's equivalence principle that Einstein insists as crucial were the same 1911 assumption of equivalence that has been proven invalid by the light bending experiments.

Like Pauli, they also did not refer to the related mathematical theorems [10]. Pauli's version [8] is as follows:

"For every infinitely small world region (i.e. a world region which is so small that the space- and time-variation of gravity can be neglected in it) there always exists a coordinate system K_0 (X_1, X_2, X_3, X_4) in which gravitation has no influence either in the motion of particles or any physical process."

Thus, Pauli initiated that, for any given point P, there is a small neighborhood of local Minkowski space. Apparently, Pauli did not see that the removal of gravity in a small region is different from a removal of gravity at one point, but Einstein does. In fact, Einstein [5] remarked, "For it is clear that, e.g., the gravitational field generated by a material point in its environment certainly cannot be 'transformed away' by any choice of the system of coordinates…"

Naturally, one may ask the following questions:

1) Does the interpretation of Misner et al. [4] agree with Einstein's equivalence principle?
2) If they do not agree, would their interpretation be valid in physics?
3) Is a violation of the local Lorentz invariance also a violation of general relativity?

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In this paper, we shall address the above questions with detailed analysis. It will be shown in this paper: 1) the in-terpretation of Misner et al. also does not agree with Einstein's equivalence principle; 2) mathematical analysis shows that the interpretation of Misner et al. is not valid in mathematics and physics; 3) based on general relativity and mathematics, a violation of the Lorentz invariance is generally expected (see Section 2).

General relativity is commonly considered as difficult to be understood because its theory of measurement is incompatible with the rest of physics. However, few recognize that Einstein's general relativity is not self-consistent yet. Moreover, the errors are often inextricably related; and thus to see an error, one must be able to trace the related errors. For instance, Gullstrand [11, 12] suspected that there is no dynamic solution and this is confirmed in 1995 [13-15]. For this, one must understand that the linearization of Einstein equation is invalid for the dynamic case since a dynamic solution of the linearized equation is not an approximation for a solution of the non-linear Einstein equation [15]. Before this, one must see that a field equation may not satisfy a physical requirement [13] and etc.

Nevertheless, to counter Gullstrand, in 1993 Princeton University published a book [16] by Christodoulou & Klai-nerman. They claimed that bounded *dynamic* solutions have been constructed, but actually have not shown that their initial dynamic set is non-empty [17-19]. Similarly, Misner et al. [4] invalidly claimed that their eq. (35.31) has a bounded plane-wave solution [20]; and Wald [21] invalidly claimed that his eq. (4.4.52) has a solution for the second order [22]. Wald [21; p. 183] also incorrectly extended the process of perturbation approximation to the case that the initial metric is not flat. These show that a biased belief can absurdly lead to collective mistakes in mathematics.

In current theory of general relativity, there are three kinds of errors: 1) errors that are related to misinterpretations of Einstein's equivalence principle [23]; 2) some physical principles that Einstein has implicitly used, but other theorists mis-interpreted or even ignored; 3) errors that can be traced back to earlier misunderstandings in physics and mathematics [13, 14]. They are the obstacles for the theoretical progress, and thus must be clearly rectified.

Many of these problems have been solved recently. For instance, the speculation of $E = mc^2$ being unconditionally true, has been proved as invalid for electromagnetic energy theoretically; and recently it has been directly verified by experiments that are not sensitive to the accuracy of electromagnetism [13, 14]. The non-existence of a dynamic solution is a problem discovered by Gullstrand [11, 12]. The principle of causality was implicitly used for symmetry consideration by Einstein [5, 6]; and it also is the underlying reason for Einstein's requirement for weak gravity [24].[2)] However, theorists such as Penrose [25] simply ignored it. Due to inadequate understanding of the principle of causality, some theorists accept solutions that violate Einstein's requirement for weak gravity [25, 26]. These problems are often due to, as shown by't Hooft [20, 27, 28], a failure in distinguishing between mathematics and physics. Einstein's theory of measurements, which Whitehead [29] pointed out as invalid, has been rectified as just what Einstein has practiced in calculations [5, 6].

