Graduate Student Research Seminar

Spring 2022

Linear Oscillations of Sessile Bubbles and Flux Drop

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Advisor: Dr. Joshua Bostwick

Monday, April 4th

3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

The resonant behavior of bubbles in contact with a partially-wetting substrate and drops connected to a fluid reservoir is important for many industrial applications, such as ultrasonic-assisted soldering and drop-on-demand printing. Theoretical analyses were carried out to investigate the linear natural oscillations of a compressible sessile bubble on a planar solid support and a flux drop connected to a reservoir in an ambient fluid. We consider small disturbances to the spherical-cap interface whose three phase contact line is either (i) pinned or (ii) moves freely with a fixed contact angle. The governing equations for the inviscid incompressible liquid are reduced by a normal-mode expansion to a functional eigenvalue problem on linear operators using a boundary integral. We use inverse operators to construct Green's function for these two contact line conditions, and the Rayleigh-Ritz method to find the characteristic oscillation frequencies and related modal shapes, which are characterized by the mode number pair (k, l). We show how the characteristic oscillation frequencies, modal shape, and the flow field depend upon the contact angles (α), and the dimensionless equilibrium bubble pressure inside the bubble (Π) or the dimensionless empirical constant χ relating the reservoir pressure to volume exchanged. Instabilities of axisymmetric and the non-axisymmetric rocking mode will be highlighted either.

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