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Clustering Instabilities in Homogeneously Cooling Particulate Flows PETER MITRANO, STEVEN DAHL, JOHN ZENK, CHRISTOPHER EWASKO, CHRISTINE HRENYA, University of Colorado at Boulder — Particulate flow instabilities, such as particle clustering, are commonly observed in industrial applications (e.g., gasifiers and fluidized beds). The particle dynamics associated with such instabilities have been studied through experiment, theory, and discrete-particle simulation. However, most previous theoretical analysis has been limited to linear stability analyses, and no quantitative predictions about instabilities have been obtained via numerical simulations of hydrodynamic models or via direct simulation Monte Carlo. In this work, we use a combination of numerical hydrodynamic simulations, linear stability analyses, and discrete-particle simulations to quantitatively assess the ability of hydrodynamics to describe instabilities in particulate flows. We find excellent agreement between discrete-particle simulations and hydrodynamic simulations for the onset of particle clustering. Such agreement demonstrates the aptitude of the Enskog equation in describing particulate flows and (since velocity gradients exist) the versatility of the small-Knudsen-number expansion. A systematic under prediction of clustering onset by linear analyses exemplifies the importance of nonlinear mechanisms (e.g., viscous heating) in cluster formation.

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