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Thermal thrust accelerations on LAGEOS satellites

David Lucchesi[1], Luciano Anselmo[2], Massimo Bassan[3], Marco Lucente[1], Carmelo Magnafico[1], Carmen Pardini[2], Roberto Peron[1], Giuseppe Pucacco[3], and Massimo Visco[1]

[1]Istituto di Astrofisica e Planetologia Spaziali (IAPS) - Istituto Nazionale di Astrofisica (INAF), Via Fosso del Cavaliere 100, 00133 Tor Vergata Roma, Italy

[2]Istituto di Scienza e Tecnologie dell?informazione - Consiglio Nazionale delle Ricerche (CNR), Via Moruzzi 1, 56124 Pisa, Italy

[3]Dipartimento di Fisica - Università di Roma Tor Vergata, Via della Ricerca Scientifica 1, 00133 Tor Vergata Roma, Italy

Thermal thrust forces are non-conservative forces that act on the surface of a satellite as a result of temperature gradients across its surface. In the case of the older LAGEOS satellite these kinds of perturbations have been well-known since the end of 80s. The main effects are due to the thermal inertia of the corner cube retroreflectors (CCRs) of the satellites with sources the Earth's infrared radiation and the direct solar visible radiation modulated by the eclipses. However, the solar radiation reflected by the complex Earth-atmosphere system, i.e. the albedo, is also responsible for a non-uniform heating of the satellite surface. We reconsider such perturbations by means of a new thermal model for the satellites called LATOS (LArase Thermal mOdel Solutions), which is not based on averaged equations as those previously developed in the literature. Of course, in such analyses the attitude of the satellite plays an important key role; we modeled it by means of the LASSOS (LArase Satellites Spin mOdel Solutions) model for the evolution of the spin-vector that we have already developed within the LARASE (LAser RAnged Satellites Experiment) research program. We also included the contribution of the Earth's albedo in the determination of the overall distribution of temperature on the surface of the satellites, that was not considered in previous works. The CERES (Clouds and the Earth's Radiant Energy System) data have been used to account for this effect. The thermal thrust accelerations have been computed together with their effects on the orbital elements by means of the Gauss equations. These effects are compared with the orbit residuals of the satellites in the same elements, obtained by an independent Precise Orbit Determination (POD), in order to highlight the signature of the unmodeled effects. The improvement in the POD that can be achieved through a better modeling of the thermal thrust perturbations is of fundamental importance for the geophysical products that are determined by means of the analysis of the orbits of the two LAGEOS satellites. Similarly, the measurements in the field of fundamental physics that are obtained with these satellites can benefit from a more precise modeling of their orbit.