However, errors of the first kind are essentially mathematical problems and are easier to be rectified. On the other hand, they are popular due to common inadequacy in pure mathematics among physicists. Eric J. Weinberg,[3)] the editor of the Physical Review D, insisted [30] that there is no difference in physics between Pauli's version and Einstein's. Moreover, John L. Friedman, Divisional Associate Editor of Phys. Rev. Lett., [30] advocated that the existence of local Minkowski space has replaced the equivalence principle that initially motivated it. A. Ashtekar, editor-in-chief of Gen. Rel. Grav., claims the Wheeler School as "well-established in science" (March 8, 2012).[4)] C. M. Will, editor-in-chief of Class. & Quant. Grav., has a Ph. D. (1971) from Caltech under Kip Thorne.[5)] Thus, to help such a majority, further de-tailed analysis would be needed. Now, let us address what is Einstein's equivalence principle [5, 6].

II. Validity of Einstein's Equivalence Principle and its Misrepresentations

Although most theorists agree with Einstein [5, 6] that his equivalence principle is the foundation, there is no book or reference, other than Einstein's own work, that can state and explain his principle correctly. In fact, many often con-fused the 1916 principle with Einstein's 1911 assumption of equivalence [7]. Another source of confusion is that many theorists have mistaken Pauli's invalid version [8] as Einstein's equivalence principle [4, 31].

In the book "Gravitation" [4], there is no reference to Einstein's equivalence principle (i. e. [5] and [6]). Instead, it misleadingly refers to Einstein's invalid 1911 assumption [7] and Pauli's invalid version [8]. Thus, due to their influence, Einstein's equivalence principle was often mistakenly regarded the same as the 1911 assumption.[6)] Moreover, many simply cannot tell the difference between the principle of 1916 and the assumption of 1911 [30-32]. [7)]

Einstein's equivalence principle [5, 6] leads to the Einstein-Minkowski condition, on which the time dilation and space contractions are based. On his equivalence principle, Einstein [6] wrote:

'Let now K be an inertial system. Masses which are sufficiently far from each other and from other bodies are then, with respect to K, free from acceleration. We shall also refer these masses to a system of co-ordinates K', uniformly accelerated with respect to K. Relatively to K' all the masses have equal and parallel accelerations; with respect to K' they behave just as if a gravitational field were present and K' were unaccelerated. Overlook-ing for the present the question as to the "cause" of such a gravitational field, which will occupy us later, there is nothing to prevent our conceiving this gravitational field as real, that is, the conception that K'; is "at rest" and a gravitational field is present we may consider as equivalent to the conception that only K is an "allowable" sys-tem of co-ordinates and no gravitational field is present. The assumption of the complete physical equivalence of the systems of coordinates, K and K', we call the "principle of equivalence;" this principle is evidently intimately connected with the law of the equality between the inert and the gravitational mass, and signifies an extension of the principle of relativity to coordinate systems which are non-uniform motion relatively to each other.'

Later, Einstein made clear that a gravitational field is generated from a space-time metric. What is new in Einstein's equivalence principle in 1916 is the claim of the Einstein-Minkowski condition as a consequence for gravity.

Moreover, the Einstein-Minkowski condition has its foundation from mathematical theorems [10] as follows:

Theorem 1. Given any point P in any Lorentz manifold (whose metric signature is the same as a Minkowski space) there always exist coordinate systems (x^μ) in which $\partial g_{\mu\nu}/\partial x^\lambda = 0$ at P.

Theorem 2. Given any time-like geodesic curve Γ there always exists a coordinate system (the so-called Fermi coordinates) (x^μ) in which $\partial g_{\mu\nu}/\partial x^\lambda = 0$ along Γ.

In these theorems, the local space of a particle is locally constant, but not necessarily Minkowski. However, after some algebra, a local Minkowski metric exists at any given point and along any time-like geodesic curve Γ.

What Einstein added to the Einstein-Minkowski condition is that such a locally constant metric must be naturally Minkowski [6, 31]. Note that these theorems imply that gravity may not be transformed away in a small region by a coordinate transformation. In fact, Einstein [5; p.144] remarked with a counter example to Pauli's version.[8)]

Misner et al. [4] make essentially the combined errors of Pauli and the 1911 assumption. However, they are not alone in misinterpreting Einstein's equivalence principle. Will [33] claimed "'Equivalence' came from the idea that life in a free falling laboratory was equivalent to life without gravity." The British Encyclopedia also stated Einstein's Equi-valence Principle incorrectly and ignored the Einstein-Minkowski condition [31]. Instead of rectifying their errors, the Royal Society and the Physical Review also supported them!

