

## **THE BLACK HOLE FIREWALL PROBLEM. INFORMATION PARADOX RESOLVED USING RUSSELL'S PARADOX OF SET THEORY.**

### **THE PARADOX:**

The concept of black-hole firewall postulated by J. Polchinski and others in July 2012 (<http://arxiv.org/abs/1207.3123>) was extended this year to suggest that typical black holes with field theory duals have firewalls at the event horizon (10.1103/PhysRevLett.111.171301). This argument makes no reference to entanglement between the black hole and any distant system; hence it is not evaded by identifying degrees of freedom inside the black hole with those outside. During the last one year, more than 100 papers and three conferences/workshops have addressed the idea of firewalls and examined different aspects. We present three different empirical solutions to the paradox by revisiting the foundational principles in each case. In this paper, we reexamine foundations of the Equivalence Principle (EP) using Russell's paradox of set theory.

First the black hole firewall concept needs to be explained for the uninitiated. Consider a scenario: frustrated Alice wants to commit suicide by jumping into a very large black hole, leaving Bob outside the event horizon, beyond which nothing, not even light, can escape. According to the EP, if the black hole is large enough, Alice will not notice anything unusual as she falls through the event horizon – she will see the same phenomena as an observer floating in empty space. In this scenario, dubbed “No Drama”, the gravitational forces will not become extreme until she approaches a point inside the black hole called the singularity. There, the gravitational pull will gradually tug at her feet more strongly than at her head. As she inexorably plunges downwards, the difference in forces would quickly increase and Alice will be “spaghettified” or crushed and torn (remember the saying in the last century: looking ahead inside a black hole, you will see the back of your head in front of you!). The new hypothesis suggests: as Alice crosses the event horizon, breaking correlation with Bob (her entangled partner) would release lots of energy turning the event horizon into a massive firewall that will incinerate her.

Empty space is full of particles-antiparticles pairs that continually pop up into existence before rapidly recombining and instantly vanishing releasing lots of energy. If a pair forms just outside a black hole's event horizon, sometimes one particle may fall inside the event horizon, while the other may escape as the Hawking radiation. The first particle would balance the positive energy of the outgoing particle by carrying negative energy inwards. This is allowed by Quantum Mechanics (QM). That negative energy would get subtracted from the black hole's mass, causing the hole to shrink and steadily lose mass. If no ordinary matter falls in, the hole would eventually evaporate. With this, all information about the black hole would disappear permanently.

But the equations of General Relativity (GR) say that black holes can only swallow mass and grow - not evaporate. Also QM says that information cannot be destroyed. Now consider another possibility. Since the particle pairs have their states ‘entangled’, by measuring the state of the radiation coming out from the emitted particles, we can get all information about the objects falling into the black hole even after the hole evaporates (it must be encoded in the quantum states of the emitted particles). Which of the possibilities is likely? This is the information paradox.

## THE PROBLEM:

If somehow lots of radiating twin-particles could break their correlation with their in-falling partners, massive energy should be released like breaking the bonds of many molecules. The released energy should create a firewall around the black hole event horizon. But this violates one aspect of the equivalence principle that free-fall should feel the same as floating in empty space. Thus either firewall exists or information is lost in black holes permanently. The above scenario creates a paradox bringing into focus the inherent conflict between Relativity and Quantum theories, because it means that at least one of the following three established notions of theoretical physics must be wrong.

- First: the postulates of “No Drama”. According to the EP, there is no difference between free fall - even into the strong gravitational field inside a black hole - and inertial motion in empty space. Since Alice is in free fall when she crosses the event horizon, she should not feel extreme effects of gravity. *Is the EP universally valid or it breaks down at the event horizon or somewhere else? Are the mathematics or concepts that lead to singularity or event horizon, correct? What is gravity? Is it like the other interactions? Can gravity be quantized?*
- Second: the postulates of “unitarity”. Alice and Bob are like an entangled particle pair so that they are strongly correlated. The information carried by the radiation is emitted from the region near the event horizon, with low energy effective field theory valid beyond some microscopic distance from the event horizon. *Can entanglement be by-passed at the event horizon? Can the notion of monogamous quantum entanglement be changed to two different kinds of entanglements?*
- Third: the postulates of “normality”. Physics works normally far away from a black hole even though it breaks down at some point within the black hole. *Is Hawking radiation in a pure state – all information is lost in the black holes? Can quantum Xeroxing - seeing the same information in the Hawking radiation - be resolved by complementarity? What about black-hole particle-jets and blazars?*

Together, these concepts make up what is dubbed “**the menu from hell**”. Since all three cannot be simultaneously true, the paradox is: which of the above three concepts, is/are wrong? One solution lies in Russell’s paradox of set theory and revisiting the foundations of Relativity instead of building on “accepted theories” that goes tangentially in a reductionist manner like “Is time Newtonian or relativistic?” without defining time.

