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Physics and Space Science

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Proof of No "Black Hole" Binary in Nova Scorpii

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Abstract - This paper proves in a simple way, with minimal mathematics, that there is no black hole or close black hole binary system in Nova Scorpii, contrary to the published claims of Schmidt et al. (2002). It also consequently proves that the concept of the black hole violates the physical principles of General Relativity and is therefore invalid.

Keywords : Black Hole, Black Hole Binary, Nova Scorpii, Michell-Laplace Dark Body, escape velocity.

GJSFR-A Classification : FOR Code: 020102, 020105,020109

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Strictly as per the compliance and regulations of :

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Keywords : Black Hole, Black Hole Binary, Nova Scorpii, Michell-Laplace Dark Body, escape velocity.

I. Introduction

Schmidt et al. (2002) authored the paper Formation of the Black Hole in Nova Scorpii, The Astrophysical Journal, 567:491-502, 2002 March 1. Despite the arguments of the authors there is in fact no black hole and no close black hole binary in Nova Scorpii. The implication of this is that there are no black holes anywhere. It is in truth an irrefutable scientific fact that nobody has ever found a black hole, despite the frequent claims for the discovery of many black holes and the alleged black holes at the centres of galaxies.

II. Discussion

I remark that all alleged 'black hole solutions' to Einstein's field equations pertain to a universe that contains only one mass, namely, the mass of the alleged black hole itself. There are no known solutions to the field equations for two or more masses and there is no existence theorem by which it can even be asserted that the field equations contain latent solutions for two or more masses.

In the model and analysis for the close black hole binary system in Nova Scorpii the authors have inadvertently applied the Principle of Superposition where the Principle of Superposition does not apply. In Newton's theory of gravitation the Principle of Superposition applies and so one can simply pile up masses in space at will, although the gravitational interaction of these masses soon becomes intractable. In Einstein's theory the gravitational field, manifest in the curvature of spacetime, is coupled to its sources by the field equations, the sources being described by an appropriate energy-momentum tensor, and so the Principle of Superposition does not apply.

This means that one cannot simply pile up masses in any given spacetime because the field equations must be solved separately for each and every configuration of matter proposed.

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The proposed model for Nova Scorpii has not done this. For instance, upon what energy-momentum tensor do the authors rely for the black hole close binary system they claim to be present, and hence upon what solution to the field equations do they rely for this binary system? There is in fact no known set of field equations for the black hole binary system model proposed by the authors for Nova Scorpii.

The authors' model begins with a Newtonian universe and ends with a non-Newtonian universe, manifest as an inadvertent blending of two different and incompatible theories, by means of an inappropriate application of the Principle of Superposition; a Newtonian universe containing a non-Newtonian entity (a black hole), which is impossible; or conversely, a Relativistic universe that contains additional masses besides that of the black hole, which is also impossible, as paragraphs two and three above show. Concerning the fact that the Principle of Superposition does not apply in General Relativity, Landau and Lifshitz remark (1951):

> "*In a gravitational field, the distribution and motion of the matter producing it cannot at all be assigned arbitrarily --- on the contrary it must be determined (by solving the field equations for given initial conditions) simultaneously with the field produced by the same matter.*"

Similarly, McMahon (2006) also points out that the Principle of Superposition does not apply in General Relativity:

> "*An important characteristic of gravity within the framework of general relativity is that the theory is nonlinear. Mathematically, this means that if g_{ab} and γ_{ab} are two solutions of the field equations, then $ag_{ab} + b\gamma_{ab}$ (where a, b are scalars) may not be a solution. This fact manifests itself physically in two ways. First, since a linear combination may not be a solution, we cannot take the overall gravitational field of the two bodies to be the summation of the individual gravitational fields of each body.*"

Owing to the foregoing one cannot, by an analogy with Newton's gravitational theory, assert that the black hole can exist in multitudes, merge or collide or otherwise interact with one another or other matter, be located at the centres of galaxies, or that a black hole can be a component of a binary system. Thus the model for the close black hole binary system in Nova Scorpii is invalid.

The subject paper does not clearly specify what type of black hole is allegedly formed in Nova Scorpii. The signatures of the simplest black hole, whether or not it is rotating, are an infinitely dense point-mass singularity and an event horizon. Now it is an irrefutable fact that nobody has ever found an infinitely dense point-mass singularity or an event horizon and so nobody has ever assuredly found a black hole. This is not surprising owing to paragraphs two to five above. Additionally, all reports of the black hole being found in multitudes and being located at the centres of galaxies is wishful thinking due to a misapplication of the Principle of Superposition.

According to Einstein his Principle of Equivalence and his Special Relativity must hold in sufficiently small regions of his gravitational field and that these regions can be located anywhere in his gravitational field. Now a simple calculation proves that Special Relativity forbids infinite densities. Thus an infinitely dense point-mass singularity is forbidden by the Theory of Relativity no matter how it is alleged to be formed, and so there can be no black hole present in Einstein's gravitational field. It is worth noting that infinitely dense point-mass singularities occur in Newton's gravitational theory too; they are merely 'centres of masses'. But a centre of mass is not a physical object – it is a mathematical artifice, nothing more. A point is a mathematical entity, not a physical object, whereas a mass is a physical object that has extension, not a mathematical entity without extension, i.e. a point. In the case of the black hole the infinitely dense point-mass singularity is claimed to be a real object, which is impossible. Nonetheless, according to Hawking (2002),

> *"The work that Roger Penrose and I did between 1965 and 1970 showed that, according to general relativity, there must be a singularity of infinite density, within the black hole."*

Furthermore, the Principle of Equivalence is defined in terms of the a priori presence of multiple arbitrarily large finite masses and Special Relativity is defined in terms of the a priori presence of multiple arbitrarily large finite masses and photons. According to Einstein (1967),

> *"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. Overlooking 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' 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 co-ordinate systems which are in non-uniform motion relatively to each other. In fact, through this conception we arrive at the unity of the nature of inertia and gravitation. For,according to our way of looking at it, the same masses may appear to be either under the action of inertia alone (with respect to K) or under the combined action of inertia and gravitation (with respect to K').*
>
> *"Stated more exactly, there are finite regions, where, with respect to a suitably chosen space of reference, material particles move freely without acceleration, and in which the laws of special relativity, which have been developed above, hold with remarkable accuracy."*

Thus, neither the Principle of Equivalence nor Special Relativity can manifest in a spacetime that by construction contains no matter or a spacetime that allegedly contains only one mass. Hence, the black hole violates the physical foundations of General Relativity because it exists in a universe that contains no other masses. According to the Dictionary of Geophysics, Astrophysics, and Astronomy (Matzner 2001),

> *"Black holes were first discovered as purely mathematical solutions of Einstein's field equations. This solution, the Schwarzschild black hole, is a nonlinear solution of the Einstein equations of General Relativity. It contains no matter, and exists forever in an asymptotically flat space-time."*

The so-called 'Schwarzschild solution' upon which black hole theory mostly relies is in actual fact not Schwarzschild's solution at all, but a corruption of Schwarzschild's solution due to David Hilbert (Antoci 2001, Abrams 1989). Schwarzschild's actual solution forbids the black hole. One can easily confirm this by a reading of Schwarzschild's (1916) original paper on the subject. In addition, Schwarzschild spacetime is claimed to describe a static empty spacetime because the energy-momentum tensor is set to zero in relation to this spacetime. Owing to the relation between the gravitational field and its sources as explained in paragraph three above, Schwarzschild spacetime must in fact contain no sources! Therefore, the inclusion of a mass in Schwarzschild spacetime is spurious. Indeed, the alleged black hole mass therein is inserted post hoc by placing the square of Newton's expression for escape velocity into Hilbert's solution. Despite the fact that only one mass term is present in Newton's expression for escape velocity, this expression is implicitly a two-body relation: one body escapes from another body. Indeed, one cannot derive Newton's expression for escape velocity without recourse to a Newtonian two-body relation either by means of Newton's expression for gravitational force or by consideration of the classical conservation of energy related to Newton's theory of gravitation. Now it is impossible for an implicit two-body relation to appear in what is alleged to be an expression that describes a universe that contains only one body (but which actually describes a universe that is totally empty by virtue of the removal of all sources at the outset by mathematical construction).

Unfortunately most astronomers and astrophysicists are completely unaware of Schwarzschild's actual paper because it has become buried and all but forgotten in the literature, and the metric which bears his name has thereby become incorrectly associated with him. It is from Hilbert's corruption that the black hole was incorrectly spawned, as pointed out by the late American theoretical physicist Dr. Leonard S. Abrams (1989).

Some other interesting and relevant issues arise from the foregoing. Scientists frequently assert that the escape velocity of a black hole is that of light in vacuum and that nothing, not even light, can escape from the black hole. In fact, according to the same scientists, nothing, including light, can even leave the black hole. But there is already a serious problem with these claims. If the escape velocity of a black hole is that of light in vacuum, then light, on the one hand, can escape. On the other hand, light is allegedly not able to even leave the black hole; so the black hole has no escape velocity. If the escape velocity of a black hole is that of light in vacuum, not only can light both leave and escape, material objects can also leave the event horizon, but not escape, because, according to the Theory of Special Relativity, they can only have a velocity less than that of light in vacuum. This just means that if the black hole has an escape velocity then material bodies can in fact leave the black hole and eventually stop and fall back to the black hole, just like a ball thrown into the air here on Earth with an initial velocity less than the escape velocity for the Earth. However, as explained above, there can be no other material bodies present in a black hole universe because the alleged black hole universe contains only the black hole mass, so there are no material bodies present that can leave a black hole or fall into a black hole. It is clearly evident that the concept of black hole escape velocity is meaningless as is the notion that the black hole sucks in external matter. Let us consider further the determination of the Newtonian expression for escape velocity and gravitational potential. As noted above, even though one mass appears in the expression for Newton's escape velocity, it cannot be determined without recourse to a fundamental two-body gravitational interaction. Newton's theory of gravitation is defined in terms of the interaction of two bodies and the Principle of Superposition. Recall that Newton's Universal Law of Gravitation is

$$F_g = -G\frac{mM}{r^2}, \tag{1}$$

where G is the gravitational constant and r is the distance between the centre of mass of m and the centre of mass of M. The velocity required by a mass m to escape from the gravitational field due to masses M and m is determined by,

$$F_g = -G\frac{mM}{r^2} = ma = m\frac{dv}{dt} = mv\frac{dv}{dr}. \tag{2}$$

Separating variables and integrating gives

$$\int_v^0 mv\,dv = \lim_{r_f\to\infty}\int_R^{r_f} -GmM\frac{dr}{r^2}, \tag{3}$$

whence

$$v = \sqrt{\frac{2GM}{R}}, \tag{4}$$

where R is the radius of the mass M. Thus, escape velocity necessarily involves two bodies: m escapes from M. In terms of the conservation of kinetic and potential energies

$$K_i + P_i = K_f + P_f, \tag{5}$$

whence

$$\frac{1}{2}mv^2 - G\frac{mM}{R} = \frac{1}{2}mv_f^2 - G\frac{mM}{r_f}. \tag{6}$$

Then as $r_f \to \infty, v_f \to 0$, and the escape velocity of m from M is

$$v = \sqrt{\frac{2GM}{R}}. \tag{7}$$

Once again, the relation is derived from a two-body gravitational interaction.

Similarly, Newton's gravitational potential Θ is defined as

$$\Theta = \lim_{\sigma\to\infty}\int_\sigma^r -\frac{F_g}{m}dr = -G\frac{M}{r}, \tag{8}$$

which is the work done per unit mass in the gravitational field due to masses M and m. This is a two-body concept. The potential energy P of a mass m in the gravitational field due to masses M and m is therefore given by

$$P = m\Theta = -G\frac{mM}{r}, \tag{9}$$

which is clearly a two-body concept as well.

It has also become commonplace in the literature, and in textbooks for students, to claim that Newton's theory predicts the existence of a kind of black hole. But the black hole is not predicted by Newton's theory of gravitation either, despite the claims of the astrophysical scientists that the theoretical Michell-Laplace dark body is a kind of black hole. The Michell-Laplace dark body possesses an escape velocity, whereas the black hole has no escape velocity; it does not require irresistible gravitational collapse to form, whereas the black hole does; it has no infinitely dense point-mass singularity, whereas the black hole does; it has no event horizon, whereas the black hole does; there is always a class of observers that can see the dark body but there is no class of observers that can see the black hole; the Michell-Laplace dark body can persist in a space which contains other Michell-Laplace dark bodies and other masses and interact with one another and other masses, but the spacetime of the black hole is devoid of masses other than that of the alleged black hole itself and so it cannot interact with any other masses. Thus the Michell-Laplace dark body does not possess the signatures of the alleged black hole and so it is not a black hole. A very simple mathematical proof that the Michell-Laplace dark body is not a black hole was given by the British astronomer G. C. McVitte (1978).

Finally, it is proven in Crothers (2010) that the concept of the black hole is invalid because Einstein's field equations actually violate the usual conservation of energy and momentum and are therefore in conflict with experiment on a deep level, rendering General Relativity itself invalid.

III. Conclusion

It is clear from the foregoing that there is in fact no black hole and no close black hole binary system in Nova Scorpii. Furthermore, black holes have not been discovered anywhere by anybody, despite the numerous claims made in the literature for the discovery of many black holes and the presence of black holes at the centres of galaxies, because the black hole does not exist.

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Comments on the 2011 Shaw Prize in Mathematical Sciences -- An Analysis of Collectively Formed Errors in Physics

By C. Y. Lo
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Abstract - The 2011 Shaw Prize in mathematical sciences is shared by Richard S. Hamilton and D. Christodoulou. However, the work of Christodoulou on general relativity is based on obscure errors that implicitly assumed essentially what is to be proved, and thus gives misleading results. The problem of Einstein's equation was discovered by Gullstrand of the 1921 Nobel Committee. In 1955, Gullstrand is proven correct. The fundamental errors of Christodoulou were due to his failure to distinguish the difference between mathematics and physics. His subsequent errors in mathematics and physics were accepted since judgments were based not on scientific evidence as Galileo advocates, but on earlier incorrect speculations. Nevertheless, the Committee for the Nobel Prize in Physics was also misled as shown in their 1993 press release. Here, his errors are identified as related to accumulated mistakes in the field, and are illustrated with examples understandable at the undergraduate level. Another main problem is that many theorists failed to understand the principle of causality adequately. It is unprecedented to award a prize for mathematical errors.

Keywords : Nobel Prize; general relativity; Einstein equation, Riemannian Space; the non-existence of dynamic solution; Galileo.

GJSFR-A Classification : 04.20.-q, 04.20.Cv

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Keywords : Nobel Prize; general relativity; Einstein equation, Riemannian Space; the non-existence of dynamic solution; Galileo.

> "Science sets itself apart from other paths to truth by recognizing that even its greatest practitioners sometimes err. … We recognize that our most important scientific forerunners were not prophets whose writings must be studied as infallible guides—they were simply great men and women who prepared the ground for the better understandings we have now achieved." -- S. Weinberg, Physics Today, November 2005.

I. Introduction

The Shaw Prize, named after Hong Kong film and television magnate Run Run Shaw, each year recognizes innovation in three fields—astronomy, medicine and mathematics—with three awards of US$1 million each. It's often called Asia's Nobel Prize, though it's a global honor; this year's winners, announced by the Shaw Prize Foundation in Hong Kong, are all from Europe and the U.S.

However, as a new prize since 2002, the committee also makes some errors in choosing the winners and recognizing their merits. This year of 2011, a half of the prize in mathematics is awarded to Richard S. Hamilton, a distinguish mathematician for his work on the Ricci flow that lays down the foundation to prove the Poincare conjecture. Unfortunately the Shaw Prize also made a mistake by awarding the other half prize to Christodoulou for his work, based on obscure errors, against the honorable Gullstrand [1, 2] of the 1921 Nobel Committee.1) Although Christodoulou has misled many including the 1993 Nobel Committee [3], his errors are now well-established and they have been illustrated with mathematics at the undergraduate level [4, 5]. Thus, it is possible to neutralize this disservice to science.

The official announcement for awarding them is,2) "for their highly innovative works on nonlinear partial differential equations in Lorentzian and Riemannian geometry and their applications to general relativity and topology." Christodoulou claimed in his Autobiography that his work is essentially based on two sources: 1) The claims of Christodoulou and Klainerman on general relativity as shown in their book ***The Global Nonlinear Stability of the Minkowski Space*** [6]; 2) Roger Penrose had introduced, in 1965, the concept of a trapped surface and had proved that a space-time containing such a surface cannot be complete [7]. However, this work of Penrose, which uses an implicit assumption of unique sign for all coupling constants, actually depends on the errors of Christodoulou and Klainerman [6]. However, such a relation was not clear until 1995 when this implicit assumption was proved incorrect [8].

Due to inadequate mathematical background in comparison with Gullstrand, physicists including Einstein [9], Pauli [10], Misner, Thorne & Wheeler [11], etc. believed that, as in the case of linear equation, the nonlinear Einstein equation should have the bounded dynamic solutions. This view seems to be supported by solutions of the static case, and also a linearization of the Einstein equation. Thus, Gullstrand's suspicion on validity of Einstein's calculation was not generally accepted. Although nobody can provide valid evidence to support Einstein's view, some went so far as to claim that Gullstrand had the advantage because he was Swedish.

The fact is, however, that Einstein's equation cannot have a bounded dynamic solution [8]. Also, the singularity theorems of Penrose and Hawking [7] are actually irrelevant to physics because they use an

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unphysical implicit assumption [8] that violates the principle of causality [12].

Historically, in 1921 Gullstrand [1, 2] conjectured and sustained that Einstein's equation may not have a dynamic solution. In 1993 Christodoulou and Klanerman [6] claimed that bounded dynamic solutions were constructed. However, in 1995, as a continuation of the non-existence of plane-wave solutions, it is proven that there are no dynamic solutions or wave solutions for Einstein's equation [8]. Moreover, for the dynamic case, linearization to obtain an approximation is not valid in mathematics. Thus, Gullstrand's conjecture is proven to be correct. Subsequently their book [6] was severely criticized [13-15] while it is still classified as No. 41 in the Princeton Mathematical Series. Moreover, these criticisms are also supported by the fact that there is no bounded dynamic solution in the literature. The physical reason is identified as that, for a dynamic case, Einstein's equation violates the principle of causality.[3)]

Nevertheless, Nobel Laureate't Hooft attempted to challenge Gullstrand with a bounded time-dependent solution in 2004, but was defeated because his solution also violates the principle of causality [4, 16].[4)] In addition, Wald [7] believed that perturbation approach was always valid to obtain an approximate solution. Meanwhile Professor P. Morrison of MIT met Nobel Laureate Professor J. Taylor of Princeton University several times to discuss problems on the dynamic solution [17], but Taylor failed to defend their calculation of the binary pulsars [18, 19].[5)]

To facilitate theorists, whose views are based on earlier mathematical errors, in understanding the absence of dynamic solutions and wave solutions of the Einstein equation, a review paper on this subject with counter examples being understandable at the undergraduate level [4, 5] was published in 2011. Thus, the errors of Christodoulou on general relativity are further clarified and no longer in doubt.[6)] *A basic rule in mathematics learned in my undergraduate years is that one must be able to support his mathematical statements with examples. It seems that some theorists including members of the Selection Committee of the Shaw Prize have forgotten this simple rule.*

Both Christodoulou and Hamilton have cited the influence of Fields Medalist (1982) S. T. Yau. However, there are some important details that the Shaw Committee failed to notice. While supporting Hamilton in the recent participation in solving the Poincare conjecture, Yau has in effect withdrawn his support to Christodoulou by declaring his loss of earlier interest on the related work [6] as acknowledged. Nevertheless, Yau may still not understand that general relativity was not yet self-consistent [19] since he has not made any modification on the positive mass theorem of Schoen and Yau [20, 21] that also used the invalid implicit assumption of unique sign for all coupling constants, as Penrose and Hawking did [7].[4)] Since acceptance of invalid claims and misinterpretations has reached the level of Fields Medalists [22],[7)] the mistake of the awarding a prize to a mathematician for his errors should no longer be a great surprise!

