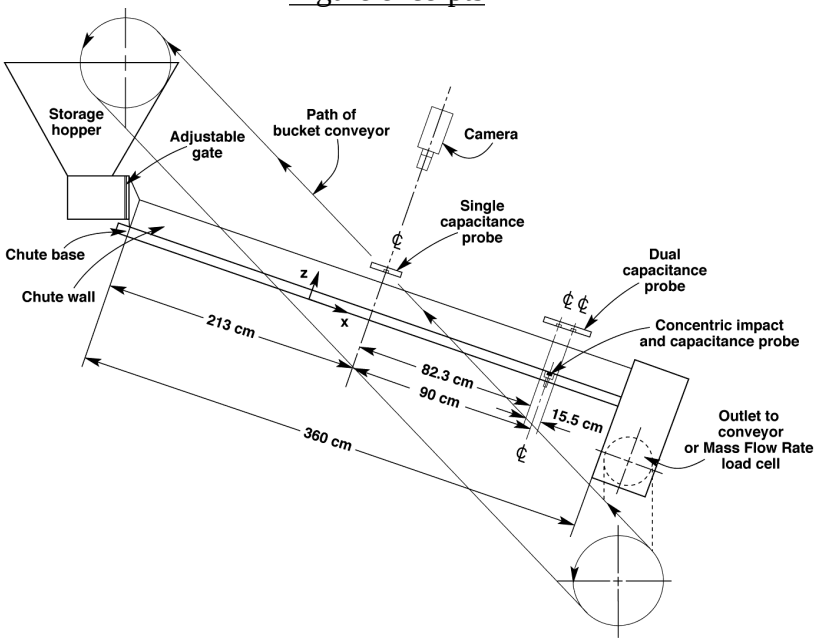
M. Louge and S. Keast: "On Dense Granular Flows Down Flat Frictional Inclines," *Phys. Fluids* (2000), under review.

We consider dense, relatively shallow flows of 3 mm glass spheres moving down a chute with a flat, frictional base of 3.6 m length. Sustained flows are observed at inclinations corresponding to an effective friction between the static and dynamic friction of individual grains. A capacitance instrument records the formation of waves with a dominant component traveling upstream. Simultaneous measurements of granular temperature at the base using a load cell reveal that the waves are accompanied by substantial reduction in granular agitation.

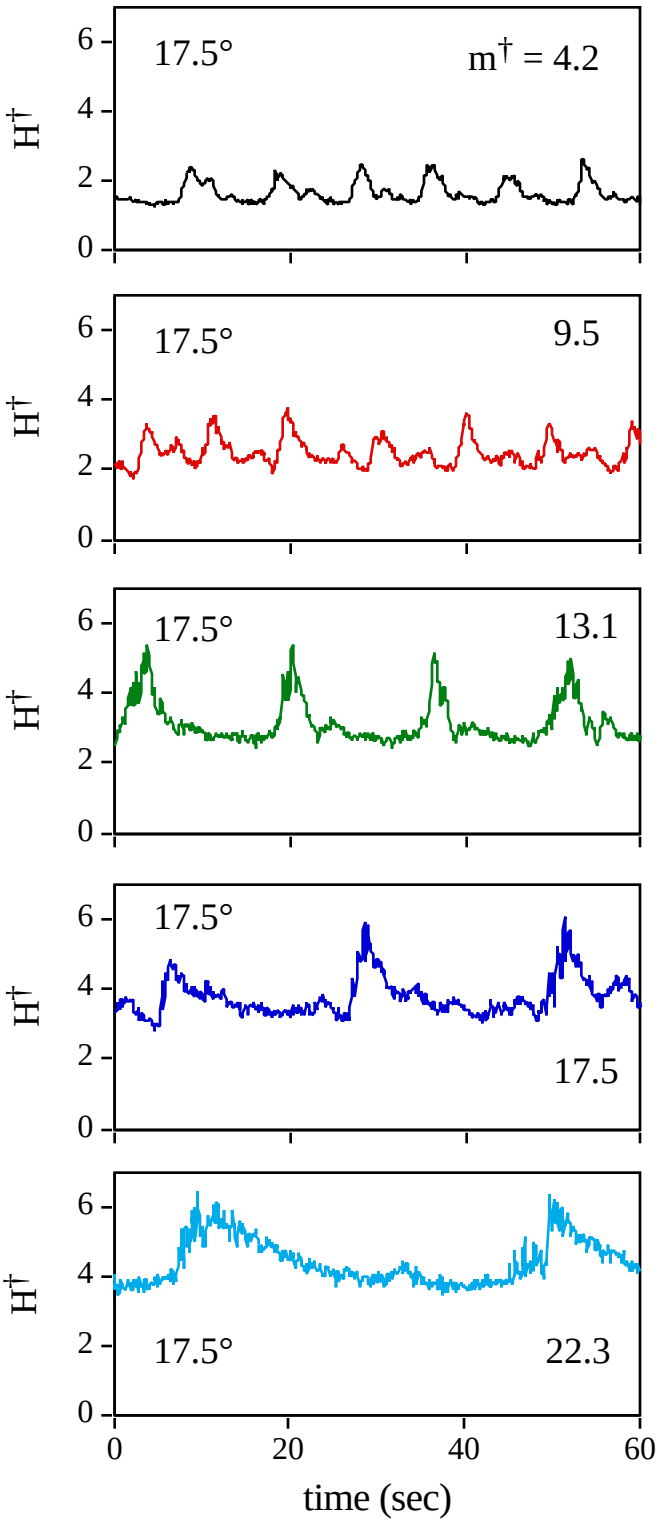
A theory incorporating contributions from impulsive and enduring interactions with the base produces quantitative predictions for the range of sustained flows observed in the experiments. Closure of the theory is achieved using a balance between the production and dissipation of angular momentum in a narrow basal shear layer. A linear stability analysis of the corresponding hydraulic equations further suggests the origin of the waves.

