Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Constitutive relations in dense granular flows JOHN DROZD, The University of Western Onatrio, COLIN DENNISTON, The University of Western Ontario — We use simulations in a vertical chute configuration to investigate constitutive relations in dry granular flow. We study relations describing the local stresses, heat flow, and dissipation in different granular regions or phases and compare our results to both theory and experiments. Particularly we investigate a free-fall dilute granular gas region at the top of the chute, a granular fluid in the middle and a glassy region at the bottom. We show that while the pressure can be reasonably described by hard sphere gas models, transport coefficients such as viscosity and heat conductivity cannot. In contrast to a hard sphere gas, the viscosity and heat conductivity increase with decreasing temperature in the fluid and glassy phases. In the fluid region, we compare our simulation values for viscosity and heat conductivity with published theoretical expressions based on Enskog expansions. In the glassy region, we observe signs of a finite yield stress and examine relations involving an internal friction coefficient. We show that the static sand pile is a limit of our glassy state, and we also solve for the eigenvectors of the stress tensor independent of any particular model.

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Date submitted: 16 Nov 2009 Electronic form version 1.4