Thorne [34] even criticized the distortion of his student [33, 35] as if Einstein's as follows:

"In deducing his principle of equivalence, Einstein ignored tidal gravitation forces; he pretended they do not ex-ist. Einstein justified ignoring tidal forces by imagining that you (and your reference frame) are very small."

However, Einstein has already explained these problems in his letter of 12 July 1953 to Rehtz [9] as follows:

"The equivalence principle does not assert that every gravitational field (e.g., the one associated with the Earth) can be produced by acceleration of the coordinate system. It only asserts that the qualities of physical space, as they present themselves from an accelerated coordinate system, represent a special case of the gravitational field."

Moreover, Einstein [6] explained to Laue, "What characterizes the existence of a gravitational field, from the empirical standpoint, is the non-vanishing of the $\Gamma^l{}_{ik}$ (field strength), not the non-vanishing of the R_{iklm}."

Following the misidentification of Fock [36], the Wheeler School [37] later also claimed that Einstein's equivalence principle was invalid. [9)] Although Einstein's equivalence principle was clearly illustrated only recently [13, 14], [10)] the Wheeler School [4] should bear some responsibility of their misinformation on this principle by ignoring both crucial work of Einstein, i. e., references [5] and [6]. However, the fact that Einstein has not given a clear example to illustrate his principle is also partially responsible.

Since Einstein did not provide an explicit example to illustrate the Einstein-Minkowski condition, a careless reader could mistake the 1911 assumption of equivalence as the 1916 equivalence principle. It is not until 2007 that a metric for uniform gravity [31] for a uniform acceleration "*a*" was published as follows:

$$ds^2 = (c^2 - 2U)\, dt'^2 - (1 - 2U/c^2)^{-1} dx'^2 - (dy'^2 + dz'^2), \quad (1)$$

where

$$U(x', t') = (at)_t^2/2 \quad \text{and} \quad cdt' = cdt - (at/c)dx'[1 - (at/c)^2]^{-1}$$

Here $c^2 > (at)^2$, and "a" is the acceleration of system K'(x' y' z') with respect to K(x, y, z, t) in the x-direction. Metric (1) shows the Einstein-Minkowski condition and thus the time dilation and space contractions clearly. For those Γlik related to accelerations, please see [31]. Moreover, metric (1) is equivalent to the metric

$$ds^2 = (c^2 - a^2t^2)dt^2 - 2at\, dtdx' - dx'^2 - (dy'^2 + dz'^2) \qquad (2)$$

that was derived by Tolman [38], but his earlier form (2) does not show the related Einstein-Minkowski condition clearly. It was a surprise that U is actually time-dependent, and this explains the earlier failures in the derivation of such a metric [39]. Thus, the 1916 principle can be expressed in terms of a metric, and Fock [36] is clearly wrong.

Moreover, Einstein's equivalence principle has been further illustrated by considering a disk K' uniformly rotating w. r. t. an inertial system (x, y, z, t), a metric for the disk of space K' (x', y', z') is derived [23].

According to Landau & Lifshitz [40], the metric is

$$ds^2 = (c^2 - \Omega^2 r^2)\, dt^2 - 2\Omega r^2\, d\phi' dt - dr^2 - r^2\, d\phi'^2 - dz'^2, \qquad (3)$$

Where Ω is an angular velocity relative to an inertial system K (x, y, z, t), z and z' coincide with the rotating axis, and $r^2 = x^2 + y^2 = x'^2 + y'^2$. Metric (3) is equivalent to its canonical form,

$$ds^2 = (c^2 - \Omega^2 r'^2)\, dt'^2 - dr'^2 - (1 - \Omega^2 r'^2/c^2)^{-1} r'^2\, d\phi'^2 - dz^2, \qquad (4a)$$

where

$$cdt' = cdt - (r\Omega/c)\, rd\phi'[1 - (r\Omega/c)^2]^{-1}. \qquad (4b)$$

However, (4b) is not integrable [23] because local time dt' is related to different inertial systems at different r or time t.

