PRISM Seminar Series – Spring 2012

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PURDUE UNIVERSITY Discovery Park

"Multiscale Considerations in DNS Studies of Multiphase Flows"

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3:00 pm, Birck 1001

Abstract: Direct numerical simulations (DNS) of multiphase flows, where all continuum length and time scale are fully resolved, have now advanced to the point where it is possible to study in considerable detail fairly complex systems, such as the flow of hundreds of bubbles, drops, and solid particles. Here we discuss such simulations from a multi-scale perspective, focusing on two aspects: First of all, DNS results can help with the development of closure relations of unresolved processes in simulations of large-scale "industrial" systems. As an example we discuss recent results for deformable bubbles in weakly turbulent channel flows. The lift induced lateral migration of the bubbles controls the flow, but the lift is very different for nearly spherical and more deformable bubbles, resulting in different flow configuration and flow rates. Nevertheless, the results show that the collective motion of many bubbles leads to relatively simple flow structure in both cases, emphasizing the need to examine as large a range of scales as possible. The other multi-scale aspect results from the fact that multiphase flows often produce "features" such as thin films, filaments, and drops that are much smaller than the "dominant" flow scales. The geometry of these features is usually simple, since surface tension effects are strong and inertia effects are relatively small. In isolation these features are therefore often well described by analytical or semi-analytical models. Recent efforts to capture thin films using classical thin film theory, and to compute mass transfer in high Schmidt number flows using boundary layer approximations, in combination with direct numerical simulations of the rest of the flow, are described.

Bio: Gretar Tryggvason is currently the Viola D. Hank Professor of Aerospace and Mechanical Engineering at the University of Notre Dame. He served as the Head of the Department of Mechanical Engineering at Worcester Polytechnic Institute from 2000 to 2010, and before that he was an assistant, associate and full professor of Mechanical Engineering and Applied Mechanics at the University of Michigan in Ann Arbor for fifteen years. Tryggvason received his doctorate from Brown University in 1985 and spent a year as a postdoctoral researcher at the Courant Institute. He has also held short term visiting positions at Caltech, NASA Lewis Engineering Research Center, University of Marseilles, and University of Paris VI. Professor Tryggvason is best known for developing, with his students and collaborators, a front tracking method for direct numerical simulations of multiphase flows and the use of this method to examine several systems, including bubbly flows, droplet motion and boiling. He is the author of over hundred journal papers and numerous other publications, and has supervised over twenty doctoral dissertations. Tryggvason is an active member of several professional societies, a fellow of the American Physical Society and ASME, and the editor-in-chief of the Journal of Computational Physics.

Refreshments will be served. For further information please contact Prof. Alina Alexeenko, alexeenk@purdue.edu
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