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The LARASE Spin Model of the two LAGEOS and LARES satellites

Massimo Visco (1,2), David Lucchesi (1,2,3), Luciano Anselmo (3), Massimo Bassan (4,2), Carmelo Magnafico (1,2), Anna Maria Nobili (5,6), Carmen Pardini (3), Roberto Peron (1,2), Giuseppe Pucacco (4,2), Ruggero Stanga (7,8)

(1) INAF-IAPS, Roma, Italy , (2) INFN Sez. Roma Tor Vergata, Roma, Italy, (3) ISTI-CNR, Pisa, Italy, (4) Dip. di Fisica, Univ. di Roma Tor Vergata, Roma, Italy, (5) Dip. di Fisica, Univ. di Pisa, Pisa, Italy, (6) INFN Sez. di Pisa, Pisa, Italy, (7) Dip. di Fisica e Astronomia, Università degli Studi di Firenze, Firenze, Italy, (8) INFN, Sez. di Firenze, Firenze, Italy

Satellite Laser Ranging (SLR) represents a very important technique of the observational space geodesy. In fact, Lunar Laser Ranging, Very Long Baseline Interferometry, Global Navigation Satellite Systems, Doppler Orbitography and Radiopositioning Integrated by Satellite, together with SLR constitute the Global Geodetic Observing System (GGOS). In the context of the GGOS activities, improvements in technology and in modeling will produce advances in Geodesy and Geophysics as well as in General Relativity (GR) measurements. Therefore, these important research fields are not independent, but tightly related to each other.
The LARASE (LAser RAnged Satellites Experiment) research program has its main objectives in tests and measurements of Einstein's theory of GR via Precise Orbit Determination (POD) of a set of geodetic satellites. In order to reach such goals by means of very precise measurements of a number of relativistic parameters (and, at the same time, to provide a robust and unassailable error budget of the main systematic effects), we are also reviewing previous models and we are developing new models for the main perturbations (both gravitational and non-gravitational) that act on the orbits of the two LAGEOS and on that of LARES satellites.
Within this paper we focus on modeling the spin vector of these satellites. The spin knowledge, both in orientation and rate, is of fundamental importance in order to correctly model the thermal effects acting on the surface of these satellites. These are very important non-gravitational perturbations (NGP) that produce long-term effects on the orbit of the cited satellites, especially for the two LAGEOS, and improvements in their modeling will be very useful both in the field of GR measurements and in those of space geodesy and geophysical applications.
Indeed, the current RMS value of the range residuals of the LAGEOS satellites, obtained by the Analysis Centers of the International Laser Ranging Service, is at the level of a few cm since 1992, down to a cm or less during the last years. However, because of the incompleteness in current knowledge of dynamical models, empirical accelerations have been heavily employed to obtain such results.
In this context, any step forward in the models developed for the NGP will be useful to reduce the use of empirical accelerations; it also represents an essential prerequisite to reach a sub-mm precision in the RMS of the SLR range residuals and the corresponding benefits in Geophysics and Geodesy, regarding e.g. stations coordinates knowledge, Earth's geocenter and reference frame realization.
The paper will focus upon the improvements we obtained with respect on previous models of the spin of the two LAGEOS satellites based on averaged equations for the external torques in the rapid-spin approximation, as well as in a new general model that we developed and based on the solution of the full set of Euler equations.