Having been educated in Hong Kong, I feel the need to point out this error of the Shaw Committee that is clearly against the wish of Mr. Shaw, to award advancements in sciences. To help the scientific community overcome these errors, which have involved the 1993 Nobel Committee, Caltech, Harvard University, Princeton University, the Physical Review, and the Royal Society, etc., it would be necessary to point out the literature related to the errors in mathematics and physics. Moreover, Christodoulou should be informed formally in an open letter that his work is still incorrect.

II. Open Letter to Christodoulou

The errors of Christodoulou are described in an open letter to him as follows:

Prof. Demetrios Christodoulou,Professor of Mathematics and Physics
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Dear Professor Christodoulou:

Congratulations for the Shaw Prize in mathematics! It is an honor that you are able to share a prize with a distinguished mathematician Richard Streit Hamilton, a professor at Columbia University.

I have been looking for you since 2000 after I have read your book [6] coauthored with Klainerman. I find that your proof on the existence of a dynamic solution is incomplete because you failed to show that the set of your initial conditions is non-empty. In fact, other reviewers say the same thing indirectly that your first chapter is not comprehensible. I have asked your coauthor Klainerman to provide the missing information, but he declined. I was also informed that you were no longer at Princeton University, and have returned to Greece.

Nevertheless, if your errors were unclear because of your complicated calculations, your errors can now be understood much easier because they can be illustrated with mathematics at the undergraduate level. I would like to inform you that a Nobel Laureate't Hooft had attempted to defend your work, but failed since he does not understand the related physics [4, 15].[4)] In fact, your errors are also well known by now because I have written a paper, "Linearization of the Einstein Equation and the 1993 Press Release of the Nobel Prize in Physics" [5]. This paper shows how the errors in your erroneous book [6] are criticized by other scientists and how your errors have misled others as shown in the errors of the 1993 press release of the Nobel Committee [3].

I have reported my paper in the **18th Annual Natural Philosophy Alliance Conference,** July 6-9, 2011, at the

University of Maryland, College Park, USA; and my paper is well received because of its clarity that also explains your mathematical errors well. I can say this with such a definitive tone because there are explicit examples that confirm your errors. For your perusal, a copy of the file of this paper is attached.

The basic problem in terms of physics is that just as in Maxwell's classical electromagnetism [23], there is also no radiation reaction force in general relativity. Although an accelerated massive particle would create radiation [24], the metric elements in the geodesic equation are created by particles other than the test particle [9].[8)]

This problem is manifested by the fact that there is no dynamic solution for the Einstein equation [8, 12, 13, 18], which does not include the gravitational energy-stress tensor of its gravitational waves in the sources.[9)] Thus, to fit the data,[10)] it is necessary to modify the Einstein equation [8] to

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = -K\left[T(m)_{\mu\nu} - t(g)_{\mu\nu}\right] \qquad (1)$$

where $t(g)_{\mu\nu}$ is the energy-stress tensor for gravity. For radiation, the tensor $t(g)_{\mu\nu}$ is equivalent to Einstein's notion of gravitational energy-stress. Because a wave carries energy and momentum in vacuum, it is necessary to have such an additional tensor term. However, Einstein's notion is a pseudo-tensor and can become zero by choosing a suitable coordinate system, but the energy-momentum of a radiation cannot be zero, and thus must be a tensor [8].

In conclusion, the Einstein equation cannot have a dynamic solution because the principle of causality is violated! Thus, your work on general relativity is clearly incorrect in terms of both mathematics and physics. Therefore, please rectify these errors to overcome the rejection of the brilliant work of Gullstrand [1, 2]. You owe the scientific world for rectifying these errors. Moreover, your errors are the main obstacles to theoretical progress in general relativity that have been experimentally confirmed [19]!

The Wheeler School needs to rectify their errors, but they have neither the background in mathematics nor the will to rectify their mistakes [22]. In addition, it would be to your benefit to rectify these errors. You are young and thus still have a chance to take a more honorary role in science! Besides, there is still no authority in general relativity yet [19].

I would suggest that you use your share of the award money to help assemble a team to develop general relativity and to rectify the remaining errors. This would be a very fruitful field since a new force has been discovered [19].

Best wishes!

Sincerely yours,

C. Y. Lo

In the next section, some details of Christodoulou's mathematical errors in logic are provided.

III. Some Remarks on the Errors of Christodoulou in Mathematics and Physics

The book of Christodoulou & Klanerman [6] is confusing (see Appendix A). Their main Theorem 1.0.3 states that any strongly asymptotically flat (S.A.F.) initial data set that satisfies the global smallness assumption leads to a unique globally hyperbolic asymptotically flat development. However, because the global smallness assumption has no dynamic requirements in their proofs, there is no assurance for the existence of a dynamic S.A.F. initial data set [13]. Thus, the existence of a bounded dynamic initial set is assumed only, and their proof is at least incomplete.

Perlik [14] complained, "What makes the proof involved and difficult to follow is that the authors introduce many special mathematical constructions, involving long calculations, without giving a clear idea of how these building-blocks will go together to eventually prove the theorem. The introduction, almost 30 pages long, is of little help in this respect. Whereas giving a good idea of the problems to be faced and of the basic tools necessary to overcome each problem, the introduction sheds no light on the line of thought along which the proof will proceed for mathematical details without seeing the thread of the story. This is exactly what happened to the reviewer." Thus, their claim on "dynamic" solutions was met with wide spread skeptics [14]. They assume the existence of a bounded initial set to prove the existence of a bounded solution. *Moreover, his initial condition has not been proven as compatible with the Maxwell-Newton approximation which is known to be valid for weak gravity* [13].

The above claim is similar to what Misner et al. [11] did. They claimed their plane-wave equation,

$$\frac{d^2L}{du^2} + L\left(\frac{d\beta}{du}\right)^2 = 0 \qquad (2)$$

where $L = L(u)$, $\beta = \beta(u)$, $u = t - x$ has a bounded plane-wave solution as follows:

$$ds^2 = dt'^2 - dx'^2 - L^2(e^{2\beta}dy^2 + e^{-2\beta}dz^2). \qquad (3)$$

Careful calculation with undergraduate mathematics shows that this is impossible [4, 5]. Thus, many others like Chistodoulou made or accepted an invalid claim, but was unaware of errors at the undergraduate level.

An example to illustrate a violation of the principle of causality is the solution of Einstein's cylindrical symmetric wave solution [16]. The metric of Bondi, Pirani & Robinson [25] also violates this principle, and is as follows:

$$ds^2 = \exp(2\phi)(d\tau^2 - d\xi^2) - u^2[ch2\beta\,(d\eta^2 + d\zeta^2) + sh2\beta\cos2\theta\,(d\eta^2 - d\zeta^2) - 2sh2\beta\sin2\theta\, d\eta d\zeta], \qquad (4)$$

where ϕ, β, θ are functions of u $(= \tau - \xi)$. It satisfies the differential equation (i.e., their Eq. [2.8]),

$$2\phi' = u(\beta'^2 + \theta'^2 \, sh^2 2\beta). \qquad (5)$$

This metric is unbounded. When the time-dependent factors are reduced to constant (i.e.,$\phi' = \beta' = \theta' = 0$), this metric cannot be reduced to the flat metric as the case of Einstein's "wave" [16]. Thus, the Royal Society like Christodoulou, also claimed dynamic solutions, but was unaware of a violation of the principle of causality in physics.

Another "plane wave", which is intrinsically unphysical, is the metric accepted by Penrose [26] as follows:

$$ds^2 = du\, dv + Hdu^2 - dx_i\, dx_i, \quad \text{where} \quad H = h_{ij}(u)\, x_i\, x_j \quad (6)$$

where $u = ct – z$, $v = ct + z$, $x = x_1$ and $y = x_2$, $h_{ii}(u) \geq 0$, and $h_{ij} = h_{ji}$. This metric satisfies the harmonic gauge. The cause of metric (6) can be an electromagnetic plane wave. Metric (6) satisfies

$$\eta^{\alpha\beta}\, \partial_\alpha\partial_\beta\, \gamma_{tt} = –2\{h_{xx}(u) + h_{yy}(u)\} \quad \text{where} \quad \gamma_{\mu\nu} = g_{\mu\nu} - \eta_{\mu\nu} \qquad (7)$$

However, this does not mean that causality is satisfied although metric (14) is related to a dynamic source. The violation of the principle of causality of this metric is due to containing unphysical parameters [16].

Many theorists assume a physical requirement would be unconditionally satisfied by the Einstein equation [19]. Apparently, Christodoulou adapted such a view. As shown, his mathematical analysis is also not reliable at the undergraduate level although Christodoulou claimed to have such a strong interest in his autobiography. In addition, Christodoulou does not understand the difference between mathematics and physics. According to the principle of causality in physics, a bounded dynamic solution should exist, but this does not necessarily mean mathematically that the Einstein equation has such a solution.

Gullstrand was not the only theorist who questioned the existence of the bounded dynamic solution for the Einstein equation. As shown by Fock [27], any attempt to extend the Maxwell-Newton approximation (the same as the linearized equation with mass sources [8]) to higher approximations leads to divergent terms. In 1993, it has been proven [8, 28] that for a dynamic case the linearized equation as a first order approximation, is incompatible with the nonlinear Einstein field equation. Moreover, the Einstein equation does not have a dynamic solution for weak gravity unless the gravitational energy tensor with an anti-gravity coupling is added to the source (see also eq. [1]). The necessity of an anti-gravity coupling term manifests why a bounded wave solution is impossible for Einstein's equation.

After it has been shown that there is no bounded dynamic solution for the Einstein equation [8], in 1996 Perlick published a book review in ZFM, pointing out that Christodoulou and Klanerman have made some unexpected mistakes, and their mathematical proof is difficult to follow, and suggested their main conclusion may be unreliable. However, to many readers, a suggestion of going through more than 500 pages of mathematics is not a very practical proposal.

Their book [6] was accepted because it supports and is consistent with existing errors as follows:

1) It supports errors that created a faith on the existence of dynamic solutions of physicists including Einstein etc.
2) Due to the inadequacy of the mathematics used, the book was cited before 1996 without referring to the details.
3) Nobody suspected that professors in mathematics and/or physics could made mistakes at the undergraduate level.
4) Because physical requirements were not understood, unphysical solutions were accepted as valid [26, 29-31]. Thus, in the field of general relativity, strangely there is no expert almost 100 years after its creation.

In physics, a dynamic solution must be related to dynamic sources, but a "time-dependent" solution may not necessarily be a physical solution [4, 16, 25].[4)] To begin with, their solutions are based on dubious physical validity [13]. For instance, their "initial data sets" can be incompatible with the field equation for weak gravity. Second, the only known cases are static solutions. Third, they have not been able to relate any of their constructed solutions to a dynamic source. In pure mathematics, if no example can be given, such abstract mathematics is likely wrong [32].

In fact, there is no time-dependent example to illustrate the claimed dynamics (see Appendix B and [13]). In 1953 Hogarth [33] already conjectured that a dynamic solution for the Einstein equation does not exist. Moreover, in 1995 it is proven impossible to have a bounded dynamic solution because the principle of causality is violated [8].

IV. The Shaw Prize and Her Governing Committees

The Shaw Prize is governed by a Board of Adjudicaters, under which there are three selection committees of astronomy, medicine and mathematics. Each committee selects the winners for each prize.

Board of Adjudicators

Chairman: Professor Chen-Ning Yang <cnyang@tsinghua.edu.cn>

Vice Chairman: Professor Kenneth Young <kyoung@cuhk.edu.hk>

Members: Professor Jiansheng Chen hlhl@public.sti.ac.cn, Professor Yuet-Wai KAN <iomwww@nas.edu>, and Professor Peter C. Sarnak <sarnak@math.ias.edu>.

Selection Committee for the Shaw Prize in Mathematical Sciences

Chairman: **Professor Peter C. Sarnak**
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Professor of Mathematics
Princeton University and Institute for Advanced Study
USA
Members: **Sir Michael Atiyah** M.Atiyah@ed.ac.uk
Honorary Professor
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The Einstein Institute of Mathematics
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The selection of mathematicians for the prize lies in this selection committee. However, if you check the background, it seems none of the members has an adequate research background in general relativity. The award speech for mathematics (see Appendix C) was made by Margaret H. Wright, who is in Computer Science but not functional analysis. From her speech, it is clear that the works of Christodoulou and Hamilton are actually not related. Thus, one may wonder who initiated the nomination of Christodoulou.

It is known that, based on gauge invariance, Professor C. N. Yang is against the view of Zhou Pei-Yuan [34, 35] on invalidity of Einstein's covariance principle. However, according to S. Weinberg on gauge theories [36] and direct research in general relativity [19],[11)] Yang is proven wrong; but the work of Christodoulou is in another area.

It seems that, inheriting from Christodoulou, Penrose, and 't Hooft, etc. a failure in distinguishing mathematics and physics ,[9),10)] the Selection Committee in Mathematical Sciences leads to giving an award for mathematical errors. They seem to neglect whether there are supporting examples with valid dynamic sources;[4)] and also do not understand the related physical requirements. Their misjudgment should have been expected since they seem to be unaware of the known errors of Hawking and Penrose in physics [8] as at least a dozen of Nobel Laureates had made such errors.

V. Discussions and Conclusions

However, although the Shaw Prize is directly responsible for this error, there are theorists, starting from Einstein and Hilbert in 1915 [37], helping its unusual long gestation of more than 95 years because of inadequate knowledge in the non-linear equation [19]. It took a genius such as Gullstrand[1)] to discover this error, but it was still not believed among many theorists due to their inadequacy in mathematics. Meanwhile, this error was made obscure by other errors such as the failure in distinguishing the difference between mathematics and physics [19]. Such a failure is responsible for rejecting invalidity of Einstein's covariance principle, a discovery of Zhou Pei-Yuan [34, 35]. This confusion also leads to an inadequate understanding on the physical principles,[3)] and this problem leads to further errors in general relativity [19]. We should learn from errors of Penrose etc. [7, 26] to prevent further errors in the future.

This analysis shows that the misunderstanding of physics on the existence of dynamic solutions is the root of other related errors. Because of background in mathematics, and/or a failure to distinguish the difference between mathematics and physics and etc., only some theorists are able to see the errors of Christodoulou [8, 14, 15, 17]. Instead, many are misled by the invalid claims of Christodoulou, and failed to see counter examples [4, 5].

For instance, his errors are related to the implicit assumption of unique sign for all coupling constants [8], which is used in the singularity theorems of Hawking and Penrose [7] that lead to the speculation of an expanding universe [38]. The errors of Christodoulou also supports the invalid speculation that $E = mc^2$ is unconditionally valid [39, 40]. In turn, this supports that gravity is always attractive, a foundation of the theory of black holes [41]. Such errors lead also to the acceptance of unbounded solution, implicitly rejecting the principle of causality [16], etc. Now, the errors of Christodoulou lead to an award of the Shaw Prize in mathematics for standing in the way of theoretical progress.[12)]

It is expected that this paper would recover the honor of Gullstrand. Because of accumulated mistakes by the institutes, a highly competent theorist[1)] could be defeated by an incompetent.[13)] In a way, this is an inevitable result of long time accumulation of errors. However, the Shaw Prize Committee has the responsibility for exposing these errors although she is not solely responsible for their creation. It seems that frontier physicists should pay more attention to physical principles and have a better education in pure mathematics. Moreover, in view of the errors once prevailing in general relativity,[14)] the communication between mathematicians and physicists should be further strengthened.

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Appendix A : A Book Review on "The Global Nonlinear Stability of the Minkowski Space".

This book review originally appeared in ZfM [14] in 1996; and, with the kind permission of its Editor, B. Uegner, will be republished in the journal, GRG [15] again with the editorial note, "One may extract two messages: On the one hand, (by seeing e.g. how often this book has been cited), the result is in fact interesting even today, and on the other hand: There exists, up to now no generally understandable proof of it." For the convenience of the reader, this review is provided as an appendix. The review is as follows:

"For Einstein's vacuum field equation, it is a difficult task to investigate the existence of solutions with prescribed global properties. A very interesting result on that score is the topic of the book under review. The authors prove the existence of globally hyperbolic, geodesically complete, and asymptotically flat solutions that are close to (but different from) Minkowski space. These solutions are constructed by solving the initial value problem associated with Einstein's vacuum field equation. More precisely, the main theorem of the book says that any initial data, given on R^3, that is asymptotically flat and sufficiently close to the data for Minkowski space give rise to a solution with the desired properties. In physical terms, these solutions can be interpreted as space-times filled with source-free gravitational radiation. Geodesic completeness means that there are no singularities. At first sight, this theorem might appear intuitively obvious and the enormous amount of work necessary for the proof might come as a surprise. The following two facts, however, should caution everyone against such an attitude. First, it is known that there are nonlinear hyperbolic partial differential equations (e.g., the equation of motion for waves in non-linear elastic media) for which even arbitrarily small localized initial data lead to singularities. Second, all earlier attempts to find geodesically complete and asymptotically flat solutions of Einstein's vacuum equation other than Minkowski space had failed. In the class of spherically symmetric space-time and in the class of static space-times the existence of such solutions is even excluded by classical theorems. These facts indicate that the theorem is, indeed, highly non-trivial. Yet even in the light of these facts it is still amazing that the proof of the theorem fills a book of about 500 pages. To a large part, the methods needed for the proof are rather elementary; abstract methods from functional analysis are used only in so far as a lot of L^2 norms have to be estimated. What makes the proof involved and difficult to follow is that the authors introduce many special mathematical constructions, involving long calculations, without giving a clear idea of how these building-blocks will go together to eventually prove the theorem. The introduction, almost 30 pages long, is of little help in this respect. Whereas giving a good idea of the problems to be faced and of the basic tools necessary to overcome each problem, the introduction sheds no light on the line of thought along which the proof will proceed for mathematical details without seeing the thread of the story. This is exactly what happened to the reviewer."

"To give at least a vague idea of how the desired solutions of Einstein's vacuum equation are constructed, let us mention that each solution comes with the following: (a) a maximal space-like foliation generalizing the standard foliation into surfaces t = const. in Minkowski space; (b) a so-called optical function u, i.e. a solution u of the eikonal equation that generalizes the outgoing null function $u = r - t$ on Minkowski space; (c) a family of "almost conformal killing vector fields on Minkowski space. The construction of these objects and the study of their properties require a lot of technicalities. Another important tool is the study of "Bianchi equations" for "Weyl tensor fields". By definition, a Weyl tensor field is a fourth rank tensor field that satisfies the algebraic identities of the conformal curvature tensor, and Bianchi equations are generalizations of the differential Bianchi identities."

