Dynamics of buoyant particles and air bubbles in turbulent flows

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Abstract:

Particle suspensions in turbulent flows occur widely in nature and industry. In most situations, the particles have a density that is different from the carrier fluid density, which can affect their motion in multiphase flow settings. In this talk, I will discuss the use of Lagrangian particle-tracking experiments to study the dynamics of light (buoyant) particles in turbulent flows. In the first part, we examine the applicability of small Stokes number bubbles as tracers of turbulent acceleration. We reveal how gravity can cause the accelerations of even tiny bubbles to deviate from that of the fluid. In the second part, we examine the role of gravity on buoyant spherical particles of finite size (particle size large compared to the dissipative scales of turbulence). For spheres, buoyancy produces interesting variability in 3D translational dynamics. In addition, 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 isotropic bodies including spheres and two-dimensional cylinders. These help draw analogies to some of the motions previously observed for anisotropic objects such as falling cards and paper.

Bio:

Varghese Mathai obtained a PhD in 2017 from University of Twente, the Netherlands. His research interests are in high Reynolds number dispersed two-phase and particle-laden flows, and membrane aerodynamics. He was recipient of the 2017 Da Vinci award (Europe) for top-5 PhD theses in fluid mechanics, and the 2018 European COST Prize for best research in flowing matter. At Brown he works with Kenny Breuer, on bio-inspired membrane flows and energy harvesting.