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Continuum modeling of dense granular flow down heaps DAVID HENANN, DAREN LIU, Brown University — Dense, dry granular flows display many manifestations of grain-size dependence, or nonlocality, in which the finite-size of grains has an observable impact on flow phenomenology. Such behaviors make the formulation of an accurate continuum model for dense granular flow particularly difficult, since local continuum models are not equipped to describe size-effects. One example of grain-size dependence is seen when avalanches occur on a granular heap – a situation which is frequently encountered in industry, as in rotating drums, as well as in nature, such as in landslides. In this case, flow separates into a thin, quickly flowing surface layer and a slowly creeping bulk. While existing local granular flow models are capable of capturing aspects of the flowing surface layer, they fail to even predict the existence of creeping flow beneath, much less being able to quantitatively describe the flow fields. Recently, we have proposed a new, scale-dependent continuum model – the nonlocal granular fluidity (NGF) model – that successfully predicted steady, slow granular flow fields, including grain-size-dependent shear-band widths in a variety of flow configurations. In this talk, we extend our model to the rapid flow regime and show that the model is capable of quantitatively predicting all aspects of gravity-driven heap flow. In particular, the model predicts the coexistence of a rapidly flowing, rate-dependent top surface layer and a rate-independent, slowly creeping bulk – a feature which is beyond local continuum approaches.

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