## EQUIVALENCE PRINCIPLE REVISITED:

The cornerstone of GR is the principle of equivalence of inertial and gravitational masses:  $m_i = m_g$ . The EP does not flow from any mathematics. No one has given any mathematical reason (like a consistency constraint) why all matter fields should couple universally to gravity. This is not the case for the other fundamental forces or the Higgs field (which is why different particles have different masses). Higgs field is specific as to which particle couples to it. Gravity is a universal field - an all pervading medium. Every particle in the universe, whether massive or not, couples to it. Since  $F=ma$  and universal free fall for all mass types hold,  $F \approx g \approx a$  holds. It can be explained only if gravity acts like river current *propelling all objects uniformly* based on local density gradient. The apple fell because its coupling with the stem softened and became weak. The galactic and star systems are like a “free vortex” arising out of conflicting currents in which the tangential velocity ‘ $v$ ’ increases as the center line is approached, so that the angular momentum ‘ $rv$ ’ is constant. The orbits are not elliptical, but circles with a shifting center. Hence gravity cannot be quantized and gravitons will never be found.

The EP has been generally accepted without much questioning. Actually GR assumes general covariance and the equivalence of the two masses follows. General covariance means invariance under diffeomorphisms. This implies the equivalence principle. This implies that gravitational and inertial masses are equal. It is not a first principle of physics, but merely an ad hoc metaphysical concept designed to induce the uninitiated to imagine that gravity has magical non-local powers of infinite reach. The appeal to believe in such a miraculous form of gravity is very strong. Virtually everyone accepts EP as an article of faith even though it has never been *positively verified directly* by either experimental or observational physics. All indirect experiments show that the equivalence or otherwise of gravitational and inertial masses is only one of description.

No one knows why there should be two or more mass terms. In principle there is no reason why  $m_i = m_g$ : why should the gravitational charge and the inertial mass be equal? The underlying gauge symmetries that describe the fundamental interactions require the fundamental fields to be massless. The Higgs mechanism of spontaneous symmetry breaking appears in the equation of motion of the field particle, i.e.,  $m_i$  (in the classical limit). If we put the particle in a gravitational field, then it will “feel a force” given by the “gravitational charge” times the gravitational field. This appears as two masses “ $m_g$ ” and “ $m_i$ ”, though there is only one mass term associated with each field.

The gravitational mass  $m_g$  is said to produce and respond to gravitational fields. It is said to supply the mass factor in the inverse square law of gravitation:  $F=Gm_1m_2/r^2$ . The inertial mass  $m_i$  is said to supply the mass factor in Newton’s 2<sup>nd</sup> Law:  $F=ma$ . If gravitation is proportional to  $g$ , say  $F=kg$  (because the weight of a particle depends on its gravitational mass, i.e.  $mg$ ), and acceleration is given by  $a$ , then according to Newton’s law,  $ma=kg$ . Since according to GR,  $g=a$ , combining both we get  $m=k$ . Here  $m$  is the so-called “inertial mass” and  $k$  is the “gravitational mass”. But the problem is the difference between the values of  $G$  (constant – though it might be changing: doi/10.1103/ PhysRevLett.111.101102) and  $g$  (known to be variable).

Alternatively, the inertial mass measures the “inertia”, while the gravitational mass is the coupling strength to the gravitational field. The gravitational mass plays the same role as the electric charge for electromagnetic interactions, the color charge for strong interactions and the particle flavor for weak interactions. Inertial mass  $m_i$  is the mass in Newton’s law  $F=m_i a$ . Gravitational mass  $m_g$  is the coupling strength in the Newton’s law of gravitation:  $F_g = (gm_1m_2/r^2) \times m_g$ . Thus,  $m_i a = F_g = (gm_1m_2/r^2) \times m_g$ . The quantity  $gm_1m_2/r^2$  is the “gravitational field” (say  $G$ ) and  $m_g$  is the “gravitational charge”, so that one can write:  $F \times g = m_g \times G$ , just like we write:  $m_i \times a = q \times E$  for the electric field. This has nothing to do with the Brout-Englert-Higgs mechanism.

Some think that the EP implies that a test particle travels along a geodesic in the background space-time. The EP assumes that in all locally Lorentz (inertial) frame, the laws of Special Relativity (SR) must hold. From this, it is concluded that only the geometric structure of spacetime can define the paths of free bodies. If  $x$  is a particle’s world-line, parameterized by proper time,  $T$  is its tangent vector,  $D$  denotes covariant differentiation along the world-line, and  $R$  is the Ricci tensor, then:  $D(T) = 0$  and  $D(T)=R(T)$  are both tensorial; hence generally covariant. But only one of them describes a geodesic in a general curved space-time.

