APRI-TH-PHY-010-03

COMMENTS ON THE “CYLINDRICALLY SYMMETRIC WAVES” OF ‘T HOOFT

C. Y. Lo

Applied and Pure Research Institute,

7 Taggart Drive, Unit E, Nashua, NH 03060 USA

March 2010

ABSTRACT

It has been found that it is impossible to have a dynamic solution for the Einstein equation and the nonexistence of gravitational wave solutions is due to a violation of the principle of causality. However, ‘t Hooft claimed that his “cylindrical symmetric wave” would challenge this conclusion. It is shown that the metric form of the Einstein-Rosen type violates the principle of causality. Thus, the “wave” of ‘t Hooft is invalid in physics because he fails to tell the difference between mathematics and physics. Moreover, there are two errors in his construction, namely: 1) the plane wave has been extended beyond its physical validity as an idealization, and 2) the integration over the angle is not a wave packet and cannot be justified with any physical process.

Key words: Einstein’s equivalence principle; covariance principle; principle of causality; gravitational wave. 04.20.-q, 04.20.Cv

“Science sets itself apart from other paths to truth by recognizing that even its greatest practitioners sometimes err.” -- S. Weinberg, Physics Today, November 2005.

1. INTRODUCTION

A common mistake among theorists [1] including Einstein [2], Feynman [3], Landau & Lifshitz [4], etc., was assuming the existence of dynamic solutions for the Einstein equation of 1915. This issue of dynamic solutions was raised by Gullstrand [5] in his report to the Nobel Committee in 1921. 1) Due to conceptual errors such as ambiguity of coordinates as pointed out by Whitehead [6] and Zhou [7], many cannot reconcile the non-existence of dynamic solutions with the three accurate predictions. It was not until 1995 that the impossibility of having dynamic solutions is proven [8, 9] and related issues are addressed subsequently [1, 10]. Meanwhile, in the 1993 press release of the Nobel Prize in physics, 2) The Royal Swedish Academy of Sciences changed their position on the Einstein equation from being skeptical to affirmative [11]. Perhaps, encouraged by the errors of Nobel Committee, 't Hooft [12] produced his "counter" example because he was unaware of its invalidity in physics.

Historically, Einstein & Rosen [13] could be considered as the first to discover the non-existence of wave solutions, but editors of the Physical Review found that the singularities they discovered are removable [14]. This led to a self-deceptive satisfaction that hindered progress in physics. Also Christodoulou & Klainerman [15] claimed to have constructed dynamic solutions for the Einstein equation due to some elementary errors in mathematics [16, 17]. Moreover, the editors of the Physical Review and other journals failed to identify the violation of physical principles such as the principle of causality [10, 18, 19].

Surprisingly some theorists such as 't Hooft still clinch on the cylindrical solution of Einstein-Rosen type. The reason seems to be that this provides a seemingly close mathematical analogy with the case of electromagnetism. For instance, 't Hooft provided an example [12] to justify the linearization of the Einstein equation although this has been proven invalid for the dynamic case [1, 8]. In fact, the cylindrical solution of Einstein-Rosen type is invalid because both Einstein's equivalence principle and the principle of causality are violated [20]. However, 't Hooft was not convinced [21] because he failed to understand both Einstein's equivalence principle (see Appendix) and the principle of causality (see Section 2). Moreover, he claimed that his views are popular [21], and thus his errors should be identified.

In this paper, it will be shown in details that the cylindrical solution of Einstein-Rosen type is invalid. The violation of physical principles will be identified and discussed with details of the cylindrical solution. Moreover, the errors of 't Hooft are explained in details. It is hoped that thereafter theorists would study the problem of gravitation anew with adequate physical considerations. In particular, it is hoped that relativists would learn from his errors and thus understand physics better.

2. THE PRINCIPLE OF CAUSALITY

The time-tested assumption that phenomena can be explained in terms of identifiable causes is called the principle of causality [1, 8]. This principle is the basis of relevance for all scientific investigations. This principle is commonly used in symmetry considerations in electrodynamics.

In general relativity, Einstein and subsequent theorists have used this principle implicitly on symmetry considerations [1] such as for a circle in a uniformly rotating disk and the metric for a spherically symmetric mass distribution. In fact, a crucial argument in the proof of the nonexistence of dynamic solutions of Einstein equation [1, 8] is based on symmetry considerations due to the principle of causality. Nevertheless, this principle is often neglected in the consideration of solutions [1, 12].

