On Mass Problem in Relativistic Mechanics and Gravitational Physics

Abstract

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The proper mass of a test particle in General Relativity Theory (GRT) is a rest mass, so it is considered principally constant, just as in Kinematics of Special Relativity Theory (SRT). One may think that the same is true in SRT Mechanics (Dynamics). We found that a proper mass change occurs under a force action that is, during a transition from one inertial reference frame to another. The proper mass constancy in SRT Mechanics is, in fact, a weak field approximation leading to the Newtonian limit. We show that a variability of the proper mass is a fundamental physical phenomenon. It becomes especially important under strong field conditions, therefore, for understanding of the so-called self-energy divergence. The problem was seemingly overcome with help of the known renormalization procedure in Electrodynamics but not in gravitational field theory. GRT was shown to be nonrenormalizable. Our analysis of the SRT mass-energy concept showed that, after the proper mass variation was taken into account in SRT Mechanics equations, arguments for an exclusion of the gravity phenomenon from the SRT domain fell away. Moreover, this approach resulted in principal elimination of the gravitational divergence problem. Another new result concerned the speed of light. The conclusion was that the speed of light is not a fundamental physical constant: it is a physical quantity determined by a gravitational potential and has a cosmological meaning.
In spite of radically different physical interpretation, the alternative approach to the gravitational problem gives an adequate description of “weak-field” gravitational experiments as GRT does: a numerical difference from GRT predictions is not meaningful. However, the difference in predictions progressively rises with field strength and an energy increase. One particular result concerns a behavior of a massive particle being in free fall in a gravitational field. In GRT, both a free particle and a photon, when approaching a gravitational center, tend to slow down, the particle speed being always less then the photon speed. In the SRT approach, the photon similarly slows down but not the particle. If so, superluminal particles exist. This is a new physical phenomenon, which may be called a gravitational refraction. We propose the experiment on the detection of superluminal particles in high-energy cosmic rays. It should be considered a new relativistic test having a falsifying power in a strong-field domain.
This work is mainly conceptual. The purpose is to present in a simple form for a wide physical community some results of our study of Relativistic Mechanics, in which a source of a gravitational field is the proper mass. The main conclusion is that the development of the SRT-based divergence-free gravitation field theory is possible.

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