

Gravitation: Frequency Shift vs. Lensing

V.N. Strel'tsov strlve@sunhe.jinr.ru
Laboratory of High Energies, JINR
Dubna, Moscow Region 141980, RUSSIA

Abstract: It is emphasized that the phenomena of gravitational lensing and photon frequency shift (at an atomic transition) in a gravitational field exclude each other mutually. Therefore, the results of experiments with an atomic clock (confirming the shift) call in question the truth of gravitational lensing observation.

Keywords: general relativity, lensing, quantum gravodynamics, frequency shift.

Introduction

Serious doubts about the trustworthiness of experimental results on the light deflection in the Sun gravity field have appeared in the last few years (see, e.g., [1,2] and references therein). In the light of this, the gravitational lensing has become one of the basic arguments in favor of the general theory of relativity (GTR). However, this phenomenon is hardly combined with the observed frequency change of atomic transition leading to the frequency shift of photons emitted in a gravitational field (GF).

Gravitational Microlensing

The standard model of microlensing (see, e.g., review [3]) is based on photon notion as a particle with mass $m=h\nu/c^2$. The effect of gravitational light deflection, marked by Newton's by himself is the consequence of it. However, the formula derivation for the light deflection angle by a gravitating body, was first published by Soldner at the beginning of the past century [4].

It should be emphasized that the "gravity" mass E/c^2 and the potential energy is ascribed to every energy E in GTR [5] based on the known Einstein formula

$$E=mc^2 \quad (1)$$

As a result, the photon (as a material body) has, along with kinetic energy $h\nu$, the potential energy

$$E_p=(h\nu/c^2)\Phi \quad (2)$$

where Φ is the gravitational potential. The effect of light ray deflection in GF in GTR was predicted by Einstein in 1915.

However, one should pay attention to Minkowski's equation here

$$E=m\gamma c^2 \quad (3)$$

where γ is the Lorentz factor, formula (1) is the particular case of this (for $\gamma=1$). From eq. (3) it is directly follows that the inert mass of photon $m=0$ since its $\gamma=\infty$. Therefore, we cannot ascribe the gravitational mass to the photon in order not to contradict the equivalence principle of these quantities.

Remark that just the Minkowski equation (3) is the base of the (alternative GTR) relativistic gravodynamics (RGD) or Lorentz-covariant theory of gravity, theory of gravi-vector field (see, e.g. [6, 7]), according to which the photon is gravitationally neutral.

The Photon Frequency Emitted in GF

GTR. When a free excited atom (nucleus) of mass M^* emits a photon (a γ -quantum) of energy $h\nu$, it returns to a ground-state of mass M by quantum transition, and we have the energy balance

$$M^*c^2 = Mc^2 + h\nu \quad . \quad (4)$$

Whence

$$\nu = \Delta Mc^2 / h \quad . \quad (5)$$

when radiation occurs in GF with potential Φ

$$M^*c^2 + M^*\Phi = Mc^2 + M\Phi + h\nu_G + (h\nu_G/c^2)\Phi \quad (6)$$

or

$$M^*c^2(1 + \Phi/c^2) = Mc^2(1 + \Phi/c^2) + h\nu_G(1 + \Phi/c^2) \quad (6')$$

after adding potential items (taking (2) into account). As a result of contraction by the quantity $(1 + \Phi/c^2)$, we obtain (see, e.g., [8])

$$M^*c^2 = Mc^2 + h\nu_G \quad , \quad (7)$$

which evidently answers the energy balance in the GF absence, i.e.,

$$\nu_G = \nu \quad . \quad (8)$$

Thus, according to GTR, *the photon frequency (of atomic transition) does not change in GF.*

However, this conclusion contradicts directly the results of experiments [9-11] with atomic clocks, which change their rate in GF. As known, the quantum standards of frequency are the base of atomic clocks. Therefore, the frequency invariability of corresponding quantum transitions, according to (8), must mean the rate invariability of atomic clocks in GF. This contradicts experiment! The revealed difficulty makes us return to initial expression (6).

RGD. We affirm that the right relation for an energy balance at photon emission in GF takes the form (see, e.g., [12, 8])

$$M^*c^2 + M^*\Phi = Mc^2 + M\Phi + h\nu_g \quad , \quad (9)$$

i.e. the photon potential item should be reflected. As a result, we have

$$\nu_g = \nu(1 + \Phi/c^2) \quad . \quad (10)$$

This frequency decrease of corresponding atomic transitions in quantum frequency standards leads to slowing down the atomic clock rate that is corroborated by the mentioned experiments [9-11]. It should be especially stressed here that eq.(7) is a quantum relation. Therefore, the derivation of eq. (8) should be qualified as a result of the quantum theory of gravity - quantum gravodynamics [13].

Incompatibility of Two Phenomena

The discussed gravitational lensing is a consequence of ascribing the gravity potential energy E_p to the photon. This representation, however, leads a wrong formula for the photon frequency (at atomic transition) in GF. We have the demanded equation for (a shift of) the gravitational frequency (confirmed experimentally) only for $E_p=0$ but we “lose” the lensing.

However, it should be marked that gravity has an influence on the forming of the celestial bodies atmosphere (the gaseous substance surrounding them) and this influence must show through the effect of the light rays reflection. Therefore, the gravitational lensing can be considered only as an undistinguished influence on the optical properties of atmosphere.

Conclusion

The gravitational microlensing and photon frequency shift (at atomic transition) in GF are mutually excluding phenomena. Therefore, the high accuracy of the experiments with an atomic clock (confirming this shift) calls into question the truth of microlensing observations.

References

- [1] P.Marmet, C.Couture, *Phys.Essays* **12**, 162 (1999).
- [2] V.N.Strel'tsov, *J. of Theoretics* **3**, No.5 (2001).
- [3] A.F.Zakharov, M.V.Sazhin, *Physics-Uspekhi* **168**, 1041 (1998).
- [4] J.G.Soldner, *Berliner Astvon. Jahrbuch* 1804, 161 (1804).
- [5] A.Einstein, *Jahrb.Radioakt.Elect.* **4**, 411 (1907).
- [6] V.N.Strel'tsov, *Apeiron* **6**, 55 (1999).
- [7] V.N.Strel'tsov, *Galilean Electrodynamics* **12**, SI No.2, 27 (2001).
- [8] V.N.Strel'tsov, *Apeiron* **6**, 243 (1999).
- [9] J.C.Hafele & R.E.Keating, *Science* **177**, 166 (1972).
- [10] C.O.Alley et al., **Experimental Gravitation**. Proc.conf. at Pavia, ed. B.Bertotti (Academic Press, 1977).
- [11] L.Briarore & S.Leschiutta, *Nuovo Cim.* **37B**, 219 (1977).
- [12] R.P.Feynman, F.B.Morinigo, W.G.Wagner, **Feynman Lectures on Gravitation** (Addison-Wesley, 1995) Sec. 5.2.
- [13] V.N.Strel'tsov, *Apeiron* **7**, 125 (2000); *Galilean Electrodynamics* **13**, 88 (2002).

[Journal Home Page](#)

© Journal of Theoretics, Inc. 2002