GRAIN DYNAMICS:
AVALANCHES IN A DRIVEN HEAP

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Granular Media

- Granular Media- anything made up of many distinct grains
- Large quantities of this material behave differently from solids or liquids
- Grain dynamics in a pile: Avalanches

Granular Dynamics

- Avalanches : Crossing the threshold angle of maximum stability
- Under a large amount of forcing the flow is fluid, continuous and smooth.
- Forcing just above the threshold results in an intermittent flow
- Flow determined by individual grain fluctuations

The Experiment

- Granular Medium: Dry, cohesionless, glass beads of diameter range = .25mm-.35 mm
- The repose angle θ=25°
- ρ = 1.5 g/cm^3
- The heap is created between 2 Lucite plates 28.5cm x 28.5cm
- Length of slope = 28.5cm/cos θ =31cm

2 Methods of Determining Time-Resolved Avalanche Dynamics.

- Particle-Image Velocimetry (PIV)- gives the time dependent coarse grained hydrodynamic surface flow speed.
- Time-dependent average speed determined from cross correlation of successive images.
- (SVS) Speckle Visibility Spectroscopy- capable of resolving the evolution dynamics of an avalanche event by measuring the time-dependent speed of the grain fluctuations around the flow.

Measuring fluctuation speeds using PIV (Time Stacked Images for the Surface)

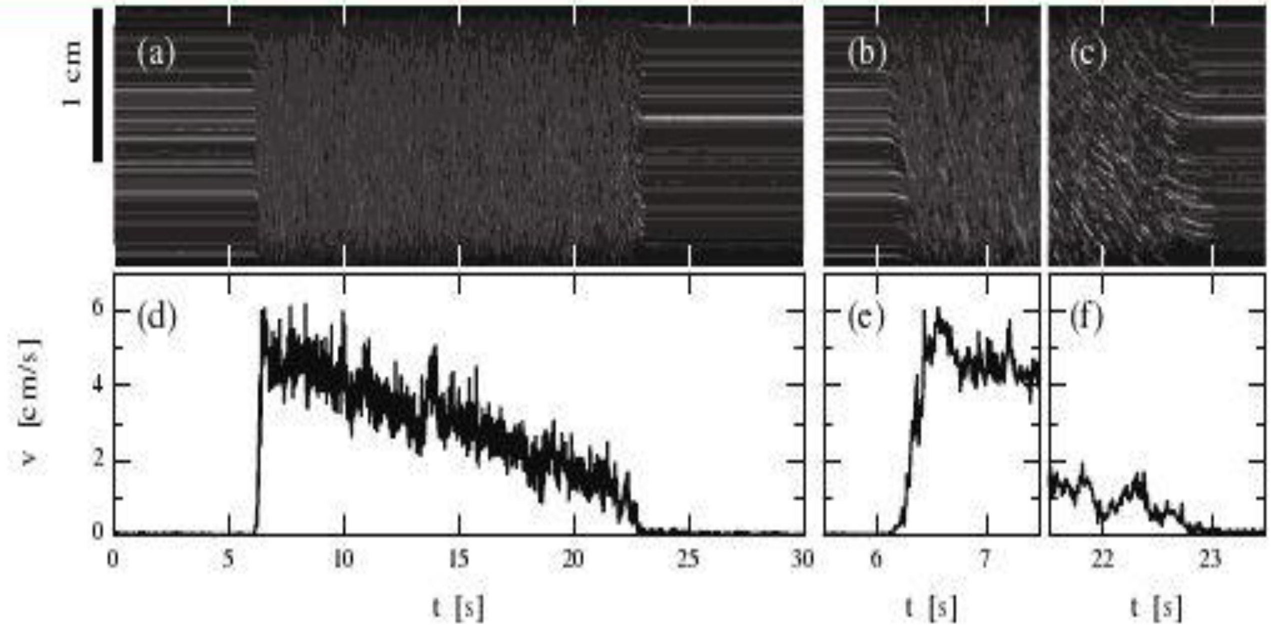

FIG. 1. Time-stacked line-scan images of the surface of the heap for an avalanche (a) and for zoom-ups of it turning on (b) and turning off (c). Sand grains appear as bright lines with slope proportional to their speed down the channel. The slope is measured by locating the maximum of the cross-correlation function for consecutive time snapshots. The bottom row shows the flow speeds extracted from the corresponding images above.

