

EQUVALENCE PRINCIPLE IMPLIES A GRAVITATIONAL-REDSHIFT PROPORTIONAL SPACE DILATION AND HENCE GLOBAL CONSTANCY OF c

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Abstract

The equivalence principle, Einstein's famous 1907 paradigm of the constantly accelerating extended long rocketship in outer space, has a new implication. The constant recession speed of the bottom relative to the tip causes not only a "gravitational time dilation" (redshift) whereby the distance paradoxically remains invariant; it in addition also causes a proportional blowup of size valid downstairs – "gravitational space dilation." This result implies a return to the *global constancy of the speed of light c* of special relativity in the equivalence principle and therefore in gravitation. The consequences are staggering (no global space expansion, no gravitational waves, no Hawking evaporation, no incompatibility between gravitation and quantum mechanics). A global- c transform of the Einstein equation is preprogrammed.

Keywords: Equivalence principle, Gravitational redshift, Einstein light clock, Gravitational size change, Global constancy of c , Convergence with quantum electrodynamics, Cosmology

Introduction

A return to the roots of relativistic gravitation theory, Einstein's "equivalence principle" of 1907 [Einstein, 1907; Weinstein, 2012] is offered. A combination of the "Einstein light clock" [Lewis, Tolman, 1909] with the Einstein equivalence principle reveals the existence of a *spatial corollary* to the temporal gravitational redshift. Some first-order implications are pointed out.

Special Relativity, re-exploited

The point of departure is a simple fact in special relativity: The speed of light inside a light clock that is transversally receding from the observer

appears reduced optically to the latter. Nonetheless the up- and down-moving laser pulse inside the glass tube with the two mirrors at the ends is, while the light clock is receding, traveling along a proportionally elongated (slanted) light path in the rest frame of the observer. Thus the constant speed of light c applies in *both* frames – in the rest frame of the light tube and in the rest frame of the observer. This result from special relativity proper carries over to the equivalence principle where a corollary holds:

Corollary. When the light clock lies flat on the bottom of the constantly accelerating long rocketship in outer space, the speed of the light pulse zipping back and forth across the light tube likewise looks reduced when watched from above since the bottom is constantly receding from the top [Einstein, 1907]. In contrast to previous belief, however, the observed slowdown *remains* the mere projection effect that it was in ordinary special relativity. The paradoxical feature seen by Einstein in the equivalence principle – that the distance between top and bottom does not increase despite the ongoing recession of the bottom from the top – is only a second-order effect. Locally, the recession is genuine. Therefore the speed of light c remains globally constant *also* in the equivalence principle and, by implication, in gravitation. Compare [Rossler, 2013a] for a picture.

Pre-history of the Result

The above *Corollary* was not yet noticed by Einstein [1907] in his groundbreaking paper. He rather wrote down, on the second-but-last page four lines underneath his Eq.(32b), the following expression (without an equation number added and without a formal equality sign, and with an intermediary expression that is omitted here):

$$c' = c (1 + \Phi/c^2). \quad (1)$$

Note that the gravitational potential Φ possesses a negative sign by definition, so that

$$c' < c \quad (1')$$

was predicted to hold true downstairs in the equivalence principle by Einstein.

The equation labeled Eq.(1) above re-appears, in exactly the above form, as “Eq.(3)” in Einstein’s *second* paper on gravitation [Einstein, 1911]. The delay of 4 years between both papers was apparently caused by the fact that gravitation theory had totally lost its appeal to Einstein in the meantime in view of the glaring inconsistency between Eq.(1’) on the one hand, and his own epoch-making discovery two years before that the speed of light c is a universal constant in special relativity [Einstein, 1905] on the other. Without his good friend Ehrenfest’s altruistic intervention – who visited him in Prague asking for assistance with his own subtly related rotating-disk paradigm – Einstein might have given up on the topic of gravitation.

The improved Result

The correct expression for the speed of light in gravity valid downstairs reads

$$c' \equiv c. \quad (2)$$

The reason is the above *Corollary*. It implies that the light path inside a light clock that lies flat on the receding floor is – just as in special relativity proper – blown up in length by the redshift factor relative to the observer at the tip. The redshift factor reads – compare Einstein’s [1907] Eq.(30a) –

$$L = 1 - \Phi/c^2 \quad (3)$$

(the symbol L is introduced here for convenience). Note that the product of Eq.(3) with Einstein’s Eq.(1) yields Eq.(2). Hence c is globally constant, q.e.d.

In light of Eq.(2), all atoms in the wall of the glass tube and hence all atoms downstairs are increased in their linear size by the redshift factor L . This fact is optically invisible from above just as it is under ordinary recession in special relativity. In the other direction (looking upwards rather than downwards), the opposite effect holds true: All atoms upstairs in the Einstein rocketship are shrunk in their linear size by the blueshift factor, $1 + \Phi/c^2$, without this size change being visible to the observer below.

Discussion

An unexpected “hard finding” was described: a redshift-proportional blow-up of spatial intervals in the equivalence principle. It followed from a new *Corollary* to ordinary special relativity found valid in the equivalence principle.