Since the coordinates are ambiguous, it is often difficult to apply the principle of causality in a logical manner other than implicitly as Einstein did. The "covariance principle" is also responsible for such a strange situation. Since the covariance principle is necessary to remedy the shortcomings of Einstein's theory of measurement, many would still believe on the covariance principle even counter examples have been found [22]. This problem is settled only recently because it is found that the justifications of his theory of measurement were based on invalid applications of special relativity [23, 24].

However, physicists have not considered its other consequences until recently. For instance, parameters unrelated to any physical cause in a solution are not allowed and that the weak sources would produce weak gravity is, in fact, the theoretical foundation of Einstein's requirement on weak gravity. Moreover, a dynamic solution must be related to appropriate dynamic sources, and a gravitational wave should have an appropriate source to be compatible with that gravity cannot be screened. For the massive sources, the non-existence of dynamic solutions is proven [1, 8].

On might argued that a gravitational plane-wave would have no source just as in electrodynamics. However, a plane wave is an idealization of a section of the wave, whose source strength is implicitly implied in the amplitude. For a cylindrical symmetric wave, however, appropriate sources must be present. The Einstein-Rosen type waves are invalid because no appropriate sources can be found [20].

Because of inadequate understanding of physics, ‘t Hooft believed [21] that “Dynamical solutions means solutions that depend non-trivially on space as well as time.” Thus, he has different, but invalid understanding of the principle of causality [21]. He claimed, “To me, causality means that the form of the data in the future, $t > t_1$, is completely and unambiguously dictated by their values and, if necessary, time derivatives in the past, $t = t_1$. So, I constructed the complete Green function for this system and showed it to Lo. This function gives the solution at all times, once the solution and its first time derivative is given at $t = t_1$, which is a Cauchy surface.” Apparently, he acquired his invalid notion from his undergraduate years.

‘t Hooft failed to see that his causality only means that a Maxwell-type equation, which produces the green function, is satisfied. This is inadequate because a solution of Maxwell equation could violate the principle of causality if other physical requirements are not satisfied. For instance, the electromagnetic potential $A_0[\exp(t - z)^2]$ (A_0 is a constant), is invalid in physics. This example illustrates that ‘t Hooft as well as his followers often cannot tell the difference between mathematics and physics.[3)]

3. THE CYLINDRICAL SYMMETRY METRICS OF EINSTEIN AND ROSEN

Let us examine their cylindrical “waves” of Einstein & Rosen [13] again. In coordinates ρ, φ, and z their solution is

$$ds^2 = \exp(2\gamma - 2\Psi)(dT^2 - d\rho^2) - \rho^2\exp(-2\Psi)d\varphi^2 - \exp(2\Psi)dz^2 \tag{1}$$

where T is the product of the velocity of light and the time coordinate. Its frame of reference has the Euclidean-like structure. Ψ and γ are functions of ρ and T. They satisfy

$$\Psi_{\rho\rho} + (1/\rho)\Psi_\rho - \Psi_{TT} = 0, \tag{2a}$$

$$\gamma_\rho = \rho[\Psi_\rho{}^2 + \Psi_T{}^2], \quad \text{and} \quad \gamma_T = 2\rho\Psi_\rho\Psi_T. \tag{2b}$$

Also, the function γ satisfies an inhomogeneous linear equation of Maxwell-type,

$$\gamma_{\rho\rho} + \gamma_\rho/\rho - \gamma_{TT} = 2\psi_T{}^2 \tag{3}$$

When gravity is absent (i.e., $\Psi = \gamma = 0$), the reduced metric is equivalent to the flat metric.

Weber & Wheeler [25] claimed, “We concluded that many of the otherwise apparently paradoxical properties of this cylindrical wave can be understood by taking into account the analogy between gravitational waves and electromagnetic waves, and the special demands of the equivalence principle, which rules out a special role for any particular frame of reference."[4)] Their claims could be valid if γ (r, T) had a physical solution. However, their own solution implies otherwise [20]. In terms of physics, a cylindrically symmetric metric must have a source because it is not a local idealization of waves from distant sources. However, as will be shown, it is impossible to have appropriate sources for such a metric.

