The flaw in Einstein's box and its essentially non-destructive impact on the General relativity theory

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Abstract

A trivially easy argument, which – in fact – follows from the General relativity theory, is used in order to point out an evident flaw in the commonly accepted interpretation of the Principle of equivalence in Einstein's box. It is shown that the flaw by itself has no destructive impact on the Theory.

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It can be objected that the limitation to the local Lorentz reference frame, introduced in connection with the validity of the Principle of equivalence between the gravitational and inertial accelerations in Einstein's box, makes the Principle essentially false, since the limits of measurability of effects discerning between their respective causes, can never be definitively established; the extension of the box in space and time is given in a manner being too arbitrary in relation to the always surmountable degree of measurement precision. In Lawden (1982), the possible disagreement is avoided by the introduction of the notion *irreducible* gravitational field, contrasting with the reducible fictitious field, which is linked to the acceleration caused by an external force pushing on the box (produced, *e.g.*, by an attached rocket motor). Thus, having purposely pointed out the differences, any possible contradiction is effectively eliminated.

On this place, however, another – rather different – problem of the Principle will be considered. Many years ago, Abramowicz (1993) in a convincing article, quite seriously (while on a trivial level and in a very pictorially telling manner) pointed out that the floor of the box, staying at rest on the surface of a relativistically massive cosmic body (*i.e.*, on a strong source of the gravitational field), would appear flat when touched with by the hand of a (over-naturally anatomically-mechanically robust) person in the box. Yet, the author didn't develop this idea more; its consequences are however so enormous that they deserve to be investigated more deeply.

For the sake of simplicity we use a static source of the Schwarzschildean gravitational field, with the radius chosen to be equal to that of the respective photon horizon[1]. Further purposely, having chosen the mass of the source of the field and – consequently – the radius of its photon horizon to be small, the convex bending of the floor of the box is sizable for the coordinate observer; it is assumed as well that the scale of the horizontal extension of the box is large enough, that the bending of its floor is ascertainable by the same observer. As already mentioned above, according to Abramowicz, in spite of the quoted circumstances it is not possible for a person inside the box to feel the convexity of the floor. It is because his hands and the floor are bent in an equivalent manner and degree: For the coordinate observer, the manifestation of both bendings is apparent, while for the person in the box the bending of body tissues in his hand does not mean a 'common sense' mechanical deformation causing the feeling of stress or pain. The explanation is that no rigid, in a Euclidean sense – straight, rods exist in the box with significant space extension. They are not definable there, at all (*c.fr.* Pfister and King, 2015; p. 14).

[1]The *photon horizon* is the sphere concentric with the spherically symmetric source of the gravitational field, where the path of a horizontally radiated photon is the great circle on the mentioned sphere, as described in the view of the coordinate observer. (The *coordinate observer* is a very distant observer at rest relative to the source of the considered gravitational field, not being significantly influenced by it.)

When now, in the box, a photon is emitted orthogonally relative to the local radial coordinate, it will follow the photon horizon. In such a way, the direction of the photon (i) is defining the notion *horizontal* at every point of its path, while the path (being the space component of the adjacent null-geodesic in the curved spacetime) (ii) is playing the role of a 'straight line', with absolutely all physical consequences:

Inside the box it is not possible, by any means, to observe/measure the relevant deflection of the light, while it is ascertainable by the coordinate observer.

For the observer in the box, the path of the photon always appears as a straight line, both with the use of eyes of any thinkable physical/optical instrument. On this place it is important to emphasize that the space extension of the box along the path of the horizontally sent photon is allowed to be arbitrarily large.

On the other hand, when the same box is accelerating orthogonally relative to its floor in the 'free space' (*i.e.* under the special relativistic conditions), with acceleration equal to the gravitational acceleration at rest on the surface of the previously considered cosmic body, the differential specially relativistic aberration of a photon, radiated parallelly with the floor, will be measurable (and possibly interpreted in a non-adequate manner, to be its 'pseudo-'gravitational directional deflection).

Thus, the two considered situations in Einstein's box are not equivalent, but – quite oppositely – they are discernible, which states the flaw in the concept of the original idea of the Principle when based on usually presented grounds (see, *e.g.*, Lambourne, 2010; pp. 114–117).

Nevertheless, there does not exist an impact of the analysis made above, which would be destructive for the GRT; the Theory is in fact latently applied in the analysis. It means that the GRT is self-consistent in spite of its principal idea (formulated by A. Einstein) was 'born in the box'. This is because the problem with the light deflection, presented here in a contradictory way, is just a 'blind alley' from the main path of logic of the Theory as a whole. The variation would be possible to avoid in a rather non-conventionally 'perverted' manner, namely, keeping the condition of adequate scale-dimension of space and time intervals of/in the box imperatively under the limits of measurability of respective effects[2] arising thanks to the external force applied in the 'free-space' of the SRT. Then the light deflection caused by the differential SRT-aberration, would not be possible to observe inside the box and the questioned Principle would be saved, even if in a quite different new way.

[2]Even the time limitation is necessary, otherwise the photon used in an experiment could indicate the changing angle of aberration in the box, *e.g.* if its sidewalls were coated by a mirroring material keeping the photon reflecting between them under the time-interval long enough for the indication of the change of its direction.

Note
Expressed in a rather free style, it is now possible to state that the GRT was born in Einstein's box, but as an adult theory it doesn't need that cradle any more in order to survive with success; the cradle became too small and began to pinch. (For a more thorough explanation of the idea of the Note, see Voráček, 1987[3] and 1989.)

Motto a posteriori – Popper's principle of falsifiability:
Any small flaw in a widely established scientific theory renders it untenable, either in its hitherto presented form or – maybe – even in its entirety.

References

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[3]The argumentation in the reference needs to be completed: The concept presented in Misner *et.al.*, 1973 (p. 13), that the gravitational force is a manifestation of the deviation of the world-line of a test particle from the geodesic caused by an external force, while the gravitational force is only apparent (*i.e.*, it is not really existing), together with the idea that for the test particle following a geodesic exists neither the gravitational nor the inertial force, denies practically the existence of the gravitation as a physical interaction, which is a serious contradiction with reality. Our argument, that for the test particle at rest on the surface of a planet, the real gravitational force is primary and the force with which the solid surface of the planet is pushing upwards on the particle is secondary, in accordance with Newton's Principle of action and reaction, is not possible to reject with the claim that the Principle appertains only to classical mechanics and not to the GRT; the Principle is valid in the GRT if the forces are co-local (see Voráček, 2015 and references therein).