Measurement of the Post Newtonian Parameter Gamma by the Cluster of Spacecrafts in the Gravity Field of the Earth: the Mission Concept

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Recent development of space-qualified technologies opens new prospects for ultra-precise test of General Relativity. A space-based laboratory opens access to conditions with the special dynamic "purity", unattainable in terrestrial laboratories, but essential for successful carrying out precision experiments. Therefore, for many experiments in the area of fundamental gravitation, access to space becomes inevitable. The accuracy, with which GR is currently confirmed, is fractions of percent: 2.3×10^5. However, in spite of the remarkable success of GR in the weak-field approximation, there are many reasons to consider alternative relativistic theories of gravity that predict the existence of effects other than GR, thus motivating new fundamental gravitational experiments. In this connection, the experimental measurements of PPN of parameters play a special role.

To improve the accuracy of measurement of geodetic effects in the gravitational field of the Earth the clusters of spacecrafts, connected by microwave radio links and optical links, are widely used. Such a scheme allows to suppress effectively a coherent noise acting on the spacecraft, and to measure the distance between the satellites within a fraction of a millimeter. This technology was already tested for GRACE and GRAIL NASA missions. Furthermore, there are technologies allowing to effectively compensate non-gravitational noise to the level of $10^{-10} - 10^{-12}\ m/s^2/Hz^{1/2}$.

The project, which assume the lunch of cluster of the spacecrafts, intended to measure the Eddington PPN parameter γ is proposed in this report. The mission uses four spacecrafts that are placed in high-altitude circular orbits around the Earth. Each spacecraft is equipped with three sets of identical laser ranging transceivers that are used to measure distances between the spacecraft to high accuracy ($\sim$ 0.1 nm). Such accuracy of measurement of the intersatellite distance is able to provide an accuracy of a part in 10^9 in measuring the parameter γ, i.e. a factor of 30,000 beyond the present best result, provided by microwave tracking of the Cassini spacecraft.

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