4. REMARKS ON THE MAXWELL-NEWTON APPROXIMATION

To the above end, a review of the Maxwell-Newton Approximation would be useful. It was incorrectly believed that the linearized Approximation always provides the first order approximation for the Einstein equation [26-28]. This belief was verified for the static case only. For a dynamic case, however, this is no longer valid [1, 8, 10] because it is impossible to have a bounded dynamic solution. Nevertheless, ‘t Hooft believed that the cylindrically symmetric metric could be an exception.

To discuss this, let us consider the Maxwell-Newton Approximation as follows:

$$\frac{1}{2}\partial^c\partial_c\bar{\gamma}_{\mu\nu} = -K\,T(m)_{\mu\nu}\,, \quad \text{where} \quad \bar{\gamma}_{\mu\nu} = \gamma_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu}(\eta^{cd}\gamma_{cd}) \qquad (4a)$$

and

$$\bar{\gamma}_{\mu\nu}(x^i, t) = -\frac{K}{2\pi}\int \frac{1}{r}T_{\mu\nu}[y^i, (t-r)]d^3y, \quad \text{where} \quad r^2 = \sum_{i=1}^{3}(x^i - y^i)^2\,. \qquad (4b)$$

From (4b), a source would give $\gamma_{\mu\nu}$ as of the first order. From (4a), it is clear that the linearized harmonic gauge $\partial^c\bar{\gamma}_{cd} = 0$ would imply the conservation law, $\partial^c T(m)_{cd} = 0$. In turn, as pointed out by Wald [27], this would mean that the test bodies move on geodesics of the flat metric $\eta_{\mu\nu}$. On the other hand, the covariant conservation law,

$$\nabla^c T(m)_{cd} = 0, \qquad (5)$$

implies only that $\partial^c\bar{\gamma}_{cd}$ is of the second order. Thus, theoretical consistency requires that the linearized harmonic gauge is not exact.

Now, consider the metric of Einstein & Rosen [13]. For the case of weak gravity as Professor ‘t Hooft believed, we have the lowest order:

$$\bar{\gamma}_{tt}(\rho, t) = -2\Psi^2, \quad \bar{\gamma}_{zz}(\rho, t) = -4\Psi(\rho, t) + 2[\gamma(\rho, t) + \Psi^2], \quad \bar{\gamma}_{xy}(\rho, t) = -2\gamma(\rho, t)\,xy/\rho^2,$$

$$\bar{\gamma}_{xx}(\rho, t) = 2\gamma(\rho, t)\,y^2/\rho^2 + 2\Psi^2, \quad \text{and} \quad \bar{\gamma}_{yy}(\rho, t) = 2\gamma(\rho, t)\,x^2/\rho^2 + 2\Psi^2. \qquad (6)$$

Thus, since $\bar{\gamma}_{tt}(\rho, t)$ is of second order, according eq. (4), there is no T_{tt} to generate the metric. Thus, there is no valid source for a metric of Einstein-Rosen type. In other words, the principle of causality is violated. Thus, independent of the form of ‘t Hooft’s solution, it is invalid in physics.

On the other hand, the time dilation and space contractions would mean

$$-g_{\rho\rho} \geq 1 \geq g_{tt}, \qquad -g_{\varphi\varphi}/\rho^2 \geq 1, \qquad \text{and} \qquad -g_{zz} \geq 1. \tag{7a}$$

In fact, it follows (7a) directly that

$$(2\gamma - 2\Psi) \geq 0 \geq (2\gamma - 2\Psi), \qquad -2\Psi \geq 0, \qquad \text{and} \qquad 2\Psi \geq 0. \tag{7b}$$

Thus, $\Psi = \gamma = 0$. This also shows that there is no physical wave solution for $G_{\mu\nu} = 0$.

5. THE CYLINDRICAL SYMMETRY ‘WAVE’ SOLUTION OF ‘t Hooft

The cylindrical metric constructed by ‘t Hooft [20] is as follows:

$$\Psi(r,t) = A\int_0^{2\pi} d\varphi e^{-\alpha(t-r\cos\varphi)^2}, \tag{8}$$

where A and α (> 0) are free parameters. ‘t Hooft claimed (8) is a wave packet just as a wave packet in electrodynamics. It is well known that such a wave packet takes the form [29],

$$u(x, t) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} A(k)u_k(x,t)dk \qquad \text{where} \qquad u(x,t) = e^{ikx - i\omega(k)t}. \tag{9}$$

An example of the wave packet is

$$u(x,t) = Ae^{-(t-x)^2}, \tag{10}$$

where A is a constant. Note that a plane wave is an idealization whose validity is within the narrow neighbourhood of a ray propagating in the x-direction. Thus, such a wave packet (10) is a valid idealization since it is also propagating in the same x-direction, and validity of packet (10) is also within the narrow neighborhood of a ray. However, ‘t Hooft seems to forget the above restrictions.

