# The Brazil-nut effect and its application to asteroids

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Out of the handful of asteroids that have been imaged, some have distributions of blocks that are not easily explained. For example, Asphaug et al. (2001) pointed out that the blocks on (433) Eros do not obey any obvious dynamical distribution. Although these blocks are likely to be ejecta fragments, most of them are not seen with pits that would indicate collisions at meters per second into the low-gravity regolith. Another example is (25143) Itokawa, where smooth and rugged regions are observed (Fujiwara et al. 2006). Since the total volume of boulders on Itokawa is larger than the available volume in the identified craters, all the boulders cannot come from these craters.

A potential solution to such distributions of blocks is the size sorting in asteroid regolith (e.g., Asphaug et al. 2001, Miyamoto et al. 2007). In this talk, we investigate the possibility that seismic shaking leads to the size sorting of particles in asteroids. In particular, we focus on the so-called Brazil Nut Effect (BNE) that separates large particles from small ones under vibrations (e.g., Rosato et al. 1987). We first study the BNE over a wide range of parameters by using the N-body code PKDGRAV (Stadel 2001, Richardson et al. 2000, Schwartz et al. 2012). We show that the occurrence of the BNE is largely independent of the choice of coefficients of restitution, but is strongly affected by the values of friction constants as well as the oscillation speed. We also show that the nondimensional critical conditions for the BNE agree well with previous studies. Finally, we apply the critical conditions to observed asteroids and find that the critical oscillation speeds for the BNE might be comparable to the seismic oscillation speeds that are expected from non-destructive impacts.

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