Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Affine and Non-Affine motion in a Granular Couette Experiment[1]

BRIAN UTTER, James Madison University, ROBERT BEHRINGER, Duke University — We characterize local motion of grains in a 2D granular Couette shear. In steady state, grains exhibit a shear band, where the grains are dilated near the shearing surface, $r = 0$. The mean velocity is in the tangential direction, and decays somwhat faster than exponentially. We characterize the local motion by tracking small clusters of particles. The overall motion of the cluster can be described in terms of a smooth affine part, and a non-affine part that is not captured by the smooth deformation. We determine the measure of non-affine motion, D^2_{min} of Falk and Langer. This quantity shows characteristic distributions that initially grow roughly as power laws, but are then cut off exponentially. Distributions of non-affine displacements for individual particles are roughly guassians. The width of these distributions, the widths of the distributions for D^2_{min} and previously measured diffusivities show essentially identical variation with local shear rate. We understand the formation of the shear band from an initially homogeneous packing in terms of outwardly directed diffusion next to the shearing surface. In the steady state, there is a balance between inward diffusion from a density gradient, and ourward diffusion driven by the shearing.

[1]Work supported by NASA grant NNC04GB08G and NSF grant DMS0555431

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Date submitted: 17 Nov 2006 Electronic form version 1.4