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Effect of Mach number on granular impacts[1] ABE CLARK, ALEC PETERSEN, Duke University, LOU KONDIC, New Jersey Institute of Technology, ROBERT BEHRINGER, Duke University — When an object strikes a granular material, its momentum and energy are transferred to the grains and dissipated. An important dimensionless parameter in such impacts is M, the ratio of the intruder speed, v_0, to a typical granular sound speed, c. In many previous studies, M has been very small, $M \sim 10^{-2}$. In this regime, the granular force on the intruder is dominated by a v^2 drag term, leading to a smooth, monotonic deceleration of the intruder. To probe the regime closer to $M \sim 1$, we perform experiments (and matching simulations) with granular materials comprised of photoelastic disks of varying stiffness, where softer particles allow us to reduce the granular sound speed. As we increase M, we reach a regime for which the intruder dynamics are no longer described by v^2 drag, but rather show a shock-like front which behaves elastically in response to the impact. Surprisingly, for the higher M impacts ($M \sim 10^{-1}$), penetration depth is greatly reduced compared to the smaller M impacts ($M \sim 10^{-2}$), and the intruder typically rebounds temporarily, before coming to rest. We understand the transition from v^2 drag to damped elastic behavior in terms of grain-grain collision time compared to the time for the intruder to move one grain size.

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