TESTING FUNDAMENTAL PHYSICS WITH SATELLITE LASER RANGING: PERSPECTIVES AND GOALS OF THE LARASE EXPERIMENT

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Introduction: Passive laser-ranged satellites, launched for geodynamics and geophysics purposes, not only have contributed to significant measurements in space geodesy [1,2], but they also provided an outstanding test bench to fundamental physics.

Two significant examples in this field are represented by the first measurement of the Lense-Thirring precession on the combined nodes of the two LAGEOS satellites [3], and by the measurement of the total relativistic precession of the argument of pericenter of the LAGEOS II satellite [4,5].

Indeed, the physical characteristics of such satellites — such as their low area-to-mass ratio — as well as those of their orbits, and the availability of high-quality tracking data provided by the International Laser Ranging Service (ILRS) [6], allow for precise tests of gravitational theories.

The aim of LARASE (LAser RAnged Satellites Experiment) is to go a step further in the tests of the gravitational interaction in the field of Earth (i.e. in the weak-field and-slow motion (WFSM) limit of general relativity) by the joint analysis of the orbits of the two LAGEOS satellites and that of the most recent LARES satellite [7]. To reach such a goal, a key ingredient is to provide high-quality updated models for the perturbing non-gravitational (i.e. non-conservative) forces acting on the surface of such satellites.

A large amount of Satellite Laser Ranging (SLR) data of LAGEOS and LAGEOS II has been analyzed using a set of dedicated models for satellite dynamics, and the related post-fit residuals have been analyzed. A parallel work is on-going in the case of LARES that, due to its much lower altitude, is subject to larger gravitational and non-gravitational effects; the latter are in part mitigated by its much lower area-to-mass ratio.

Recent work on the data analysis of the orbit of such satellites will be presented together with the development of some new refined models to account for the impact of the subtle and complex non-gravitational perturbations.

The general relativistic effects leave peculiar imprint on the satellite orbit, namely in the secular behavior of its three Euler angles. Recent results will be provided together with updated constraints on non-Newtonian gravitational dynamics. The measurement error budget will be discussed, emphasizing the role of the modeling of gravitational and, especially, non-gravitational forces on the overall precise orbit determination quality.

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