Bubbles in Isotropic Homogeneous Turbulence

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An experimental study of the bubble deformation in an isotropic homogeneous turbulent flow field was carried out. It is of a fundamental importance to understand the rate of coalescence and breakup in two phase disperse flows. The size of bubbles or droplets has a significant impact on the heat and mass transfer rates in such flows (Risso and Fabre 1998). Several mechanisms has been identified: capillary instabilities, turbulence, to name a few. The turbulent flow field was characterized by Particle Image Velocimeter (PIV) measurements and the bubble dynamics was recorded with a high speed camera both measurements were taken simultaneously. The deformation process was characterized by quantifying bubble aspect ratio at each instant of the process and by measuring the local turbulent Reynolds number at a distance of the diameter size around the bubble. The deformation process was governed by the gradient of turbulent stresses that accelerate some parts of the bubbles surfaces, which induces a redistribution of internal flow and causes a pressure difference inside the bubble which lead to its eventual breakup when this try to recover its original shape.

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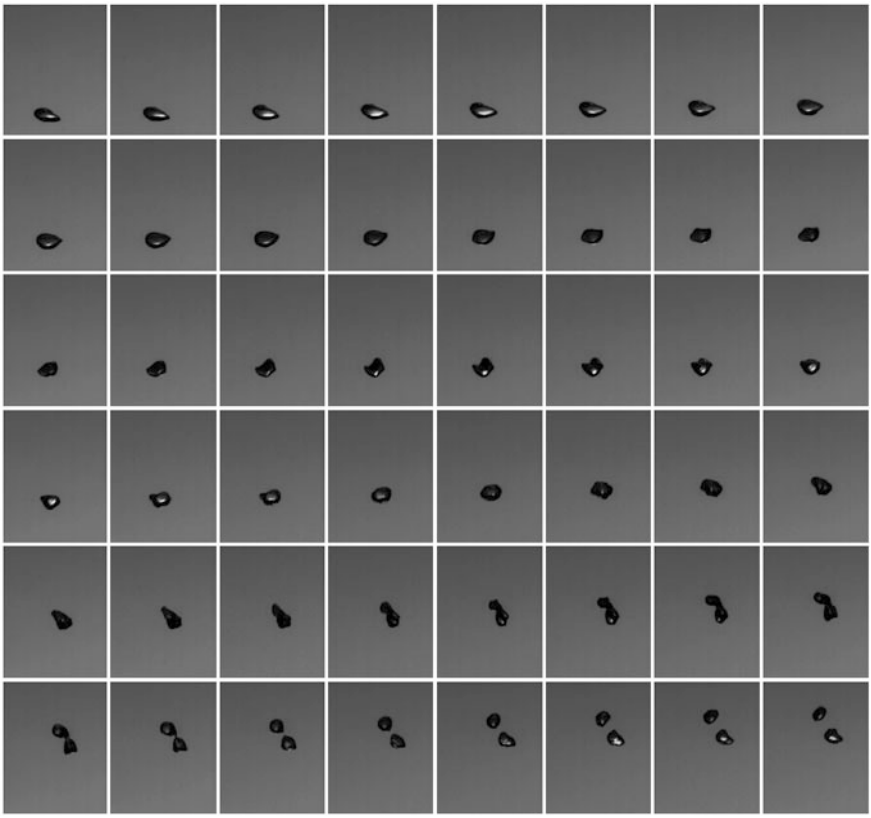

The sequence of images shows a typical bubble undergoing a break up process. The time step between frames is 5 μs; the initial diameter of the bubble is 3 mm. The flow is characterized by $\mathrm{Re}_\lambda = 0.623$, $\mathrm{We}_\mathrm{t} = 0.04$. It can be observed that the bubble undergoes significant deformation and oscillation prior to the actual breakup. We have identified the critical conditions for this process to occur.

Reference

Risso F, Fabre J (1998) Oscillation and breakup of a bubble immersed in a turbulent field. J Fluid Mech 372:323–355