On the scaling of jetting from bubble collapse at a liquid surface

Sangeeth Krishnan[1], Emil Hopfinger[2], and Baburaj Puthenveettil[*†1]

[1]Indian Institute of Technology Madras (IIT Madras) – Fluid Mechanics Laboratory, Dept of Applied Mechanics, IIT Madras, Chennai, India

[2]Laboratoire des écoulements géophysiques et industriels (LEGI) – Université Grenoble Alpes, CNRS : UMR5519 – 1209–1211 Rue de la piscine - BP 53 38041 GRENOBLE CEDEX 9, France

Abstract

We present a scaling law for the jet velocity from bubble collapse at a liquid surface which brings out the effects of gravity and viscosity. The present experiments in the range of Bond numbers $0.02 < Bo < 2.5$ and Ohnesorge numbers $0.001 < Oh < 0.1$ were motivated by the discrepancy between previous experimental results and numerical simulations. We show here that power law variation of the jet Weber number, $We \sim 1/\sqrt{Bo}$ suggested by Ghabache et al. (2014) is only a good approximation in a limited range of Bo values; there is no power law dependency of the jet velocity on Bo. The actual dependence of We on Bo is here shown to be identical to that of the square of the dimensionless cavity depth on Bo. Viscosity enters the jet velocity scaling in two ways: (a) through damping of the parasitic capillary waves which merge at the bubble base and weaken the pressure impulse, and (b) through direct viscous damping of the jet formation and the bubble collapse. These damping processes are expressed by a dependence of the jet velocity on Oh, from which critical values of Oh are given for the onset of jet weakening, the absence of jetting and the absence of jet breakup into droplets.

[*]Speaker

[†]Corresponding author: apbraj@gmail.com