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Why No Theory Based On Einstein's Principle Of Equivalence Can Tell What Gravitation Is

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Abstract

The present work criticizes the principle of equivalence as an assumption that purposely blurs the distinction between gravitation and inertia. It is shown that Einstein sets artificial limits to the means by which an observer can distinguish between the two situations he can find himself in, i.e. between a gravitational field and an accelerated platform. We argue that an observer can, if he so wishes, discern between gravitation and inertia and has any right to consider them two different manifestations of nature. Recognizing the limitations brought in by the principle of equivalence offers us the right to reject any conclusion stemming from it and, in particular, to object to the fact that Einstein's General Theory of Relativity can offer any explanation at all regarding the true cause and nature of the gravitational force.

Keywords: gravitation, inertia, principle of equivalence

Introduction

Einstein's principle of equivalence (EPE) states that an observer is not able to tell, by performing measurements of forces alone, whether he is standing in a gravitational field on the surface of a planet or on a platform in an uniformly accelerated motion. Einstein concentrates solely on the fact that the observer will detect in each case the same kind of motion for a body left to move freely and, in general, that all physical phenomena will obey the same laws irrespective of the situation. He states that [1]:

"We shall therefore assume complete physical equivalence between the gravitational field and the corresponding acceleration of the reference system."

Taking this assumption to hold true, Einstein willfully cancels any distinction between the gravitational and inertial force. While not understanding the cause of gravitation, Einstein seems to try to tell us in his General Theory of Relativity that we actually need not struggle to understand gravitation any more because, being "equivalent", we can describe the gravitational force in terms of accelerating platforms. He seems to really believe in his ability "to 'produce' a gravitational field merely by changing the system of coordinates" [2].

This leads to the perplexing situation in which the present science does not even take the gravitational field as *equivalent* with an accelerating platform any more, but it holds that the gravitational field *is* a region of accelerated space. According to this theory, we have to believe that when we stand on the ground of our planet we are actually accelerating upwards. If this is too hard for you to accept, you have the alternative to imagine that the ground actually does not really move upwards but, instead, the "space-time" itself has been "curved" by the presence of the planet. How matter is supposed to accomplish this is, however, not made clear in the theory. Although the gravitational force is reduced to an inertial force, it is worth noting that Einstein's theory does not, and actually is not able to, elaborate on the origin of inertia, so we are at a loss when it comes to understanding what actually pushes an observer towards the wall of its accelerating platform.

There is also no indication in this theory why we have to replace the gravitational force with an inertial force and not vice-versa. Since EPE states that the two are equivalent, the opposite must be also true, namely that an acceleration of the reference system must be equivalent with a gravitational field. This leads to another curious result: when you accelerate an object, you have every right to believe that you in fact create matter out of nothing with a mass whose gravitational field gives the corresponding attractive force. This Einstein acknowledges and calls the respective gravitational field "apparent" [3].

In what follows we show that EPE, although based on experimental evidence, cannot be developed into a theory which can claim to explain the true nature of either the gravitational or the inertial force.

Main

Einstein's principle of equivalence (EPE) is based on the experimentally verified fact that, when a box containing an object is accelerated uniformly through space, the respective object will press on the box wall with a force. The same effect can be obtained if the same box is placed in the gravitational field of a planet. For the two forces to be equal, a supplementary condition must be fulfilled: that the acceleration of the movement in the first case be equal with the acceleration with which the object would fall freely in the gravitational field of the planet. This condition is highly symmetric between the two situations, since the object in the accelerated box will approach the box wall with the same acceleration with which it does when falling freely in the gravitational field. It is also obvious that, prior to touching the box wall, the object in the accelerated box will detect no force. Experiments show that the same applies to the object falling freely in the gravitational field of the planet.

As a consequence of the above, one can say that the behavior, or the laws of mechanics obeyed by, the two objects must not depend on the two situations they are studied in. Hence the existence of EPE.

It is to be remarked from the above description how different are the circumstances and the phenomena that lead to the identical effect of a force of pressure on the box wall. The force of the first case, called force of inertia, is born through the acceleration of the "environment" that the object is placed in. The force of the second case, called force of weight, is born through the presence of the planet which, through some mechanism, is able to exert an attractive force on the object.

