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Collisional Model of the Stopping Force of 3D Granular Impact[1]

CACEY STEVENS, JONATHAN BARES, ROBERT BEHRINGER, Department of Physics, Duke University — A dense granular packing can cause a free-falling intruding object to come to an abrupt stop as its momentum is dissipated to the grains. An empirical force law has been widely accepted to describe this process; it characterizes the stopping force as the sum of depth-dependent friction and velocity-dependent inertial drag.[2] However, a complete interpretation of this force, incorporating grain-scale interactions during impact, remains unresolved. Here, the momentum transfer is proposed to occur through sporadic collisions with clusters of high force-carrying grains at the intruder's surface.[3] To test this model in 3D impact experiments, we determine the forces acting on an intruder decelerating through a dense granular medium using high-speed video of its trajectory. By attaching a rod to the intruder and observing its motion from perpendicular angles, we obtain all translational and rotational dynamics. We vary the shape of the impeding object to infer intruder-grain interactions from its consequent path. As a result, we connect the inertial drag to the effect of intruder shape and rotation based on the collisional model.

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[2]H. Katsuragi et al, Nat. Phys. **3**, 6 (2007)
[3]Y. Takehara et al EPL **92**, 44003 (2010), A. Clark et al, PRE **89**, 012201 (2014)

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