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Low-speed impact cratering in loose granular media

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In this talk I shall describe the penetration of projectiles dropped into noncohesive granular media, and how the results vary with the properties of both the projectile and the medium. In contrast to wide assumption, the penetration depth and crater diameter represent two distinct length scales. The diameter scales as the 1/4 power of projectile energy, but curiously the depth is not a simple function of either the projectile energy or momentum at impact. Rather, it scales as the 1/2 power of density, the 2/3 power of projectile diameter, and the 1/3 power of total drop distance. This same result also holds for cylinders with a variety of tips, and so is not an accident of projectile shape. It is crucial to understand the penetration depth because it is directly related to the mechanics of impact, namely the average stopping force acting between projectile and medium. In addition to this discussion, I shall also present new data on the dynamics of impact. All experiments were constructed and carried out at UCLA by undergraduate physics majors: Jun Uehara, Katie Newhall, Chris Santore, and Mike Ambroso.

[1] J.S. Uehara, M.A. Ambroso, R.P. Ojha, and D.J. Durian, "Low-Speed Impact Craters in Loose Granular Media," Phys. Rev. Lett. **90**, 194301 (2003).
[2] K.A. Newhall and D.J. Durian, "Projectile-shape dependence of impact craters in loose granular media," Phys. Rev. E **68**, 06030R (2003).
[3] M.A. Ambroso, C.R. Santore, A.R. Abate, and D.J. Durian, "Penetration depth for shallow impact cratering," cond-mat/0411231 (2004).