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USING MISSION IMAGES TO STUDY EVIDENCE OF BLOCK MOTION ON ASTEROIDS: IMPLICATIONS FOR SEISMOLOGY OF SMALL BODIES

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ABSTRACT

Asteroids preserve, in some form, the early geologic records of the Solar System, data that are important for understanding the processes and timescales for terrestrial planet formation. Conversely future asteroid impacts with the Earth are potentially hazardous, and a sound strategy for either deflecting or destroying an asteroid is not yet developed. While it is relatively easy to examine the surface of an asteroid, little is known regarding their internal structure. A reliable, relatively inexpensive method for determining the internal structure of an asteroid using cameras and optical instruments would provide considerable benefits to the general knowledge of asteroids and to the processes of planetary formation and mechanisms of evolution.

Analytical and numerical models indicate that seismic shaking is a powerful mechanism for stimulating regolith activity and boulder movement. Seismic shaking on an asteroid is when energy imparted by asteroidal (or cometary) impacts induces accelerations capable of moving surficial materials. The mechanics behind seismic shaking were investigated with computer models [1, 2] and attenuation scaling [3]. If distance and direction of reorientation or ballistic motion are known, it is possible to calculate the peak velocity of a particular block from simple kinematics. By comparing the displacements of blocks as a function of the distance the blocks were originally from the crater center and assuming that seismic energy is dissipated in a solid body as a function of its material strength, then it is possible to constrain the properties of the internal structure of an asteroid. This idea of using blocks as a proxy for seismology provides a new tool to evaluate images from previous missions to asteroids.

Using accurate shape models of asteroids available from the Planetary Data System (PDS), we will use impact hydrocodes to model the effects of an impact on the surface features of asteroids. We will map areas of predicted seismic energy

enhancement and determine whether they show evidence for high levels of regolith and block mobility, taking into account friction and strong cohesion forces that exist on asteroid surfaces [4]. By combining the information from the models and comparing the surface appearances of an asteroid, the models can constrain the maximum seismic acceleration experienced at the surface and the attenuation felt on the interior [3]. We will then compare these models to the observations of actual asteroid surfaces to better understand their evolutionary histories.

This research can be tested directly as a science objective in upcoming missions. Two possible test missions are the joint mission concept by NASA and ESA is the Asteroid Impact Deflection Assessment (AIDA) [5] and the AOSAT concept from ASU [6].

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