The fact that the local time t'is not a global time was a problem that leads to the rejection by the editor of the Royal Society [23]. This rejection is incorrect since validity of metric (4) can be derived theoretically with special rela-tivity. Experimentally, the time dilation from metric (4a) for the local metric, $ds^2 = c^2dT^2 - dX^2 - dY^2 - dz^2$, is

$$dT = [1 - (r\Omega/c)^2]^{1/2}\, dt'. \qquad (4c)$$

From (3'b) the local clock resting at K', if observed from K, would have

$$dt' = dt. \quad \text{and} \quad dT = [1 - (r\Omega/c)^2]^{1/2}\, dt. \qquad (4d)$$

Moreover, as Kundig [41] has shown, the time dilation (3'd) is valid for a local clock fixed at K'. Note also that this gra-vitational effect cannot be eliminated with a linear acceleration; thus the claim of Fock [36] and the Wheeler School [4] on equivalence of gravity and linear acceleration is clearly wrong. Since Einstein's equivalence principle has experimen-tal supports, the 1993 Nobel Committee press release should not frivolously reject this principle implicitly [42].

Moreover, the above analysis clarifies a puzzle why Einstein [5, 6] seemed to be able to derive the time dilation and space contractions of a rotating disk with only special relativity. Now, it is clear that Einstein's derivation is based on invalid applications of special relativity and the results are incorrect. *Note that Einstein also used such invalid claims to justify his adaptation of the notion of distance from a Riemannian space* [5, 6]. Whitehead [29] has pointed out such an adaptation is not valid in physics, but he did not go deep enough to find out what actually went wrong,

III. Implications of Einstein's Equivalence Principle and the Distortions of the Wheeler School

In general relativity, Einstein's equivalence principle actually would imply:

In any and every local Lorentz frame, anywhere and anytime in the universe, all the (non-gravitational) laws of physics must take on approximately their familiar special-relativistic form. Also, there is possibly a way, by experiments to distinguish one local Lorentz frame in one region of space-time frame from any other local Lorentz frame in the same or any other region.

Thus, in the interpretation of Misner et al. [4], the phrase "must take on" should be changed to "must take on approx-imately" Also, the phrase, "experiments confined to infinitesimally small regions of space-time" does not make sense since experiments can be conducted only in a finite region. Also, there is possibly a way, by experiments to distinguish local Lorentz frames. Thus, a violation of the Lorentz invariance is not necessarily a violation of general relativity, and in fact is generally expected as suggested by the above theorems.

Moreover, in their eq. (40.14) they got an incorrect local time of the earth.[1)] Thus, these three theorists [4] not only were very far from being an expert, but also failed in understanding the basics of general relativity [5, 6].[11)]

Furthermore, in mathematical analysis, there is a big difference between for each point "there is a local Minkowski metric with a small region where special relativity is approximately valid" from "there is a small region where special relativity is valid"; and no matter how small the region is. However, many cannot tell the difference because they may not know the famous theorem on open coverings for a bounded closed set in mathematical analysis. An editor of mathematical physics even claimed such mathematical analysis does not make any difference.[11)] Thus, owing to such a level in mathematics, understandably the errors of the Wheeler School were accepted without being questioned.

The finite sub-covering theorem states that any open covering of a bounded closed set, has a finite sub-covering for such a closed set [43].[12)] Now, consider that for any point there is a neighborhood where special

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relativity is valid. Then it is obvious that such neighborhoods form an open covering for any closed set. Thus, for instance, a closed sphere would have a finite sub-covering of open neighborhoods where special relativity is valid.

It is crucial to note that, in a finite dimensional space, if the intersection of two open sets is non-empty, it contains an open subset. Consider a common open subset of two connected neighborhoods, then, the metrics in this subset are all Minkowski with respect to each of the local coordinate system. (Note that this would not follow if the local Minkowski metric is valid only at one point of a given neighborhood.) It thus follows that these two local coordinate systems are related by a Lorentz transformation according to special relativity. Therefore, one can choose any of the local coordinate system as the coordinate system for the union of the two open neighborhoods.

