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Numerical Simulations of Complex Multiphase Flows

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ABSTRACT:

Direct numerical simulations of multiphase flows are rapidly becoming routine, at least for relatively simple disperse flows, and we will briefly discussed how such simulations have provided important insight into the dynamics of bubbly flows. Current progress is also opened up several new possibilities. In particular, the question of how to use the results to increase our ability to predict is an increasingly important question. Routine predictions usually require course models where the large scales are evolved deterministically and small scales are included statistically. Advances in extracting information from data are opening up new possibilities in building coarse models and we will discuss the use of machine learning to find closure models from results of fully resolved simulations. Modern data techniques also give us some freedom in how to coarsen the flow. For multiphase flows the presence of the phase boundary is often the most prominent feature and we describe a systematic process to coarsen results from fully resolved simulations while retaining a sharp, but simplified, interface, as well as initial efforts to develop models to evolve the coarse flow. In addition, success in following the evolution of relatively simple systems calls for simulations of more complex ones and we discuss briefly efforts to do so, including simulations of three-phase flows as found in froth flotation, for example.

BIOGRAPHY:

Gretar Tryggvason is the Charles A. Miller, Jr. Distinguished Professor at the Johns Hopkins University and the head of the Department of Mechanical Engineering. He received his PhD from Brown University in 1985 and was on the faculty of the University of Michigan in Ann Arbor until 2000, when he moved to Worcester Polytechnic Institute as the head of the Department of Mechanical Engineering. Between 2010 and 2017 he was the Viola D. Hank professor at the University of Notre Dame and the chair of the Department of Aerospace and Mechanical Engineering. Professor Tryggvason is well known for his contributions to computational fluid dynamics; particularly the development of methods for computations of multiphase flows and for pioneering direct numerical simulations of such flows. He served as the editor-in-chief of the Journal of Computational Physics 2002-2015, is a fellow of APS, ASME and AAAS, and the recipient of several awards, including the 2012 ASME Fluids Engineering Award and the 2019 ASTFE Award.