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Critical failure of the principle equivalence between acceleration and gravity

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Abstract. The principle of equivalence between acceleration and gravity of general relativity is reviewed in a thought experiment of two bodies, aligned according to the perpendicular, under the reciprocal action of their gravity, in free fall, inside of an uniformly accelerated reference system, in the vacuum. The result is that the two bodies fall with a different acceleration. This result invalidates such principle.

Keywords: Principle equivalence, acceleration, gravity

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Introduction

In the construction of the general relativity, in October and November 1907, Albert Einstein adopted the so-called weak equivalence principle (WEP), introduced by Isaac Newton as fundament of your mechanics, in particular with respect to the gravity (second law of the motion and law of universal gravitation), and originally principle of Galileo Galilei, its discoverer, ie: “Gravity accelerates all objects equally regardless of their masses or the materials from which they are made”. The root cause of this principle is the equality of inertial and gravitational masses established in the Eötvös experiment. Einstein reworked this principle in the equivalence strong principle like the foundation that spacetime is curved, successfully supported in the gravitational redshift experiment [1], and he during the rest of your life insisted in the fundamental importance of this principle in the general relativity, that nevertheless, it in its original formulation is not hold [2].

The Einstein´s equivalence strong principle (EEP) says that: “acceleration and gravity are equivalents”. Here, we will show that this statement is false.

Einstein´s equivalence principle

The EEP is compound of the three elements: WEP, local Lorentz invariance (LLI) and local position invariance (LPI). LLI means that “the outcome of any local non-gravitational experiment is independent of the velocity of the freely-falling reference frame in which it is performed” [1]. And LPI means that “the outcome of any local non-gravitational experiment is independent of where and when in the universe it is performed” [1].

The tests of EEP made are restricted to the tests on WEP, LLI and LPI, very successfully supported in the experiments. The result is that EEP is valid. WEP test has verified rigorously the equivalence between gravitational mass and inertial mass using various technologies as the realized by the Washington group (2012), based in “torsion balance”, “with precisions at the part in 10^{13} level” [3], that improves similar result of Eötvös (1908), in near 10^{4}, also it has used rolling balls (Galilei, 1610), pendulums (Newton, 1680) and lunar laser ranging (Shapiro, 1976) [4]. LLI test has proved that the linear, homogeneous change of coordinates of Lorentz preserves locally the physical laws in all the inertial systems. First, it was performed by Michelson (1981), and it was repeated with Morley (1887) using an interferometer, but only was after 1905 that clearly it was understood by Einstein's special relativity. After, it has been repeated numerous times and improved its precision. During recent years are used lasers and resonators [5]. For example, Brillet and Hall (1979) using a laser, they improved “the accuracy of the Michelson–Morley experiment by a factor of 4000” [6], i.e. respect to the possible anisotropies of the speed of the electromagnetic wave. With resonators, it has reached the best accuracy, down to a level 10^{-17} (2009) [7]. LPI test has proved that dimensionless fundamental constants does not change in space or time, since also refers to position in time, mainly through gravitational red-shift measurements using “the frequency or wavelength shift between two identical frequency standards (clocks) placed at rest at different heights in a static gravitational field”. “The first successful, high-precision redshift measurement was the series of Pound–Rebka–Snider experiments of 1960 – 1965”. Until 2006 “The most precise standard redshift test to date was the Vessot–Levine rocket experiment that took place in June 1976” at 10^{-4} level. “The gravitational redshift could be improved to the 10^{-10} level using an array of laser cooled atomic clocks on board a spacecraft which would travel to within four solar radius of the Sun” [1]. In 2012, this test has been improved to the 10^{-6} level [8].

LLI and LPI although “are so very different in their empirical consequences, it is tempting to regard them as independent theoretical principles” [1], however, they are very linked with WEP, since LLI and LPI interlock with WEP, in the special relativity, “such as Maxwell’s equations of electromagnetism” [1], and in general relativity, “such as curved spacetime” [1].

The primary importance of WEP in the EEP led to the Schiff’s conjecture, impossible to prove, due to that “some special counter-examples are known, yet a number of powerful plausibility arguments can be formulated” [1], insomuch as “the validity of WEP alone guarantees the validity of local Lorentz and position invariance, and thereby of EEP” [1]. Thus, Schiff’s conjecture would explain the successive successes of relativity in its confrontations in many sundry experiments of spatial and astronomical character also of atomic physics. Therefore, WEP is the main cause of the successes of EEP and WEP is the fundamental principle of the classic mechanic.