It follows that one can start from an open neighborhood and extend its local coordinate system to an open set that is the union of all the connected open sets that form a covering of an closed set. This implies that any finite closed subset of the space is a Minkowski space. Thus, the notion of local Lorentz invariance is meaningful essentially only for the case of special relativity. In other words, the interpretation of Pauli [8] is invalid in mathematics.[13] Since only mathematical analysis at the undergraduate level is used, this testifies the inadequacy in pure mathematics of many physicists.[14]

Moreover, the assumed existence of a local small region that satisfies special relativity leads to the misidentification of the principle to the 1911 assumption that states the equivalence of gravitation and acceleration. Subsequently, Wald [21] takes a "modern point of view" that abandons Einstein's equivalence principle. In fact, this is the incorrect view of the 1993 Nobel Committee for physics [42]. Many theorists probably suspected that Einstein's equivalence principle is in conflict with Einstein's covariance principle [13, 14].

IV. The Conflict Between Einstein's Equivalence Principle and his Covariance Principle

In general relativity, Einstein's covariance principle is actually in conflict with his equivalence principle. Perhaps, this is the underlying reason that the Wheeler School distorted the latter.

Einstein's equivalence principle implies that the time dilation and the space contractions can be measured [5, 6], and therefore should be unique for a given frame of reference. On the other hand, the covariance principle would imply different gauges for the same frame as equivalent in physics. In fact, Einstein actually obtained distinct space contractions from different gauges [5, 6]. However, if one reads carefully, Einstein actually only assumed, but did not prove his equivalence principle to be valid for the gauge considered. Hence, it is possible that only one gauge is valid for the equivalence principle, i.e. the covariance principle is actually invalid. [15]

Consider the shortest distance r_0 from a ray to center of the sun and the impact parameter b, one has

$$b \approx 2\kappa M + r_0 \,, \quad \text{but} \quad b \approx \kappa M + r_0 \tag{5}$$

from the harmonic and the Schwarzschild gauges respectively [27]. Thus, Einstein's covariance principle is invalid.

However, the covariance principle is Einstein's remedy for his theory of measurement. For its justification, Einstein had used special relativity; and this probably was why Whitehead's criticisms [29] of Einstein's theory of measurement being invalid, was rejected [13, 14]. The problem is finally settled after it is discovered that Einstein's justifications were actually based on invalid applications of special relativity [13, 14]. [16] This also means that nobody can claim to be an expert of general relativity since they did not even understand special relativity adequately.[17]

Another major problem among the "experts" is that many are still misunderstanding Einstein's equation as having dynamic solutions and wave solutions.[18] For instance, Misner et al. consider their plane-wave equation equation,

$$d^2L/du^2 + L(d\beta/du)^2 = 0, \qquad \text{where}$$
$$L = L(u), \;\; \beta = \beta(u), \;\; u = ct - x, \tag{6}$$

and c is the light speed. They [4] claimed that there exists a bounded wave solution of the following form as follows:

$$ds^2 = c^2dt^2 - dx^2 - L^2\left(e^{2\beta}dy^2 + e^{-2\beta}dz^2\right) . \tag{7}$$

The truth is, however, that their equation (6) has no bounded solution [13].

On the other hand, many attempted to justify the existence of the dynamic solution and the wave solution with un-bounded time-dependent solutions [24-26] in spite of disagreement with Einstein's requirement on weak gravity. They thought the covariance principle was a convenient excuse to accept unbounded solutions. However, a problem remains that the calculation of the radiation for the binary pulsars needs a bounded dynamic solution.

In short, sources of errors are not only the rejection of Einstein's equivalence principle, but also the acceptance of Einstein's invalid covariance principle [27].[19] In addition to the mistake due to a failure in distinguishing physics from mathematics [20, 28], the Wheeler School has a special need because the covariance principle is used for their theory of black holes [4, 21, 27]. Moreover, they probably were aware of the inconsistency between Einstein's covariance principle and Einstein's equivalence principle since they used a different approach to derive the light bending [4].

