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Using a Discrete Element Method with Realistic Packing and Irregular Particle Shapes to Investigate Seismic Response 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 our previous work we performed numerical simulations of

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the encounter using a soft-sphere discrete element method, representing Earth as a rigid sphere and the target body as a monodisperse, cohesionless, self-gravitating granular assembly subject only to contact and gravitational forces [1]. Those simulations showed that the tidal encounter between Earth and Apophis would result in a mean change in axis length among the primary body axes of 0.132 ± 0.066 mm, and a change in the rotational period of Apophis from $+14$ to -8 hours, with a median change of -1.9 hours. Here we present new results, modeling the target body as a polydisperse rubble pile. From these simulations, we show similar results for the change in the rotational period of the body, but a larger potential change in axis length among the three principal body axes, ranging from 0.278 mm to 2.62 m, assuming a bulk Young's modulus of 10^6 Pa. These larger strains can be attributed to the lower bulk shear strength from a random polydisperse packing distribution [2]. We also present preliminary results from simulations with constituent particles comprised of both spheres and "aggregates" of spheres that have been "glued" together in the code to create more realistic, irregular, polyhedral shapes [3]. The strains on the timescale of peak stress during our simulated encounters may be 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.

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