Gravity does not couple to the “gravitational mass” but rather to the Ricci Tensor, which works only if space-time is flat. Ricci Tensor does not provide a full description in

more than three dimensions. Schwarzschild equations for black holes, where space-time is extremely curved, uses the Riemann Tensor. Using Riemann tensor, instead of Ricci tensor to calculate energy momentum tensor in 3+1 dimensions would not lead to any meaningful results, though in most cases, the Riemann Tensor is needed before one can determine the Ricci Tensor. Thus, there is really no relation between “gravitational mass” and “inertial mass”, except in Newtonian physics. This is why photons (with zero inertial mass) are affected by gravity. Only manipulations of the Standard Model (SM) to include classical gravity (field theory in curved spacetime) leads to effects like Hawking radiation and the Unruh effect. This is where gravitation and the SM can hypothetically meet.

Gravitation and GR are not included in the SM. Hence the SM really cannot say anything about gravitational mass. If any theory conclusively unifies gravitation with the SM, it may be able to explain the equivalence of the inertial mass and the gravitational mass. The Higgs Boson and the Higgs fields are predictions of the SM which incorporates SR. The Higgs mechanism is intended to explain the “rest mass” of fundamental particles such as quarks and electrons that constitute only about 4% of the total theorized mass of the universe. This rest mass of fundamental particles comprises only a tiny fraction (~1%) of the “rest mass” of atoms. Most of the invariant mass of protons and neutrons is the product of quark kinetic energy confinement when bound by the strong interaction mediated by gluons. It is not directly the result of the Higgs mechanism. However, since SR is part of the SM and since  $e = mc^2$ , the SM may be said to imply that rest mass from the Higgs mechanism and binding energy from the color force will both contribute equivalently to inertial rest mass of all particles.

It is believed that the Higgs field obeys ordinary theory of GR. It means that equivalence of inertial and gravitational masses takes place. The mass-energy of the universe that Dark Energy is said to represent has been reduced from 72.8% to 68.3%. At the same time Dark Matter has been increased from 22.7% to 26.8%. This means the percentage of ordinary matter has gone up from 4.5% to 4.9% only. Yet the constituent particles of these mysterious fields most likely do not couple to Higgs field at all.

## **EQUIVALENT OR DIFFERENT?**

If we think of gravitational and inertial masses outside the context of a generally covariant theory, then there is still no evidence that they are equal. They may differ by an arbitrary factor which may be absorbed into  $G$  or by a variable  $G$ . The equivalence of the inertial and gravitational masses has been proved by the Eötvös experiment and many later experiments. An analysis of the experiments of Eötvös about the ratio of gravitational to kinetic mass of a few substances by some scientists yields the result that this ratio for the hydrogen atom, and for the binding energies are equal to that for the neutron with a precision of one part in at least 5.105, and 104 respectively. No conclusion can be drawn about these ratios for the proton and the electron separately.

The Eöt-Wash experiment of University of Washington tried to measure the difference in these two masses *indirectly* by considering “charge/mass” ratios. They have obtained a result, which can be summarized as:  $(m_g/m_i) - 1 \leq 10^{-13}$ .

Lunar Laser Ranging (LLR) experiment used to test for 35 years the equivalence principle with the moon, earth and sun being the test-masses to determine whether, in accordance with the EP, these two celestial bodies are falling toward the Sun at the same rate, despite their different masses, compositions, and gravitational self-energies. Analyses of

precision laser ranges to the Moon continue to provide increasingly stringent limits on any violation of the equivalence principle. Current LLR solutions give  $\Delta(m_g/m_i)_{EP} = (-1.0 \pm 1.4) \times 10^{-13}$  for any possible inequality in  $\Delta(m_g/m_i)$  - the ratios of the gravitational and inertial masses for the Earth and Moon. This result, in combination with laboratory experiments on the weak EP, yields a strong equivalence principle (SEP) test of:  $\Delta(m_g/m_i)_{SEP} = (-2.0 \pm 2.0) \times 10^{-13}$ .

Also, the corresponding SEP violation parameter  $\eta$  is  $(4.4 \pm 4.5) \times 10^{-4}$ , where  $\eta = 4\beta - \gamma - 3$  and both  $\beta$  and  $\gamma$  are post-Newtonian parameters. Using the Cassini  $\gamma$ , the  $\eta$  result yields  $\beta - 1 = (1.2 \pm 1.1) \times 10^{-4}$ . The geodetic precession test, expressed as a relative deviation from general relativity, is:  $K_{gp} = -0.0019 \pm 0.0064$ . The time variation in the gravitational constant results in  $\dot{G}/G = (4 \pm 9) \times 10^{-13} \text{yr}^{-1}$ . Consequently there is no evidence for local (1AU) scale expansion of the solar system. (DOI: 10.1103/PhysRevLett. 93.261101). Apart from the technical problems in these indirect methods and the assumed values of various parameters - including latest precisely measured value of G - continuing the uncertainty, the measured result that the Moon is moving away from the Earth at the rate of about 3.8 centimeters higher in its orbit each year shows that these indirect results cannot be fully relied upon.

