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COUPLED DYNAMICS ANALYSIS AROUND ASTEROIDS BY MEANS OF ACCURATE SHAPE AND PERTURBATIONS MODELING.

Abstract

One of the most important aspects when dealing with the dynamics close to an irregularly shaped body is the accurate description of the force field in its surrounding. In particular, the determination of the gravitational field and the three-dimensional rotation motion is important to propagate accurately a trajectory in the vicinity of this kind of celestial bodies.

The paper discusses the analysis and the study of the motion around an irregular small solar system object, with particular attention to the representation of its gravitational influence and the characterization of its complex non-principal axis rotational dynamics. All perturbations, relevant to the case of study, are included in the model, from the classical to the more complex, such as the Solar Radiation Pressure (SRP) the third body gravitational effect (presence of the Sun), the YORP effect and the internal dissipation of energy.

The study has been performed considering different characteristic shapes for typical NEO asteroids: from the simple almost spherical to more complex shapes, such as the dog-bone and the elongated ones. The irregularities in the geometry represent one of the most important sources of disturbances for what concern the dynamics around asteroids, and therefore particular attention has been paid to accurately model their gravitational field. In fact, the gravitational attraction is computed using the polyhedral approach and the "mascons" approach. These two modeling techniques are compared and the former is also improved applying an optimization process to find the best distribution of the point masses inside the body.

The perturbations due to external sources are modeled numerically and the surface of the body is represented exploiting the polyhedron shape of the object. In this way the fidelity of the model is uniform for all the different aspects in this work, and the computation of the radiative perturbations takes into account for self-shadowing on non-convex geometries.

The sources of disturbances are then ranked and a fully coupled model to propagate orbital and rotational motions is derived for the different shapes of the observed bodies. Even if the simulation results have been verified on selected asteroids environments, the presented methods and approach apply to the dynamical propagation around any kind of irregularly shaped object.