MAR07-2006-005282
Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Beyond Navier-Stokes Order Effects in Granular Gases[1]

CHRISTINE HRENYA, University of Colorado

The vast majority of continuum theories for rapid granular flows are based on Navier-Stokes order descriptions (up to first order in spatial gradients). In this effort, a simple system is used to illustrate the presence and impact of higher-order effects in both the Knudsen boundary layer and the domain interior. Specifically, a thermally-driven, zero mean flow system is considered via molecular dynamics (MD) simulations. The Knudsen boundary layer is identified via an abrupt mismatch in the simulation data for heat flux and predictions from Navier-Stokes order theories. When access to heat flux measurements is not available, a rule-of-thumb is established to estimate the thickness of the Knudsen boundary layer based on concentration measurements. The effect of boundary layer thickness on continuum predictions is assessed via MD simulations, and further illustrated via a comparison between predictions and experimental data for a vibro-fluidized bed. Next, the presence of higher-order effects in the domain interior is explored via MD simulations. The system displays a stress anisotropy, which can be traced to Burnett order effects. Furthermore, a surprisingly large mismatch is observed between Navier-Stokes order theory and MD values for the heat flux. Because there are no Burnett-order contributions to the heat flux, the responsible mechanisms appear to be beyond Burnett order.

[1]Engineering and Physical Sciences Research Council (UK) and National Science Foundation (US)