Perhaps, the Wheeler School chose Einstein's invalid "covariance principle" because it is closely related to gauge invariance that has a long history starting from electrodynamics. Subsequently, gauge invariance has been formally de-veloped in 1954 to non-Abelian gauge theories such as the Yang-Mills-Shaw theory [44, 45]. They extended the gauge invariance to the cases of the Non-Abelian gauges in terms of mathematics. However, as shown by Aharonov & Bohm [46] in 1959, the electromagnetic potentials actually are physically effective; and, as shown by Weinberg [47], all the physical non-Abelian gauge theories are not gauge invariant such that masses can be generated. Yet, one may argue that whether this is really what happens in Nature is still entirely open. The crucial point is, however that for a non-Abelian theory in physics, there are different elements representing distinct particles, and thus the whole theory cannot be gauge invariant.[20)] Thus, gauge theories also support Einstein's covariance principle being invalid.

V. Conclusions and Remarks

The attempt [4] to replace Einstein's equivalence principle (1916) with the equivalence assumption (1911) and/or Pauli's version [30] leads to great confusions [13]. Journals including the Physical Review [1)] and the Royal Society, accept unbounded solutions as valid [24] and other crucial errors [13, 30]. Theorists such as 't Hooft [28] even failed to tell the difference between physics and mathematics [20]. This error eventually leads to the implicit rejection of Einstein's equivalence principle by the 1993 Nobel Committee for Physics [42]. As a consequence, courses in general relativity of almost all, including the well-known universities, are affected.[21)] Thus, for the progress of physics, it is necessary to rectify the damages done to general relativity [4, 33-35, 37, 48]. [22)]

A related problem was that many were reluctant to question, accepted but unverified assumptions, and misin-terpreted scientific evidence [13-15, 21]. These often result in that accumulated errors become not only prevailing but also dominating. Fortunately, Dr. Daniel Kulp [49], however, is an exception and has recently discontinued such practices. Thus, the current position of the Physical Review is that they are not yet convinced of the recent theoretical developments [48], but no longer object to the criticisms toward the Physical Review D.

Up to 1990, Zhou Pei-Yuan of Peking University probably was the only known theorist, rejecting the covariance principle but accepting Einstein's equivalence principle [50, 51]. Moreover, Zhou could have discovered that lineariza-tion to obtain an approximate wave solution is invalid if his student and friends had not made surprising mistakes [52, 53]. However, nobody would continue the experiments on local light speeds that Zhou initiated [51, 54] because the works of Zhou on relativity have been misunderstood and also distorted.[23)] Many blindly adapt the views of Princeton University as representing the truth, without adequate examination [55].[24)] This problem is perpetuated by the claim of gauge invariance by C. N. Yang [44] who also masqueraded to be an expert of general relativity [56, 57].[25)]

Thus, the distortion of Einstein's equivalence principle is the initial obstacle to progresses in general relativity eve-rywhere,[26)] including China [55, 58]. The invalid acceptance was, in part, due to that many still do not understand the principle of causality adequately [20, 24-28]. Owing to physical and mathematical inadequacy, Misner et al. [4] created a distortion of the Einstein-Minkowski condition, the so-called "local Lorentz invariance". This could unfairly give fur-ther damages to the reputation of Einstein. Now, it is clear that experimental tests should give unfavorable results [2].

In summary, the main source of errors is unexpectedly the Princeton University.[27)] To deny their errors, Christodou-lou and Klainerman [16] claimed that they have constructed dynamic solutions of the Einstein equation. However, this only exposed their incompetence at the undergraduate level further [15-19, 57].[28)] Nevertheless, this does support con-siderable questionable "claims" from collapsing immediately. Then, they even succeeded in converting the 1993 Nobel Committee for Physics into agreeing with their erroneous views. Another consequence was that Christodoulou had re-ceived dubious honors from his supporters and many physicists were misled (Wikipedia).

It should be noted that after the Shaw Prize award of his errors, Christodoulou has been elected to be a member of U.S. National Academy of Sciences (2012). Now, it is clear that the problem is far beyond an invalid award but proba-bly involves the credibility of US academic honor. Fortunately, the advocates for Christodoulou have run out of valid excuses since their errors can be illustrated with mathematics at the undergraduate level. Nevertheless, some theorists still pretend that no valid objections have ever existed as Hawking did.[29)] Fortunately, the American Physical Society led by Kulp etc. has awakened up to examine physics according to evidence. Note that Einstein emerges from the recti-fications as a even better theorist since his conjecture of unification is proven as necessary [13]. Moreover, since the Wheeler School and their associates are unable to put the genii back to the bottle,[30)] a better choice for them would be to work on new developments such as the charge-mass interaction [48].

