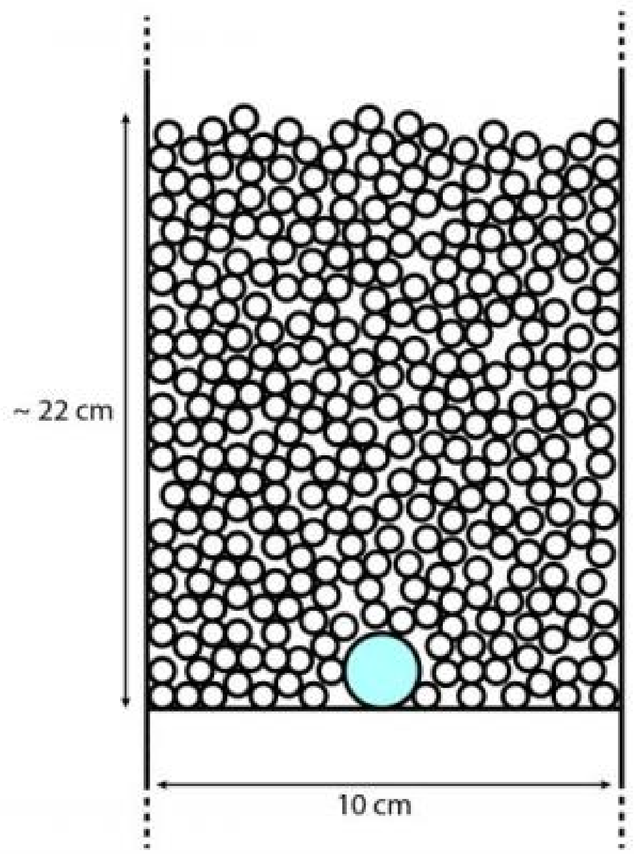
Experiments show disproportionately large number of big boulders on asteroids likely due to Brazil-nut effect

July 17 2014, by Bob Yirka



Schematic diagram of a cross-section of the experiment after an infinitely long cylindrical container (with a diameter of 10 cm) is filled up with small particles (up to ~ 22 cm from the origin), but before shaking begins. The large cyan particle (the intruder) is initially located at the floor. Credit: arXiv:1407.2748 [astro-ph.EP]

(Phys.org) —A team of researchers led by Soko Matsumura of Dundee University in Scotland has found evidence that appears to explain the inordinately large numbers of big boulders found on the surface of asteroids. In their paper uploaded to the preprint server *arXiv*, the team describes lab experiments they conducted that show the Brazil-nut effect is likely responsible for the seemingly odd phenomenon.

A decade ago, Japan's Hayabusa spacecraft revealed what appeared to be an anomaly, the asteroid it was studying, Itokawa, had more large boulders on it than could be accounted for by volcanic activity. Scientists could have just chalked it up to an idiosyncrasy of that particular asteroid, except that five years earlier, researchers studying Eros had found the same thing. In this new effort, the researchers appear to have found a reasonable explanation for what has been observed.

It's all due to the Brazil-nut effect they say, when space rocks collide with an asteroid and cause enough oscillation to push smaller rocks down, and larger rocks up. The Brazil-nut effect is what happens when large nuts in a jar work their way to the top due to jostling—the smaller nuts actually work their way down as they fit into smaller spaces below. The team believes they have proved the same thing is possible with the asteroids by conducting experiments in their lab. They put one large sphere in with a group of smaller spheres in a tube and then shook the tube under various simulated gravity states meant to mimic that found on Earth, the moon and several known asteroids. They found that under the right conditions, the large sphere did indeed rise to the surface, even under the weak gravity simulations. Furthermore, other simulations conducted by the team suggest that oscillations that would occur on an asteroid due to space rock collisions would be sufficient to drive the large rocks to the top (in as little as several hours) offering an explanation of the large numbers seen by space probes.

The large numbers of such big boulders on asteroid surfaces then appears to be the result of many collisions with space rocks, each subjecting the asteroid to the Brazil-nut effect.

More information: The Brazil-nut effect and its application to asteroids, arXiv:1407.2748 [astro-ph.EP] arxiv.org/abs/1407.2748

Abstract

Out of the handful of asteroids that have been imaged, some have distributions of blocks that are not easily explained. In this paper, 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. We study the BNE over a wide range of parameters by using the N-body code PKDGRAV, and find that the effect is largely insensitive to the coefficients of restitution, but sensitive to friction constants and oscillation speeds. Agreeing with the previous results, we find that convection drives the BNE, where the intruder rises to the top of the particle bed. For the wide-cylinder case, we also observe a "whale" effect, where the intruder follows the convective current and does not stay at the surface. We show that the non-dimensional critical conditions for the BNE agree well with previous studies. We also show that the BNE is scalable for low-gravity environments and that the rise speed of an intruder is proportional to the square root of the gravitational acceleration. Finally, we apply the critical conditions to observed asteroids, and find that the critical oscillation speeds are comparable to the seismic oscillation speeds that are expected from non-destructive impacts.

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