Journal of Theoretics Vol.4-5

«Time Arrow» as a Consequence of «Antigravity» Absence

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Abstract: It is emphasized that the previous arguments against "antigravity" are removed within the framework of relativistic gravidynamics (the theory of gravivector field). The search for this phenomenon is of paramount importance to elucidate the nature of gravitational interaction. According to Feynman, time flows backward for antiparticles (a consequence of T-symmetry) therefore the "antigravity" absence can mean (like in the case of weak interaction) the violation of T-invariance (the "time arrow" existence).
Keywords: time arrow, antigravity, symmetry violation.

Introduction

At the end of the 1950's, in particular in connection with the discovery of heavy antiparticles, interest in 'antigravity' was aroused [1-3]. The possibility that antiparticles have a negative gravitational mass was discussed and as far as one can judge, the main objection to this hypothesis was the violation of the principle of equivalence, as the inertial mass was considered to be a positive one. However, as it turned out 40 years later this difficulty does not take place in relativistic gravidynamics (RGD) or in the Lorentz-covariant theory of gravity [4,5]. Therefore, the observation of this phenomenon becomes an actual problem again.

"Antigravity"

Recall that the prediction of this phenomenon in RGD is based on that the 4-velocity U^i of antiparticles has an opposite in sign:

$$U_a^i = -U^i \quad . \tag{1}$$

In particular, the negative sign of the time component $U^0{}_a$ (energy) means that the time flows backwards for antiparticles (known as the Feynman interpretation). This fact can be considered as a consequence of the existence of objects answering T-symmetry (time reversal) [6]. Taking into account the afore-said, let us consider the equation for the relativistic Newton force of gravity (an analog of the Lorentz force) [4,5]:

$$\vec{F} = -mU^0\,\vec{E}/c \quad . \tag{2}$$

Here $\vec{E}$ is the strength of the gravity field. For antiparticles:

$$U_a^0 = -U^0 \tag{1'}$$

and therefore

$$\vec{F}_a = -mU_a^0\;\vec{E}/c = -\vec{F} \tag{3}$$

(gravitational repulsion). Thus, according to RGD, the 'antigravity', described by eq.(3), does not really require the ascription of negative gravity mass to antiparticles. As a result, the other previous objections (see, e.g., [7]) to the possible existence of 'antigravity' (concerning, in particular, an indirect observation of this phenomenon) lose their validity.

In the light of the above, a direct observation of the behaviour of antiparticles (anti-atoms) in the gravity field becomes an actual task. Here, however, we pay attention to the following.

A Possible Violation of T-Invariance

At first sight it can seem that the absence of 'antigravity' automatically means the failure of RGD but it should be recalled that we leaned on the T-symmetry condition when deriving eq.(3), leading to the gravity repulsion. Assuming that the gravitational interaction (as a weak one) goes on with the violation of T-invariance, then the derivation itself loses its sense. Since the time reversal is directly related to the space reflection P through the Lorentz transformation, the violation of T-invariance must lead to the non-conservation of P-parity (the violation of 4-inversion). Thus, it is in principle impossible to exclude that gravitational interaction (answering the 'electromagnetic-like' relativistic gravidynamics [4,5]) may also have typical features of the weak interaction.

Conclusion

RGD (the theory of gravivector field) removes the previous objections against 'antigravity'. Therefore, the investigation of the antiparticle (anti-atom) behaviour in the gravity field becomes an actual task again. The 'antigravity' absence can mean the violation of T-symmetry.

References

[1] H.Bondi, "Negative Mass in General Relativity", Rev.Mod. Phys. **29**, 423-428 (1957).

[2] P.Morrison, "Approximate Nature of Physical Symmetries", Am.J.Phys. **26**, 358-368 (1958).

[3] L.I.Schiff, "Gravitational Properties of Antimatter", Proc.Nat.Acad.Sci. **45**, 69-80 (1950).

[4] V.N.Strel'tsov, "On the Lorentz-Covariant Theory of Gravity", Apeiron **6**, 55-61 (1999).

[5] Idem, "Gravitational Consequences of Lorentz Covariance", Galilean Electrodynamics **12,** Special Issues 2, 27-8 (2001).

[6] Idem, "Antiparticles", Phys.Essays **5**, 201-205 (1992).

[7] M.M.Nieto, T.Goldman, "The Arguments against "Antigravity" and the Gravitational Acceleration of Antimatter", Phys.Rep. **205**, 221-281 (1991).