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VII. Endnotes

1. Liu [59], Wald [21] and Weinberg [60] do not make the same mistake, but Ohanian & Ruffini [37] do.
2. The editor of the Physical Review considered the rejection of Einstein & Rosen to a gravitational wave solution being incorrect since the singularity identified by them is removable. However, their rejection is actually valid since such a solution violates Einstein's requirements on weak gravity. Subsequently,'t Hooft came up with a bounded solution in vacuum, but without a valid source; and thus the principle of causality is violated again [20].
3. Eric J. Weinberg obtained his Ph. D. (1973) in physics from Harvard University under Prof. Sidney Coleman. He graduated with BA (1968) from Manhattan College, which is famous for engineering and applied sciences. Ap-parently, his inadequate background in pure mathematics is shown in his erroneous judgments as an editor. This illustrates that pure mathematics can also be important in physics although it may not be used very often.
4. It is clear that A. Ashtekar was unaware of their mistakes [4] at the undergraduate level on crucial calculations of waves [13]. His thesis, "*Asymptotic Structure of the Gravitational Field at Spatial Infinity*", seems to just inherit the errors of Wald [21] since there is no bounded dynamic solution for the Einstein equation [15]. Ashtekar failed to see in his quantum gravity that the photons must include gravitational energy [13, 14, 61].
5. Like his thesis advisor Thorne [4], mathematical physicist C. M. Will is known for his mathematical errors at the undergraduate level. In particular, Will insists on his errors, on $E = mc^2$ being unconditional [33, 62].
6. To guard against misjudgments, the Nobel Prize Committee allows a long time delay to settle possible errors. However, this method is not effective when theorists practice authority worship of the 16th century [42].
7. In the book of Liu [59], though referred to Einstein [5], also refers to others who misinterpreted Einstein's equiva-lence principle [4, 31]. Liu also claimed that Einstein's equivalence principle is not rigorously valid.
8. In effect, Einstein pointed out that the versions of both Misner et al [4] and Pauli [8] are invalid in physics.
9. The misidentification of Fock [36], Ohanian & Ruffini [37] and Wheeler and etc. on Einstein's equivalence prin-ciple has projected an unfair and incorrect image of Einstein since the 1911 assumption has been proven incorrect. Fock has the excuse of being for the campaign of the Soviet Union, but the motivation of others is not clear.
10. Hsu & Hsu [39] failed to get a transformation between an inertial frame and a uniformly accelerated frame.
11. However, based on Misner et al, [4], Fields Medalists S. T. Yau and E. Witten have [15] assumed uniqueness of coupling signs in the positive energy theorems [63, 64] as Hawking did [21]. Moreover, B. L. Z. Nachtergaele, editor of the J. of Math. Phys. does not see a problem in the mathematics of Misner et al. [4] (June 22, 2012).
12. For a finite sub-covering theorem in general topology, one can read the book by Kelley [65].
13. One might ask why mathematicians (including the Field Medalists E. Witten (1990), and S. T. Yau (1982) whose works have been closely related to general relativity) also failed to discover the distortions of the Wheeler School (a rather simple problem for mathematicians) if the non-existence of dynamic solutions is a too complicated prob-lem. The answer seems to be that they are very careless or put it under a better light, they trust the physicists.
14. Theorists, including Nobel Laureate 't Hooft, the Editor-in-Chief of the Foundation of Physics, still agrees with the misinterpretation of the Wheeler School because he also has similar problems in mathematics [20].
15. Einstein's covariance principle is regarded as similar to gauge invariance in a gauge theory in particle physics. Understandably, C. N. Yang, who initiated the Yang-Mills-Shaw theory [44, 45] based on the notion of total gauge invariance, would disagree with P. Y. Zhou [50, 51] of Peking University, who first pointed out the invalidity of Einstein's covariance principle. It turns out that Yang-Mill-Shaw theory is actually invalid in physics. Thus, it is misleading to call a non-Abelian gauge theory as a Yang-Mill theory. As pointed out by Weinberg [47], in a phys-ical gauge theory, gauge invariance applies only formally to the Lagrangian, but gauge invariance is necessarily broken due to physical considerations such as the well-known spontaneous broken symmetry etc. Such a broken symmetry is similar to the case that a valid gauge must be chosen in general relativity [13, 14].
16. That theorists including Einstein make mistakes related to special relativity are not rare incidences. For instance, Nobel Laureate, 't Hooft also made

errors related to special relativity in his 1999 Nobel Lecture [66]. One may note also that many theorists, including this author, did not discover Einstein's error before 2005.

