MAR07-2006-001240

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

Thresholds and Dynamics for Oscillating Granular Layers[1]

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The onset and dynamics of flow in shallow horizontally oscillating granular layers are studied and compared to the behavior of avalanches. The variation with depth of the starting acceleration for the oscillating layer matches (approximately) the corresponding variation of the tangent of the starting angle for avalanches in the same container at low frequencies, but deviates as the frequency is increased. However, the threshold behavior depends significantly on the measurement protocol. Just above threshold, the motion decays with time as the material re-organizes over a minute or so, causing the apparent threshold to increase. Once excited, the rheology of the material is found to vary in time during the cycle in surprising ways. If the maximum inertial force (proportional to the container acceleration amplitude) is slightly higher than that required to produce flow, the flow velocity grows as soon as the inertial force exceeds zero in each cycle, but jamming occurs long before the inertial force returns to zero. At higher acceleration, the motion is fluid- like over the entire cycle. However, the fraction of the cycle during which the layer is mobile is typically far higher than what one would predict from static considerations or the behavior of the inclined layer. Finally, we consider the flow profiles as a function of both the transverse distance across the cell at the free surface, and also as a function of the vertical coordinate in the boundary layer near the sidewall. These profiles have time-dependent shapes, and are therefore significantly different from profiles previously measured for avalanche flows.

[1]Supported by NSF-DMR.