The described size change is in perfect harmony with modern quantum electrodynamics, of all things. For the photons emitted downstairs, with their longer wavelengths and lower energies [Einstein, 1907], can be locally transformed – via the creation and annihilation operators of QED – into atoms (positronium in the simplest case) as usual. The atoms thereby generated have a proportionally reduced mass. Note that PET scans which are based on positronium annihilation do work at sea level as well as in the mountains. The lower-in-mass atoms downstairs necessarily are exactly so much *larger* by virtue of the Bohr radius formula of quantum mechanics [Rossler, 2014]. This fact represents a surprise “pre-established harmony” between gravitation theory on the one hand and quantum electrodynamics on the other. The seemingly reduced speed of light downstairs when watched from above, described by Einstein [1907], therefore indeed *masks* a parallel blowup of spatial intervals, so that c remains globally constant.

The new size increase valid in the equivalence principle thirdly follows independently also from angular-momentum conservation [Rossler, 2013b], a fact already seen by Heinrich Kuypers in his unpublished doctoral

dissertation [Kuypers, 2005]. A “gravitational space dilation” was described also by Richard J. Cook [2009], cf. [Rossler, 2008, 2012].

The *global* nature of the speed of light c – demonstrated above in the equivalence principle as the “hardest” form of gravitation theory because falsification in case of an error is nowhere easier – alters the face of physics:

(i) The old more-than-20-digit accuracy at which *gravitational waves* have been experimentally *excluded* (as one can legitimately characterize the failure to find them) has a natural explanation: The global constancy of c rules out longitudinal oscillations in c . The long ago obtained “indirect evidence in favor of gravitational waves” in a double-star system (of Nobel fame) can be accounted for by a non-zero tidal-friction parameter that was inadvertently put equal to zero [Rossler, 2009].

(ii) The most recent indirect finding of gravitational waves (“Bicep2”) in a putative inflationary phase of the hypothetical Big Bang (cf. [Cowen, 2014] for the editorial) is unfortunately also a *fata morgana*.

(iii) The glaring “anomalies” seen in the *microwave background radiation* by the PLANCK mission and its precursor [ESA, 2013] can be faced squarely. With all globally expanding solutions to the Einstein equation ruled out by *c-global* (so that there is no “Big Bang”), the microwave background radiation (MBR) possesses a “backyard origin” and hence need not be isotropic any more nor time-invariant (as is easy to check). Note that along with the Big Bang, also “cosmic inflation” and “accelerated expansion” and hence “cold dark matter” (of Nobel fame) lose their physical validity in the wake of *c-global*. Only Zwicky’s ordinary dark matter remains.

(iv) The Sunyaev-Zeldovich (SZ) effect, honored by the custom-made “South Pole Telescope,” loses its physical validity because it presupposes a maximally far-away origin of the microwave background radiation. The many false-positive results call for a picture-processing type explanation.

(v) The famous Greisen-Zatsepin-Kuzmin (GZK) effect which is close to being confirmed by the multi-purpose “Pierre-Auger Observatory” is – in the absence of a maximally distant origin of the microwave background radiation on which it likewise relies – inexistent, too. Hence the phenomena if confirmed harbors new physics.

(vi) The “Baryonic Oscillation Spectroscopy Survey” (BOSS) also loses its rationale in the absence of the Big Bang while the empirical results retain their phenomenological interest.

(vii) Black holes can no longer “Hawking-evaporate” in finite outer time. For the well-known infinite in-falling (and escape) times for light, valid in the outside world [Oppenheimer, Snyder, 1939], reflect an equally long (optically compressed) spatial distance when c is globally constant. The

beautiful – ostensibly negative – empirical data of [Aad *et al.*, 2014] at CERN regarding black holes require a (safety relevant) re-interpretation.

(viii) A global- c version of the Schwarzschild metric exists already [Rossler, 2012].

(ix) The full “global- c version” of the Einstein equation waits to be written down.

In view of the long list of electrifying consequences of c -global, it is of great importance to try and falsify (or confirm) the *gravitational space dilation* implicit in the equivalence principle. Due to the simplicity of that principle, the task is open to the scrutiny of gravitational specialists and non-specialists alike. Therefore a decision is bound to be in soon.

To conclude, a return to the oldest gravitational intuition of Einstein uncovered a new first-order implication of the equivalence principle. The constant recession speed of the bottom of the Einstein rocketship entails a *spatial* corollary to Einstein’s *temporal magnification* result. The obtained “revival of a global speed of light c in gravitation after 107 years’ time” is worth the scrutiny of the scientific community and the public at large. The public was unaware of the fact that c had lost its global status (remaining only “locally constant”). The revived dream of Einstein (c global) which he did not mention again after 1905 affects cosmology, black-hole theory and unification. If it is false – as any new result in science must be reckoned with to be – it is “grandiosely false.” For the damage to currently accepted wisdom which can be *avoided* by a rebuttal is without precedent, as the above 9 items are proof of. Can it be that Einstein’s mind was even more powerful than he himself thought possible?

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