Impact into granular media: a collisional process

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Examples of granular materials exist in abundance, from rice and cereal to sand and rocks. These particulate systems seem simple; they consist of dry, rigid grains that interact by contact forces. However, granular materials present complexities that are not well-understood, such as disordered force networks that transmit forces between individual grains and flow behavior that can readily change between solid-like rigidity and fluid-like flow. Impact of a granular target by a solid projectile illustrates both of these aspects. We use high-speed video photography of impact experiments to determine the drag force acting on a projectile as it penetrates a dense granular medium. The momentum transfer from the projectile to the target occurs through intermittent, normal collisions with high force carrying grains at the projectile surface. Based on these observations, we determine a collision-based model to describe the drag force and interpret its grain-scale origin.