IOWA STATE UNIVERSITY
Center for Multiphase Flow Research and Education

Long-range Particle Interactions and Particle-fluid Particle Stress in Disperse Multiphase Flows

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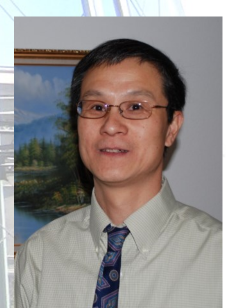
Abstract
Due to the limitations of numerical schemes most numerical simulations studying particle-fluid interactions are performed in statistically uniform systems. How to post-process the results from such simulations and to develop models for practical systems, which are often non-uniform, is an important issue having significant theoretical and practical consequences. In this seminar, it will be shown that there is a particle-fluid-particle (PFP) stress in a disperse multiphase flow. The commonly used phase interaction force (e.g. drag and added mass force) models need to be added with the divergence of this PFP stress in a non-uniform system.

The PFP stress is defined similar to the contact stress in a dense granular medium. However, direct use of the definition encounters two conceptual difficulties. Firstly, with the presence of the fluid, it is not possible to identify the interaction force between a pair of particles as required in the definition of the contact stress. The pair interaction force can only be approximately calculated in dilute particle suspensions. Secondly, even if this approximated pair interaction force is accepted, the summation over all the interaction pairs diverges due to the long-range hydrodynamic interaction among particles. To overcome these difficulties, a relation between the ensemble average and the nearest particle statistics is derived. It is shown that pair interaction force required in the definition can be replaced by the force acting on a reference particle conditional on the nearest particle. Because of the rapid far-field decay of the nearest particle probability, the integral defining the stress always converges absolutely. Using this definition, the PFP stress is calculated for dilute particle suspensions. Numerical results for finite volume fractions and Reynolds numbers will also be discussed.

Biography


Duan Z. Zhang obtained his B.S. Degree from Hohai University, China, M.S. Degree from the Chinese Academy of Sciences, and Ph.D. in Mechanical Engineering from the Johns Hopkins University in 1993. After his Ph.D study he was invited to the University of Cambridge to work on theories of multiphase flows. Shortly after his return to the U.S., he joined the Theoretical Division of the Los Alamos National Laboratory. Currently, he is a senior scientist of the lab. His research is in the area of theoretical models and computational methods for multi-material interactions, including large deformation of solids, multiphase and granular flows, flows in porous media, chemical reactions, and scale-bridging theories and numerical methods from atomistic to continuum. Since 2004, he has been leading the CartaBlanca code team that won the R&D 100 award in 2005. The code has been used in defense, mining, chemical, and petroleum industries.

Refreshments will be provided.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

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