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Continuum modeling of flow and size-segregation

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ABSTRACT:

Dense granular systems that consist of particles of disparate size segregate based on size during flow, resulting in complex, coupled segregation and flow fields. In this talk, we study size-segregation phenomenology using discrete-element method (DEM) simulations of dense, bidisperse particles and propose a continuum model for coupled size-segregation and flow in dense, bidisperse granular systems. In our DEM simulations, we consider four flow geometries: (1) gravity-driven flow down a long vertical chute, (2) annular shear flow, (3) gravity-driven flow down a rough, inclined surface, and (4) planar shear flow in the presence of gravity - all while varying system parameters, such as the flow rate, system size, fraction of large/small grains, and grain-size ratio. Selected DEM simulation data inform continuum constitutive equations for the relative flux of large and small particles. The segregation model accounts for two driving forces - shear-strain-rate-gradients and pressure-gradients. When coupled with the nonlocal granular fluidity model - a nonlocal continuum model for dense granular flow - we show that both flow fields and segregation dynamics may be simultaneously captured using the coupled, continuum model.

BIOGRAPHY:

David L. Henann is the James R. Rice Associate Professor of Solid Mechanics at Brown University. He received his B.S. in Mechanical Engineering from Binghamton University in 2006, followed by his S.M. and Ph.D. in Mechanical Engineering from MIT in 2008 and 2011, respectively. After postdoctoral appointments at MIT and Harvard, he joined the faculty at Brown University in the fall of 2013. His research focuses on the formulation of new continuum-level constitutive theories for describing material behavior and the quantitative modeling of material behavior through numerical simulation. Henann is the recipient of an NSF CAREER Award and the 2016 Pi Tau Sigma Gold Medal from the American Society of Mechanical Engineers (ASME).