Solitary granular avalanches

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The rheology of dense granular flows is among the most important issues to address in order to describe slope processes. The standard experimental procedure to determine the flow rheology in the lab is to investigate homogeneous steady flows. Here, we wish to test this rheology in the demanding case of an unsteady, inhomogeneous situation, namely solitary avalanches. Experimentally, avalanches of controlled mass can be generated on an erodible layer of grains (either sand or glass beads) inclined at some angle by scraping the sediment with a plate at a constant velocity. Solitary profiles propagate at constant speed that increases with the mass. The experimental profiles can be theoretically reproduced in the framework of a depth averaged (St Venant) description only if non-local effects are included into the granular rheology. Finally, for large enough avalanches, the profiles destabilize into a train of several waves. The dispersion relation of this Kapitza-like instability is also well reproduced by the St Venant equations.