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A granular flow law based on nonlocal fluidity KEN KAMRIN, MIT, GEORG KOVAL, INSA Strasbourg — A general, three-dimensional law to predict granular flow in an arbitrary geometry has been an elusive goal for decades. Recently, an elasto-plastic continuum model has shown the ability to approximate steady flow and stress profiles in multiple inhomogeneous flow environments. However, the model does not capture some phenomena observed in the slow, creeping flow regime. As normalized flow-rate decreases, granular stresses are observed to become largely rate-independent and a dominating length-scale emerges in the mechanics. This talk attempts to account for these effects using the notion of nonlocal fluidity, which has proven successful in treating nonlocal effects in emulsions. The idea is to augment the usual granular fluidity law with a diffusive second-order term scaled by the particle size that spreads flowing zones accordingly. Below the yield stress, the local contribution vanishes and the fluidity becomes rate-independent, as we require. We implement the modified law in multiple geometries and validate its predictions for velocity, shear-rate, and stress against discrete particle simulations.

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