The indirect methods to prove equivalence or otherwise; are questionable. It has been accepted as given that  $ma = mg$ . This equivalence is faulty because the description:  $F = ma$  is faulty. Once a force is applied to move the body along any axis and the body moves, the force ceases to act and the body moves at constant velocity  $v'$  due to inertia (assuming no other forces present). The relation between the original velocity  $v$  (zero if the body is at rest) and  $v'$  is the rate of change. To accelerate the body further, we need another force to be applied to the body. Without such a new force, the body cannot be accelerated. What is this new force and from where it comes? If any other force acts, then it has to be introduced into the equation. Where is that? Further, the new force will change the velocity  $v'$  to  $v''$  - a new action. The "rate of change of the rate of change" means relating  $v$  to  $v'$ ,  $v''$ , etc. But why should we compare  $v''$  with  $v$  instead of  $v'$ ?

When answering a question, one should first determine the framework. If we assume nothing then there can be no answer. However, if we take as given that we are going to formulate theories in terms of Lagrangians then there is essentially only one mass parameter that can appear, i.e., the coefficient of the quadratic term. Thus, whatever mass is there, it is only one mass. The Higgs field clearly modifies the on-shell condition in flat space and general relativity simply says that anyone whose frame is locally flat should reproduce the same result. Thus, the Higgs field appears to modify the gravitational mass. It may also modify the inertial mass by the same amount as can be verified by analyzing some scattering diagrams. However, knowing that we are working within the context of a Lagrangian theory, the fact that inertial and gravitational mass are equal is essentially a foregone conclusion. Are they really different? Let us examine.

### **RUSSELL'S PARADOX:**

Now we will examine EP in the light of Russell's paradox of Set theory. Russell's paradox raises an interesting question: If S is the set of all sets which do not have themselves as a member, is S a member of itself? The general principle is that: there cannot be a set without individual elements (example: a library - collection of books - cannot exist without individual books). There cannot be a set of one element or a set of one element is superfluous (example: a book is not a library). Collection of different objects unrelated to each other would be individual members as it does not satisfy the condition of a set. Thus a collection of objects is either a set with its elements, or individual objects that are not the elements of a set.

Let us examine the property  $p(x): x \notin x$ , which means the defining property  $p(x)$  of any element  $x$  is such that it does not belong to  $x$ . Nothing appears unusual about such a property. Many sets have this property. A library  $[p(x)]$  is a collection of books. But a book is not a library  $[x \notin x]$ . Now, suppose this property defines the set  $R = \{x : x \notin x\}$ . It must be possible to determine if  $R \in R$  or  $R \notin R$ . However if  $R \in R$ , then the defining properties of  $R$  implies that  $R \notin R$ , which contradicts the supposition that  $R \in R$ . Similarly, the supposition  $R \notin R$  confers on  $R$  the right to be an element of  $R$ , again leading to a contradiction. The only possible conclusion is that, the property “ $x \notin x$ ” cannot define a set. This idea is also known as the Axiom of Separation in Zermelo-Frankel set theory, which postulates that; “Objects can only be composed of other objects” or “Objects shall not contain themselves”. In order to avoid this paradox, it has to be ensured that a set is not a member of itself. It is convenient to choose a “largest” set in any given context called the universal set and confine the study to the elements of such universal set only. This set may vary in different contexts, but in a given set up, the universal set should be so specified that no occasion arises ever to digress from it. Otherwise, there is every danger of colliding with paradoxes such as the Russell’s paradox. And in the case of EP, we do just that.

### THE THOUGHT EXPERIMENTS OF GR AND EP:

There are similar paradoxes in the theory of SR, GR and the EP. Let us examine EP. All objects fall in similar ways under the influence of gravity. Hence locally, one, it is said, cannot tell the difference between an accelerated frame and an un-accelerated frame. But these must be *related to be compared as equivalent or not?* Let us take the example of a person in an elevator. The person seats in the elevator that is falling down a shaft. It is assumed that locally (i.e., during any sufficiently small amount of time or over a sufficiently small space) the person in the elevator can make no distinction between being in the falling elevator and being stationary in completely empty space, where there is no gravity. This is a wrong assumption. We have experienced the effect of gravity in closed elevators. Even otherwise, unless the door opens and we find *a different floor* in front of us, we cannot relate *motion of the elevator* to the un-accelerated structure of the building – hence no equivalence. The moment we relate to the structure beyond the elevator, we can know the relative motion of the elevator, because unlike the effect of *inertia or gravitation, both of which induce motion*, the building is stationary.