Figure excerpts

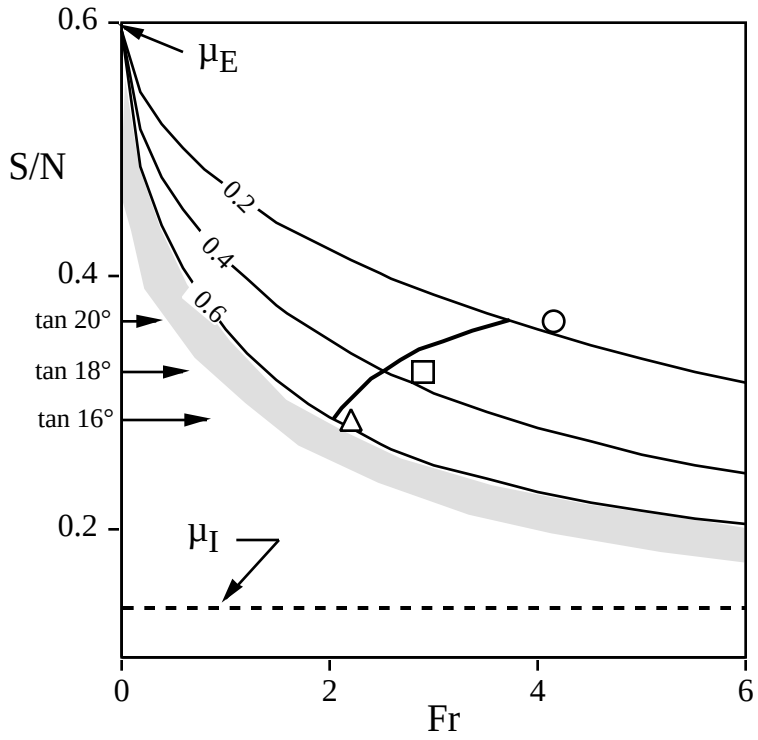


ML/SK/99.01

Sketch of the chute facility and placement of its instruments.



Time-history of the solid holdup at the inclinations and dimensionless mass flow rates shown



Effective friction versus Froude number. The thin oblique lines represent theoretical predictions at $\nu_0 = 0.22$, 0.43 and 0.60, which are the volume fractions predicted by the theory for SFD flow at 20, 18 and 16° inclination, respectively. Hash marks indicate where grains with $\nu_0 \geq 60\%$ can no longer flow. The thick upward line is the locus of steady, fully-developed solutions where production and dissipation of angular momentum balance in the shear layer. The triangle, square and circle are experimental data showing $S/N = \tan\alpha$ versus Fr^* at 16, 18 and 20° inclination, respectively.