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The orbital decay of the semi-major axis of LARES and the LARASE contribution to SLR measurements for applications in the fields of space geodesy and geophysics

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The new laser-ranged satellite LARES (LAser RElativity Satellite) is expected to provide new refined measurements of relativistic physics as well as significant contributions to space geodesy and geophysics. The very low area-to-mass ratio of this passive and dense satellite was chosen to reduce as much as possible the disturbing effects due to the non-gravitational perturbations in order to compensate for its much lower altitude with respect to the two older LAGEOS (LAser GEOdynamic Satellite) satellites, currently the best tracked satellites of the International Laser Ranging Service network.

Indeed, because of its height, about 1450 km with respect to the 5900 km of the two LAGEOS, LARES is subject to a much stronger perturbation provoked by the neutral drag than that on the two LAGEOS.

From a Precise Orbit Determination (POD) of LARES over a time span of about 3.7 years we have been able to measure an orbital decay in the residuals of its semi-major axis of about 1 m/yr, that corresponds to a transversal mean acceleration of about -1.457×10^{-11} m/s^2. This POD has been obtained analyzing LARES normal points with the GEODYN II (NASA/GSFC) software. Neither the neutral drag nor the thermal effects have been included in the dynamical models of GEODYN II.

By means of a modified version of the SATellite Reentry Analysis Program (SATRAP) of ISTI/CNR, the neutral drag perturbation has been computed over the same time span accounting for the measured decay and considering the real evolution of the solar and geomagnetic activities for several atmospheric models. In particular, assuming as reference for the unmodeled transversal acceleration due to the neutral atmosphere the above value, the drag coefficient estimated by SATRAP is comparable to the average value estimated by GEODYN II in a least square fit of the tracking data. This means that the current best models developed for the atmosphere behavior are able to account for the observed decay, within their errors and range of applicability.

A further analysis is needed in order to extract from the observed decay a possible smaller contribution related with other unmodeled effects, as the thermal ones, acting on the satellite. In this context it will be necessary to fix the contribution of the signature of the drag and of the thermal effects in the residuals of the other orbital elements of LARES.

This study falls within the activities of the LARASE (LAser RAnged Satellites Experiment) research program. LARASE main goal is to provide new and refined measurements of the relativistic effects acting on the orbit of the two LAGEOS and LARES satellites.

In particular, a major point of these activities is to provide a final robust and reliable error budget for the main systematic effects of gravitational and non-gravitational origin.

Therefore, a special attention is devoted to the modeling of the non-gravitational perturbations acting on these passive laser-ranged satellites. Improvements in their modeling will be useful both in the field of general relativity measurements and in those of space geodesy and geophysical applications.