Inside a spaceship in deep space, objects behave like suspended particles in a fluid (un-accelerated) or like the asteroids in the asteroid belt (accelerated). Usually, they are relatively stationary (fixed velocity) within the medium unless some other force acts upon them. This is because of the relative distribution of mass and energy inside the spaceship and its dimensional volume that determines the average density at each point in the medium. Further the average density of the local medium of space is factored into in this calculation. If the person is in a spaceship where he can see the outside objects, then he can know the relative motions by comparing objects at different distances. In a train, if we look only at nearby trees, we may think the trees are moving, but when we compare it with distant objects, we realize the truth. If we cannot see the outside objects, then we will consider only our position with reference to the spaceship – stationary or floating within a frame. There is no equivalence because there is no other frame for comparison. The same principle works for other examples.

It is said that a ray of light, which moves in a straight line will appear curved to the occupants of the spaceship. The light ray from outside can be related to the spaceship only if we consider the bigger frame of reference containing both the space emitting light and the

spaceship. If the passengers could observe the scene outside the spaceship, they will notice this difference and know that the spaceship is moving. In that case, the reasons for the apparent curvature of light path will be known. If we consider outside space as a separate frame of reference unrelated to the spaceship, the ray emitted by it cannot be considered inside the spaceship. The consideration will be restricted to those rays emanating from within the spaceship. In that case, the ray will move straight inside the spaceship. In either case, the description of Einstein is faulty. Thus, the foundation of GR - the EP - is wrong description of reality. Hence all mathematical derivatives built upon such wrong description are also wrong. There is only one type of mass.

The shifting of Mercury's perihelion that is used to validate GR can be explained by  $(v/c)^2$  radians per revolution, where  $v$  is not the escape velocity, but the velocity component induced by Sun's motion in the galaxy, which drags the planets also. Mercury being smallest and closest to the Sun, its effect is most profound. Before Einstein, Gerber has solved the problem differently. Eddington's experiment about gravitational lensing has been questioned repeatedly. The effect is due to contrasting refractive indices of the media like the time dilation seen in GPS, where light bends and travels a longer path (also slows down) after entering the denser atmosphere of Earth. Every material that light can travel through has a refractive index, denoted by the letter  $n$ . The velocity of light in a vacuum is about  $3.0 \times 10^8$  m/s. The refractive index equals the ratio of the velocities of light in vacuum ( $c$ ) to that in the medium ( $v$ ), that is  $n = c/v$ . Light slows down when traveling through a medium, thus the refractive index of any medium will be greater than one. By definition, the refractive index of vacuum is 1. For air at STP it is 1.000277. For air at 0 °C and 1 atm., it is 1.000293. This, and not time dilation, slows down light.

### **SPECIAL RELATIVITY REVISITED:**

Now let us examine Lorentz transformation. The description of the measured state at a given instant is physics and the use of the magnitude of change at two or more designated instants to predict the outcome at other times is mathematics. Measurement is a comparison between similars, of which the constant one is called the unit. The factor  $v^2/c^2$  or  $(v/c)^2$  is ratio or comparison of two dynamical quantities where  $c$  is the constant - hence a unit of measurement of a dynamic variable. It can be used to measure only the comparative dynamical velocities – not changes in mass or dimension, which is possible only through accumulation or reduction of similars. The two dimensional factor  $(v/c)^2$  represents the modifications of incoming light signal (third dimension like the e.m. radiation) as seen by an observer without changing any physical characteristics of the observed. This is why we have three dimensions of ocular perception.

The concept of measurement has undergone a big change over the last century. It all began with the problem of measuring the length of a moving rod. Two possibilities of measurement suggested by Einstein in his 1905 paper (published as *Zur Elektrodynamik bewegter Körper* in *Annalen der Physik* 17:891, 1905) were as follows:

- (a) "The observer moves together with the given measuring-rod and the rod to be measured, and measures the length of the rod directly by superposing the measuring-rod, in just the same way as if all three were at rest", or
- (b) "By means of stationary clocks set up in the stationary system and synchronizing with a clock in the moving frame, the observer ascertains at what points of the stationary system the two ends of the rod to be measured are located at a definite time. The distance between these two points, measured by the measuring-rod already employed, which in this case is at rest, is the length of the rod"

The method described at (b) is misleading. We can do this only by setting up a measuring device to record the emissions from both ends of the rod at the designated time, (which is the same as taking a photograph of the moving rod) and then measure the distance between the two points on the recording device in units of velocity of light or any other unit. But the picture will not give a correct reading due to two reasons:

- If the length of the rod is small or velocity is small, then length contraction will not be perceptible according to the formula given by Einstein.
- If the length of the rod is big or velocity is comparable to that of light, then light from different points of the rod will take different times to reach the recording device and the picture we get will be distorted due to Doppler shift of different points. Thus, there is only one way of measuring the length of the rod as in (a).