To see this, let us transform (8) in terms of the x, y coordinates. Since x = r cosφ, we have

$$e^{-\alpha(t-r\cos\varphi)^2} = e^{-\alpha(t-x)^2} \quad \text{and} \qquad d\varphi = dy/x = dy/(r^2 - y^2)^{1/2} \tag{11}$$

where the integration is over y with limit from y = -r to y = r. Since the idealization of such a packet is valid within a narrow neighborhood of a ray propagating in the x-direction, this integration over a large rang of y, just makes no sense in physics. This illustrates again that Professor ‘t Hooft needs to improve his understanding in physics at the undergraduate level.

6. DISCUSSION AND CONCLUSIONS

Apparently, ‘t Hooft is not free from the habit, acquired from calculating the Feynman diagrams for years, assuming a perturbation approach would always be valid. Thus, he does not understand that, for the dynamic case, it is impossible to have a bounded dynamic solution for the Einstein equation with massive sources [1, 8]. Having inadequate background in pure mathematics, ‘t Hooft failed to understand that, for the dynamic case, the linearization of Einstein equation does not produce an approximate solution [5)] since the non-linear Einstein equation does not have bounded dynamic solutions [1, 8, 10]. [6)]

In scientific discussions, almost everybody makes mistakes in some occasions. Nobody should be considered as a villain [21] because of his honest scientific opinion since we are working for the same goal, the scientific truth. Also, one should be very careful to make claims such as “irrefutable evidence” [21]. There are occasions such as the invalid covariance principle and Einstein’ justification for his measurement theory, the major errors are due to inadequate deliberation of the “irrefutable evidence” [23, 24, 30].

In general relativity, problems are often related to inadequate understanding of Einstein’s equivalence principle. However, ‘t Hooft took this principle lightly. Note that sometimes even Einstein himself also did not understand his own principle well. Otherwise, he would not have proposed a metric form (1) that has its violation. Thus, to understand general relativity, Professor ‘t Hooft should read Einstein’s equivalence principle and related mathematics carefully. Einstein is correct in regarding Pauli version as a misinterpretation (see Appendix). Also, many still incorrectly regard Einstein’s equivalence principle of 1921 to be the same as the 1911 assumption of equivalence [31] in text books [32, 33] as well as in course notes.[7)] However, there is no analysis concluding that “test particles are forbidden” [21].

To help the students, Professor ‘t Hooft has written an article “How to become a good theoretical physicist” posted in the INTERNET. From his article, it is clear where his shortcomings come from [34]. Prof. ‘t Hooft stated, “I can tell you of my own experiences. I had the extreme luck of having excellent teachers around me. That helps one from running astray. It helped me all the way to earn a Nobel Prize.” It is likely that he used to relying on his teachers to give him guidance in physics. However, a Nobel Prize in physics probably leads him to believe that he is a good theoretical physicist.

It is true that a Nobel Prize confirms his valuable contribution to physics, but applied mathematics is not the same as physics. For example, an intelligence officer may obtain some crucial information to won a battle and should be rewarded. However, his contribution does not necessarily make him a general. In this paper, it is clear that Professor ‘t Hooft himself still has some mileages to run for reaching the goal of being a good theoretical physicist. One should be aware that in order to defend an error, it would inevitably create more errors, logical errors in particular. Moreover, science is based on evidence, not just opinions.[8)]

Einstein also made mistakes, but he admits them. However, this does not diminish his status as a great scientist earned by his contributions. In fact, in spite of shortcomings, new discoveries just further reaffirm Einstein’s great contribution since implications of general relativity have far reaching consequences such as unification that only recently we begin to appreciate [23, 35, 36].

ACKNOWLEDGMENTS

The author is grateful for stimulating discussions with G. ‘t Hooft and John Dyson, University of Leeds UK, for extensive discussions on the solution of ‘t Hooft. This work is supported in part by Innotec Design, Inc., U.S.A.