17. Since there is no authority for general relativity, everybody has to argue with evidences.
18. A half of the 2011 Shaw Prize was awarded to Christodoulou [56] for his errors against Gullstrand [11, 12]. If the Shaw Prize had checked whether there is a solution that can satisfy the claims of Christodoulou, they could have found his errors. However, maybe we should be a little bit easy on the Shaw Prize Committee since a number of Nobel Laureates also made such a mistake. For instance, Nobel Laureates, G.'t Hooft and F. Wilczek also failed to see that there is no dynamic solution for the Einstein equation [15, 22, 53]. Moreover, as shown in their Nobel lectures,'t Hooft [66] who does not understand special relativity adequately, regarded the electric energy of a charged particle contributes to its inertial mass, and Wilczek [67] failed to see that $m = E/c^2$ is not generally valid.
19. Rectifications in general relativity are necessary since there is no radiation reaction force. Although an accelerated massive particle would create radiation [22], the metric elements in the geodesic equation are generated by other particles [5]. Nevertheless, this does not affect the validity of Einstein's equivalence principle [68].
20. C. N. Yang seems still fail to understand the logic that a non-Abelian theory in physics cannot be gauge invariant. Nevertheless, a mathematical foundation of studying non-Abelian gauge theories was laid down by Yang-Mills [44] and Shaw [45], but a non-Abelian gauge theory in physics is not really a Yang-Mills-Shaw theory.
21. Misinterpretations of Einstein's equivalence principle and the invalid speculation $E = mc^2$, being as mass and energy unification [68-70], are prevailing in university courses such as MIT's open course Phys. 8.033, and Stan-ford's open lectures on Einstein's Theory of Relativity by L. Susskind. Susskind also omits crucial issues and overlooked errors in mathematics and physics at the undergraduate level. Theorists, including some editors, be-lieved the speculation that any energy would always create the attractive gravity; but it is actually invalid [50].
22. As Feynman [71] pointed out, many in gravitation are incompetent. For instance, an error is the failure to see the impossibility to have a dynamic solution [13, 14], and the misinterpretation of the Hulse-Taylor experiments [15]. This error has far reaching consequences in theoretical developments such as the singularity theorems [15, 21].
23. In fact, L. Z. Fang misinterpreted Zhou's theory, and I discovered this only after I read a paper [72] of his student.
24. Some theorists still failed to see that linearization is not valid for the dynamic case [73] since 1993 [57, 74].
25. Under the leadership of C. N. Yang & K. Young whose errors in general relativity [73] were pointed out in 1993 [74], the 2011 Shaw Prize awarded to Christodoulou is not the only problem. The 2008 Prize in Astronomy was awarded to R. Genzel, "in recognition of his outstanding contributions in demonstrating that the Milky Way contains a super-massive black hole at its centre". However, Genzel himself is not 100% sure.
26. B. Richter [75] comments, "… I think some of what passes for the most advanced theory these days is not really science." Many theorists just have not been able to be out from their past errors [9, 31, 53, 54, 56, 57, 76].
27. However, this does not diminish my respect to this institute. My respected teachers such as Prof. A. J. Coleman and Prof. I. Halperin, who was my advisor for my degrees in mathematics, were graduated from Princeton.
28. In sciences, the defense of an error often leads to the exposition of other errors.
29. In his visit to China, Hawking still claimed that his invalid theory is based on general relativity only. Nevertheless, the Chinese physicists bought such a claim because they were also out-dated then.
30. It was claimed that the puzzle of pioneer anomaly of NASA has been solved with an improved model. A problem is, as a discoverer of the anomaly commented, that such a model can be made to fit essentially any data at all.

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