Here also we are reminded of an anecdote relating to a famous scientist, who once directed two of his students to precisely measure the wave-length of sodium light. The students returned with two different results – one resembling the normally accepted value and the other a different value. Upon enquiry, the latter replied that he had also come up with the same result as the accepted value, but since everything including the Earth and the scale on it is moving, for precision measurement he applied length contraction to the scale treating the star Betelgeuse as a reference point. This changed the result. The scientist told him to treat the scale and the object to be measured as moving with the same velocity and recalculate the wave-length of light again without any reference to Betelgeuse. After sometime, both the students returned to tell that the wave-length of sodium light is infinite. To a surprised scientist, they explained that since the scale is moving with light, its length would shrink to zero. Hence it will require an infinite number of scales to measure the wave-length of sodium light!

Some scientists try to overcome this difficulty by pointing out that length contraction occurs only in the direction of motion. They claim that if we hold the rod in a transverse direction to the direction of motion, then there will be no length contraction. But how can the length be measured by holding the rod in a transverse direction! If the light path is also transverse to the direction of motion, then the terms  $c+v$  and  $c-v$  vanish from the equation making the entire theory redundant. If the observer moves together with the given measuring-rod and the rod to be measured, and measures the length of the rod directly by superposing the measuring-rod while moving with it, he will not find any difference because the length contraction, if real, will be in the same proportion for both.

The fallacy in Einstein's description is that if one treats "as if all three were at rest", one cannot measure dynamic variables such as velocity or momentum, as the object will be relatively at rest, which means zero relative velocity. Either Einstein missed this point or he was clever enough to camouflage this when he said: "Now to the origin of one of the two systems ( $k$ ) let a constant velocity  $v$  be imparted in the direction of the increasing  $x$  of the other stationary system ( $K$ ), and let this velocity be communicated to the axes of the co-ordinates, the relevant measuring-rod, and the clocks". But is this the velocity of  $k$  as measured from  $k$ , or is it the velocity as measured from  $K$ ? This is crucial because  $K$  and  $k$  each have their own clocks and measuring rods, which are not treated as equivalent by Einstein. Therefore, according to his theory, the velocity will be measured by each differently. In fact, they will measure the velocity of  $k$  differently. But Einstein does not assign the velocity specifically to either system. His spinning disk and other example in SR and GR also fall for the same reason.



Before we discuss time orderings or whether time is Newtonian or Relativistic, let us define time precisely. In his 1905 paper, Einstein says: “It might appear possible to overcome all the difficulties attending the definition of ‘time’ by substituting ‘the position of the small hand of my watch’ for ‘time’. And in fact such a definition is satisfactory when we are concerned with defining a time exclusively for the place where the watch is located; but it is no longer satisfactory when we have to connect in time series of events occurring at different places, or - what comes to the same thing - to evaluate the times of events occurring at places remote from the watch”.

It is not a precise or scientific definition of time, but the description of the recordings of a clock, which is subject to mechanical error in its functioning. Space, Time and coordinates, like matter, have no physical existence. They arise out of orderings or sequence or our notions of priority and posterity. When the orderings are for objects, the interval between them is called space. When it is for transformations in objects (events), the intervals are called time. When we describe the specific nature of orderings of space (straight line, geodesic, angular, etc), it is called coordinate system. Since measurement is a comparison between similars (Einstein uses *fixed speed of light per second* to measure distance), we use similar, but easily intelligible and uniformly transforming natural sequence, such as the day or year or its subdivisions as the unit of time. If a clock stops or functions erratically, time does not stop or becomes erratic. Now is a fleeting interface between two events. Hence while at the universal level it is the minimum perceivable interval between two events, in specific cases, it can have longer durations as present continuous. For example, all life cycles are present-continuous for those individuals and comparison between two different natural life cycles is the time dilation between them. Hence Einstein’s definition of time is scientifically wrong. His definition of synchronization is also wrong as shown below.

Einstein uses a privileged frame of reference to define synchronization between clocks and then denies the existence of any privileged frame of reference – a universal “now” - for time. We quote from his 1905 paper:

“We have so far defined only an ‘A time’ and a ‘B time’. We have not defined a common ‘time’ for A and B, for the latter cannot be defined at all unless we establish *by definition* that the ‘time’ required by light to travel from A to B equals the ‘time’ it requires to travel from B to A. Let a ray of light start at the ‘A time’  $t_A$  from A towards B, let it at the ‘B time’  $t_B$  be reflected at B in the direction of A, and arrive again at A at the ‘A time’  $t'_A$ . In accordance with definition the two clocks synchronize if:  $t_B - t_A = t'_A - t_B$ .”

