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Force fluctuations and shear banding near the jamming transition in granular materials

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What are the structural changes which turn an un-jammed system that flows like a liquid into a jammed, solid-like configuration or vice versa? For granular just as for molecular systems it turns out that these changes are so subtle that so far there still has been no clean way of identifying the transition based on direct measurements of the grains' or molecules' spatial arrangements. However, in macroscopic granular systems it is possible to measure also the forces between contacting grains. At high packing densities near jamming, where nearly all particles touch neighbors, contact force measurements pick up directly and sensitively what matters most, namely changes in relative grain position. They thus can act as magnifier for even minute structural rearrangements. This talk will discuss experiments [1] able to detect a structural signature of the jamming transition by analyzing changes in the shape of the distribution of contact forces. The second part of the talk will be devoted to discussing new experimental geometries in which shear bands, usually localized to within about 10 grain diameters at the onset of shear, can become much wider. This allows for detailed studies of the shear rate profile and the associated velocity fluctuations. I will compare data we recently obtained from direct imaging by video, magnetic resonance imaging of the interior, and molecular dynamics simulations [2].

[1] E. I. Corwin, H. M. Jaeger, S. R. Nagel, Structural signature of jamming in granular media, Nature 435, 1075 (2005).
[2] X. Cheng, J. B. Lechman, A. F. Barbero, G. S. Grest, H. M. Jaeger, G. S. Karczmar, M. E. Möbius, and S. R. Nagel, Three- dimensional shear in granular flow, cond-mat/0507469.