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Three Fundamental Questions Challenging Einstein's Relativity

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ABSTRACT This article, after reviewing briefly the current circumstances of publishing dissenting articles that, say, suggest some rebuttals to relativity or quantum mechanics in (non-)mainstream media, calls into question Einstein's relativity theory accusing it of incompleteness and being ill-defined. It is demonstrated that the physical effects of acceleration have dramatically been overlooked by Einstein as he was extending the special theory to the general one so that such a deficiency gives rise to absurdities in both special and general relativity.

KEYWORDS Special relativity, General relativity, Acceleration, Gravitation, Gravitational potential, Inertial observer, Schwarzschild observer, Angular velocity

INTRODUCTION

It has been more than a century since Einstein proposed his theory of relativity, and now we can trace its effects in every physical phenomenon, from the fundamental particles to giant galaxies. Although the special and general theories of relativity satisfy all the crucial tests such as the kinematic and gravitational time dilation [1], the gravitational red shift [2], perihelion precession of Mercury [3], deflection of light by a gravitational mass [4], gravitational waves [5], etc., there are also some current discussions that challenge the validity of some of these experiments. [6,7]

So far, besides a gorgeous yet complicated mathematics, a firm logic has depicted the theory as a flawless picture in the minds of many scientists and researchers such that the relevant experts rarely dare to question the main tenets of relativity. Among these people, those who have academically learnt, or teach relativity in universities are the most stubborn in acknowledging possible deficiencies as to this theory proposed by other scientists in the field, or in setting similar accusations and refutations against relativity by themselves. Such a prejudicial attitude is unfortunate, for it causes mainstream journals to shrink from publishing any controversial article which barely targets any possible weak spots in relativity or even in quantum mechanics.

It has occurred many times that a crank or an unsophisticated researcher – mistakenly thinking that he/she has found the Achilles heel of a widely acclaimed theory – submits an article to a mainstream journal, whereas it has been determined after the peer-review procedure that the article is mathematically flawed or it includes misapprehensions or absurd concepts. However, unrelenting behaviors conducted by the editors and reviewers can also reject an article for publication even in case of applying mathematics correctly to some plausible assumptions. To register and distribute their ideas as fast as possible, these physicists perforce submit their articles to dissident journals or other alternative media in which the articles are not peer-reviewed, or the review process is of low sensitivity to criticism. The author of the present article, however, tries to question relativity using a plain language so that anyone having an initial knowledge about relativity can easily follow the discussion. It is demonstrated that the physical effects of acceleration have dramatically been overlooked by Einstein as he was extending the special theory to the general one so that such a deficiency gives rise to absurdities in both the special relativity theory (SRT) and the general one (GRT).

EINSTEIN'S CLAIMS

In his book, *Relativity: The Special and General Theory* [8], Einstein claimed that the clocks in a gravitational field, as well as those located on a rotating disc, run slower solely due to the gravitational potential (g-potential), no matter how much acceleration they undergo. He then replaces potential per unit mass with velocity square ($r^2\omega^2$) of a clock located at a radius r on the disc. He explains:

"If we represent the difference of potential of the centrifugal force between the position of the clock and the center of the disc by φ, i.e. the work, considered negatively, which must be performed on the unit of mass against the centrifugal force in order to transport it from the position of the clock on the rotating disc to the center of the disc, then we have:

$$\varphi = r^2\omega^2/2 , \tag{1}$$

... Now, as judged from the disc, the latter is in a gravitational field of potential φ, hence the result we have obtained will hold quite generally for gravitational fields. ... Now $\varphi = -KM/r$, where K is Newton's constant of gravitation, and M is the mass of the heavenly body." [8]

Einstein's example of the rotating disc is however slightly deceptive because it is as if the effect of acceleration has unintentionally been considered in, say, time dilation factor, since the larger the radius at which the clock is rotated, the greater both its tangential velocity ($v = r\omega$) and centrifugal acceleration ($a = r\omega^2$). Therefore, we can ask the first question as follows:

QUESTION #1: WHY DOES NOT ACCELERATION AFFECT TIME DILATION IN ADDITION TO THE TIME DILATION CAUSED BY VELOCITY?

Let us modify Einstein's example of the rotating disc. Assume we have two concentric rings on a plane one with a large radius and the other with a very small one. If the rings rotate at the same tangential velocity of v, yet having different angular velocities of ω_1 and ω_2, according to Einstein, the clocks attached to the rings run slower at the same rate as measured by an inertial observer at rest with respect to the rings' center (plane). However, according to the centrifugal acceleration formula:

$$a = v^2/r , \tag{2}$$

the clock on the ring with a smaller radius experiences much more acceleration than that located on the ring with a larger radius. How can it be possible that such a large centripetal force / acceleration, which can easily mash the nearer clock to the center of rotation (if the radius is small enough), is ineffective in altering time rates? (Forget about the viewpoint of the rotating observers.) Remember that if the radius approaches zero, both the angular velocity ω and the centrifugal acceleration tends to infinity, yet the tangential velocity deliberately remains unchanged. It is really hard to understand why an *infinite* acceleration / force cannot affect clock rates! However, one may say that the time dilation can be very important in particle accelerator experiments, where the rest frame half-life of reaction products can be very small. If centripetal acceleration affected time dilation then it would have been detected in experiments such as those involved with circular accelerators. To the author, this allegation is not compulsorily valid because we do not know, if there is an impact, how acceleration affects time dilation. For instance, if the acceleration effect appears as the term a^2d^2/c^4, where a is the centrifugal acceleration, and d is the diameter of the particle, it would be evident that our nowadays technology can hardly detect the traces of such a small quantity.

QUESTION #2: IS THERE AN ABSURDITY IN THE GENERAL RELATIVITY PREDICTION ABOUT TIME DILATION INSIDE A THICK SPHERICAL SHELL?

It is a common misunderstanding that the gravitational time dilation is related to the gravitational *acceleration* (g-acceleration). As emphasized by Einstein, it is indeed the gravitational *potential* that rules time dilation. Now, assume that we have a massive spherical planet with a tiny hollow core. The gravitational acceleration is zero everywhere inside the hollow core as predicted by both classical mechanics and GRT. However, the gravitational potential is not zero in the core. Now, consider two observers, one has been trapped and is floating inside the core of this massive planet, and the other floating inside a massless shell in an interstellar space away from the gravitation of the planet, though at rest with respect to the planet. (Also called a Schwarzschild observer.)

If these observers hold similar light clocks, general relativity predicts that time dilates for the clock within the planet's core because of non-zero gravitational potential compared to the clock held by the observer inside the massless shell. Nonetheless, this result is not logically tenable because it is in contrast to the spirit of Einstein's equivalence principle (EEP). Indeed, using EEP, each of these observers can by no means detect if he/she is inside a massive planet or a massless shell floating in interstellar space. That is, observers' *feelings* are the same, both undergoing similar weightlessness, and all experiments have similar outcomes from the viewpoint of these observers. According to the fact that the relative velocity of these observers is zero, it is logically anticipated that their clocks run at the same rate, but this is not the case!

It is worthwhile to mention that both of the issues explained in this article are two sides of the same coin. That is to say, since high accelerations cannot affect time dilation in the example of the rotating disc, the clocks, as discussed in the second question, can run slower in the absence of acceleration. It seems that a deficiency in SRT about neglecting the effect of acceleration in the relative measurements just puts on a new make-up in GRT. It is, however, worth noting that EEP – as stated in the relevant textbooks – makes claims only about the physics of the local vicinity, specifically that the physics should be *locally* the same in gravitational free-fall as in field-free space. In short, one can claim that the equivalence principle only applies if you use a region of space-time which is too small to measure any curvature. Indeed, the prediction of GRT that one clock runs more slowly than another, discussed in our example, would only be a problem for EEP if one could somehow devise a local experiment to distinguish between the two clocks. In practice, however, our original test will require comparison of two clock rates at two different locations, in different gravitational fields, involving some sort of message passing over that interval.

First, the author is highly doubtful about the application of the locality of EEP. This condition is misused many times. To the author, EEP's locality arises from the fact that the difference of g-field obeys an inverse-square law, i.e., the gravitational field is not uniform in reality. Therefore, the acceleration vectors are convergent towards the center of the planet, which causes tidal forces to be detected, say, inside a freely falling compartment. Nonetheless, if we can assume a uniform g-field like that near an infinitely (or very) large *plate*, the space-time is *entirely* and *exactly* flat everywhere inside the freely falling compartment regardless of how large the spatial dimensions of the compartment are. Remember that, for such a plate, the g-field, similar to the E-field inside a parallel-plate capacitor, is exactly uniform. In this case, the EEP is no longer local, in other words, locality is not an intrinsic limitation for EEP.

Second, passing messages between the observers cannot challenge the validity of the deficiency discussed here. Observers' communication can usually upset local results when they are transferred via some non-local arrangements. Many other experiments do have this deficiency, and thus this is not fundamentally problematic to the author's claim. For better understanding, let us set forth another example.

In SRT, it is known that time dilates by the Lorentz factor for, e.g., a light source approaching an observer – at rest in the lab frame of reference – at a constant velocity of v. Now, let us see what happens if the light source decides to communicate with the lab observer by sending a signal towards him. The Doppler effect predicts that the frequency of the photon received by the observer is increased by a factor other than that of Lorentz. Nevertheless, when the lab observer receives the increased frequency of an approaching light source, he is *not* allowed to deduce that the source clock runs *faster*. He needs to consider the relativistic Doppler Effect to obtain the correct time dilation and deduce that the source clock runs *slower*. It became obvious in this example that communication, per se, is capable of changing the true results. However, these changes cannot intrinsically affect the local results. For any observer, indeed, it suffices to *imagine* any experiment, rather than to receive the results by communication.