We assume that this definition of synchronism is free from contradictions, and possible for any number of points; and that the following relations are universally valid:—

1. If the clock at B synchronizes with the clock at A, the clock at A synchronizes with the clock at B.
2. If the clock at A synchronizes with the clock at B and also with the clock at C, the clocks at B and C also synchronize with each other.”

The concept of relativity is valid only between two objects. Introduction of a third object brings in the concept of privileged frame of reference and all equations of relativity fall. Yet, Einstein precisely does the same while claiming the very opposite. In the above description, the clock at A is treated as a privileged frame of reference for proving synchronization of the clocks at B and C. Yet, he claims it is relative! Thus; his conclusion - there are many quite different but equally valid ways of assigning times to events or different observers moving at constant velocity relative to one another require different notions of time, as their clocks run differently - is wrong. Paradoxically, standard formulations of quantum mechanics use the universal “now” frequently.

## SPEED OF LIGHT:

The constant speed of light, which is one of the foundations of SR, only measures equal distance in equal time units in a medium of uniform density. Using this or a multiple or a fraction of this as the unit, the fixed (uniformly accelerating) distance between A and B can be measured by way of length comparison in any uniform medium. But this will not be time measurement, as A and B are not time variant events or states, but time invariant positions. Of course we have the choice of taking the interval between the events when light leaves A and reaches B as the unit and compare the other intervals with it to get the time measured. But light travels at different velocities in different media and the interval for it to cross the same distance in various media will not be the same. The GPS proof has already been discussed. The same is true for particle accelerator experiments that are contained in high flux magnetic tubes. The speedometer reading and the actual kilometer readings in cars do not match. It is always slower due to friction. This puts severe restrictions on Einstein's proposition, which cannot be used universally. For example, if there is a very hot or very cold cloud of gas between points A and B not equidistant from both, the results would be different as is evident from absorption and emission spectra. Some of the wave-lengths are absorbed by the gas cloud. If the cloud is not at the center, this will happen at different intervals for both way motion.

After his SR paper of 1905, Einstein has frequently held that the speed of light is not constant. In his 1911 paper "ON THE INFLUENCE OF GRAVITATION ON THE PROPAGATION OF LIGHT", he says: "For measuring time at a place which, relatively to the origin of the co-ordinates, has the gravitation potential  $\Phi$ , we must employ a clock which – when removed to the origin of co-ordinates – goes  $(1 + \Phi/c^2)$  times more slowly than the clock used for measuring time at the origin of co-ordinates. If we call the velocity of light at the origin of co-ordinates  $c_0$ , then the velocity of light  $c$  at a place with the gravitation potential  $\Phi$  will be given by the relation:  $c = c_0 (1 + \Phi/c^2)$ .....(3).

*The principle of the constancy of the velocity of light holds good according to this theory in a different form from that which usually underlies the ordinary theory of relativity (italics ours).*

### 4. Bending of Light-Rays in the Gravitational Field

**FROM** the proposition which has just been proved, that the velocity of light in the gravitational field is a function of the place, we may easily infer, by means of Huyghens's principle, that light-rays propagated across a gravitational field undergo deflexion".

Interestingly, it was not the only occasion when Einstein maintained that **velocity of light is not constant**. In 1912, he wrote "*On the other hand I am of the view that the principle of the constancy of the velocity of light can be maintained only insofar as one restricts oneself to spatio-temporal regions of constant gravitational potential*". He repeated this in 1913 when he said: "*I arrived at the result that the velocity of light is not to be regarded as independent of the gravitational potential. Thus the principle of the constancy of the velocity of light is incompatible with the equivalence hypothesis*". In 1915, he wrote in *Die Relativitätstheorie* on page 259: "*the writer of these lines is of the opinion that the theory of relativity is still in need of generalization, in the sense that the principle of the constancy of the velocity of light is to be abandoned*".

