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Using a Discrete Element Method to Investigate Seismic Response and Spin Change of 99942 Apophis During its 2029 Tidal Encounter with Earth

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Near-Earth and Potentially Hazardous Asteroid 99942 Apophis presents a unique opportunity to study the dynamics, bulk properties, and interior structure of a rubble-pile asteroid when it makes its close encounter with the Earth in 2029. In order to better understand the potential outcomes of a tidal encounter between Earth and Apophis, and to support a potential future mission to Apophis, we

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perform numerical simulations of the encounter. We represent Earth as a rigid sphere and the target body as a cohesionless, self-gravitating granular aggregate subject only to contact and gravitational forces. We use a radar-derived shape model for the asteroid, along with current best estimates for the orbital solution of Apophis to simulate the encounter trajectory, and perform a large parameter sweep over different potential encounter orientations and bulk densities for the body. We find that the median change in the rotational period for Apophis, sampled for a range of different initial body and spin orientations, is -1.9 hours (mean -0.1 ± 6.0 (1-σ) hours) during the encounter. Additionally, we measure that the mean of the largest change in axis length among the 3 primary body axes, also sampled over trials with different initial body and spin orientations, is 0.132 ± 0.066 mm during the encounter, assuming a bulk Young's Modulus of 10^6 Pa. Such strains on the timescale of peak stress during the encounter may be large enough to be detected by an *in-situ* seismometer.

Comments:

This abstract is intended for the Apophis special session. An oral presentation is preferred. This is a student submission that we would like to have considered for the Student Competition.