"SCHWINGER-THEOREM": ASCENDING PHOTONS IN EQUIVALENCE PRINCIPLE IMPLY GLOBALLY CONSTANT c IN GENERAL RELATIVITY

Otto E. Rossler

University of Tubingen, Faculty of Science, Tubingen, Germany

Abstract

Nobel laureate Julian Schwinger in his 1986 book "Einstein's Legacy" cast a new light on the Einstein equivalence principle and, by implication, on general relativity. He demonstrated that the gravitationally redshifted photons arriving upstairs in gravity possess their lower frequency and energy on emission already, without this fact being locally manifest downstairs. Thus unlike a stone thrown, photons do not lose their kinetic energy on the way up. The consequences of this counterintuitive finding are far-reaching. In particular, the long-abandoned global constancy of the speed of light c gets resurrected. This fact rules out all globally expanding solutions to the Einstein equation. The same far-reaching cosmological finding is already implicit in the recently discovered fundamental field of cryodynamics, sister discipline to thermodynamics.

Introduction

Schwinger took up where Einstein left in 1907 [Einstein, 1907]. Einstein had shown that clocks are slowed-down downstairs in his ignited extended long rocketship and in gravity. Schwinger [1986] showed that photons appear normal downstairs in gravity but nonetheless possess their reduced energy already on emission down there. The two pertinent paragraphs showing in his book read verbatim:

"Recall that the energy of a photon is proportional to the frequency of the light. Suppose that a light source and a light detector are going to be installed at different heights in an [add: *accelerating*]*spaceship or in a terrestrial laboratory. First the source is positioned. The next step is to raise the detector to a height* h *above the source. Think of what that means*

for an individual atom, one that has some relativistic energy E*, at the height of the source. To raise that atom, of mass* m*, a distance* h *against the acceleration of gravity,* g'*, requires an amount of work (the product of force and distance) equal to* mg'h*. This work increases the energy of the atom; that is, it has been given additional potential energy. Now, because Einstein has told us that* m = E/c²*, the additional energy is* (E/c²)g'h*, which is an increase in energy by the fraction* g'h/c²*. Whatever energy values the atom can have at the height of the source, all those energy values are increased by the* same *fraction,* g'h/c²*, as the atom is raised the distance* h*."*

And (paragraph after next): *"Note that we have taken for granted that the frequency of the light emitted by the source is received by the detector as light of the* same*frequency. One sometimes encounters a different explanation of the gravitational redshift. A photon rising up against a gravitational attraction loses energy and therefore suffers a decrease in frequency. But the energy of the photon, like that of any other projectile (friction aside) is* conserved*; its frequency does* not *change. Rather, it is the* standards *of frequency that differ at different locations."*[Schwinger, 1986].

Consequences of Schwinger's Insight

In our current age of the *GPS* satellites, Schwinger's demonstration says that the slower clocks down here on earth go hand in hand with a proportionally reduced photon energy on emission valid down here without this fact being manifest to us.

The "constant-frequency finding" of Schwinger was never put in doubt but it was never endorsed explicitly (only implicitly [Cook, 2009, Rossler, 2012, 2013]). Therefore, it could happen that the main impact of Schwinger's demonstration – a return to the original intuition of Einstein regarding *c* which he had so reluctantly given up in 1907 [Einstein, 1907] – would go unnoticed. Schwinger's result can be cast into the form of a theorem:

Theorem: The speed of light c is a global constant in gravitation.

Proof: (1) The locally masked reduced photon energy downstairs, demonstrated by Schwinger, implies that the rest mass of any ordinary particle present downstairs is likewise reduced by the Einstein redshift factor. The reason is Quantum Electrodynamics (Schwinger's main field) which implies that photons and particles are mutually inter-convertible via "creation-annihilation" operators.

(2) The reduced particle rest mass downstairs implies a proportional size increase which (like the change in clock rate) is locally imperceptible. The cause of the size change is quantum mechanics again: by virtue of the Bohr-radius formula valid in full-fledged quantum mechanics,

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the size of the hydrogen atom $a_0$is inversely proportional to electron mass m(with proton mass assumed to be larger by a constant factor put equal to infinity so that it does not show up in the formula),

$$a_0 = \hbar/(\alpha cm) ,(1)$$

with$\hbar$ and $c$global constants and α the dimensionless fine structure constant as is well known[Tipler and Llewellyn, 2012]. Therefore, all objects present downstairs are enlarged by the redshift factor $g'h/c^2$ of Schwinger in strict parallelism to the Einstein slowdown of time.

(3) The increased spatial wavelength of photons and the concomitant size increase of atoms jointly imply a proportional increase of all spatial distances downstairs. Therefore, the ratio "length over time" is not only a *local* invariant in gravitation as is well known, but also a *global* invariant. This global constancy of all linear velocities fact extends to the speed of light c. **Q.e.d.**

Discussion

The retrieved global constancy of c has one major consequence: The formalism of general relativity is up for a "re-scaling operation" because c is not a global invariant in general relativity up until now. This difficult formal re-writing task can be easily accomplished only in a special case – the Schwarzschild [1916] metric. Here, the mathematically equivalent new distance formula (the "*gothic-R distance*") is already available [Rossler, 2008a,b]. The generalization to all three space dimensions – involving the Lambert W function – was accomplished by an anonymous specialist ["Ich", 2008].

Regarding the full task, however, it is hard to find specialists in general relativity ready to do the re-scaling operations on the Einstein equation so as to let it display the new-found *global-c property*. The reason: even trying is tantamount to putting in doubt many canonical transformations and solutions of the Einstein equation in its traditional form. In particular, the most famous solution to the Einstein equation – the expanding "Big-Bang" model – ceases to be physical when c is a global constant. This is because the expansion speed can then no longer be added to the speed of light c, so that all globally expanding solutions are ruled out.

Ordinarily, a planet-wide scientific consensus ("c is *not* globally constant") cannot be overthrown overnight. However, in the present case the Big Bang solution to the Einstein equation did already lose its physical validity owing to an independent result from chaos theory. The famous deterministic statistical mechanics of Sinai [1970] got split up into two equal-rights sub-disciplines – "statistical thermodynamics" and "statistical cryodynamics" [Rossler, 2013]. The new discipline of cryodynamics rules out the Big Bang since it implies the Hubble phenomenon as a lawful

implication of the gravitational interaction between light particles (photons) and randomly moving heavy particles (galaxies). Fritz Zwicky's formerly ridiculed "tired light hypothesis" [Zwicky, 1929] is a valid implication of cryodynamics [Rossler et al., 2003, 2007, Rossler 2011]. The new chaos-based explanation of the Hubble law replaces the 4-digit accuracy ("13.81 billion years") for the age of the cosmos by an infinite number. Apart from its pertaining to the sky, cryodynamics also promises a down-to-earth application – "dynamical stabilization of hot fusion" in the famous, still precarious ITER project and hence unlimited free energy for an energy-thirsty planet [Rossler et al., 2013]. Harking back to Schwinger's finding is therefore an attractive option. Regaining the original global-c of Einstein after 107 years lets physics become non-speculative again due to the "Schwinger theorem."

To conclude, a straightforward result, obtained by quantum physicist Julian Schwinger almost three decades ago, was shown to re-establish a previously abaned feature of gravitation: *global constancy of the speed of light in the vacuum, c*.

Acknowledgment

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