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ASTEROIDS COUPLED DYNAMICS ANALYSIS BY MEANS OF ACCURATE MASS DISTRIBUTION AND PERTURBATIONS MODELLING

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ABSTRACT

One of the most important aspects when dealing with a Potentially Hazardous Asteroid (PHA) is the accurate determination of its dynamical state. In particular, the determination of orbital and rotational perturbations is important to propagate accurately the heliocentric orbital path of the asteroid and being more precise in the impact risk determination and related uncertainty containment.
The paper discusses the analysis and study of the motion of an asteroid, with particular attention to its complex three-dimensional rotation motion: the asteroids rotation, nutation and precession motions are considered while modeling. All perturbations, relevant to the case of study, are included in the dynamical 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 Yarkovsky and Yorp effects.
In addition, particular attention has been paid to accurately modelling the mass distribution of the asteroid: simple spherical or single mass models demonstrated to possess low accuracy when the asteroid is not spherically shaped. Irregular shapes represent indeed one of the most important sources of disturbances for what concern the dynamics of an asteroid.
The study has been performed by considering different characteristic shapes for typical NEO asteroids: from the simple spherical to diamond shape, from the dog-bone to the elongated shape.
Perturbations due to external sources are modeled numerically, while perturbations due to non-spherical mass distribution are modeled with a mixed analytical/numerical approach.
The sources of disturbances are then ranked and different criteria to propagate orbital and rotational motions have been derived depending on the shape of the observed asteroid.

Even if the simulation results have been verified on selected asteroids dynamics, the presented methods and approach apply to the dynamical propagation of any kind of asteroid.

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