"In addition to the difficulties that are in the nature of the matter the reader has to struggle with a lot of unnecessary problems caused by inaccurate formulations and misprints. E.g., "Theorem 1.0.2" is not a theorem but rather an inaccurately phrased definition. The principle of conservation of signature" presented on p. 148 looks like a mathematical theorem that should be proved; instead, it is advertised as an "heuristic principle which is essentially self-evident." For all these reasons, reading this book is not exactly great fun. Probably only very few readers are willing to struggle through these 500 pages to verify the proof of just one single theorem, however interesting."

"Before this book appeared in 1993 its content was already circulating in the relativity community in form of a preprint that gained some notoriety for being extremely voluminous and extremely hard to read. Unfortunately, any hope that the final version would be easier to digest is now disappointed. Nonetheless, it is to be emphasized that the result presented in this book is very important. Therefore, anyone interested in relativity and/or in nonlinear partial differential equations is recommended to read at least the introduction."

Note that the above review actually suggests that problems would be adequately identified in the introduction. As shown in the present paper, the possible nonexistence of their dynamic solutions and its incompatibility with Einstein's radiation formula can be discovered in their introduction. Their book has often been cited [42-52], in spite of the invalid "proof". Note, however, such citations in some journals have stopped since 1996.

From this review, what the Shaw Prize claimed as "for their highly innovative works on nonlinear partial differential equations in Lorentzian and Riemannian geometry and their applications to general relativity and topology.", in the case of Christodoulou, seems to be just a euphemism for a highly confusing and incomprehensible presentation.

Appendix B : The Smallness Assumption and the S.A.F Initial Data Condition

In this Appendix B, it is pointed out that a dynamic strongly asymptotically flat (S.A.F.) condition need not necessarily exist. Also, it is strange that the "physical" solutions are constructed with only mathematical considerations.

In their book, without physical considerations, Christodoulou and Klainerman wrote:

"Our construction requires initial data sets that satisfy, in addition to the constraint equations, the maximal condition tr k = 0 (1.0.10). We will refer to them as maximal in what follows:"

> "To make the statement of our main theorem precise, we need also to define what we mean by the global smallness assumption. Before stating this condition, we assume the metric g to be complete and we introduce the following quantity:

$$Q(x_{(0)}, b) = \sup_{\Sigma} \{b^{-2}(d_0^2 + b^2)^3 |Ric|^2\}$$

$$+ b^{-3}\{ \int_{\Sigma} \sum_{l=0}^{3} (d_0^2 + b^2)^{l+1} |\nabla^l k|^2 + \int_{\Sigma} \sum_{l=0}^{3} (d_0^2 + b^2)^{l+3} |\nabla^l B|^2\}$$

where $d_0(x) = d(x_{(0)},x)$ is the Riemannian geodesic distance between the point x and a given point x(0) on Σ, b is a positive constant, $|Ric|^2 = R^{ij}R_{ij}$, ∇^l denotes the 1-covariant derivatives, and B is the symmetric, traceless 2-tensor tensor.

The symmetry and traceless of B follow immediately from the twice-contracted Bianchi identities $\nabla^i R_{ij}$ - ½ ∇_i R = 0. In the fact we can write $B_{ij} = (1/2)(\in_i^{ab}\nabla_a \hat{R}_{jb} + \in_j^{ab}\nabla_a \hat{R}_{ib})$, where $\hat{R}_{ij}$ is the traceless part of R_{ij}, $R_{ij} = \hat{R}_{ij} + 1/3R\, g_{ij}$.

Theorem 1.0.2 : (The Global Smallness Assumption) We say that a strongly asymptotically flat (S.A.F) initial data set, (Σ, g, k), satisfies the global smallness assumption if the metric g is complete and there exists a sufficiently small positive ∈ such that

$$\inf_{x_{(0)}\in\Sigma, b\geq 0} Q(x_{(0)}, b) < \in \qquad (1.0.15)$$

Theorem 1.0.3 (Second Version of the Main Theorem) Any strongly asymptotically flat, Maximal, initial data set that satisfies the global smallness assumption 1.0.15 leads to a unique, globally hyperbolic, smooth, and geodesically complete solution of the Einstein-Vacuum equation foliated by a normal maximal time foliation. Moreover, this development is globally asymptotically flat.

Remark 1.1 : In view of the scale invariance property of the Einstein-Vacuum equations, any initial data set Σ, g, k for which $Q(x_0, b) < \in$ can be rescaled to the new initial data set ä, g', k' with $g' = b^{-2}g$, $k' = b^{-1}k$ for which $Q(x_0, 1) < \in$. The global existence for the new set is equivalent to the global existence for the original set. This is due to the fact that the developments g, g' of the two sets are related by $g' = b^{-2}g$. It thus suffices to prove the theorem under the global smallness assumption

$$\inf_{x_{(0)}\in\Sigma} Q(x_{(0)}, b) < \in."$$

then, they prove that for given arbitrary solutions $\tilde{g}$, $\tilde{k}$ to the equations

$$tr_{\tilde{g}}\, \tilde{k} = 0, \qquad (1.0.16a)$$

$$\tilde{\nabla}^j \tilde{k}_{ji} = 0 \qquad (1.0.16b)$$

which are invariant with respect to the conformal transformation, this suffices to insure an initial data set (Σ, g, k) satisfying the S.A.F. condition if

$$\tilde{g}_{ij} = \delta_{ij} + o_4(r^{-3/2}), \text{ and } \tilde{k}_{ij} = o_3(r^{-5/2})$$

and the negative part of $\hat{R}$ satisfies the smallness condition.

Moreover, g and k satisfy the global smallness assumption of the theorem provided that the metric $\tilde{g}$ is complete and that there exists a mall positive ∈ such that

$$\inf_{x(0)\in\Sigma, a\geq 0} \{ \sup_{\Sigma} (\bar{d}_0^2 + a^2)^3 / \tilde{Ric} /^2\}$$

$$+ \int_{\Sigma} \sum_{l=0}^{3} (\bar{d}_0^2 + a^2)^{l+2} | \tilde{\nabla}^{\ell} \tilde{Ric} |^2 + \int_{\Sigma} \sum_{l=0}^{3} (\bar{d}_0^2 + a^2)^{l+1} | \tilde{\nabla}^{\ell} \tilde{k} |^2 < \in$$

where $\bar{d}_0(x)$ $(= \bar{d}_0)$ denotes the Riemannian geodesic distance relative to $\tilde{g}$ between the point x and a given point x(0) on Σ. Thus, it remains to discuss whether the equation 1.0.16a and 1.0.16b have solutions.

However, because condition (1.0.15), (1.0.10) and equation (1.0.16) have no dynamic requirements in their proofs, there is no assurance for the existence of a dynamic S.A.F. initial data set. If such a dynamic set does not exist, then the entire book is just for the static case! *Moreover, when a solution is assumed to be* *bounded, it would be automatically reduced to the static case.* Another basic problem of Christodoulou is that his understanding in physics is also fundamentally inadequate. In their book [6] of 500 pages, they did not address the sources of constructed solutions. If this is not due to their careless oversight, they may have failed to relate their solution to dynamic sources.

Appendix C : Speech by Professor Margaret H Wright (Member of Mathematical Sciences Selection Committee)

The Speech by Professor Margaret H Wright manifests that many failed to understand the non-existence of dynamic solution for Einstein's equation.[14)] Her speech before awarding the Shaw Prize for mathematics is as follows:

As in recent years, many outstanding and worthy nominations were made this year for the Shaw Prize in Mathematical Sciences. However, two names – Demetrios Christodoulou and Richard Hamilton – quickly rose to the top. The primary works of both involve the global behavior of nonlinear evolution equations in geometry, a large and active area in modern mathematics and mathematical physics. The central theme of their work is the formation of singularities for geometric evolution equations, a crucial question in general relativity or Riemannian geometry.

Demetrios's contributions are in mathematical physics – in particular, partial differential equations describing physical phenomena. His study of the behavior of solutions to Einstein's equations in general relativity has shaped our understanding of the formation of singularities such as black holes, as well as basic issues such as the stability of the Minkowski-space time. He is unique in having a deep understanding and intuition about the underlying physics while at the same time being a brilliant (mathematical) analyst. This combination of traits has led him to rigorous treatments and discoveries of unexpected phenomena. Along the way he has solved problems that had resisted progress for many years.

Richard has made many contributions to geometric analysis. In particular, his Ricci Flow, introduced to describe low-dimensional positively curved spaces, is one of the great gifts to modern mathematics. Over the past three decades Richard has led the way by developing a host of techniques to study the long-time behavior of his Ricci flow and to deal with singularities. His ideas have led to many results in geometry, topology, and the physics connected with curvature flows. The most spectacular of these is Grigori Perelman's proof of Thurston's Geometrization Conjectures (including Poincare' as a special case),[15)] which builds on Richard's theory of Ricci flow. The resulting classification of three-dimensional shapes constitutes one of the finest achievements in mathematics.

To sum up, the profound and innovative works of Demetrios and Richard are very hard-earned, achieved only by sticking to their ideas and beliefs over a long period of time. Their efforts are an inspiration to us all.

Comments from the author :

From this speech, while the evaluation of Richard Hamilton is valid, the Selection Committee does not understand the mathematics of Christodoulou and related issues in physics. Perhaps, the selection for Christodolou may be a little too quick. In fact, his views were shared by others, and were severely criticized [13-15]. As shown in their book [6], he studied solutions of a field without addressing the related sources [6]. Christodoulou should have known that, a time-dependent solution has no meaning unless it is related to dynamic sources. He failed to tell the difference between mathematics and physics, and to justify his assumption in physics [14]. It is clear that he does not understand physics and the principle of causality. Moreover, he made crucial mathematical errors at the undergraduate level [6, 11].

His errors in mathematics prevent others from seeing that the implicit assumption of Penrose and Hawking on the unique sign of all coupling constants is invalid [8]. This invalid physical assumption is crucial to their singularity theorems that led others to support the notion of black holes and to claim incorrectly that general relativity is invalid for microscopic phenomena [7, 19]. Thus, the claims of Christodoulou are major obstacles to the progress in physics.

Christodoulou should have given explicit solutions, *instead of just making an invalid claim as Misner et al did* [11]. He should have shown that their solutions were compatible with physically valid sources; *and this was what't Hooft failed* [4]. Moreover, he should have checked whether their solutions satisfy all physical requirements; and this was also what Bondi et al. [25], Penrose [26], 't Hooft as well as the Physical Review [16] and the Proceedings of the Royal Society A etc. have failed. The Shaw Prize Selection Committee also failed to see these problems because they do not understand physics. Thus, just like many others, the Prize Committee seems to blindly follow mistakes in the publications of Princeton and Einstein such as references [6], [11], and [53] etc. without the necessary deliberations. Had members of the Selection Committee tried to find an example of the dynamic solution that could support the claims of Christodoulou, they would have found his errors. Their award to an erroneous work is clearly a disservice to science.

In short, D. Christodoulou is incompetent in both mathematics and physics. Nevertheless, a combination of such traits in his special way together with prevailing misconceptions has led to crucial errors that were accepted by many theorists because of their own bias in physics and/or inadequacy in mathematics. Prof. Wright, as the speaker for a prize in analysis, is in Computer Science. It seems, the work of the honorable Gullstrand [14, 15] has been ignored, and the committee was also unaware of the recent important theoretical and experimental developments [21, 54].

Endnotes

1. A. Gullstrand won a Nobel Prize in 1911, was a member of the Nobel Physics Committee of the Swedish Academy of Sciences in 1921, and was the Chairman of the committee (1922-1929). Because of his work [1, 2], Einstein's Nobel Prize was for his discovery on the law of the photoelectic effect, but not general relativity. However, the confirmation of Gullstrand's ingenuity is a natural result of long-time hard work [8] from another area.
2. All information on Shaw Prizes can be found from their announcements in Google.
3. In disagreement with Einstein & Rosen, the Physical Review accepted "wave" solutions with unbounded amplitude as valid in physics because of being unaware of the violation of the principle of causality [55].
4. Although the time-dependent solution of't Hooft is bounded, it violates the principle of causality since his "solution" has no valid sources [4]. He failed in distinguishing a difference between mathematics and physics [4, 56]. In his 1999 Nobel Speech [57],'t Hooft showed misunderstandings of the notion of mass and special relativity.
5. Their calculation of the gravitational waves of binary pulsars failed because Einstein's equation does not have a bounded dynamic solution [8], which is necessary for their calculations of the gravitational radiation.
6. Many errors are actually created by the so-called "experts" [19]. For instance, the notion of local Lorentz invariance comes from the misinterpretation of Einstein's equivalence principle by the Wheeler School [22]. Such a notion is theoretically invalid [13, 18, 22, 24] and recently has been shown as not supported by experiments [58].
7. A difficulty is that mathematicians do not always understand the physical requirements, and physicists do not always understand the related mathematics. For instance, Christodoulou failed in both mathematics and physics [8, 13, 18]. Fields Medalists S. T. Yau (1982) and E. Witten (1990) also follow the invalid assumption of Penrose and Hawking [22] because of their inadequacy in physics. In fact, Yau even overlooked Hawking's logical error at the high school level although it is clearly stated in Hawking's book, "A Brief History of Time".
8. Since the radiation reaction force is very small, the geodesic equation would be an accurate approximation.
9. Mathematically, the non-linear Einstein equation unexpectedly has no bounded dynamic solution [8].
10. Physically, according to the principle of causality, a bounded dynamic solution must exist [12] for a valid equation.
11. According to Veltman [59], one may question whether "spontaneous symmetry breakdown" is really what happens in a non-Abelian gauge theory? However, it is clear that a particular gauge has to be chosen in physics [60].
12. However, theoretical errors are often manifested in so many ways that make a thorough cover up impossible.
13. Errors at the undergraduate level show that D. Christodoulou is inadequate in both mathematics and physics.
14. For instance, Eric J. Weinberg, editor of the Physical Review D, also incorrectly believes that there are dynamic solutions for the Einstein equation [61]. Friedrich W. Hehl, Co-Editor of Annalen der Physik, also incorrectly believes an approximate solution can always be obtained by perturbation [21].
15. To be precise, the case of Poincare' conjecture is completed by Cao & Zhu [62]. Although Grigori Perelman provides a number of sub-conjectures that lead to the completion, there is no evidence that he has done the work. One of his conjectures remains to be proved as valid, in spite of that Perelman had claimed that all have been proved.

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Quantum Mechanics, Cosmic Acceleration and CMB Radiation

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Abstract - Based on the big bang concepts - in the expanding universe, rate of decrease in CMBR temperature is a measure of the cosmic rate of expansion. If universe is accelerating, CMBR temperature must decrease continuously. It is noticed that, Bohr radius of hydrogen atom, quanta of the angular momentum and the fine structure ratio - are connected with the large scale structure of the massive expanding universe. In the accelerating universe, as the space expands, in hydrogen atom, distance between proton and electron increases and is directly proportional to the size of the universe. 'Rate of decrease in the laboratory fine structure ratio' is a measure of cosmic rate of expansion. Considering the integral nature of number of protons (of any nucleus), integral nature of $\hbar$ can be understood. Obtained value of the present Hubble constant is 70.75 Km/sec/Mpc. Instead of the Planck scale, initial conditions can be represented with the Coulomb scale. Finally it can be suggested that, if the primordial universe is a natural setting for the creation of black holes and other non-perturbative gravitational entities, throughout its journey, the whole universe is a primordial (growing and rotating) black hole.

Keywords : Reduced Planck's constant, Fine structure ratio, Bohr radius, Cosmic mass, Coloumb scale, CMB radiation, Cosmic acceleration, Light speed rotation and Primordial cosmic black hole..

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QUANTUM MECHANICS, COSMIC ACCELERATION AND CMB RADIATION

Strictly as per the compliance and regulations of :

Quantum Mechanics, Cosmic Acceleration and CMB Radiation

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Abstract - Based on the big bang concepts - in the expanding universe, rate of decrease in CMBR temperature is a measure of the cosmic rate of expansion. If universe is accelerating, CMBR temperature must decrease continuously. It is noticed that, Bohr radius of hydrogen atom, quanta of the angular momentum and the fine structure ratio - are connected with the large scale structure of the massive expanding universe. In the accelerating universe, as the space expands, in hydrogen atom, distance between proton and electron increases and is directly proportional to the size of the universe. 'Rate of decrease in the laboratory fine structure ratio' is a measure of cosmic rate of expansion. Considering the integral nature of number of protons (of any nucleus), integral nature of $\hbar$ can be understood. Obtained value of the present Hubble constant is 70.75 Km/sec/Mpc. Instead of the Planck scale, initial conditions can be represented with the Coulomb scale. Finally it can be suggested that, if the primordial universe is a natural setting for the creation of black holes and other non-perturbative gravitational entities, throughout its journey, the whole universe is a primordial (growing and rotating) black hole.

Keywords : Reduced Planck's constant, Fine structure ratio, Bohr radius, Cosmic mass, Coloumb scale, CMB radiation, Cosmic acceleration, Light speed rotation and Primordial cosmic black hole.

