Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

A simple depth-averaged model for dry granular flow CHI-YAO HUNG, National Taiwan University, COLIN P. STARK, Lamont-Doherty Earth Observatory, Columbia University, HERVE CAPART, National Taiwan University — Granular flow over an erodible bed is an important phenomenon in both industrial and geophysical settings. Here we develop a depth-averaged theory for dry erosive flows using balance equations for mass, momentum and (crucially) kinetic energy. We assume a linearized GDR-Midi rheology for granular deformation and Coulomb friction along the sidewalls. The theory predicts the kinematic behavior of channelized flows under a variety of conditions, which we test in two sets of experiments: (1) a linear chute, where abrupt changes in tilt drive unsteady uniform flows; (2) a rotating drum, to explore steady non-uniform flow. The theoretical predictions match the experimental results well in all cases, without the need to tune parameters or invoke an ad hoc equation for entrainment at the base of the flow. Here we focus on the drum problem. A dimensionless rotation rate (related to Froude number) characterizes flow geometry and accounts not just for spin rate, drum radius and gravity, but also for grain size, wall friction and channel width. By incorporating Coriolis force the theory can treat behavior under centrifuge-induced enhanced gravity. We identify asymptotic flow regimes at low and high dimensionless rotation rates that exhibit distinct power-law scaling behaviors.

Chi-Yao Hung
National Taiwan University

Date submitted: 20 Nov 2015 Electronic form version 1.4