JOHNS HOPKINS
Center for Environmental & Applied Fluid Mechanics

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3:00 PM, 213 Hodson Hall

"Dynamics of Buoyant Particles in Turbulent Flows"

Presented by Dr. Varghese Mathai
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Particle suspensions in turbulent flows occur widely in nature and industry. In most situations, the particles have a density which is different from that of the carrier fluid. This density difference can affect their motion through flows, and offers potential for changing the flow properties in many multiphase settings. In this talk, we will discuss the use of Lagrangian particle-tracking techniques to study the dynamics of light (buoyant) particles in turbulent flows.

In the first part, we address the acceleration dynamics of tiny buoyant particles (100-micron air bubbles) in a turbulent water flow. We examine the role of gravity on the bubble acceleration statistics. We find that microbubbles experience very different accelerations as compared to fluid tracers, and these occur despite their small size and minute Stokes number (small response time). Some implications of these findings to particle tracking experiments will be discussed.

In the second part, we move to the case of buoyant particles of finite size (particle size is large compared to the smallest turbulent flow length-scales). For spherical particles, buoyancy produces interesting variability in particle dynamics. In addition to buoyancy, we reveal the role of a largely ignored control parameter, the particle's moment of inertia. Using experiments and direct numerical simulations, we demonstrate that the moment of inertia can be tuned to trigger distinctly different wake-induced-motions for both spherical and cylindrical particles. We draw some interesting analogies to the motions observed for anisotropic particles.

Dr. Varghese Mathai is a postdoctoral researcher in the Physics of Fluids group at University of Twente, the Netherlands. He received his Master's in Mechanical Engineering from Indian Institute of Science, Bangalore, and PhD in Applied Physics from University Twente, the Netherlands (2017). His PhD research was focused on the dynamics of buoyant particles and air bubbles in turbulent flows by using Lagrangian Particle Tracking and Particle Image Velocimetry techniques. His research interests lie in dispersed multiphase flows, bluff body flows, and free surface flows. His work has appeared in journals such as Physical Review Letters, Journal of Fluid Mechanics, Experiments in Fluids, and Journal of Vascular Surgery. Varghese's work was selected among the top five PhD theses in fluid mechanics by the European Research Committee on Flow, Turbulence, and Combustion (ERCOFTAC). In 2018, he received the Best Research Prize by the European Cooperation in Science and Technology (Eu-COST).