Appendix: Einstein’s Principle of Equivalence, the Einstein-Minkowski Condition

A consequence of Einstein’s equivalence principle [26, 37] is the *Einstein-Minkowski condition* that the local space of a particle under gravity must be locally Minkowskian, from which he obtained the time dilation and space contractions. However, many often regarded this condition as non-essential [38]. Although Einstein used it in his book [26], many may still have missed this important point [39]

In his book, “The Meaning of Relativity”, Einstein [26] 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 gravita-

tional field were present and K' were unaccelerated. Overlooking for the present the question as to the "cause' of such a gravitational field, which will occupy us latter, 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" system 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.

Einstein's equivalence principle is different from Einstein's 1911 preliminary assumption on the equivalence between uniform acceleration and uniform Newtonian gravity [37]. Fock [31] found it impossible to show that the related metric is of the following form, $ds^2 = g_{tt}(x)\, c^2dt^2 - dx^2 - dy^2 - dz^2$ [39].

What is new in Einstein's equivalence principle in 1916 is the claim of the Einstein-Minkowski condition as a consequence [37; p. 161]. The Einstein-Minkowski condition additionally has its foundation from mathematical theorems [40] in Riemannian geometry 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. The only condition is that the space-time metric has a proper Minkowski signature.

What Einstein added to these theorems is that physically such a locally constant metric must be Minkowski. Such a condition is needed for special relativity as a special case [39]. In a uniformly accelerated frame, the local space in a free fall is a Minkowski space according to special relativity.

However, Pauli's version [41] is a simplified but corrupted version of these theorems 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 regards the equivalence principle as merely the mathematical existence of locally constant spaces, which may not be locally Minkowski. In addition, Pauli invalidly extended the removal of uniform gravity to the removal of gravity in general. However, in spite of Einstein's objection [38], his equivalence principle was commonly but mistakenly regarded the same as Pauli's version.

However, Einstein's equivalence principle is also often misinterpreted. For instance, this happens in the highly praised book of Will [28], which also misinterpreted [1, 8] the binary pulsars experiment of Hulse & Taylor. Will [42] claimed "'Equivalence' came from the idea that life in a free falling laboratory was equivalent to life without gravity." Moreover, the British Encyclopedia also stated Einstein's Equivalence Principle incorrectly and ignored the Einstein-Minkowski condition [39].

Apparently, Pauli [41], and Will [39, 42], overlooked (or disagreed with) Einstein's [37; p.144] remark, "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…" Now, it should be clear that Pauli and his followers knew little about functional analysis in mathematics.

Nevertheless, 't Hooft [21] claimed there is no difference between Einstein's version and Pauli's version. Ignoring the Einstein-Minkowski condition, Misner, Thorne, & Wheeler [43] claimed that Einstein's equivalence principle is as follows: -

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

In their eq. (40.14), they got an incorrect local time of the earth. Ohanian and Ruffini [32; eq. (50)] also made the same mistake. Based on invalid calculations of Fock, Ohanian & Ruffini [32], and Wheeler also claimed that Einstein's equivalence principle is invalid.

Moreover, there is no common consensus among the founders of the International Society on General Relativity and Gravitation [39, 44]. Note also that Herrera, Santos & Skea [45] publish an incorrect paper on $E = mc^2$ [46], and missed the evidence for unification [35].

ENDNOTES

1) It was believed [2, 3] that the two-body problem could be solved in Einstein's equation. However, as suspected by Gullstrand [5] and conjectured by Hogarth [47], the opposite is correct [1, 8, 10].
2) The Nobel Laureates are selected by a Nobel Committee that consists of five members elected by The Royal Swedish Academy of Sciences. In its first stage, several thousand people are asked to nominate candidates. These names are scrutinized and discussed by experts until only the winners remain. The nomination and selection process for the Nobel Prize in Physics is usually long and rigorous. This is a key reason why these Nobel Prizes have grown in importance over the years to become the most important prizes in Physics. On the other hand, any error of the Nobel Committee in physics is almost certainly an error of those considered to be experts in the field. However, like any human institute, the Nobel Committee is not always faultless [1, 8, 10].
3) However, as Burton Richter [48] put it, "I have a very hard time accepting the fact that some of our distinguished theorists do not understand the difference between observation and explanation, but it seems to be so." It was very difficult to accept that some of our distinguished theoreticians cannot really tell the difference between mathematics and physics, but it is found to be so.
4) They [25] have mistaken Einstein's "Covariance principle" as Einstein's equivalence principle.
5) Professor 't Hooft [21] boasts that he has the mathematical ability to do the calculations. Apparently, he did not know such calculations are incorrect [1, 8, 10]. This tells a lot about his remark [21], "I only accept scientific facts when I fully understand the arguments on which they are based."
6) Because of inadequate understanding of physics, some theorists incorrectly believed, just as 't Hooft [21], that "Dynamical solutions means solutions that depend non-trivially on space as well as time." However, to calculate gravitational radiation, so far one still requires a bounded dynamic solution.
7) Fock [31], Ohanian & Ruffini and Wheeler [32] and etc. have mistaken the equivalence assumption of 1911 that a uniform Newtonian gravity (generated by a scalar potential) is equivalent to a uniformly