He repeated it again in late 1915, on page 150, "The Foundation of the General Theory of Relativity", where he says "*the principle of the constancy of the velocity of light in vacuo must be modified*". He really spells it out in section 22 of the 1916 book "Relativity: The Special and General Theory", where he wrote "*In the second place our result shows that,*

*according to the general theory of relativity, the law of the constancy of the velocity of light in vacuo, which constitutes one of the two fundamental assumptions in the special theory of relativity and to which we have already frequently referred, cannot claim any unlimited validity. A curvature of rays of light can only take place when the velocity of propagation of light varies with position. Now we might think that as a consequence of this, the special theory of relativity and with it the whole theory of relativity would be laid in the dust. But in reality this is not the case. We can only conclude that the special theory of relativity cannot claim an unlimited domain of validity; its results hold only so long as we are able to disregard the influences of gravitational fields on the phenomena (e.g. of light). Thus, Einstein himself has contradicted one of the fundamental postulates that has gone into developing SR without abandoning the findings based on such wrong postulates.*

Einstein has used equations  $x^2+y^2+z^2-c^2t^2 = 0$  and  $\xi^2 + \eta^2 + \zeta^2 - c^2 \tau^2 = 0$  to describe two spheres that the observers see of the evolution of the same light pulse. The above equation of the sphere is mathematically wrong. Since  $x^2+y^2 = 0$  describes a circle,  $x^2+y^2 - c^2 t^2 = 0$  describes a sphere with z-axis zero and  $x^2+y^2-c^2t^2 = 0$  describes a circle that evolves in time. Multiplying and not **adding** another factor  $z^2$  will transform a two dimensional circle (representing area) into a three dimensional sphere (volume). Both the equations mentioned by Einstein can at best describe two spheres with origin at (0,0,0) and the points (x,y,z) and ( $\xi, \eta, \zeta$ ) on the circumference of the respective spheres. Since the second person is moving away from the origin, the second equation is not relevant in his case (he is there). Assuming he sees the other sphere, he should know its origin (because he has already seen it, otherwise he will not know that it is the same light pulse. In that case, there is no way to relate both pulses) and its present location. In other words, he will measure the same radius as the other person, implying:  $c^2t^2 = c^2 \tau^2$  or  $t = \tau$ .

Again, if  $x^2+y^2+z^2-c^2t^2 = x'^2+y'^2+z'^2-c^2 \tau^2$ ,  $t \neq \tau$ .

This creates a contradiction, which invalidates his mathematics.

Relativity is an operational concept, but not an existential concept. The equations apply to data and not to particles. When we approach a mountain from a distance, its volume appears to increase. The visual perception of volume (scaling up of the angle of incoming radiation) changes at a particular rate. But there is no such impact on the mountain. It exists as it was. The same principle applies to the perception of objects with high velocities. The changing volume is perceived at different times depending upon our relative velocity. If we move fast, it appears earlier. If we move slowly, it appears later. Our differential perception is related to changing angles of radiation and not the changing states of the object. It does not apply to locality. Thus, the Galilean relativity is real and the Lorentz transformation is apparent to the observer only. Einstein's assertion that the clash between Lorentz invariance and the Galilei invariance of Newtonian mechanics was inconsistent with the physical principle of relativity is misplaced and wrong.

## **CONCLUSION:**

Thus, it is clear that simultaneity - the notion of "now" - is not relative, the universal clock is not fiction, and time is not a proxy for the movement and change of objects in the universe – it is the rate of change in objects. It is not true that two events are truly simultaneous only if they are causally related – unless we assign that cause to application of energy. However, since application of energy at one position with one object cannot generate action (event) at another position involving another object, they cannot be causally related.

Einstein had wrongly assigned several length and time variables in SR, giving them to the wrong coordinate systems or to no specific coordinate systems. He skipped an entire coordinate system, achieving two degrees of relativity when he thought he had only achieved one. Because his  $x$  and  $t$  transformations were compromised, his velocity transformations were also compromised. He carried this error into the mass transformations, which infected them as well. This problem then infected the tensor calculus and GR. This explains the various anomalies and variations and the so-called violations within Relativity. Since Einstein's field equations are not correct, Schwarzschild's solution of 1917 is not correct. Israel's non-rotating solution is not correct. Kerr's rotating solution is not correct. And the solutions of Penrose, Wheeler, Hawking, Carter, and Robinson are not correct. The three Friedmann models of the Universe and the equation-of-state parameter are not correct. The so-called expansion of the Universe only at galactic scales and not lesser scales is actually temporary and will be reversed in future, as the galactic clusters are rotating against a common center like the planets around the Sun. The concept of Dark matter and dark energy are not correct because energy is perceived only through its interactions; hence cannot be dark. The smoothness and persistence indicates a background structure, which it is.

"Lorentz Invariance" is the symmetry of SR. General covariance, which comes from SR, is limited to space-time coordinate systems related to each other by uniform relative motions only - "Inertial frames". It extends Lorentz invariance and treats it as a property of GR. EP deals with the equivalence of gravitational and inertial mass. We have shown both covariance and EP are wrong descriptions of reality. Thus, we have solved one paradox. In the next paper, we will discuss macro representation of entanglement and the mathematics that leads to singularity and event horizon. We will also explain gravity, and discuss misconceptions about dark matter and dark energy to show their true nature.