The problem

It is true that EEP responds very well to the experiments but the conceptual model of EEP is inconsistent because Gravity is a particular way of acceleration but is not exactly acceleration. This is the problem of the distinguishability between particular and general, where acceleration is general and gravity is particular. Although, in 1949, “Einstein reconsidered his viewpoint on the principle of equivalence and did not insist on the complete equivalence of fields of forces of inertia and gravitational fields” [9], however, in the original version of Einstein gravity is equal to acceleration and the consequences in the model of EPP are:

- Due to that gravity goes in the direction and sense of the centre of masses of a physical system, it is necessary, vanish this properties and not exist a satisfactory solution because in an accelerated system, that would be equivalent to gravity, the direction of the acceleration is orthogonal to x axis and its sense is contrary. If the scope of EPP is restricted to an infinitesimal lapse of spacetime as usually is made, ie, is used a Minkowski’s spacetime, this does not destroy the centre of masses of a gravity system (and if gravity system is reduced to infinitesimal volume then gravity system does not exist), that is located in it and such equivalence is spurious. Although the direction between acceleration and gravity were the same, neither while exist the gravity system is possible do coincide the sense of gravity with the sense of the acceleration of the accelerated system because these are opposites.

- While, in a gravity system, the bodies in free fall are accelerated, in an accelerated system these are in rest.
- During free fall, while in the gravitational systems the masses of the bodies are not involved, because for every body the inertial mass is canceled by the gravitational mass; in change, in accelerated systems, the masses of the bodies are involved, due to that these bodies are in rest, and in this state, the bodies lack both of inertial mass as of the gravitational mass.

Today, it is well established that "the equivalence principle, if understood as the possibility of excluding the gravitational field in an infinitesimal region, is not correct since there is no way in which we can exclude the curvature of space (if it is nonzero) by selecting an appropriate reference frame, even with in a given accuracy. Moreover, gravitational fields and fields of forces of inertia do no have a similar effect on all physical processes." [9]. Thus, the conceptual model of EEP does not respond exactly to the physical characteristics of a gravity system confronted with an accelerated system.

In spite of the absence of preservation of the direction y sense between gravity and acceleration, and that is accepted, against all empirical evidence previous to general relativity and scientific understanding, that a curve of the spacetime can put in motion to a body in rest [10], due to the analogy between free fall of a body in rest in a accelerated system and a body accelerated in a gravity system, however, EEP preserves that all bodies fall with the same acceleration. Such property of the equivalence is truly the esential cuestion, that if it is lost is impossible continue supporting EEP.

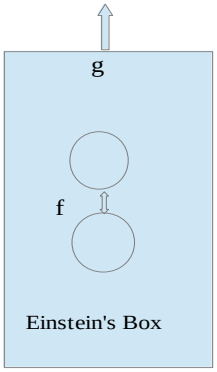
We have found the crucial experiment in the free fall, in an accelerated system, which violates equal acceleration for all bodies; therefore, we provide a definitive test to rule EEP.

The thought experiment

In the outer space (Minkowski's spacetime), in an uniformly accelerated reference system (Einstein's box) with value g, in orthogonal direction to soil and in up sense, that according general relativity produces a homogeneous artificial gravitational field, forming a real gravitational system (when is null such gravitational system? exactly, when only exist a body), there are two bodies, initially in rest, with equal mass=m (although they can have different masses), to a distance=r, in the orthogonal direction to soil, who is at a distance d>>r. Since even in Minkowski's spacetime, the acceleration due to the gravity force f between the two bodies is:

$$f = \frac{Gm}{r^2}$$

Figure 1. Einstein's Box



However, this experiment it can realize in a laboratory under suitable conditions.

5. Motion equations

- For the first body the motion equation is:

$$a_1 = g - \frac{Gm}{r^2}$$

a_1 is acceleration on first body, g is gravity acceleration and G is gravitational constant

- For the second body the motion equation is:

$$a_2 = g + \frac{Gm}{r^2}$$

a_2 is acceleration on second body

6. Conclusions

The result of this work is contrary to the statement: “acceleration and gravity are equivalents”, since in an accelerated system, two bodies fall with different acceleration while in a gravitational system, they fall with equal acceleration. As $a_1 \# a_2$ the result in summary is:

1. The bodies, in this experiment, in an accelerated system (Einstein’s box at Minkowski’s spacetime), fall with an acceleration different. In effect, it is violated the equal acceleration for all bodies, in the free fall, when the experiment it is realized in an accelerated system.
2. It proves that although in the box of Einstein does not exist the curvature of spacetime, however, the effect of attraction between two spheres exist, and it is impossible of eliminate. When two bodies fall with the same acceleration?. If it responds that the the principle EEP is violated because inside Einstein’s box two bodies make curve the spacetime, then that argument is irrelevant since independent of any natural physical cause, the statement of EEP, about “acceleration and gravity are equivalents”, is false because they maybe are not.
3. The difference in free fall between the accelerated and gravitational systems is minimum quantitatively, some might say despicable, but the issue is that they are different conceptually, ie they are different qualitatively.

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