accelerated frame, with the equivalence principle of 1916 that a uniformly accelerated frame is equivalent to a uniform gravity generated by a space-time metric [26, 37]. In fact, their errors are so common among theorists [33] that the discovery of their errors was announced as an achievement in the memorial for P. Morrison of MIT in 2005. (Nevertheless, their errors are repeated even in the open course ware of MIT phy. 8. 033.) Moreover, Fock [31] found it impossible to express a uniform Newtonian gravity in terms of a spacetime metric. Based on the above misidentification, they claimed that Einstein's equivalence principle is invalid (see also Appendix). Recently, they are proven clearly wrong *because the metric for a uniform gravity has been derived* [39].

8) Referring to the publication of references [1], [8], or [10], 't Hooft [21] imagined, "It is clear to me that the referee in question must have been inattentive." The facts are, however, these referees all give valuable suggestions that lead to better presentations.

REFERENCES

1. Lo, C. Y., *Phys. Essays*, **13** (4): 527-539 (December 2000).
2. Einstein, A., Infeld L., & Hoffmann, B. *Annals of Math*. **39** (1): 65-100 (1938).
3. Feynman, R. P. ***The Feynman Lectures on Gravitation*** (Addison-Wesley, New York, 1996).
4. Landau, L. D. & Lifshitz, E. M. ***Classical Theory of Fields*** (Addison-Wesley, Reading Mass, 1962).
5. Gullstrand, A., Ark. Mat. Astr. Fys. **16**, No. 8 (1921); ibid, Ark. Mat. Astr. Fys. **17**, No. 3 (1922).
6. Whitehead, A. N., ***The Principle of Relativity*** (Cambridge Univ. Press,1922)
7. Zhou, Pei-Yuan, in ***Proc. of the Third Marcel Grossmann Meetings on Gen. Relativ.*** ed. Hu Ning, Sci. Press & North Holland. (1983), 1-20.
8. Lo, C. Y., Astrophys. J. 455, 421-428 (Dec. 20, 1995); Editor S. Chandrasekhar, a Nobel Laureate, suggests and approves the Appendix: The Gravitational Energy-Stress Tensor for the necessity of modifying Einstein equation.
9. Lo, C. Y., *Phys. Essays* **12** (3): 508-526 (September, 1999).
10. Lo, C. Y., *Astrophys. Space Sci*., **306**: 205-215 (2006).
11. **The Press Release of the Nobel Prize Committee** (The Royal Swedish Academy of Sciences, Stockholm, Oct. 1993) Nobelprize.org.

12. Lo, C. Y., Special Relativity, Misinterpretation of $E = Mc^2$, and Einstein's Theory of General Relativity, in Proc. IX International Scientific Conference on '**Space, Time, Gravitation,'** Saint-Petersburg, August 7-11, 2006.

13. Einstein, A. & Rosen, N., *J. Franklin Inst*. **223:** 43 (1937).

14. Kennefick, D. "Einstein versus the Physical Review," Phys. Today (September, 2004).

15. Christodoulou, D. & Klainerman, S. ***The Global Nonlinear Stability of the Minkowski Space*** (Princeton University Press, 1993). Princeton Mathematical series no. 41.

16. Lo, C. Y. *Phys. Essays*, **13** (1): 109-120 (March 2000).

17. Volker Perlick (republished with an editorial note), Gen. Relat. Grav. 32(4), 761-763 (2000).

18. Lo, C. Y., *Phys. Essays*, **16** (1): 84-100 (March 2003).

19. Lo, C. Y., *Phys. Essays*, **20** (3), 494-502 (Sept. 2007).

20. Lo, C. Y. Bulletin of Pure and Applied Sciences, **27D** (2), 149-170 (2008); at the request of 't Hooft, his article on gravitational waves is attached as the Appendix B of this paper.