QUESTION #3: WHY DOES THE "GRAVITATIONAL POTENTIAL" – SOMETHING DEFINED BY CONVENTION – RULE TIME DILATION AND LENGTH CONTRACTION IN GRT?

Assume that we have an *exactly* uniform gravitational field (g) like that occur for an infinitely large plate. ($g = 2\pi G\sigma$, where σ is the surface density of the plate.) As we know, two similar clocks located on a specific alignment in the field perpendicular to the plate, with different distances away from the plate, and at rest relative to the plate, undergo similar gravity, and thus the clocks are expected to run at the same rate. Even all the experiments performed in the compartments within which the clocks are located have the same outcomes. Remember that, as stated earlier, the locality of EEP is no longer valid in this exactly uniform g-field, and thus the observers can extend its application to large distances away from the local vicinity of their frame of reference or from the plate itself.

However, according to GRT, the clock which is nearer to the plate, oddly enough, runs slower as viewed by the other clock located farther from the plate just because the nearer clock is in a lower (more negative) gravitational potential regardless of the strength of the gravitational field! If the gravitational potential is something determined by convention, why and how it has become so important, rather than acceleration with real physical impacts, in affecting some objectively measurable phenomena such as time dilation and length contraction? To the author's knowledge, those physical qualities determined by convention are somehow *apparent*. Therefore, the author thinks it is as if we claim that because the apparent *size* of the farther clock is smaller, thus this apparent phenomenon affects time rates or the length measurements! Nevertheless, one may claim what matters in GRT is the *difference* in the gravitational potential energy, and not the potential at a specific point. That is, although the absolute values of the potentials at specific points are not physical observables but rather determined by convention, their differences have physical meanings. Indeed, the mentioned *difference* can be interpreted as the *work* done on a unit mass (the clock) to move it from one point to the other as pointed out earlier by Einstein. To the author, however, it is not clearly perceivable how this work plays a decisive role in the clock rates.

For better understanding this issue, assume that we have a massive spherical shell like that discussed in the previous question. The g-acceleration is zero inside the shell as well as in infinity. The Schwarzschild observer located at infinity measures the rate of the clock located on the surface of the shell smaller than the same clock in his own hand. However, the observer at the center of the shell with similar feelings (zero g-field) to those experienced by the Schwarzschild observer, detects no change in the rate of the clock located on the shell compared to his because the potential difference is zero. To the author, this deduction is slightly strange.

On the other hand, if there is an authenticity with the work done on the clock in GRT, why general relativity predicts no change for the clock rates in E-fields (E-potentials) for charged clocks? That is, if we consider a massless shell though highly electrically charged and if we use a charged clock, we may have to do the same work as we did on the electrically neutral clock in the previous example. However, this work cannot affect the time rate of the clock located on the charged shell from the viewpoint of the Schwarzschild observer in a clear manner. Even if one uses, for example, the Reissner–Nordström (RN) metric [9,10] to describe the space-time outside a charged and non-rotating spherical source, the mentioned metric, contrary to the Schwarzschild one, is not interpretable in a way so that the *work* done on a charged clock (q) – to move it inside the electric field of, say, a charged black hole (Q) – plays the sole and decisive role in decreasing / increasing the rate of the charged clock. Indeed, the corresponding gamma factor in RN metric is written as follows:

$$\gamma = \frac{dt}{d\tau} = 1 \Big/ \sqrt{1 - \frac{2GM}{c^2 r} + \frac{GQ^2}{4\pi\varepsilon_0 c^4 r^2}} \,, \tag{3}$$

where t is the time coordinate measured by a stationary clock at infinity, and τ is the proper time. As we know from the electrical work, the work could be either positive or negative depending on the sign of the charge Q , however, according to Eq. (3), the time dilation would be the same either way since it depends only on the square of Q . Also, an uncharged clock would have the same dilation, or a clock with, say, double the charge ($2q$) because the time dilation is not contingent upon q in the RN metric, whereas the electrical work depends on both q & Q . Therefore, the uncharged and charged clocks would have the same additional time dilation from the charged source (Q) but different works. Thus, it seems that the only reason that propelled Einstein to use g-potential rather than g-acceleration in extending SRT to GRT is that the dimension of the potential per unit mass (m^2/s^2) is more reconcilable to the constant speed of light than the acceleration with a unit m/s^2 is!

CONCLUSION

According to the special theory of relativity, *acceleration* has no intrinsic effect on physical measurements such as time. This attitude culminates in implausible occurrences in the realm of relativity theory. According to special relativity, it has oddly enough been demonstrated that it is possible for a clock to undergo an infinite (centrifugal) acceleration, while the time rate remains unaffected. As a counterpart in general relativity, it has been shown, too, that time rates can be changed in zero gravitational field, which is not logically tenable.

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