DFD15-2015-000716

Abstract for an Invited Paper
for the DFD15 Meeting of
the American Physical Society

Granular materials and their connection to Russell Donnelly[1]

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I have known Russell Donnelly for most of my professional career. Our interests in liquid helium, in fluid dynamics and instabilities, the use of helium to study convection, are all points of significant overlap. Trying to decide when I first met Russ is hard, so let me focus on one year, 1996. That year Russ came to Duke to give the Fritz London Memorial Lecture. It was also a year that I remember because the DFD meeting at Syracuse had a large number of talks dealing with granular materials. I first became interested in this field as a system to test for hydrodynamic-like instabilities. Russ had been a strong supporter of including granular flows inDFD meetings, and the field was well on its way in 1996. In fact, the predicted instability was not there, but many striking and novel phenomena were: interest in the physics of granular materials has grow dramatically since then. In this talk, I will explore some of the roots of granular physics and the connections to fluid flows.In particular, flowing grains show surprising fluctuations in forces that are tied to novel structures known as force chains. These structures also play a key role in how granular materials become "solids," i.e. jam. The idea of jamming arose in early work by M. Cates et al. and by A. Liu and S. Nagel. We have recently shown that the nature of jamming is fundamentally changed when the grains have friction or shape, which are general properties of grains that form many everyday materials. In general, understanding how granular materials transition between jammed or unjammed draws substantially on statistical physics–something that would have strongly appealed to Russ.

[1]Work supported by NSF-DMR1206351, DMS1248071, NASA NNX15AD38G, and the W.M. Keck Foundation