I. The Reduced Planck's Constant - A Strange Coincidence

Large dimensionless constants and compound physical constants reflects an intrinsic property of nature [1,2]. Whether to consider them or discard them depends on the physical interpretations, experiments and observations. The mystery can be resolved only with further research, analysis and discussions. If m_e and m_p are the rest masses of electron and proton respectively, it is noticed that,

$$\frac{\hbar c}{Gm_p\sqrt{M_0 m_e}} \cong 0.99753 \quad (1)$$

Where $M_0 \cong c^3/2GH_0$ and the best value [3,4,5] of H_0 is $70.4^{+1.3}_{-1.4}$ Km/sec/Mpc. Surprisingly this ratio is close to unity! How to interpret this ratio?

a) Number of electrons or positrons in the universe

Number of electrons or positrons in the present universe can be expressed as

$$\frac{M_0}{m_e} \cong \left(\frac{\hbar c}{Gm_p m_e}\right)^2 \quad (2)$$

Considering both the number of electrons and positrons, it is noticed that,

$$\ln\left[\frac{1}{N}\cdot 2\left(\frac{M_0}{m_e}\right)\right] \cong \frac{1}{\alpha} \cong 137.024 \quad (3)$$

Where N is the Avogadro number and α is the fine structure ratio.

b) To understand the quanta of the angular momentum

Giving a primary significance to the existence of m_e, m_p, G & c, and considering the Machian concept of the distance cosmic back ground [6] in the form of 'distance cosmic mass', $\hbar$ can be considered as the compound physical constant [7,8,9].

$$\hbar \cong \sqrt{\frac{M_0}{m_e}}.\frac{Gm_p m_e}{c} \cong 1.0572\times 10^{-34} \text{ J.sec} \quad (4)$$

From the atomic structure point of view also this idea can be strengthened. If electron is revolving round the nucleus, naturally m_p and m_e both are the characteristic physical inputs. By considering the origin of the Bohr radius of Hydrogen atom this proposal can be given a chance. If so: in the expanding universe 'quanta' increases with increasing mass of the universe. Any how this is a very sensitive problem to human thoughts and observations. Considering the 'integral nature' of number of protons, integral nature of $n\cdot\hbar$ can be understood. Considering any two successive integers n and $(n+1)$, their geometric state is $\sqrt{n(n+1)}\cdot\hbar$. if this logic is true, it can be suggested that $\hbar$ is connected with the large scale structure of the expanding universe. The laboratory fine structure ratio is

$$\alpha \cong \sqrt{\frac{m_e}{M_0}}.\frac{e^2}{4\pi\varepsilon_0 Gm_p m_e} \quad (5)$$

It is the strength of electromagnetic interaction and is an intrinsic property of nature. Cosmic acceleration and dark energy constitute one of the most important and challenging of current problems in cosmology and other areas of physics [10]. If so 'rate of increase in $\hbar$' or 'rate of decrease in α' can also be

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considered as a measure of the cosmic acceleration. With reference to relation (4), magnitude of the Hubble's constant can be fitted as

$$H_0 \cong \frac{Gm_p^2 m_e c}{2\hbar^2} \cong 70.75 \text{ Km/sec/Mpc} \quad (6)$$

c) Bohr radius of the Hydrogen atom

In hydrogen atom, potential energy of electron in Bohr radius [7, 8] can be expressed as

$$E_P \cong -\frac{e^2}{4\pi\varepsilon_0 G m_p M_0} \times \frac{e^2 c^2}{4\pi\varepsilon_0 G m_p} \quad (7)$$

Thus, total energy of electron in Bohr radius is

$$E_T \cong -\frac{e^2}{4\pi\varepsilon_0 G m_p M_0} \times \frac{e^2 c^2}{8\pi\varepsilon_0 G m_p} \quad (8)$$

Considering the integral nature of number of protons (of any nucleus), above relation is

$$E_T \cong -\frac{e^2}{4\pi\varepsilon_0 G\left(n\cdot m_p\right) M_0} \times \frac{e^2 c^2}{8\pi\varepsilon_0 G\left(n\cdot m_p\right)} \quad (9)$$

where $n = 1, 2, 3, ..$ Thus in a discrete form,

$$E_T \cong -\frac{1}{n^2} \times \frac{e^2}{4\pi\varepsilon_0 G m_p M_0} \times \frac{e^2 c^2}{8\pi\varepsilon_0 G m_p} \quad (10)$$

Hence 'Bohr radius of hydrogen' atom is

$$a_0 \cong \frac{4\pi\varepsilon_0 G m_p M_0}{e^2} \cdot \frac{G m_p}{c^2} \cong \frac{1}{2}\left(\frac{4\pi\varepsilon_0 G m_p^2}{e^2}\right) \cdot \frac{c}{H_0} \quad (11)$$

This is a very simple and natural fit. The real beauty of the Mach's principle can be seen here.

$$a_0 \propto M_0 \propto \frac{c}{H_0} \quad (12)$$

In this way, independent of the telescopic observations, the exact value of the present Hubble's constant can be estimated from the ground based laboratory experiments and thus $\frac{d\alpha}{dt}$ or $\frac{d\hbar}{dt}$ represents a measure of the cosmic acceleration. Since its origin, $\hbar$ is assumed and observed to be a fundamental quantum constant. It means, at present, $\frac{d\hbar}{dt} = 0$. Hence it can be suggested that, at present there is no expansion or acceleration in the universe.

To establish this fact, one must derive the characteristic cosmic mass $M_0 \cong c^3 / 2GH_0$ independent of the cosmic critical density $3H_0^2 / 8\pi G$ concepts. If one is able to show that, H_0 is a cosmic angular velocity variable, then $3H_0^2 / 8\pi G$ represents the geometric density of the (closed) rotating and expanding universe. Not only that, by considering the universe as a primordial growing and light speed rotating black hole, $(c^3 / 2GH_0)$ can be obtained and the growing cosmic size can be minimized to (c / H_0).

d) The Coulomb scale: alternative to the Planck Scale

By any chance, if $\hbar$ is a cosmic variable, then what about the validity of 'Planck mass' and 'Planck scale'? Answer is very simple. $\sqrt{\frac{\hbar c}{G}}$ can be replaced with $\sqrt{\frac{e^2}{4\pi\varepsilon_0 G}}$. It can be called as the 'Coulomb mass'. Its corresponding rest energy is $\sqrt{\frac{e^2 c^4}{4\pi\varepsilon_0 G}}$. It can be called as the 'Coulomb energy'. Planck energy can be replaced with the 'Coulomb energy'.

$$M_C \cong \sqrt{\frac{e^2}{4\pi\varepsilon_0 G}} \cong 1.859211 \times 10^{-9} \text{ Kg} \quad (13)$$

$$M_C c^2 \cong \sqrt{\frac{e^2 c^4}{4\pi\varepsilon_0 G}} \cong 1.042941 \times 10^{18} \text{ GeV} \quad (14)$$

Here e is the elementary charge and (c^4 / G) is the classical limit of force. How to interpret this mass unit? Is it a primordial massive charged particle? If 2 such oppositely charged particles annihilates, a large amount of energy can be released. Considering so many such pairs annihilation hot big bang or inflation can be understood. This may be the root cause of cosmic energy reservoir. Such pairs may be the chief constituents of black holes. In certain time interval with a well defined quantum rules they annihilate and release a large amount of energy in the form of γ photons. In the expanding universe, with its pair annihilation, origin of the CMBR can be understood.

It is widely accepted that charged leptons, quarks, and baryons all these comes under matter or mass carriers and photons and mesons comes under force carriers. If so what about this new mass unit? Is it a fermion? or Is it a boson? or else is it represents a large potential well in the primordial matter or mass generation program? Is it the mother of magnetic monopoles? Is it the mother of all charged particles? By any suitable proportionality ratio or with a suitable scale factor if one is able to bring down its mass to the observed particles mass scale, very easily a grand unified model can be developed.

Clearly speaking e, c and G play a vital role in fundamental physics. With these 3 constants space-time curvature concepts at a charged particle surface can be studied. Characteristic 'Coulomb size' can be expressed as

$$R_C \cong \frac{2GM_C}{c^2} \cong 2.716354 \times 10^{-36} \text{ m} \quad (15)$$

Considering 'light speed rotation', characteristic 'Coulomb scale angular velocity' is

$$\omega_C \cong \frac{c}{R_C} \cong \frac{c^3}{2GM_C} \cong 1.085672\times 10^{44} \text{ rad/sec} \quad (16)$$

e) To understand the CMBR temperature

Pair particles creation and annihilation in `free space'- is an interesting idea. In the expanding universe, by considering the proposed charged M_C and its pair annihilation as a characteristic cosmic phenomena, origin of the isotropic CMB radiation can be addressed. Where the free space is occupied by a large massive body, there the pair annihilation of M_C cannot be seen and this may be a reason for the observed anisotropy of CMB. At any time t, it can be suggested that

$$k_B T_t \cong \sqrt{\frac{M_C}{M_t}}\cdot 2M_C c^2 \quad (17)$$

Where M_t is the cosmic mass at time t and T_t is the cosmic temperature at time t. Please note that, at present

$$T_0 \cong \sqrt{\frac{M_C}{M_0}}\cdot\frac{2M_C c^2}{k_B} \cong 3.5175\ ^0\text{Kelvin} \quad (18)$$

Qualitatively and quantitatively this can be compared with the present CMBR temperature 2.725^0 Kelvin. It seems to be a direct consequence of the Mach's principle. It means - at any time, the cosmic mass or cosmic size play a critical role in the pair annihilation energy of M_C. Initial temperature of the universe can be expressed as

$$T_C \cong \frac{2M_C c^2}{k_B} \cong 2.42\times 10^{31}\ ^0\text{Kelvin} \quad (19)$$

With reference to the present observed CMBR temperature, considering the 3 dimensional average thermal energy $\frac{3}{2}k_B T_t$, above relation can be expressed as

$$\frac{3}{2}k_B T_t \cong \sqrt{\frac{M_C}{M_t}}\cdot 2M_C c^2 \quad (20)$$

Thus,

$$T_0 \cong \left(\frac{2}{3}\right)\sqrt{\frac{M_C}{M_0}}\cdot\frac{2M_C c^2}{k_B} \cong 2.345\ ^0\text{Kelvin} \quad (21)$$

In this way, origin of the CMB radiation can be studied. But it has to be discussed in depth. Now, initial temperature of the universe can be expressed as

$$T_C \cong \left(\frac{2}{3}\right)\frac{2M_C c^2}{k_B} \cong 1.61\times 10^{31}\ ^0\text{Kelvin} \quad (22)$$

II. The Critical Density and Its Dimensional Analysis

Assume that, a planet of mass (M) and size (R) rotates with angular velocity (ω_e) and linear velocity (v_e) in such a way that, free or loosely bound particle of mass (m) lying on its equator gains a kinetic energy equal to potential energy as,

$$\frac{1}{2}mv_e^2 = \frac{GMm}{R} \quad (23)$$

$$R\omega_e = v_e = \sqrt{\frac{2GM}{R}} \text{ and } \omega_e = \frac{v_e}{R} = \sqrt{\frac{2GM}{R^3}} \quad (24)$$

i.e Linear velocity of planet's rotation is equal to free particle's escape velocity. Without any external power or energy, test particle gains escape velocity by virtue of planet's rotation. Using this idea, 'Black hole radiation' and 'origin of cosmic rays' can be understood. Note that if Earth completes one rotation in one hour then free particles lying on the equator will get escape velocity. Now writing, $M = (4\pi/3)R^3\rho_e$

$$\omega_e = \frac{v_e}{R} = \sqrt{\frac{8\pi G\rho_e}{3}} \text{ Or } \omega_e^2 = \frac{8\pi G\rho_e}{3} \quad (25)$$

$$\text{Density, } \rho_e = \frac{3\omega_e^2}{8\pi G} \quad (26)$$

In real time, this obtained density may or may not be equal to the actual density. But the ratio, $(8\pi G\rho_{real}/3\omega_{real}^2)$ may have some physical meaning. The most important point to be noted here, is that, as far as dimensions and units are considered, from equation (26), it is very clear that, proportionality constant being $3/8\pi G$,

$$\text{density} \propto (\text{angular velocity})^2 \quad (27)$$

Equation (26) is similar to ''flat model concept'' of cosmic ''critical density''

$$\rho_c = \frac{3H_0^2}{8\pi G} \quad (28)$$

Comparing equations (26) and (28) dimensionally and conceptually,

$$\rho_e = \frac{3\omega_e^2}{8\pi G} \text{ with } \rho_c = \frac{3H_0^2}{8\pi G} \quad (29)$$

$$H_0^2 \to \omega_e^2 \text{ and } H_0 \to \omega_e \quad (30)$$

In any physical system under study, for any one 'simple physical parameter' there will not be two different units and there will not be two different physical meanings. This is a simple clue and brings ''cosmic rotation'' into picture. This dimensional analysis cannot be ignored.

III. Modified Hubble's Law

Ever since the late 1920's, when Edwin Hubble discovered a simple proportionality between the redshifts in the light coming from nearby galaxies and their distances, we have been told that the Universe is expanding. Hubble found the recession speed v of a nearby galaxy was related to its radial distance r, $v = H_0 r$, where H_0 is the constant of proportionality. This relationship- dubbed the Hubble law- has since been strengthened and extended to very great distances in the cosmos. This was the incomplete interpretation that changed the destiny of the modern cosmology. Based on this interpretation modern cosmologists arrived at the conclusion that - at present, universe is flat and is accelerating. Later in his life Hubble varied from his initial interpretation [11] and said that the Hubble law was due to a hitherto undiscovered mechanism, but not due to expansion of space - now called cosmological expansion.

For the same observations it can also be possible to state that, in a closed and expanding universe, from and about the cosmic center, rate of increase in galaxy redshift is a measure of cosmic rate of expansion. This statement includes 3 points. 1) Light from the galaxy travels opposite to the direction of cosmic expansion and shows redshift and thus redshift is a measure of galaxy distance from the cosmic center. 2) In the expanding universe, increase in redshift is instantaneous due to instantaneous increase in galaxy distance (which is due to instantaneous increase in cosmic volume) and 3) Rate of increase in redshift indicates the cosmic rate of expansion.

a) The proposed 4 assumptions

Starting from the Coulomb scale, it is assumed that, at any time (t),

1) The universe can be treated as a primordial rotating and growing black hole.
2) With increasing mass and decreasing angular velocity, the universe is always rotating with speed of light.
3) 'Rate of decrease' in CMBR temperature is a measure of cosmic 'rate of expansion'.
4) 'Rate of decrease' in laboratory fine structure ratio is also a measure of cosmic 'rate of expansion'.

At time t, cosmic size is $R_t \cong 2GM_t/c^2$ and cosmic angular velocity is $\omega_t \cong c/R_t \cong c^3/2GM_t$. Thus $M_t \cong c^3/2G\omega_t$.

b) Universe – the primordial cosmic black hole

Based on the big bang concepts- in the expanding universe, rate of decrease in CMBR temperature is a measure of the cosmic rate of expansion. Modern standard cosmology is based on two contradictory statements. They are - present CMBR temperature is isotropic and the present universe is accelerating. In particle physics also, till today laboratory evidence for the existence of dark matter and dark energy is very poor. Recent observations and thoughts supports the existence of the cosmic axis of evil. Independent of the cosmic red shift and CMBR observations, cosmic acceleration can be verified by measuring the 'rate of decrease' in the fine structure ratio. In this connection an attempt is made to study the universe with a closed and growing model of cosmology.

If the primordial universe is a natural setting for the creation of black holes and other non-perturbative gravitational entities, it is also possible to assume that throughout its journey, the whole universe is a primordial (growing and rotating) cosmic black hole [12-16]. Instead of the Planck scale, initial conditions can be represented with the Coulomb scale.

c) Light speed rotating Black Holes: The special holes

Origin of 'rotating black hole' formation can be understood with the classical power limit (c^5/G) and (Mc^2) within 3 steps. For any rotating celestial body

$$\text{torque}, \tau \le Mc^2 \tag{31}$$

$$\text{power}, P = \tau\omega \le \frac{c^5}{G} \tag{32}$$

$$\text{thus}, \ \omega \le \frac{\mathrm{c}^3}{\mathrm{GM}} \ \text{and} \ \omega_{\max} = \frac{\mathrm{c}^3}{\mathrm{GM}} \tag{33}$$

When the celestial body rotates at light speed, to have maximum angular velocity, size should be minimum as,

$$R_{min} = \frac{c}{\omega_{max}} = \frac{GM}{c^2} \tag{34}$$

This expression is similar to the 'Schwarzschild radius' of a black hole. The only change is that coefficient 2 is missing. This is really a very interesting case. This obtained expression indicates that, to get 'light speed rotation', celestial body should have a 'minimum size' of GM/c^2. Clearly speaking this proposal is entirely different from the existing concepts of General theory of relativity. It is not speaking about the gravitational collapse of stars or space-time curvature or singularity. Now this is the time to re-examine the foundations of modern black hole physics. If the concept of 'Schwarzschild radius' is believed to be true, for any rotating celestial body or black hole of rest mass (M) the critical conditions can be stated as follows. 1) Magnitude of 'kinetic energy' never crosses 'rest energy'. 2) Magnitude of 'torque' never crosses 'potential energy' and 3) Magnitude of mechanical power never crosses (c^5/G). Note that, based on the Virial theorem, potential energy is twice of kinetic energy and thus, $\tau \le 2Mc^2$.

IV. Conclusion

The proposed methodology is very simple. Searching, collecting, sorting and compiling the cosmic code is an essential part of unification. Further research and analysis in this new direction may reveal the facts.

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In The Clear Sky: The Cosmology of the Stars

By Rishan Singh
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Abstract - In the universe that we live, in we are surrounded by trees, plants, animals, our human beings, oxygen and various other gases that make up the atmosphere. The Milky Way of the universe comprises planets, the moon, and the sun; which is a star like the other stars in the universe. This article looks at the stars within our universe and serves to inform and emphasise their role and formation to, astronomists, astrophysicists, cosmologists and, the general reader who are interested to know more about the cosmology of the stars.

Keywords : Milky Way, Constellation, Nebula, Galaxy, Gaseous Cloud, Nuclear Fusion, Gravitational force, Hydrostatic support, Cosmology.

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IN THE CLEAR SKY THE COSMOLOGY OF THE STARS

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In The Clear Sky: The Cosmology of the Stars

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Abstract - In the universe that we live, in we are surrounded by trees, plants, animals, our human beings, oxygen and various other gases that make up the atmosphere. The Milky Way of the universe comprises planets, the moon, and the sun; which is a star like the other stars in the universe. This article looks at the stars within our universe and serves to inform and emphasise their role and formation to, astronomists, astrophysicists, cosmologists and, the general reader who are interested to know more about the cosmology of the stars.

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On a clear night, the sky is inhabited by thousands, if not millions, of stars that vary in brightness, some of which form part of the Milky Way; an elongated cloudy stripe of stars. The discovery of stars as comprising the Milky Way, was first observed by Galileo Galilei in 1610, and supported by Thomas Wright in 1750. However, Thomas Wright suggested that individual stars formed a conglomerate in the shape of a flat disc which we, today, call the galaxy (Giancoli, 1998).

The galaxy contains about 10^{11} stars with a total mass of approximately 3×10^{41} kg (Giancoli, 1998). From the Shakespearean poem 'Let Me Not to the Marriage of True Minds', the 'star' played an important role in those days for survival and religious purposes. In many parts of the world it was used for celestial navigation and orientation, out at sea, when one was lost and caught up in the storms. Today it is used by astronomers to track the motion of the planets and the position of the sun by grouping them into constellations (Forbes, 1909). One way in which farmers regulated their agricultural practices was by creating calendars by observing the motion of the sun and/or moon against the background stars and horizon (Tøndering, no date supplied).

Stars are formed both within and outside the Milky Way (Giancoli, 1998) i.e. they exist in the galaxy and intergalactically (Hubble News Desk, no date supplied). When stars cluster together they form globular stars and these stars appear cloudy to the naked eyes. Since they appear cloudy they are called nebula; because these globular stars exist in variations whereby they may actually be glowing clouds of gas or dust. In general, stars that appear as globular clusters occur in constellations such as Andromeda, Orion or even Hercules. They appear as gaseous nebula in the constellation, Carina. Apart from globular stars, there are also stars that are elliptical in shape and that are analogous to the shape of our galaxy i.e. disk-like. The reason for this elliptical stars are visualised at an angle (something like a flying freeze-bee). These stars are extragalactic i.e. they are in existence beyond the stars we are able to see clearly i.e. they are faint in the Milky Way.

The galaxy contains many types of stars known as (1) red gaints, white dwarfs, neutron stars, black holes, and exploding stars called novac and supernovac. In addition these are galaxies that are brighter than our ordinary galaxies. These galaxies are called quasars. It is important to remember that the brightness we see on Earth, is due to the nearest star to Earth i.e. the sun because the radiation from the sun is uniform to release brightness. The other stars of the Milky Way do not emit radiation in a uniform fashion (Giancoli, 1998 and Rishan Singh, personal writing).

