

Peer Review

Review of: "On a Paradox of Gravitational Redshift"

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I wish to give some comments on the paper 'On a Paradox of Gravitational Redshift'.

The author gives a detailed review of the redshift effect explanations, and this is an advantage of the paper.

Unfortunately, all these explanations, as well as the paradox presented by the authors, are based **on the mass-energy equivalence for the photon**.

From my point of view, only Einstein's original explanation of the redshift is correct. All explanations based on the balance of energy - in the interpretation of the author - contain weak points.

1. Misner, Thorne, and Wheeler's derivation. According to their explanation,

> Now, suppose the particle annihilating at point , converting its total energy

The particle alone cannot annihilate. The particle can annihilate only if it collides with the antiparticle. So if the energy of some particle increases by + ΔE in some displacement in the gravitational field, the energy of the antiparticle will decrease by $-\Delta E$. Nothing can change for the system particle-antiparticle moving in the gravitational field.

2. Weinberg's derivation. The terms $\phi_i \Delta m_i$ require that the photon has some mass (m_i are the masses of the photons). But until now, there is no solid confirmation that the photon has any mass.

Yes, some act of absorption of the photon by the atom increases the energy of the latter - the electrons go to a higher energetic level. But it does not mean that the mass of the atom changes after the act of absorption.

3. Feynman, Leighton, and Sands's derivation

One can find that according to this derivation, the energy of the emitted photon depends on the position of the atom, the source of this photon, in the constant gravitational field:

> Now, suppose we have such an atom in state E_1 sitting on the floor, and we carry

it to a height d . To achieve this, work is required to lift the mass $m_1 = E/c^2$ against the gravitational force.

Meanwhile, the energy of the photon (in the optical frequency range) depends only on the difference in the energies of stationary states of the atom. For a constant gravitational field, this difference, and therefore the energy of the emitted photon, should be independent of the height of the atoms in this field.

From my point of view, the author implicitly uses the idea that the energy which the photon transfers from one body to another must be equal to some mass via the relation $E/c^2 = M$.

But this assumption means that the photon - and in general - the EM field must have mass. Unfortunately, this assumption has no experimental confirmation. Moreover, there is an unsolved problem of $4/3$ in classical electrodynamics that is directly connected with the EM mass (or the mass of the EM field surrounding the classical charge).

Thus, I can say that the paradox presented by the author needs more solid scientific justification, namely, the explanation of why the photon has some property to own mass.

Declarations

Potential competing interests: No potential competing interests to declare.