Measuring fluctuation speeds using SVS (Time Stacked Images for the Speckle)

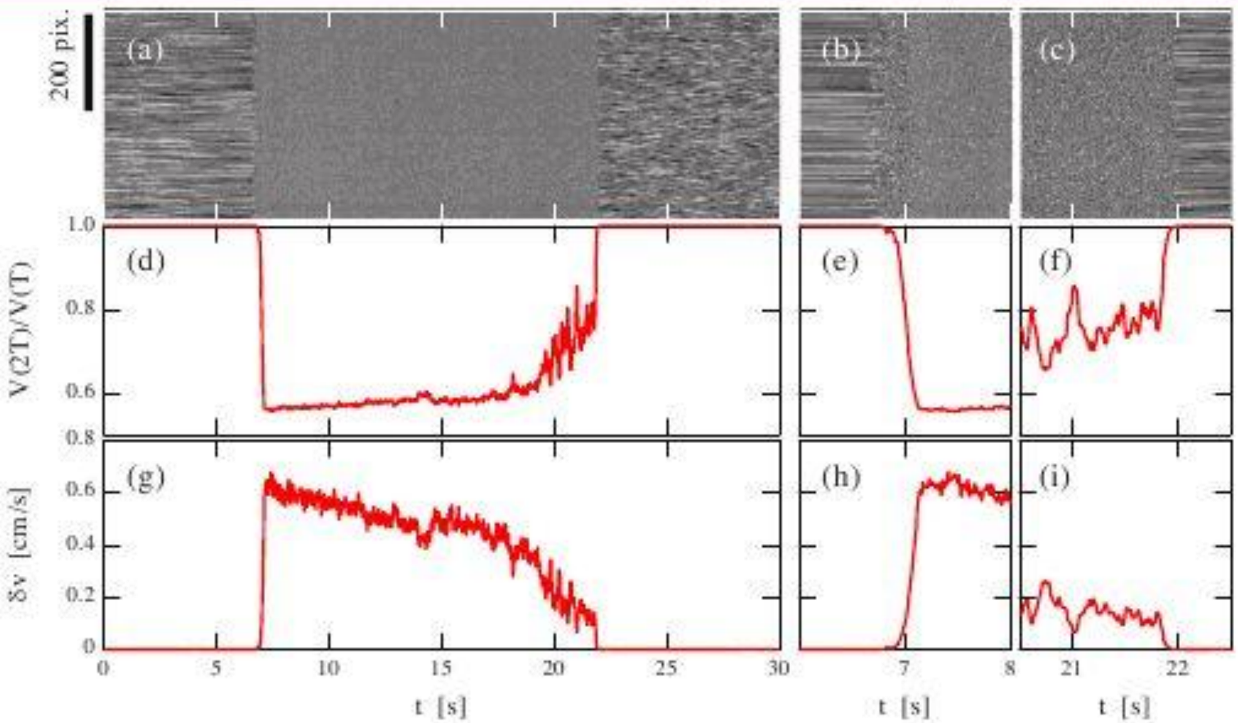

FIG. 2. (Color online) Time-stacked line-scan images of the speckle pattern for an avalanche (a) and zoom-ups of it turning on (b) and turning off (c). The middle row shows the corresponding variance ratios, which are transformed into the fluctuation speeds in the bottom row.

Results:

$\langle T \rangle = \langle T_{off}(n) + T_{on}(n) \rangle = 61s + 16s$

$\langle T \rangle$ = 77s for the nth Avalanche

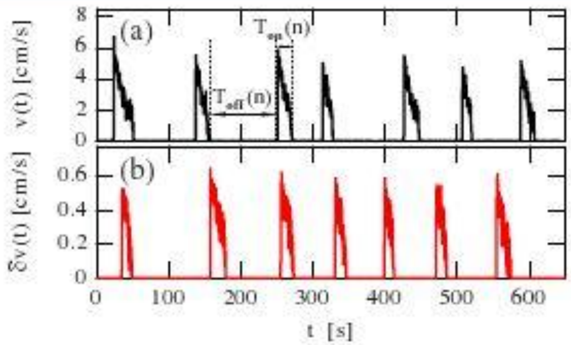

FIG. 3. (Color online) (a) Average and (b) fluctuation speed time traces for independent observations with the same sand flux Q =0.07 g/s. The on and off times, T_{on} and T_{off}, for the nth avalanche event are defined as shown.