Every night the sky remains unchanged. In the sky there are stars which remain unchanged except for their position relative to each other (Royal Greenwich Observatory, no date supplied). There are some variations in that the novac and supernovac do change a lot. Since the stars are so far away from us, precise measurements of the distance of one star relative to another are difficult to attain. Moreover, each star of a different mass and is unique to itself. Since these stars are at different distances to us, they emit brightness or radiation of different wavelengths (Giancoli, 1998).

Astronomers can determine the mass, age, chemical composition (Bahcall, 2000) and surface temperature (Giancoli, 1998) of a star by observing its spectrum, luminosity, brightness and motion through space (Bahcall, 2000; Giancoli, 1998). The wavelength of light that a star or galaxy emits is directly proportional to the surface temperature of the star. This means that a star that has a lower surface temperature would appear dim (low luminosity) because it would emit a shorter wavelength of light. In contrast, this is not the case when a star has a surface temperature that favours brightness from the blue wavelength of light emitted (Giancoli, 1998; Rishan Singh, personal writing). It is a researched fact that the surface temperature of stars range between 50.000 Kelvin (K) (blue) to 3500 K (red) (Giancoli, 1998) with high temperature and pressure centres (cores) are called white dwarfs (Mengel *et al.*, 1979). These white dwarfs form a part of the main sequence of stars (Mengel *et al.*, 1979) that form part of the Milky Way (Rishan Singh, personal writing). In contrast, red giants have higher luminosity with lower core temperatures (Giancoli, 1998) i.e. red spectrum emission (Rishan

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Singh, personal writing). According to Mengel *et al* (1979), the mass and luminosity of a star determines the duration at which a star would form part of the main sequence. It has been estimated that the sun would be part of the Milky Way for about 10^{10} years. To date no red dwarf (small stars) has reached the age of the Earth i.e. 14 billion years and it is not expected to attain this age (Richmond, no date supplied).

The lifecycle of a star can range from 1 day to hundreds and millions of years and as human-beings it is difficult to follow the exact life cycle of the variety of star types, which has been mentioned previously. In terms of the evolutionary existence of stars, a star is born and its fate determined by the forces of nature, mainly gravity (Rishan Singh, personal writing). A star is born when gravity causes hydrogen clouds to contract (Giancoli, 1998). However, the contraction of other gaseous clouds can also induce star formation (Giancoli, 1998; Rishan Singh, personal writing). The majority of those clouds consist of hydrogen with about 25 % helium and a few percent of other heavier elements (Woodward, 1978).

The contraction of gaseous clouds causes them to break/fragment into smaller masses. These smaller masses contain a centre that is slightly heavier than the point to which it is situated near to, as was the case of the original gaseous cloud. Gravity causes these smaller masses to contract further, forming protostars (Giancoli, 1998; Rishan Singh, personal writing).

Protostars are made up of particles. When these particles move inwards, the kinetic energy of these stars increase (Giancoli, 1998). Kinetic energy is defined as the energy that is required for one star to move (Rishan Singh, personal writing and definition). When the kinetic energy is sufficiently high, the Coulomb force of repulsion between hydrogen nuclei is overcome causing them to fuse. This is called nuclear fusion (Bahcall, 2000; Giancoli, 1998). Coulomb's force is defined as the force between charged particles at rest; it has magnitude and direction (Giancoli, 1998).

The few percent of heavy metals that constitute the gaseous cloud (Woodward, 1978), is a determinant and regulatory factor of the magnetic field and it also has a profound influence on the duration that a star will burn its fuel (Pizzolato, 2001). Older stars have less metalicity compared to younger stars as those stars die; portions of their outer layers get shred into the atmosphere. These shredded portions get re-used during the formation of new stars and planets. The outflow from supernovae provides the optimal medium in which star formation can occur (NASA Goddard Space Flight Center, no date supplied). An interesting key point of note is that the magnetic field can act as an inhibitor of rotation in older stars, such as the sun, because the level of surface gravity in the sun is lower compared to the other stars (Berdyugina, 2005) in the galaxy (Rishan Singh, personal writing). The structure of the galaxy, its evolution as well as the age and origin of stars can be determined from the motion of a star (ESA, no date supplied).

During nuclear fusion, a lot of energy is released which inhibits gravitational contraction causing a young star to stabilise and exist. This also applies to the sun, whose formation involves the fusion of 4 protons resulting in a $^{4}_{2}He$ nucleus. The reaction releases gamma rays and neutrinos and it occurs at the core of the star where the temperature is extremely high. As the helium within the core increases, hydrogen continues to 'burn' in the shell around it. When the hydrogen is consumed, the production energy decreases causing the gravitational force and coulombs force of repulsion to increase. This causes the hydrogen in the shell around the core to 'burn' more fiercely because the increase in temperature causes the outer envelope of the star to expand and cool. The low surface temperature causes the star to emit light in the longer wavelength i.e. red spectrum. These stars are called red giants since they are expanded in size and are more luminous, as mentioned (Giancoli, 1998). This group of stars (giants and even supergiants) (Iben, 1991) are referred to as eruptive variables by astronomers because these stars experience a sudden increase in luminosity because of flares and/or mass ejection events (AAVSO, 2010).

The actual fate of a star depends on the mass of the star relative to the solar mass of the red giant stage i.e. the change from a black dwarf to a black hole (discussion follows). If the star has a mass that is greater than 1.4 solar masses, then further fusion occurs causing the star to expand as it gains internal energy. The core increases in temperature and the star gets brighter and brighter. This is called a white dwarf. However, there are stars which have a residue mass of more than 1.4 solar masses and these are massive in size. In those stars, the kinetic energy is so high that iron can fuse in clouding elements that are heavier even though these reactions are endogonic in nature. These energy-requiring reactions cause iron and nickel to breakup into helium and eventually into protons and neutrons; but also can cause protons to join to electrons to form neutrons (Giancoli, 1998).

A nucleus of neutrons is formed as the core of a hydrogen cloud contracts under gravity. The size of the star depends on the conjugation of protons and electrons and it is called a neutronstar. These stars, just like all stars, have an outer envelope and the energy released by gravity would by some natural catastrophe cause the formation of a supernova (Giancoli, 1998; Goddard Space Flight Center, no date supplied; Rishan Singh, personal writing), a type of star that has the potential to show drastic change because it is formed from many elements of the periodic table (Giancoli, 1998; Iben, 1991). These stars are known as cataclysmic or explosive variable stars (Iben, 1991). The explosion of a supernova releases energy that emits brightness that is a billion times greater over a few days and fades away in time (Giancoli, 1998).

The backbone of supernova formation is the pulsar, a rapidly rotating star, which is known themselves to be a neutron star that emits sharp pulses of radiation at regular intervals. Their rapid rotatory nature is due to their angle of momentum being conserved while contraction occurs as their inertia decreases (Giancoli, 1998). These stars are known as pulsating variables stars because their size determines the period (seconds, months, years etc.) during which expanding and contracting occurs (AAVSO, 2010).

When the mass of a star is greater than 2-3 solar masses, the gravitational force would be so strong that the light that is emitted would not be able to escape i.e. it would be pulled back in by gravity. This means that the speed of light is less than the escape velocity. Such a star we would not be able to see since no light is emitted and therefore it would be black to astronomers. This is called a black hole (Fryer, 2003; Giancoli, 1998).

In all type of stars, the force of gravity is continually trying to cause the star to collapse, but this is counteracted by the pressure of hot gas and/or radiation in the star's interior. This is called hydrostatic support (NASA, 2010). It is important for us to acknowledge the greatness in God's creation and the history the stars of our universe have been through and to commend those people who have made it back home alive using the astronomists, physicists, cosmologists and to the general reader, putting the cosmology of the stars in societal context.

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General Relativity – A Theory in Crisis

By Stephen J. Crothers
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Abstract - The black hole, gravitational waves, and the Big Bang cosmology have no valid basis in science. It is demonstrated herein that Einstein's field equations violate the usual conservation of energy and momentum and are therefore in conflict with experiment on a deep level, so that General Relativity is invalid. This fact alone proves the invalidity of the black hole, gravitational waves, the Big Bang cosmology and Einstein's conception of the gravitational field.

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GJSFR-A Classification : *FOR Code: 020105, 020106, 020109*

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Keywords : General Relativity, field equations, black hole, Big Bang cosmology, gravitational waves, conservation of energy and momentum, pseudo-tensor.

I. Introduction

The black hole, gravitational waves and the Big Bang cosmology have been spawned by Einstein's General Theory of Relativity. However, it is rather easily proven that Einstein's field equations violate the usual conservation of energy and momentum and are therefore in conflict with experiment on a deep level and are therefore invalid. This means that the black hole, gravitational waves and Big Bang cosmology are also invalid. General Relativity fails as a theory of gravitation and cannot describe the Universe.

II. Einstein's Field Equations

According to Einstein, matter is the cause of the gravitational field and the causative matter is described in his theory by a mathematical object called the energy-momentum tensor, which is coupled to geometry (i.e. spacetime) by his field equations, so that matter causes spacetime curvature (his gravitational field) and spacetime constrains motion of matter when gravity alone acts. According to the astrophysics community, Einstein's field equations,

> "... *couple the gravitational field (contained in the curvature of spacetime) with its sources.*" (Foster & Nightingale 1995).

> "*Since gravitation is determined by the matter present, the same must then be postulated for geometry, too. The geometry of space is not given a priori, but is only determined by matter.*" (Pauli 1981).

> *"Again, just as the electric field, for its part, depends upon the charges and is instrumental in producing mechanical interaction between the charges, so we must assume here that the metrical field (or, in mathematical language, the tensor with components g_{ik}) is related to the material filling the world." (Weyl 1952).*

> *"... we have, in following the ideas set out just above, to discover the invariant law of gravitation, according to which matter determines the components $\Gamma^{\alpha}_{\beta\iota}$ of the gravitational field, and which replaces the Newtonian law of attraction in Einstein's Theory.*" (Weyl 1952).

> "*Thus the equations of the gravitational field also contain the equations for the matter (material particles and electromagnetic fields) which produces this field.*" (Landau & Lifshitz 1951).

> "*Clearly, the mass density, or equivalently, energy density $\rho(\vec{x},t)$ must play the role as a source. However, it is the 00 component of a tensor $T_{\mu\nu}(x)$, the mass-energy-momentum distribution of matter. So, this tensor must act as the source of the gravitational field.* ('t Hooft 2009).

> "*In general relativity, the stress-energy or energy-momentum tensor T^{ab} acts as the source of the gravitational field. It is related to the Einstein tensor and hence to the curvature of spacetime via the Einstein equation.*" (McMahon 2006).

> "*Mass acts on spacetime, telling it how to curve. Spacetime in turn acts on mass, telling it how to move.*" (Carroll and Ostlie 1996).

Qualitatively Einstein's field equations are:

Spacetime geometry = -ô â *causative matter*

where *causative matter* is described by the energy-momentum tensor and κ is a constant. The *spacetime geometry* is described by a mathematical object called Einstein's tensor, $G_{\mu\nu}$, (μ, ν = 0, 1, 2, 3). Einstein's field equations are therefore[1]:

$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = -\kappa T_{\mu\nu} \tag{2.1}$$

$R_{\mu\nu}$ is called the Ricci tensor and R the Ricci curvature. If $T_{\mu\nu} = 0$ then one finds that $R = 0$ and this expression according to Einstein allegedly reduces to

$$R_{\mu\nu} = 0 \tag{2.2}$$

and is said to describe a universe that contains no matter (the so-called static empty universe).

In the transition from Minkowski spacetime of Special Relativity to Schwarzschild spacetime for the

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[1] The so-called "cosmological constant" is not included.

black hole, matter is not involved. The speed of light c that appears in the Minkowski spacetime line-element is a speed, not a photon. For this speed to be assigned to a photon, the photon must be present *a priori*. Similarly, for the relations of Special Relativity to hold, multiple arbitrarily large finite masses and photons must also be present *a priori*. Minkowski spacetime is not Special Relativity because the latter requires the presence of matter, whereas the former does not. Similarly, the presence of the constant c in the line-element for Schwarzschild spacetime does not mean that a photon is present. The transition from empty Minkowski spacetime to empty Schwarzschild spacetime is thus not a generalisation of Special Relativity at all, merely a generalisation of the geometry of Minkowski spacetime. In the usual derivation of Schwarzschild spacetime, mass is included by means of a circular argument, viz. $R_{\mu\nu} = 0$ describes the gravitational field "outside a body". When one inquires of the astrophysics community as to what is the source of this alleged gravitational field "outside a body", one is told that it is the body outside of which the gravitational field exists, in which case the body must be described by a non-zero energy-momentum tensor since Einstein's field equations "*… couple the gravitational field … with its sources*" (Foster & Nightingale 1995). Dirac (1996) tells us that

> "*…the constant of integration m that has appeared … is just the mass of the central body that is producing the gravitational field.*"

We are told by Einstein (1967) that in the "Schwarzschild solution"

> "*… M denotes the sun's mass centrally symmetrically placed about the origin of coordinates.*"

According to Weyl, (1952)

> "*… the quantity m_o introduced by the equation $m{=}km_o$ occurs as the field-producing mass in it; we call m the gravitational radius of the matter causing the disturbances of the field.*"

Foster and Nightingale (1995) assert that

> "*…the corresponding Newtonian potential is $V = -GM / r$, where M is the mass of the body producing the field, and G is the gravitational constant.*
>
> "*… we conclude that $k = -2GM / c^2$ and Schwarzschild's solution for the empty space outside a spherical body of mass M is …*"

After the so-called "Schwarzschild solution" (which is not in fact Schwarzschild's solution at all – see Schwarzschild 1916, Abrams 1989, Antoci 2001) is obtained, there is no matter present. This is because the energy-momentum tensor is set to zero and Minkowski spacetime is not Special Relativity. The astrophysics community merely inserts (Weyl 1952 says "*introduced*") mass and photons by erroneously appealing to Newton's theory and assigning to the constant of integration in the resulting metric the square of Newton's expression for escape velocity, through which they also get any number of masses and any amount of radiation by applying the Principle of Superposition (and also the 'escape velocity' of a black hole). This is done despite the fact that the Principle of Superposition does not apply in General Relativity. However, Newton's relations involve *two bodies* and the Principle of Superposition. Even though only one mass term appears in Newton's expression for escape velocity it is implicitly a two-body relation: one body escapes from another body. One cannot deduce Newton's expression for escape velocity without appealing to Newton's expression for gravitational force, which is a two-body relation, or alternatively appealing to classical conservation of energy involving once again two-bodies. It is impossible for an implicit two-body relation to appear in what is alleged to be an expression for a universe that contains only one body. Conversely, $R_{\mu\nu} = 0$ contains *no bodies* and cannot accommodate the Principle of Superposition. The astrophysics community removes all matter on the one hand by writing $R_{\mu\nu} = 0$ on account of setting the energy-momentum tensor to zero, and then puts matter back in at the end with the other hand by means of Newton's theory in order to satisfy the initial words "outside a body" by which the alleged presence of a body is maintained despite setting the energy-momentum tensor to zero at the outset. The whole procedure constitutes a violation of elementary logic and a play on the words "outside a body".

Einstein asserted that his Principle of Equivalence and his laws of Special Relativity must hold in sufficiently small regions of his gravitational field, and that these regions can be located anywhere in his gravitational field. Here is what Einstein (1967) said in 1954, the year before his death:

> "*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. Overlooking 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' 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 co-ordinate systems which are in non-uniform motion relatively to each other. In fact, through this conception we arrive at the unity of the nature of inertia and gravitation. For, according to our way of looking at it, the same masses may appear to be either under the action of inertia alone (with respect to K) or under the combined action of inertia and gravitation (with respect to K').

> "*Stated more exactly, there are finite regions, where, with respect to a suitably chosen space of reference, material particles move freely without acceleration, and in which the laws of special relativity, which have been developed above, hold with remarkable accuracy.*"

In their textbook, Foster and Nightingale (1995) succinctly state the Principle of Equivalence thus:

> "*We may incorporate these ideas into the principle of equivalence, which is this: In a freely falling (nonrotating) laboratory occupying a small region of spacetime, the laws of physics are the laws of special relativity.*"

According to Pauli (1981),

> "*We can think of the physical realization of the local coordinate system K_0 in terms of a freely floating, sufficiently small, box which is not subjected to any external forces apart from gravity, and which is falling under the influence of the latter. ... It is evidently natural to assume that the special theory of relativity should remain valid in K_0 .*

Taylor and Wheeler (2000) state in their book,

> "*General Relativity requires more than one free-float frame.*"

Carroll and Ostlie (1996) write,

> "***The Principle of Equivalence***: *All local, freely falling, nonrotating laboratories are fully equivalent for the performance of all physical experiments. … Note that special relativity is incorporated into the principle of equivalence. … Thus general relativity is in fact an extension of the theory of special relativity.*"

In the Dictionary of Geophysics, Astrophysics and Astronomy (Matzner 2001) it is stated that:

> "*Near every event in spacetime, in a sufficiently small neighborhood, in every freely falling reference frame all phenomena (including gravitational ones) are exactly as they are in the absence of external gravitational sources.*"

Note that the Principle of Equivalence is defined in terms of the *a priori* presence of multiple arbitrarily large finite masses. Similarly, the laws of Special Relativity are defined by the *a priori* presence of arbitrarily large finite masses and photons, for otherwise relative motion between two bodies cannot manifest. The postulates of Special Relativity are themselves couched in terms of multiple inertial systems, which are in turn defined in terms of masses via Newton's First Law of motion. "Schwarzschild's solution" (and indeed all black hole "solutions"), pertains to a universe that contains only *one* mass. According to the astrophysics community, "Schwarzschild" spacetime consists of one mass in an otherwise *totally empty universe*, and so its alleged black hole is the only matter present - it has nothing to interact with, including "observers" (on the assumption that any observer is material).

In the space of Newton's theory of gravitation, one can pile up into space as many masses as desired. Although solving for the gravitational interaction of these masses rapidly becomes intractable, there is nothing to prevent us inserting masses conceptually. This is essentially the Principle of Superposition. However, one cannot do this in General Relativity, because Einstein's field equations are non-linear. In General Relativity, each and every configuration of matter must be described by a corresponding energy-momentum tensor and the field equations solved separately for each and every configuration, because matter and geometry are coupled, as eq. (2.1) describes. This is not the case in Newton's theory, where space is not coupled to matter. The Principle of Superposition does not apply in General Relativity:

> "*In a gravitational field, the distribution and motion of the matter producing it cannot at all be assigned arbitrarily --- on the contrary it must be determined (by solving the field equations for given initial conditions) simultaneously with the field produced by the same matter.*" (Landau & Lifshitz 1951).

> "*An important characteristic of gravity within the framework of general relativity is that the theory is nonlinear. Mathematically, this means that if g_{ab} and γ_{ab} are two solutions of the field equations, then $ag_{ab} + b\gamma_{ab}$ (where a, b are scalars) may not be a solution. This fact manifests itself physically in two ways. First, since a linear combination may not be a solution, we cannot take the overall gravitational field of the two bodies to be the summation of the individual gravitational fields of each body.*" (McMahon 2006).

