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Granular Impact at High Mach Number[1] ABE CLARK[2], YUE ZHANG, Duke University, LOU KONDIC, New Jersey Institute of Technology, R.P. BEHRINGER, Duke University — How do dynamic stresses propagate in granular material after a high-speed impact? This occurs often in natural and industrial processes. Stress propagation in a granular material is controlled by the inter-particle force law, f, in terms of particle deformation, δ, often given by $f \propto \delta^\alpha$, with $\alpha > 1$. This means that a linear wave description is invalid when dynamic stresses are large compared to the original confining pressure. With high-speed video and photoelastic grains with varying stiffness, we experimentally study how forces propagate following an impact and explain the results in terms of the nonlinear force law (we measure $\alpha \approx 1.4$). The spatial structure of the forces and the propagation speed, v_f, depend on a dimensionless parameter, $M' = t_c v_0/d$, where v_0 is the intruder speed at impact, d is the grain diameter, and t_c is a binary collision time between grains with relative speed v_0. For $M' \ll 1$, propagating forces are chain-like, and the measured $v_f \propto d/t_c \propto v_b(v_0/v_b)^{\frac{\alpha-1}{\alpha+1}}$, where v_b is the bulk sound speed. For larger M', the force response has a 2D character, and forces propagate faster than predicted by d/t_c due to collective stiffening of a packing.

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