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Perfect fluid flow from the impact of a dense granular jet WENDY W. ZHANG, JAKE ELLOWITZ, NICHOLAS GUTTENBERG, University of Chicago, HERVE TURLIER, Institut Curie, SIDNEY R. NAGEL, University of Chicago — Axisymmetric collision of a cylindrical water jet with a circular target generates a thin conical sheet, also known as a water bell [Cheng et al. Phys. Rev. Lett. 99, 2007]. Intriguingly, recent experiments on granular jet impact in the regime of dense inertial flow reveal similar behavior: the angles by which the collimated sheets of particles are ejected from the target agree closely with the angles measured in the water-bell experiments [Clanet, C. J. Fluid Mech. 430, 2001] . This quantitative correspondence suggests that the collective granular motion during impact can be modeled as an incompressible, continuum fluid. Since viscous effects are weak in water-jet impact and the granular jet is comprised of non-cohesive particles (hence possessing zero surface tension), the simplest scenario is that the continuum motion corresponds to the flow of a perfect fluid. We show an exact solution of 2D perfect fluid impact agrees quantitatively with 2D discrete-particle simulation results. Therefore, the emergence of a highly collimated outgoing sheet does not necessarily signal the creation of a thermodynamic liquid phase. Such a coherent outcome results generically when the motion is nearly incompressible and dominated by inertia.

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