The astrophysics community claims that the gravitational field "outside" a mass contains no matter, and thereby asserts that the energy-momentum tensor $T_{\mu\nu} = 0$. Despite this, it is routinely alleged that there is only one mass in the whole Universe with this particular problem statement. But setting the energy-momentum tensor to zero means that there is no matter present by which the gravitational field can be caused, by virtue of the fact that the field equations couple the gravitational field to its sources. As we have seen, when the energy-momentum tensor is set to zero, it is also claimed that the field equations then reduce to the much simpler form,

$$Ric = R_{\mu\nu} = 0 \ .$$

"*Black holes were first discovered as purely mathematical solutions of Einstein's field equations. This solution, the Schwarzschild black hole, is a nonlinear solution of the Einstein equations of General Relativity. It contains no matter, and exists forever in an asymptotically flat space-time.*" (Matzner 2001).

However, since this is a spacetime that *by construction* contains no matter, Einstein's Principle of Equivalence and his laws of Special Relativity cannot manifest, thus violating the physical requirements of his gravitational field. It has never been proven that Einstein's Principle of Equivalence and his laws of Special Relativity, both of which are defined in terms of the *a priori* presence of multiple arbitrary large finite masses and photons, can manifest in a spacetime that *by construction* contains no matter. Now the "Schwarzschild solution" relates to eq. (2.2). However, there is allegedly mass present, denoted by *m* in the "Schwarzschild solution". This mass is not described by an energy-momentum tensor. The reality that the *post hoc* mass *m* is responsible for the alleged gravitational field due to a black hole associated with the "Schwarzschild solution" is confirmed by the fact that if $m = 0$, the "Schwarzschild solution" reduces to Minkowski spacetime, and hence no gravitational field according to the astrophysics community. If not for the presence of the alleged mass *m* in the "Schwarzschild solution" there would be no cause of their gravitational field. But this contradicts Einstein's relation between geometry and matter, since *m* is introduced into the "Schwarzschild solution" *post hoc*, not via an energy-momentum tensor describing the matter causing the associated gravitational field.

In Schwarzschild spacetime, the components of the metric tensor are only functions of one another, and reduce to functions of just one component of the metric tensor. None of the components of the metric tensor contain matter, because the energy-momentum tensor is zero. There is no transformation of matter in Minkowski spacetime into Schwarzschild spacetime, and so the laws of Special Relativity are not transformed into a gravitational field by *Ric* = 0. The transformation is merely from a pseudo-Euclidean geometry containing no matter into a pseudo-Riemannian (non-Euclidean) geometry containing no matter. Matter is introduced into the spacetime of *Ric* = 0 by means of a vicious circle, as follows. It is stated at the outset that *Ric* = 0 describes spacetime "outside a body". The words "outside a body" immediately re-introduces matter, contrary to the energy-momentum tensor $T_{\mu\nu} = 0$, that describes the causative matter as being absent. There is no matter involved in the transformation of Minkowski spacetime into Schwarzschild spacetime via *Ric* = 0, since the energy-momentum tensor is zero, making the components of the resulting metric tensor functions solely of one another, and reducible to functions of just one component of the metric tensor. To satisfy the initial claim that *Ric* = 0 describes spacetime "outside a body", so that the resulting spacetime curvature is caused by the alleged mass present, the alleged causative mass is *inserted* into the resulting metric *ad hoc*. This is achieved by means of a contrived analogy with Newton's theory and his expression for escape velocity (a *two-body* relation in what is alleged to be a one-body problem), thus closing the vicious circle. Here is how Chandrasekhar (1972) unwittingly presents the vicious circle:

"*That such a contingency can arise was surmised already by Laplace in 1798. Laplace argued as follows. For a particle to escape from the surface of a spherical body of mass M and radius R, it must be projected with a velocity v such that* $v^2/2 > GM/R$ *; and it cannot escape if* $v^2 < 2GM/R$ *. On the basis of this last inequality, Laplace concluded that if* $R < 2GM/c^2 = R_s$ *(say) where c denotes the velocity of light, then light will not be able to escape from such a body and we will not be able to see it!*

"By a curious coincidence, the limit R_s *discovered by Laplace is exactly the same that general relativity gives for the occurrence of the trapped surface around a spherical mass.*"

But it is not surprising that General Relativity (apparently) gives the same R_s "*discovered by Laplace*" because the Newtonian expression for escape velocity is deliberately inserted *post hoc* by the astrophysicists and astronomers, into the "Schwarzschild solution". Newton's escape velocity does not drop out of any of the calculations to Schwarzschild spacetime. Furthermore, although $R_{\mu\nu} = 0$ is said to describe spacetime "outside a body", the resulting "Schwarzschild metric" is nonetheless, in contradiction, used to describe the *interior* of a black hole as well ($0 \leq r < 2m$) for the black hole begins at the alleged "event horizon", not at its infinitely dense point-mass singularity inside the "event horizon" (allegedly at *r* = 0 in the so-called "Schwarzschild solution"). Indeed, according to Misner, Thorne and Wheeler (1970), who use the spacetime signature (−, +, +, +),

"The most obvious pathology at r =2M is the reversal there of the roles of t and r as timelike and spacelike coordinates. In the region r > 2M, the t direction, $\partial/\partial t$ *is timelike (*$g_{tt} < 0$*) and the r direction,* $\partial/\partial r$ *, is spacelike (*$g_{rr} > 0$*); but in the region r < 2M,* $\partial/\partial t$ *, is spacelike (*$g_{tt} > 0$*) and* $\partial/\partial r$ *, is timelike (*$g_{rr} < 0$*).*

"What does it mean for r to 'change in character from a spacelike coordinate to a timelike one'? The explorer in his jet-powered spaceship prior to arrival at r =2M always has the option to turn on his jets and change his motion from decreasing r (infall) to increasing r (escape). Quite the contrary in the

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situation when he has once allowed himself to fall inside r =2M. Then the further decrease of r represents the passage of time. No command that the traveler can give to his jet engine will turn back time. That unseen power of the world which drags everyone forward willy-nilly from age twenty to forty and from forty to eighty also drags the rocket in from time coordinate r =2M to the later time coordinate r =0. No human act of will, no engine, no rocket, no force (see exercise 31.3) can make time stand still. As surely as cells die, as surely as the traveler's watch ticks away 'the unforgiving minutes', with equal certainty, and with never one halt along the way, r drops from 2M to 0.

"At r =2M, where r and t exchange roles as space and time coordinates, g_{tt} vanishes while g_{rr} is infinite."

Chandrasekhar (1972) has expounded the same claim as follows,

'There is no alternative to the matter collapsing to an infinite density at a singularity once a point of no-return is passed. The reason is that once the event horizon is passed, all time-like trajectories must necessarily get to the singularity: "all the King's horses and all the King's men" cannot prevent it.'

Carroll (1977) also says,

"This is worth stressing; not only can you not escape back to region I, you cannot even stop yourself from moving in the direction of decreasing r, since this is simply the timelike direction. (This could have been seen in our original coordinate system; for r < 2GM, t becomes spacelike and r becomes timelike.) Thus you can no more stop moving toward the singularity than you can stop getting older."

Vladmimirov, Mitskiévich, and Horský (1984) assert,

"For r < 2GM/c2, however, the component g_{oo} becomes negative, and g_{rr} , positive, so that in this domain, the role of time-like coordinate is played by r, whereas that of space-like coordinate by t. Thus in this domain, the gravitational field depends significantly on time (r) and does not depend on the coordinate t."

III. Consequences of Ric = 0

Since Ric = $R_{\mu\nu}=0$ cannot describe Einstein's gravitational field, Einstein's field equations cannot reduce to $R_{\mu\nu}=0$ when $T_{\mu\nu}=0$. In other words, if $T_{\mu\nu}=0$ (i.e. there is no matter present) then there is no gravitational field. Consequently Einstein's field equations *must* take the form (Lorentz 1915 and 1916, Levi-Civita 1917),

$$\frac{G_{\mu\nu}}{\kappa}+T_{\mu\nu}=0 \quad (3.1)$$

The $G_{\mu\nu}/\kappa$ are the components of a gravitational energy tensor. Thus the total energy of Einstein's gravitational field *is always zero*; the $G_{\mu\nu}/\kappa$ and the $T_{\mu\nu}$ *must vanish identically* (so that when $T_{\mu\nu}$ = 0 there is no gravitational field); there is *no possibility* for the localization of gravitational energy (i.e. *there are no Einstein gravitational waves*). This also means that Einstein's gravitational field violates the experimentally well-established usual conservation of energy and momentum. Indeed, according to Pauli (1981), Einstein:

"... raised the objection that, with this definition of the gravitational energy, the total energy of a closed system would always be zero, and the maintenance of this value of the energy does not require the continued existence of the system of one form or other. The usual kind of conclusions could not then be drawn from the conservation laws."

Einstein's objections however are groundless in view of the fact that Ric = 0 is inadmissible as proven above and so his field equations *must* take the form given in equation (3.1).

Since there is no experimental evidence that the usual conservation of energy and momentum is invalid, Einstein's General Theory of Relativity violates the experimental evidence, and so it is invalid.

In an attempt to circumvent the foregoing conservation problem, Einstein invented his gravitational pseudo-tensor, the components of which he says are '*the "energy components" of the gravitational field*' (Einstein 1952, Pauli 1981). His invention had a two-fold purpose (a) to bring his theory into line with the usual conservation of energy and momentum, (b) to enable him to get gravitational waves that propagate with speed *c*. First, Einstein's gravitational pseudo-tensor is not a tensor, and is therefore not in keeping with his theory that all equations be tensorial. Second, he constructed his pseudo-tensor in such a way that it behaves like a tensor in one particular situation, that in which he could get gravitational waves with speed *c*. Now Einstein's pseudo-tensor is claimed to represent the energy and momentum of the gravitational field and it is routinely applied in relation to the localization of gravitational energy, the conservation of energy and the flow of energy and momentum.

Dirac (1996) pointed out that,

"It is not possible to obtain an expression for the energy of the gravitational field satisfying both the conditions: (i) when added to other forms of energy the total energy is conserved, and (ii) the energy within a definite (three dimensional) region at a certain time is independent of the coordinate system. Thus, in general, gravitational energy cannot be localized. The best we can do is to use the pseudotensor, which satisfies condition (i) but not condition (ii). It gives us approximate information about gravitational energy, which in some special cases can be accurate."

On gravitational waves Dirac (1996) says,

> *"Let us consider the energy of these waves. Owing to the pseudo-tensor not being a real tensor, we do not get, in general, a clear result independent of the coordinate system. But there is one special case in which we do get a clear result; namely, when the waves are all moving in the same direction."*

About the propagation of gravitational waves A. S. Eddington (1960) remarked $\left(g_{\mu\nu} = \delta_{\mu\nu} + h_{\mu\nu}\right)$,

$$\frac{\partial^2 h_{\mu\nu}}{\partial t^2} - \frac{\partial^2 h_{\mu\nu}}{\partial x^2} - \frac{\partial^2 h_{\mu\nu}}{\partial y^2} - \frac{\partial^2 h_{\mu\nu}}{\partial z^2} = 0$$

> *"... showing that the deviations of the gravitational potentials are propagated as waves with unit velocity, i.e. the velocity of light. But it must be remembered that this representation of the propagation, though always permissible, is not unique. ... All the coordinate-systems differ from Galilean coordinates by small quantities of the first order. The potentials $g_{\mu\nu}$ pertain not only to the gravitational influence which is objective reality, but also to the coordinate-system which we select arbitrarily. We can 'propagate' coordinate-changes with the speed of thought, and these may be mixed up at will with the more dilatory propagation discussed above. There does not seem to be any way of distinguishing a physical and a conventional part in the changes of the $g_{\mu\nu}$.*

> *"The statement that in the relativity theory gravitational waves are propagated with the speed of light has, I believe, been based entirely upon the foregoing investigation; but it will be seen that it is only true in a very conventional sense. If coordinates are chosen so as to satisfy a certain condition which has no very clear geometrical importance, the speed is that of light; if the coordinates are slightly different the speed is altogether different from that of light. The result stands or falls by the choice of coordinates and, so far as can be judged, the coordinates here used were purposely introduced in order to obtain the simplification which results from representing the propagation as occurring with the speed of light. The argument thus follows a vicious circle."*

Now Einstein's pseudo-tensor, $\sqrt{-g}\, t_\nu^\mu$, is defined by (Levi-Civita 1917, Einstein 1952, Eddington 1960),

$$\sqrt{-g}\, t_\nu^\mu = \frac{1}{2}\left[\delta_\nu^\mu L - \left(\frac{\partial L}{\partial g^{\sigma\beta}_{,\mu}}\right) g^{\sigma\beta}_{,\nu}\right] \qquad (3.2)$$

where L is given by

$$L = -g^{\alpha\beta}\left(\Gamma^\gamma_{\alpha\kappa}\Gamma^\kappa_{\beta\gamma} - \Gamma^\gamma_{\alpha\beta}\Gamma^\kappa_{\gamma\kappa}\right) \quad . \qquad (3.3)$$

According to Einstein (1952) his pseudo-tensor,

> "*expresses the law of conservation of momentum and of energy for the gravitational field.*"

T. Levi-Civita (1917) provided a clear and rigorous proof that Einstein's pseudo-tensor is meaningless, and therefore any argument relying upon it is fallacious. I repeat Levi-Civita's proof. Contracting eq. (3.2) produces a linear invariant, thus

$$\sqrt{-g}\, t_\mu^\mu = \frac{1}{2}\left[4L - \left(\frac{\partial L}{\partial g^{\sigma\beta}_{,\mu}}\right) g^{\sigma\beta}_{,\mu}\right] \qquad (3.4)$$

Since L is, according to eq. (3.3), quadratic and homogeneous with respect to the Riemann-Christoffel symbols, and therefore also with respect to the $g^{\sigma\beta}_{,\mu}$, one can apply Euler's theorem to obtain (also see Eddington 1960),

$$\left(\frac{\partial L}{\partial g^{\sigma\beta}_{,\mu}}\right) g^{\sigma\beta}_{,\mu} = 2L \qquad (3.5)$$

Substituting expression (3.5) into expression (3.4) yields the linear invariant as L. This is a first-order, intrinsic differential invariant, i.e. it depends solely on the components of the metric tensor and their first derivatives (see expression (3.3) for L). However, the mathematicians G. Ricci-Curbastro and T. Levi-Civita, inventors of the tensor calculus, proved (Ricci-Curbastro & Levi-Civita 1900), that such invariants *do not exist*! Thus by *reductio ad absurdum* Einstein's pseudo-tensor is invalid. This is sufficient to render Einstein's pseudo-tensor entirely meaningless, both mathematically and physically, and hence all arguments relying on it false. Consequently, Einstein's conception of the conservation of energy and momentum in his gravitational field is completely erroneous.

Linearization of Einstein's field equations and associated perturbations has been popular. However,

> "*The existence of exact solutions corresponding to a solution to the linearised equations must be investigated before perturbation analysis can be applied with any reliability.*" (Wald 1984).

Unfortunately, the astrophysical scientists have not properly investigated. Indeed, linearisation of the field equations is inadmissible, even though the astrophysical scientists write down linearised equations and proceed as though they are valid, because linearisation of the field equations implies the existence of a tensor which, except for the trivial case of being precisely zero, *does not otherwise exist*, proven by the German mathematician Hermann Weyl (1944).

Over a period of some 40 years and at great public monetary expense, the international search for Einstein's gravitational waves has detected nothing. This is not surprising – the search for these waves is destined to detect none.

It follows from $R_{\mu\nu} = 0$ that not only is the black hole invalid but so too is the Big Bang and the associated expansion of the Universe and gravitational waves. The invalidity of Einstein's pseudo-tensor and the consequent violation of the usual conservation of energy and momentum cannot be circumvented in order to save General Relativity.

IV. Conclusion

General Relativity violates the usual conservation of energy and momentum and is therefore in conflict with experiment on a deep level, making it invalid. Einstein's attempt to save General Relativity from this catastrophe by means of his pseudo-tensor fails because his pseudo-tensor has no mathematical validity and therefore has no physical meaning. Consequently the black hole, gravitational waves, and the Big Bang cosmology have no theoretical basis whatsoever. The search for the black hole and gravitational waves has always been destined to detect nothing. The so-called Cosmic Microwave Background is not the afterglow of the birth of the Universe from a Big Bang.

Dedication

I dedicate this paper to my late beloved brother:

Paul Raymond Crothers

12th May 1968 – 25th December 2008

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Study on Temperature Variation of Densities of Antimony and Bismuth Using Gamma Ray Attenuation Technique

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Abstract - The densitometer was designed and fabricated with the underlying principle of gamma (γ) ray attenuation produced on passing a collimated beam of monochromatic gamma radiation through any material. After standardization, the gamma ray attenuation coefficient (μ) was calculated to determine changes in densities as a function of temperature of Sb and Bi in solid phase. The density of Sb and Bi at room temperature are $6.697\text{x}10^3$ Kgm^{-3} and $9.79\text{x}10^3$ Kgm^{-3}, and their melting points are 903.78 K and 544.7 K respectively. The measurements were conducted below melting point. The experimental results are in reasonable agreement with published data and may be used as reference data on variation of densities at various temperatures of solids.

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Study on Temperature Variation of Densities of Antimony and Bismuth Using Gamma Ray Attenuation Technique

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I. Introduction

Metals like Sb, Bi have wide range of applications in various fields. Sb is used as flame retardant while its alloys for batteries, bearings and solders. It is also being used in the semiconductor industry, medical and biological fields. Bi is a soft silvery metal with bright surface and a yellowish or pinkish tinge. The metal breaks easily and it expands as it solidifies. This property makes Bi useful for producing 'type metal'. Many alloys of Bi have melting point as low as 343 K, which are used in fire sprinkler systems, fuel tank safety plugs, solders etc,.

The physical properties and structure of materials change with temperature. Thus, it is interesting to researchers in Engineering and Science to study the physical properties as a function of temperature. Density is a basic parameter which decides nature and behavior of materials. The density and thermal expansion values of materials are useful for a variety of scientific and technological applications. Besides, other thermo-physical properties such as viscosity, surface tension, thermal conductivity, etc., can also be determined. The gamma attenuation technique [6] for density determination of materials have several advantages at high temperatures over other methods. The probe-sample compatibility problem, formation of oxide surface films etc. are totally eliminated; G.Dillon,et al. [1], F.E.Levert, et al. [2], Doge [3] and W.Drotning [4 ,5].

II. Experimental Details

a) A brief outline

Gamma Ray Attenuation technique is a non contact – non invasive method that can be used for measuring Thermal Expansion and Density of materials in solid state as well as in molten state and through melting Temperature as well. The Gamma Ray Attenuation Technique used for determination of thermo-physical properties of metals offers several advantages over other methods. This method is a noninvasive one utilizing the gamma beam as a probe which is neither in Physical nor in Thermal contact with the sample. This technique is particularly advantageous at High temperatures as Thermal loses are minimized. This technique also ensures the elimination of incompatibility of sample and probe materials. In measurement of Density by this method, only the solid or molten material of the samples are involved, eliminating the free liquid surface which has no role to play what so ever. Thus a number of problems encountered during the measurements, due to viscosity effects, sample vaporization, surface tension effects, formation of oxide films on surface, etc., by other methods, and their corresponding corrections in calculations are safely avoided.