In spite of these obvious differences, EPE states that there is no way in which an observer can distinguish between the two situations. In other words, it is purported that an observer cannot device any experiment by which he can tell whether he is located in the gravitational field of a planet or it is traveling through space at a certain acceleration. Since the observer cannot attribute the forces he measures to either of the two, EPE and the theory derived from it, the general Theory of Relativity (GRT), state that in reality we cannot be sure whether, being on the grounds of a planet we are not accelerating upwards or whether, traveling in an accelerated spaceship we are not subject of a certain gravitational field.

While we acknowledge that the effects of the gravitational field are indeed identical with that of an accelerating box, we argue that we cannot neglect the fact that they are two different manifestations of nature. As such, even if gravitation and accelerating systems give rise to identical effects, as long as we are able to distinguish between these two causes, we are compelled to study and explain them separately and, eventually to show the reason why, in spite of having different origin, they give identical physical effects.

That we are actually able to distinguish between gravitation and accelerating systems is an

obvious fact. As long as an observer is not confined into a box unable to see the world outside, but allowed to study the box itself as well as its surroundings, there are various ways by which the distinction between gravity and accelerating systems can be made.

For instance, an observer can tell whether the force that presses him to the wall of the box is due to the acceleration of the box or is gravitational in nature by attempting to leave the box but keeping himself bound to the box by a rope. Since his box is either accelerated or supported by a pillar to the ground of a planet, he can travel along that pillar to see where is the other end located. If he finds a planet, then he can conclude that he is in a gravitational field. If he finds a rocket, he will obviously conclude that his box is being accelerated. We will not detail here how the observer is able to tell the difference between a rocket and a planet, believing that the reader will see that it is obvious.

We see that whether or not we limit our observations to the interior of the box is essential. If we do limit our investigations to the interior of the box, our universe will be the interior of the box and any theory we will construct will refer solely to the space inside the box. Consequently, we cannot make statements regarding the “outside” world, much less tell what gravitation or inertia force is. We will not have the notion of these two as being different manifestations of nature. In this respect, Einstein’s GRT addresses topics which it was not supposed to address in the first place by accepting EPE. But even so, we may ask: is GRT based on realistic assumptions?

We saw that, once the observer in the box is allowed to see the world outside and to investigate it freely, he will eventually find what we already know, namely that two different phenomena, gravitation and inertia, give rise to identical dynamical behavior for the matter. It is hard to accept that, once he observed the differences in the origins of the two forces, an observer will still maintain that the ground of the planet is accelerating upwards to account inertially for the gravitational field he detects. Conversely, it is highly improbable that, once back in his accelerating box, he will maintain that there is a planet behind his box that has the right mass and position to account for the attractive force he feels.

We argue that considering an observer in such constrained circumstances as in EPE is not realistic because it introduces artificial limitation to our knowledge. We do *not* live in a closed box out of which we cannot see or go so that we can study it and, because of this essential difference, we can distinguish between a box connected to the grounds of a planet and a box in accelerated motion through space.

We contend that the artificial limitation that Einstein imposes on the observational means of his observers that would otherwise help them distinguish between a gravitational field and an accelerated box is at the heart of the confusion that exists today regarding the results and interpretations offered by GRT. Were we not knowledgeable of these two facets of phenomena, EPE would be tenable. Even so, inferences based on EPE could not be applied to the outside world

since there would be no knowledge of the existence of planets or outside forces that impart accelerated motion to the box. Therefore, a theory based on EPE would have no point in addressing the physical situation of the outside world because this would simply not exist to the observer inside the box.

Our knowledge of, and the ability to make the distinction between, the gravitational and inertial forces, even if we accept the equivalence of their effects, compel us to continue the quest for an answer regarding their nature and origin. Their effects may be equivalent, but their causes and nature may be not. We cannot make identical two phenomena only because their effects are identical for the same reason for which we do not take two objects to be made of the same material just because they have the same color. Until we have not found the answer to the origin of gravitation and inertia, we cannot say that we explain gravitation with the help of inertia or inertia with the help of gravitation.

Conclusions

The present study addressed the controversial issue of whether GRT can be said to explain the origin of gravitational force. It was shown that the assumption this theory is based on, the principle of equivalence, introduces artificial limitations to the ability of an observer to distinguish between the force of weight and that of inertia. Even if the effects of the two forces are identical, their obvious different origin does not allow us to consider them identical manifestations of nature, but compels us to continue the search for their respective origin.

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