21. G. ' t Hooft, "**Strange Misconceptions of General Relativity"**, http://www.phys.uu.nl/~thooft/gravitating_misconceptions.html

22. Lo, C. Y., Bulletin of Pure and Applied Sciences, **27D** (1), 1-15 (2008).

23. Lo, C. Y., Phys. Essays, Rectifiable Inconsistencies and Related Problems in General Relativity, **23** (2) (2010).

24. Lo, C. Y., Some Rectifiable Inconsistencies and Related Problems in Einstein's General Relativity, **Mathematics, Physics and Philosophy in the Interpretations of Relativity Theory II, Budapest, 4-6 Sept. 2009.** WWW.PHIL-INST.HU/PIRT.BUDAPEST.

25. Weber, J. & Wheeler J. A., Rev. Modern Phys. **29** (3): 509 (1957).

26. Einstein A., ***The Meaning of Relativity*** (Princeton Univ. Press, 1954).

27. Wald, R. M., ***General Relativity*** (The Univ. of Chicago Press, Chicago, 1984).

28. Will, C. M., ***Theory and Experiment in Gravitational Physics*** (Camb. Univ. 1981).

29. Jackson J. D., Classical Electrodynamics (John Wiley, New York, 1966).

30. Lo, C. Y., Bulletin of Pure and Applied Sciences, **28D** (1), 67-85 (2009).

31. Fock, V. A., ***The Theory of Space Time and Gravitation*** (Pergamon Press, 1964).

32. Ohanian, H. C. and Ruffini, R., ***Gravitation and Spacetime*** (Norton, New York, 1994).

33. Cheng, Tai-Pei, ***Relativity, Gravitation, and Cosmology*** (Oxford University Press, 2005).

34. Lo C. Y., Comments on "How to become a good theoretical physicist" by Gerard 't Hooft, Phys. Essays, **22** (4), 543-546 (2009).

35. Lo, C. Y., *Bulletin of Pure and Applied Sciences*, **26D** (1): 29 - 42 (2007).

36. Lo, C. Y., The Mass-Charge Repulsive Force and Space-Probes Pioneer Anomaly, **Physical Interpretation of Relativity Theory: Proceedings of International Meeting. Moscow, 6 – 9 July 2009 /** Edited by M. C. Duffy, V. O. Gladyshev, A. N. Morozov, P. Rowlands – Moscow: BMSTU.

37. Einstein, A., Lorentz, H. A., Minkowski, H. & Weyl, H., ***The Principle of Relativity*** (Dover, 1923).

38. Norton, J. "What was Einstein's Principle of Equivalence?" in Einstein's Studies Vol. 1: ***Einstein and the History of General Relativity,*** eds. D. Howard & J. Stachel (Birkhäuser, Boston, 1989).

39. Lo, C. Y., *Bulletin of Pure and Applied Sciences*, **26D** (2): 73-88 (2007).

40. Synge, J. L., ***Relativity: The General Theory*** (North-Holland, Amsterdam, 1971), pp. IX–X.

41. Pauli, W. 1958, ***Theory of Relativity*** (Pergamon Press, London, 1971).

42. Will, C. M., ***"Was Einstein Right?"*** (Basic Books, New York, 1986), p. 20.

43. Misner, C. W., Thorne K. S., & Wheeler J. A. ***Gravitation*** (Freeman, New York, 1973).

44. Lo, C. Y., Einstein's Requirement for Weak Gravity, versus Einstein's Covariance Principle, **International Meeting on Physical Interpretation of Relativity Theory, Imperial College, London, September 12 – 15, 2008.**

45. Herrera, L., Santos, N. O. & Skea, J. E. F., *Gen. Rel. Grav*. **35**, No.11, 2057 (2003).

46. Lo, C. Y., Phys. Essays **21** (1), 44-51 (March 2008).

47. Hogarth, J. E. 1953. Ph. D. Thesis, Dept. of Math., Royal Holloway College, Univ. of London, p. 6.

48. Richter, B. "Theory in particle physics," *Physics Today*, 59(10) 8 (2006).

Dear Sir:

I would like to submit my paper, COMMENTS ON THE "CYLINDRICALLY SYMMETRIC WAVES" OF 'T HOOFT, to your journal for publication. The copyright of this paper, if accepted, would be automatically transferred to your journal.

Thank you for your kind attention. I am looking forward to hearing from you.

Sincerely yours,

C. Y. Lo