A Gamma ray densitometer operates on the basic principle of Gamma ray attenuation caused when the gamma ray beam is interrupted on its path to strike a counting system. The basic design requirement comprises of a Gamma radiation source of detectable strength (intensity), a lead vault to house the source, lead collimators to allow a collimated beam to pass to the counting system, a counting system with lead shielding to avoid unwanted radiation.

In this work we conducted study on the densities of Sb and Bi metal samples as a function of temperature. For this purpose we have added a furnace in the path of gamma beam in which the sample is placed and its temperature is incremented or decremented in a standard linear pattern. The measurements are taken at different temperatures to study the variation of. Since the melting point of lead is

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nearly 401 K, lead collimators have been avoided inside and in the close vicinity of the furnace, as we have designed the furnace to reach to a temperature of around 1300 K. Instead, stainless steel collimators have been employed replacing the lead collimators near high temperature regions in the entire setup.

The gamma ray densitometer was designed and fabricated in our laboratory. The cross sectional view is shown in Figure 1. In this paper, an experimental apparatus using the gamma attenuation method with the furnace temperature variation of up to 1300K is described and temperature variation of densities of Sb and Bi were studied. [4, 5].

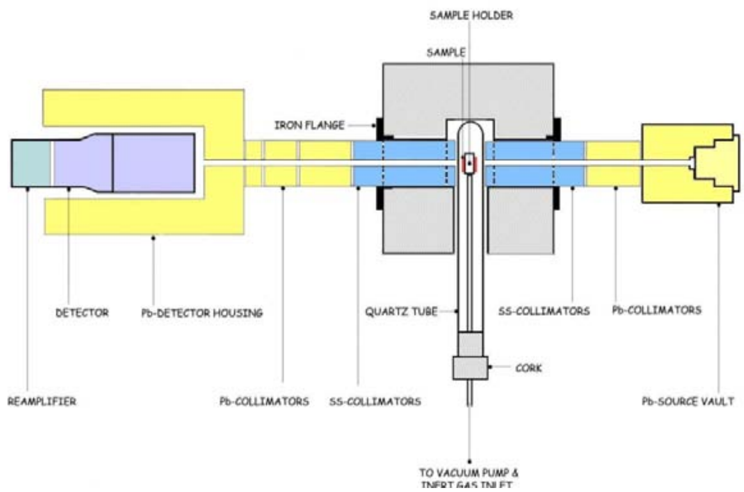

Figure.1

The source vault is made in Lead - 30cm length x 27.5cm diameter, in which the source 137Cs is housed and a collimated gamma ray beam is obtained by using collimators of Lead (5cm, 7.5cm, 10cm length and 6cm diameter) and stainless steel (10cm, 15cm length and 6cm diameter) with an aperture of 6mm diameter. Detector housing made in lead is 30cm in length x 20cm in diameter.

The programmable temperature controlled furnace has been specially designed to fit perfectly into the setup and can reach temperatures up to 1300 K. The instrumentation for the furnace has been designed such that, feedback and control of the furnace can be handled directly from the control panel placed remotely. The metal samples are placed inside the furnace in the path of gamma beam mounted on a sample holder. The sample holder is made up of a flat stainless steel strip bent in the form of a circle and mounted on one end of a stainless steel tube. The sample holder tube passing through a cork is slid into the quartz tube. The tube also assists in evacuation of the quartz tube by employing a vacuum pump and provides inert atmosphere by introducing argon gas. The quartz tube with the sample holder in place, is passed in to the furnace through an orifice at the bottom, drilled through the insulation and outer body of the furnace. A separate wire type thermocouple in perfect physical contact with the sample indicates the exact sample temperature. To detect and analyze gamma ray spectrum NETS-3M/U IK Multi Channel Analyzer in conjunction with a NaI(Tl) detector along with HV supply and preamplifier is used. The gamma radiation source 137 Cs with energy 661.6 Mev and 30 millicurie strength was used.

The PTC furnace was programmed in such a manner that the temperature is incremented by 50K in every step from room temperature and stabilizes at that point for a certain length of time. At each temperature, γ - counts with sample $[I]$and without sample $[I_o]$ were detected and recorded using a multi-channel analyzer. This process was repeated at every temperature for at least nine times. The counts were recorded while heating and cooling the sample. The difference in the reading was negligible and hence the final readings were recorded while cooling the sample. This procedure was repeated until the desired temperature range was covered in each case.

The setup was standardized using aluminum solid sample as sample and temperature variation of density was found which was in reasonable good agreement with the reported data.

III. Analysis of Date

In the present work, the γ - attenuation technique has been applied for the measurement of density of solid materials. In addition to density, this technique allows measurement of both linear thermal expansion in the solid state and the volumetric thermal expansion in the liquid state without any change in experimental conditions. The data on all the samples have been analyzed using the analytical method given by Drotning.

The basic equation which defines the γ-attenuation for mono-energetic gamma rays and a narrow beam geometry. is

$$I(T) = I_O(T)\exp[-\mu\rho(T)l(T)]$$

where $I_o(T)$ and $I(T)$ are the gamma intensities before and after passing through the sample material, $\rho(T)$ is the sample density, l is the sample length along the γ - ray path, T is the temperature of the sample and μ is the mass attenuation coefficient of the sample material. The mass attenuation coefficient is independent of the physical condition of the sample and hence is independent of temperature. The temperature dependence of I_o includes temperature induced attenuation changes in the furnace, chamber materials and quartz tube, as well as size changes in the collimation.

IV. Results and Discussion

The temperature dependence of density of Sb and Bi from room temperature to close to their annealing temperatures are plotted. Results are in agreement with published data [7]

a) Variation of Density of Sb.

Fine powder of Sb is made into a pellet of diameter 2cm with a die set by applying 3000psi pressure. The Pellet of length of 1.655 cm. is placed in the sample holder and sintered at 823 K temperature for four hours to form into a solid. A collimated beam of gamma radiation is passed through the sample at different temperatures in decreasing order with intervals of 50 K. The counts are recorded before the sample is introduced into the furnace (I_0) and after the sample is introduced into the furnace (I), at each value of temperature. The linear attenuation coefficient (μ) is determined and the density at each temperature is calculated. The temperature variation of density for Sb, is plotted in Fig. 2. The values of I_0, I, I_0 / I and ρ are tabulated in Table 1.

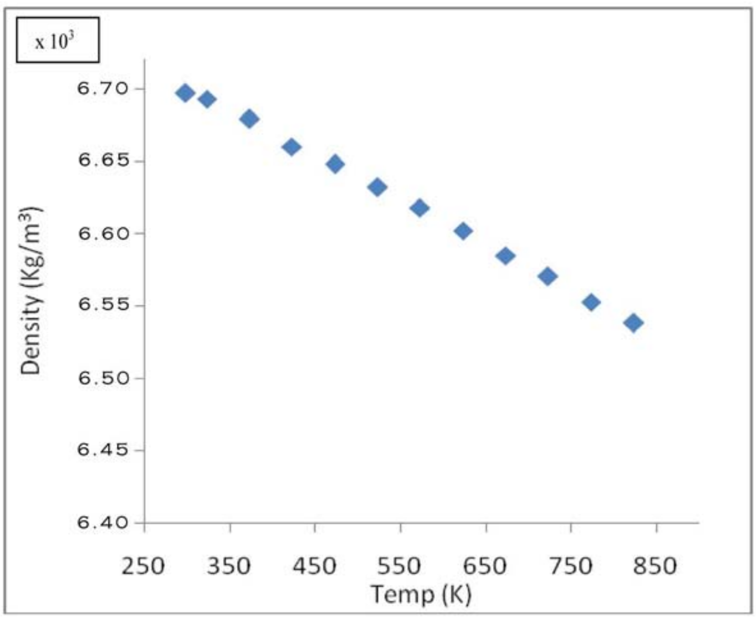

Figure.2 : Temperature variation of density of Sb.

Table 1 : Temperature variation of density of Sb.

Temperature (K)	I_0	I	I_0 / I	ρ (Kg/m^{3})
298	42972	24581	1.748159	6697.0000
323	42970	24584	1.747914	6693.4771
373	42580	24382	1.746417	6679.5327
423	42404	24311	1.744218	6660.7820
473	41779	23971	1.742913	6648.1642
523	40858	23467	1.741108	6632.1255
573	41717	23981	1.739617	6618.2465
623	40742	23443	1.737914	6602.9201
673	40209	23164	1.735819	6584.8984
723	38711	22322	1.734241	6570.4395
773	37551	21678	1.732194	6552.7613
823	32188	18599	1.730604	6538.2301

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b) Variation of Density of **Bi.**

Fine powder of Bi is made into a pellet of diameter 2cm with a die set by applying 2500psi pressure. The Pellet of length of 1.315cm. is placed in the sample holder and sintered at 473 K temperature for four hours to form into a solid. A collimated beam of gamma radiation is passed through the sample at different temperatures in decreasing order with intervals of 25 K. The counts are recorded before the sample is introduced into the furnace *(I_0)* and after the sample is introduced into the furnace *(I)*, at each value of temperature. The linear attenuation coefficient *(μ)* is determined and the density at each temperature is calculated. The density variation with temperature is plotted in Figure 3. The density variation with temperature is plotted in Fig. 2. The values of I_0 , I , I_0 / I and ρ are tabulated in Table 2.

Figure.3 : Temperature variation of density of Bi.

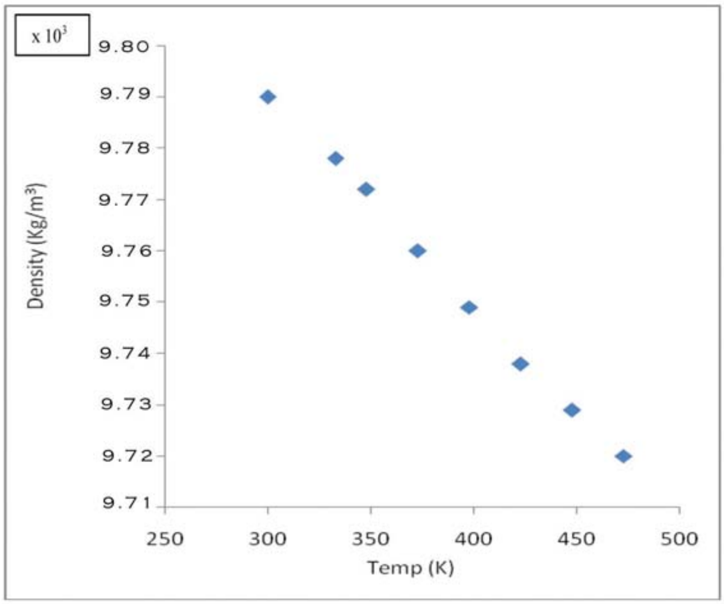

Table 2 : Temperature variation of density of Bi.

Temperature (K)	I_0	I	I_0 / I	ρ (Kg/m^{3})
300	38094	13531	2.815276478	9790.0
333	37956	13493	2.812860248	9777.6
348	37769	13432	2.811805676	9772.0
373	37621	13392	2.809099507	9759.7
398	37493	13357	2.806920933	9749.1
423	37429	13346	2.804568993	9737.9
448	37386	13338	2.802928950	9729.1
473	37324	13324	2.801104051	9719.7

V. Conclusions

From the calculated values, the density of Sb and Bi as a function of temperature by gamma ray attenuation method, it is noticed that the density is decreasing due to increase in linear expansion of material with the increase in temperature. The density of Sb has been ranging in between 6.697x 103 Kgm^{-3} and 6.538x 103 Kgm^{-3} in the temperatures 298 K and 823 K . The density of Bi has been ranging in between 9.79x 103 Kgm^{-3} and 9.719x 103 Kgm^{-3} in the temperature range 300 K and 473 K The results obtained are in agreement with already published data [7] calculated by other methods.

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FTIR and Optical Absorption Studies of New Magnesium Lead Borate Glasses

By G. Ramadevudu, S.Lakshmi Srinivasa Rao, Md. Shareeffuddin, M.Narasimha Chary & M.Lakshmipathi Rao

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Abstract - New magnesium lead borate glasses (10-x) $MgO_{-x}MgCl_2$-40PbO-50B_2O_3 (x = 0, 1, 2, 3, 4, 5, 6, 7, 8, and 10 mole%) were prepared by melt quenching technique. Fourier transform infrared spectroscopic studies revealed the presence of BO_3 trigonal and BO_4 tetrahedral structural units in these glasses. The optical energy band gaps, Urbach energies and theoretical refractive index values are reported. No considerable structural changes with the composition are observed. FTIR revealed the formation of NBOs and the behaviour of MgO as glass network modifier. The expansion of B-O network with increasing x mole% is attributed to the presence of Chlorine ions.

Keywords : infrared spectroscopy, glass network formers, glass network modifiers, optical energy band gap, Urbach energy.

GJSFR-A Classification : FOR Code: 020503, 020504, 020401

Strictly as per the compliance and regulations of :

FTIR and Optical Absorption Studies of New Magnesium Lead Borate Glasses

G. Ramadevudu[α], S.Lakshmi Srinivasa Rao[σ], Md. Shareeffuddin[ρ], M.Narasimha Chary[ρ] & M.Lakshmipathi Rao[ρ]

Abstract - New magnesium lead borate glasses **(10-x) MgO-xMgCl$_2$-40PbO-50B$_2$O$_3$ (x = 0, 1, 2, 3, 4, 5, 6, 7, 8,** and **10 mole %)** were prepared by melt quenching technique. Fourier transform infrared spectroscopic studies revealed the presence of **BO$_3$** trigonal and **BO$_4$** tetrahedral structural units in these glasses. The optical energy band gaps, Urbach energies and theoretical refractive index values are reported. No considerable structural changes with the composition are observed. FTIR revealed the formation of **NBOs** and the behaviour of **MgO** as glass network modifier. The expansion of **B-O** network with increasing **x mole%** is attributed to the presence of Chlorine ions.

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PACS : 42.70Ce, 42.70.Qs, 71.35Ce, 78, 78.20Ce, 87.50W.

I. Introduction

Borate glasses constitute an interesting system in which the charged network building units can be either borate triangles with non-bridging oxygen atoms or borate tetrahedrons with all bridging oxygen atoms. Many studies were reported to elucidate the presence of different structural units in various borate glasses. Based on structure-property relationship many studies on properties such as electrical and optical were reported in these glasses [1-3]. Optical energy band gaps, Urbach energies, refractive indices, broad band emission of various borate glasses like alkali borate, lead borate, and bismuth borate glasses have been reported by several workers [4-6]. Alkaline earth borate glasses containing rare earth dopants are some of the promising candidates for optoelectronic devices such as optical fiber amplifiers and tunable lasers [4].

Borate glasses containing PbO, ZnO, MgO form chemically stable glasses. In addition, these glasses exhibit challenging electrical, optical and thermal properties [7]. Glasses containing heavy metal oxides such as PbO can be used for laser hosts, high refractive index materials, linear and non-linear photonic materials etc [8]. Lead borate glasses are of research interest, because PBO greatly improves the non-linear optical properties of the glass [4, 9, 10]. Addition of MgO also improves stability of the borate glasses.

Infrared spectroscopy is the most advantageous and extremely used tool over the years to investigate the structure of glasses. Optical absorption is another useful spectroscopic technique to get the band structure and optical energy band gap in glasses [11]. Optical basicity, an important property of glasses, is the average electron donor power of the individual oxides in the glass matrix [12]. Optical basicity refers to the state of the oxygen atoms and how they would react to solute metal ions.

The survey of literature shows that studies on the infrared and optical properties of magnesium lead borate glasses is limited. Therefore, in this paper, studies on infrared spectra, optical energy band gap and optical basicity studies in the new and novel magnesium lead borate glasses with general formula (10-x) MgO-xMgCl$_2$-40PbO-50B$_2$O$_3$ are reported. The studies on electrical conduction through Mg^{2+} ion in these glasses and their possible application as electrolytes in the fabrication of solid state batteries are going on in our laboratory. The advantages of magnesium based glasses are (i) Mg is less hygroscopic compared to lithium, potassium and sodium (ii) Mg has diagonal symmetry with lithium (iii) magnesium is eco-friendly and (iv) MgO act as a glass network modifier (GNM) at low concentrations and as a glass network former (GNF) at higher composition in the glass matrix.

II. Experimental

Glasses with the general formula (10-x) MgO-xMgCl$_2$-40PbO-50B$_2$O$_3$ (x = 0, 1, 2, 3, 4, 5, 6, 7, 8 and 10 mole %) were prepared by the conventional melt quenching technique. Analar grades H$_3$BO$_3$, MgCl$_2$.6H$_2$O, lead monoxide (PbO) and magnesium oxide (MgO) were the starting materials. These materials were mixed in the appropriate mole percent to get required composition. The ingredients after thorough mixing were taken in a porcelain crucible and melted in an electrical furnace maintained at 1000^0C for about 30-40 minutes. To obtain homogeneity, the molten melt was shaken frequently. The melt was quickly poured onto a stainless steel plate (containing cuboids- 30mm x 7mm x 2mm and circular groves of 1cm diameter of 1mm thickness) and pressed with a steel rod, both being

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maintained at 373K. The glass samples thus obtained were clear, transparent and bubble free. Grinding and polishing are employed to get samples with uniform thickness of about 0.3 – 0.7 mm. Table.1 gives the glass compositions studied in the present investigation.

Philips Xpert PRO XRD (PanAnalytic) model powder X-ray diffractometer with copper K_α tube was used to record the X-ray diffractograms. All the X-ray diffractograms are recorded at room temperature. All the recorded peak free X-ray diffractograms confirmed the amorphous nature of the samples, used in the present studies. Figure.1 shows the X-ray diffractograms of the glass samples G4 and G5.

Finely powdered glass samples were used to record infrared spectra at room temperature by KBr pellet method at room temperature. Perkin Elmer FTIR spectrometer model Spectrum BX was used to record IR spectra. The samples were scanned in the wave number range 4400-400cm^{-1}. The resolution of the instrument is 8cm^{-1}.

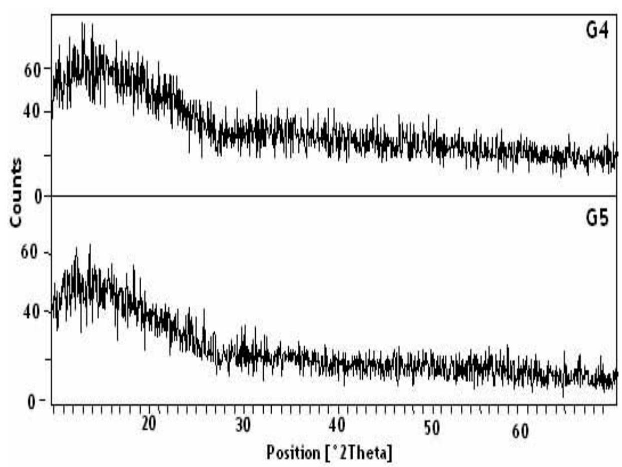


Fig.1: X-ray diffractograms of the glass samples G4 and G5.

