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Experiments on rebounding slow impacts under asteroid conditions

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The surfaces of rubble-pile asteroids are covered in regolith of a variety of sizes. In some cases like for the asteroid Itokawa, the size distribution of regolith is not uniform across the surface [1]. Some areas are dominated by finer grains, while other areas are covered by larger rocks. There are a number of competing explanations for this observed size segregation [2–4]. One approach is the so called ballistic-sorting-effect [2], where impacting particles sort themselves through different rebound behavior.

In our work we want to set practical limits on the role ballistic sorting can play in shaping an asteroids surface. To this end we conduct a series of drop tower experiments examining the impact kinetics of slow (cm/s) 3 mm sized projectiles into a regolith surface under conditions realistic for asteroid surfaces, i.e. vacuum and low gravity. We track the impactor with high-speed cameras and determine its velocity in 3 dimensions before and after the impact. From these velocities, we can then compute a coefficient of restitution (COR). We then repeat the experiment for surfaces composed of differently sized material. We find that for a regolith bed made from particles of similar size as the impactor we get a lower COR (0,1) than for beds made up of significantly larger (0,5) or smaller particles (0,8). The more elastic collisions for larger sized targets follows from conservation of momentum. For the finer material we suggest that the higher COR is a function of interparticle adhesion.

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