Improvements needed for precise and accurate measurements of relativistic effects in the field of the Earth with laser-ranged satellites: state of the art and perspectives from the LARASE experiment

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In order to ensure precise as well as accurate measurements (i.e. based on a careful assessment of the systematic errors) of relativistic gravity in the field of the Earth, it is necessary to have a reliable dynamical model for the orbit determination of a satellite.

This model is used to properly handle the main perturbations on the orbit of a satellite, in such a way to have the smallest differences between the predictions of the model for the satellite position in space with respect to the observations provided by the Satellite Laser Ranging (SLR) technique [1]. These differences are the residuals in the position of a satellite with respect to a network of ground stations, differences that are minimized in a least-squares fit of the orbit.

The LAser RAnged Satellites Experiment (LARASE) aims to provide precise and accurate measurements of the predictions of Einstein's theory of General Relativity (GR) in its weak-field and slow-motion (WFSM) limit [2]. The proof masses of LARASE are the LAGEOS and LARES satellites, precisely tracked by means of the powerful SLR technique. A peculiarity of LARASE is to develop new models to better handle the effects that arise from the subtle and complex non-gravitational perturbations (NGP). These NGP are responsible of long-term perturbations on the orbit that may alter the measurement of its secular precession produced by the gravitoelectric and gravitomagnetic fields of GR [3,4,5].

We focus on the activities carried out for the development of new models for the NGP and on the analysis of the main sources of systematic errors due to the deviation of the Earth's mass distribution from the spherical symmetry. Finally, we provide the result for a recent precise, and accurate, measurement of the Lense-Thirring precession on the combined orbits of LAGEOS, LAGEOS II and LARES. The goals of LARASE in term of future relativistic measurements in the WFSM limit of GR will be discussed together with the new constraints that can be achieved for the predictions of alternative theories of gravitation.

References

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