Finely polished glass pieces of uniform thickness were used to record optical absorption spectra on Shimadzu UV-VIS-NR-3100 spectrophoto - meter in the wavelength range 300nm to 500nm at room temperature.

III. Results and Discussion

a) FTIR Studies

Figure.2 shows the infrared spectra of the present glass samples. The FTIR spectra exhibited seven to eight peaks. These peaks can be divided as sharp, medium and broad. Similar to other borate glasses, the present samples also exhibited the following three main characteristic active vibrational modes of borate network (i)1200-1600 cm^{-1} group of bands which are due to the asymmetric stretching relaxation of B-O bond of trigonal BO_3 units (ii)Bands in the range 800-1200 cm^{-1} due to B-O bond stretching of tetraghedral BO_4 units and (iii) Peaks around 700 cm^{-1} due to bending of B-O-B linkages in the borate networks [13-16].

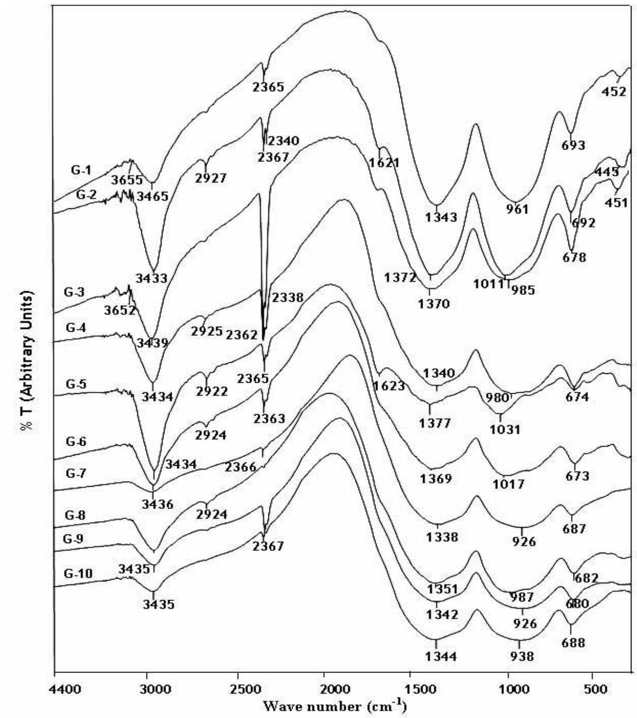


Fig.2 : FTIR spectra of the present glass samples

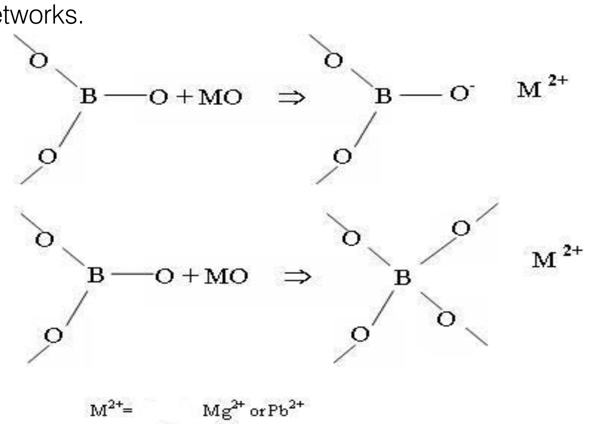
The bands in the range 3200-3600cm^{-1} in the IR spectra are attributed to the hydroxyl or water groups originating from molecular water [9, 13]. The broad band around 3434cm^{-1} corresponds to OH stretching vibration [17]. The presence of hydrogen bending in all the glass samples is ascertained due to the band at 2924cm^{-1}. The peaks around 2338-2367 cm^{-1} are attributed to –OH groups [18, 9].

The weak band around 1622cm^{-1} indicates presence of crystal water with H-O-H bending mode in the samples. The IR bands in the range 1321-1376cm^{-1} can be assigned to B-O asymmetric stretching vibrations of $(BO_3)^{3-}$ units in meta, pyro and ortho borates [19]. The peaks around 1011-1031 cm^{-1} may be assigned to asymmetric stretching of (B4)-O. The presence of diborate, formation of non-bridging oxygens (NBOs) and existence of MgO_4 tetrahedra can be confirmed from the bands 926-987 cm^{-1} [14]. Absorption peaks around 950-1050cm^{-1} may also be due to stretching vibrations of tetrahedral BO_4 group [8]. The absorption bands in the range 672-692 cm^{-1} indicates bending of B-O-B linkages in the borate network. The bands 446-453cm^{-1} show the existence of vibration of Pb^{2+} and/or Mg^{2+} ions in the network vacancies. The occurrence of these bands corresponds to Mg and Pb cations in glass network modifier (GNM) positions. However as the mole percent of PbO is greater (40 mole %), in the glass network it should act as glass former along with B_2O_3. At lower concentrations MgO acts as GNM [8] and hence in the present case MgO plays a role of network modifier. The existence of Mg^{2+} and formation of NBOs create channels for Mg^{2+} ion migration.

Hydroxyl or water groups presence is not only due to absorption of moisture in KBr pellet techniques of recording IR spectra, but also because borate glasses contain water traces and strongly dependent on OH content. The presence of crystal water and OH groups in the present glasses are due to retention of traces of water both due to H_3BO_3 and $MgO.6H_2O$ along with the capture of moisture by KBr.

It can be seen from the FTIR spectra that the effect of composition on the types of structural groups present in the glass matrix is almost negligible. This is because of small compositional variation (MgO and $MgCl_2$ concentration is limited to x = 10 mole %). The lead-borate network remains the same. This can also be attributed to the presence of symmetric triangles of $(BO_3)^{3-}$, asymmetric units of $(BO_3)^{3-}$, and formation of BO_4 tetrahedral units.

Infrared spectroscopy provides insights into the interaction between alkali/alkaline metal ions and B-O network. Addition of alkali or alkaline earth oxides (M_2O) to borate glasses changes the coordination of boron from three to four. In addition, complicated structures containing BO_3 and BO_4 units like di, tri, meta, penta borates are formed without changing B-O bond distance i.e short range order [20, 21]. Introduction of halogens (Cl, Br, I) into the interstices of borate network create disorder of BO_3 units. This disorder is due to the expansion of B-O network [20]. The presence Cl^- ions can produce path ways for Mg^{2+} by B-O network expansion further with formation of NBOs. The following structural units may be present in the present glass networks.



Borate glasses consist of random network of planar BO_3 triangle units with boroxol rings [22]. In the present glass samples the characteristic frequency of boroxol ring at 806cm^{-1} in the IR spectra is not observed. Hence no boroxol rings are present in the glass samples.

It may be evident from FTIR spectra that the present glasses consists of trigonal BO_3 and tetrahedral BO_4 structural units. The presence of tetrahedrally coordinated boron in the glass structure is evident from 1320-1376 cm^{-1} bands [23]. Hence the structure of present glasses, with absence of boroxol rings (806 cm^{-1}) consists of randomly connected trigonal BO_3 and tetrahedral BO_4 groups. It can be confirmed from the studies that MgO takes GNM positions. The glass matrix can be thought of consisting network of tri, tetra and penta borate (~1320-1376 cm^{-1}) units of BO_3 groups and tri, tetra, penta and diborate (~926-1031 cm^{-1}) units of BO_4 groups [13]. The broadening of the IR peaks can be attributed to the expansion of B-O network due to the presence of chlorine ions.

b) Optical Energy band gap, refractive index and Optical basicity

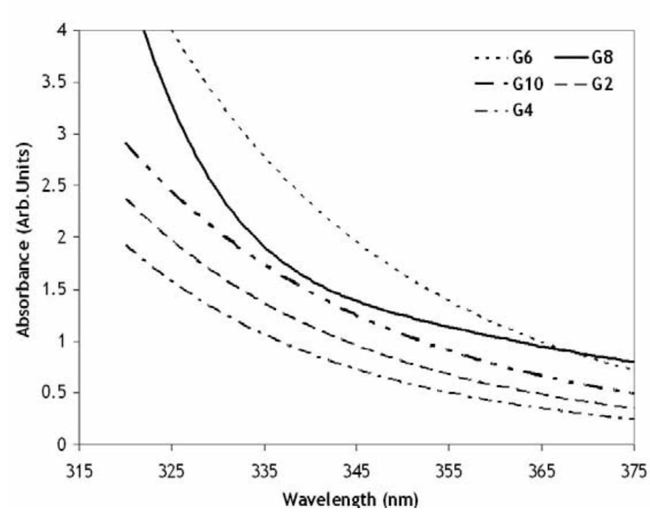


Fig.3 : Optical absorption spectra of few glass samples.

Figure.3 shows the optical absorption spectra of some of the glass samples. The optical absorption coefficient $\alpha(\nu)$ of a glass of thickness (t) near the absorption edge can be calculated from the relation [24].

$$\alpha(\nu) = \frac{1}{t}\ \ln(\frac{I_o}{I_t}) \qquad (1)$$

where $\ln(\frac{I_o}{I_t})$ is the absorbance, I_0 and I_t are the intensities of incident and transmitted light respectively. The optical absorption of disordered materials [$\alpha(\nu) \geq 10^4$cm^{-1}] follows Davis and Mott power law [23]

$$\alpha(\nu) = B\ \frac{(h\nu - E_{opt})^r}{h\nu} \qquad (2)$$

where 'r' can take values ⅓, ½, 2, 3 for direct forbidden, direct allowed, indirect allowed, indirect forbidden transitions respectively. Here E_{opt} is the optical energy band gap, B is band tailing parameter (constant) and $h\nu$ is the incident photon energy. Tauc's plot $(\alpha\hbar\omega)^{1/2}$ versus $\hbar\omega$ for r = 2 which corresponds to indirect inter band optical transitions between conduction and valence bands are shown in figure.4. Extrapolation of the linear region of $(\alpha\hbar\omega)^{1/2}$ versus $\hbar\omega$

plot to meet x-axis at $(\alpha\hbar\omega)^{1/2} = 0$ gives the optical energy band gap, E_{opt}. For absorption in lower incident photon energy [(υ) lying between 10^2-10^4 cm^{-1}] absorption coefficient α(υ) follows Urbach law given by

$$\alpha(\nu) = Cons\tan t \;\; X \;\; \frac{h\nu}{\Delta E} \qquad (3)$$

where ΔE is the Urbach's energy. Urbach's energy corresponds to the width of tail of localized states in the band gap. Hence it is a measure of disorder in amorphous solids [25]. The exponential tail is due to phonon assisted indirect electronic transitions [26]. Urbach energy values are calculated from the slopes of linear regions of the graphs lnα(ν) vs. hν. Theoretical energy band gap (E_{opt}) and Urbach energy values (ΔE) of (10-x) MgO-$xMgCl_2$-$40PbO$-$50B_2O_3$ glasses are given in Table.1, along with values reported in the literature.

The refractive index (n) of the samples is calculated theoretically from the optical energy band gap (E_{opt}) values using the relation proposed by Dimitrov and Sakka [27]

$$\frac{n^2 - 1}{n^2 + 2} = 1 - \sqrt{\frac{E_{opt}}{20}} \qquad (4)$$

Table 1 : Glass composition, energy band gap (E_{opt}) and Urbach energy values (ΔE) of (10-x)MgO-$xMgCl_2$-$40PbO$-$50B_2O_3$ glasses.

S.No	Glass	Composition	Optical bandgap E_{opt} (eV) (±0.01eV)	Urbach Energy (ΔE) eV (±0.001)	Reference
1	G1	$10MgO$-$40PbO$-$50B_2O_3$	3.34	0.074	Present
2	G2	$9MgO$-$1MgCl_2$-$40PbO$-$50B2O_3$	3.36	0.075	Present
3	G3	$8MgO$-$2MgCl_2$-$40PbO$-$50B2O_3$	3.37	0.081	Present
4	G4	$7MgO$-$3MgCl_2$-$40PbO$-$50B_2O_3$	3.29	0.101	Present
5	G5	$6MgO$-$4MgCl_2$-$40PbO$-$50B_2O_3$	3.30	0.117	Present
6	G6	$5MgO$-$5MgCl_2$-$40PbO$-$50B_2O_3$	3.31	0.105	Present
7	G7	$4MgO$-$6MgCl_2$-$40PbO$-$50B_2O_3$	3.32	0.101	Present
8	G8	$3MgO$-$7MgCl_2$-$40PbO$-$50B_2O_3$	3.33	0.096	Present
9	G9	$2MgO$-$8MgCl_2$-$40PbO$-$50B_2O_3$	3.34	0.090	Present
10	G10	$10MgCl_2$-$40PbO$-$50B_2O_3$	3.36	0.096	Present
11		$50B_2O_3$-$40PbO$-$10PbCl_2$	3.22	0.430	[30]
12		$70B_2O_3$-$15PbO$-$15Bi_2O_3$	2.16	0.429	[32]
13		$50B_2O_3$-$50PbO$	2.73	0.21	[33]

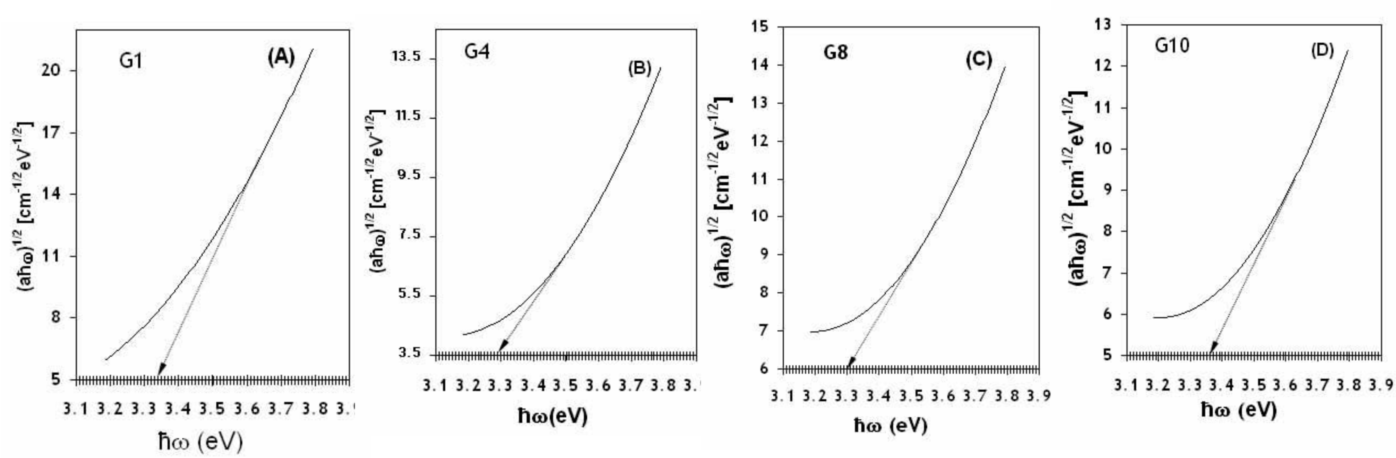


Fig.4 : Tauc's plot $(\alpha\hbar\omega)^{1/2}$ versus $\hbar\omega$ for the glass samples G1,G4,G8 and G10.

Theoretical optical basicity values are calculated by the relation [28].

$$\Lambda_{th} = X_{MgO}\Lambda(MgO) + X_{PbO}\Lambda(PbO) + X_{B_2O_3}\Lambda(B_2O_3) \qquad (5)$$

where X_{MgO}, X_{PbO} and $X_{B_2O_3}$ are the proportions of oxide atoms that each oxide in the composition contribute to the stoichiometry of the glass [29]. The optical basicity values of individual oxides are given by $\Lambda(B_2O_3) = 0.425$, $\Lambda(MgO) = 0.78$ and $\Lambda(PbO) = 1.19$ [30].

Theoretical refractive index (n), optical basicity (Λ_{th}) values along with cut-off wavelengths (λ_c) values are presented in Table.2

In the optical absorption spectra the fundamental absorption edges are not sharply defined. This is due to the amorphous nature of the glass samples. Figure.5 shows the variation of E_{opt} and refractive index (n) with $MgCl_2$ mole%. The E_{opt} values of the present glasses initially increased with increasing x mole % of $MgCl_2$ up to 2 mole% of and there is a sudden inflection. Afterwards E_{opt} value for the remaining samples increased lightly with $MgCl_2$ composition. Similar non-linear trends observed in other glass systems [31]. The variation in E_{opt} values with composition is very small. So these changes cannot be attributed to structural changes. The slightly variations may be due the change in the concentration of non-bridging oxygens (NBOs).

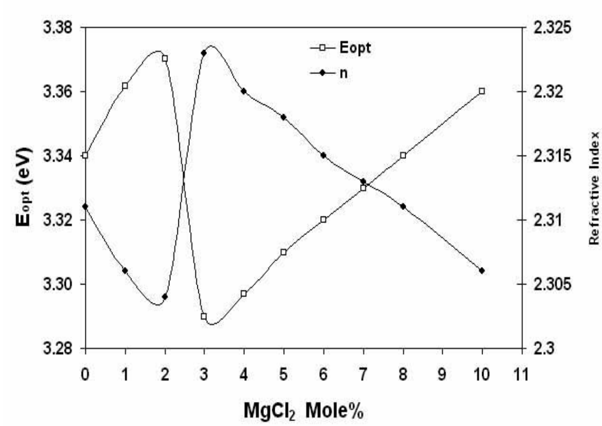


Fig.5 : Variation of E_{opt} and ref ractive index (n) with $MgCl_2$mole%.

Table 2 : Theoretical refractive index (n), Optical basicity values (Λ_{th}) and cut-off wavelengths of $(10-x)MgO-xMgCl_2-40PbO-50B_2O_3$ glasses.

Glass	Refractive Index (n) ± 0.01	Optical Basicity (Λ_{th})	Cut-off Wavelength (λ_c - nm) ± 2nm
G1	2.311	0.5770	317
G2	2.306	0.5787	316
G3	2.304	0.5797	312ss
G4	2.323	0.5807	335
G5	2.320	0.5817	332
G6	2.318	0.5828	325
G7	2.315	0.5838	323
G8	2.313	0.5848	320
G9	2.311	0.5857	322
G10	2.306	0.5877	321

Theoretical refractive index (n) values also have shown small variations with the composition of the glass which may also be due change in the concentration of non-bridging oxygens (NBOs) and expansion of B-O network with x mole %.

IV. Conclusions

The FTIR studies revealed that in the glass matrix various borate groups are randomly interconnected. Typical borate groups like other borate glasses were observed. The presence of BO_3 trigonal units, BO_4 tetrahedral units with complex borate groups like diborate, tri, tetra and penta borates units in the glass structure are confirmed from the IR absorption peaks at 1320-1376 cm^{-1} and 926-1031 cm^{-1}. The peaks around 680 cm^{-1} might be due to formation of bridges by oxygen between two trigonal atoms. MgO acted as a glass network modifier and PbO might be participated as glass network former. No considerable change in glass structure was observed with variation in composition. The variations in theoretical optical energy band gap values with $MgCl_2$ mole% are very small and these changes can be attributed to change in NBO concentration. The observed broadening of the IR peaks with increasing $MgCl_2$ mole % is attributed to B-O network expansion. The variations in theoretical refractive indices are also small.

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the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. **Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. **Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page

- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.
- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.

- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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