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The Incompatibility of General Relativity with Quantum Mechanics

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Abstract: Based upon the results of gravitational experiments with atomic clocks, it is proved that general relativity is incompatible with quantum mechanics.
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The central problem in fundamental physics is that quantum mechanics and Einstein's theory of gravitation are incompatible with each other.

J. Maddox [1]

As the experiments [2-4] have shown, an atomic clock slows down its rate in a gravitational field (in figurative words, the "frequency of its ticking" decreases). Recall that a high precision of atomic clocks provides quantum standards of frequency. Therefore the change of the atomic clocks rate is conditioned by changing the frequency of the corresponding quantum transition (the frequency of the radiated photon) according to the equation

$$\nu_g = \nu(1+\Phi/c^2) \ . \tag{1}$$

Here Φ is the gravitational potential (Φ=-|Φ|), ν is the photon (transition) frequency in the absence of gravitational field. It is determined from the law of energy conservation as expressed (neglecting a small recoil) by the known quantum equation

$$M^*c^2 = Mc^2+h\nu \ . \tag{2}$$

Here M^* is the mass of an excited atom, M is its mass in the ground state. Whence

$$\nu=(M^*-M)c^2/h \ , \tag{2'}$$

and substituting (2') in formula (1), we have [5]

$$M^*c^2 + M^*\Phi = Mc^2 + M\Phi + h\nu_g \ . \tag{3}$$

The obtained quantum equation expresses the law of energy conservation at photon emission in a gravitational field. However, according to general relativity, the "gravity" mass E/c^2 corresponds to every energy E. Therefore, the photon with "kinetic energy" $h\nu_g$ in a gravitational field also has "potential energy" $h\nu_g\Phi/c^2$ (see, e.g., [6]). As a result, according to general relativity, we have the following balance of energies

$$M^*c^2 + M^*\Phi = Mc^2 + M\Phi + h\nu_g + h\nu_g\Phi/c^2 \ . \tag{4}$$

As seen, this expression differs from Eq.(3) as checked by experiment in an added photon potential term. Thus, the thesis of incompatibility of general relativity with quantum mechanics [1] is proved. On the other hand, after contraction in (4) by common factor $(1+\Phi/c^2)$, we obtain

$$M^*c^2 = Mc^2+h\nu_g \ . \qquad (5)$$

Whence after comparison with Eq.(2), we conclude that $\nu_g = \nu$, i.e., according to general relativity (see, e.g., [7]), the frequency of quantum standards does not change in a gravitational field. But it means the atomic clock rate must not change either, and this contradicts directly the results of experiments [2-4].

Conclusion

The ascription of gravitational potential energy to the photon in general relativity contradicts the quantum relation (checked by experiment) for the energies balance at atomic transition.

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