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DNS of turbulent flows laden with deformable bubbles or droplets: Overview of methods

SAID ELGHOBASHI, University of California, Irvine

Turbulent flows laden with liquid droplets or gas/vapor bubbles are ubiquitous in nature and engineering applications. In nature, examples include rain, air bubbles in the upper ocean, and vapor bubbles in geysers. Engineering applications include liquid fuel sprays in all types of combustion engines, paint sprays, spray drying in the pharmaceutical industry as well as food processing, and water vapor bubbles in nuclear reactor cooling systems or those created by cavitation in the wakes of ship propellers, just to list a few. This lecture focuses on direct numerical simulations (DNS) of turbulent flows laden with droplets or bubbles. DNS of these flows are more challenging than those of flows laden with solid particles due to the surface deformation in the former. The numerical methods to be discussed are classified by whether the initial diameter, d, of the bubble/droplet is smaller or larger than the Kolmogorov length scale, η. The lecture discusses DNS of deformable small spherical bubbles/droplets ($d < \eta$) via a phenomenological model.[1]

[1]Elghobashi, S. " Direct Numerical Simulation of Turbulent Flows Laden with Droplets or Bubbles", Annu. Rev. Fluid Mech. 2019, 51:217-244.