Interference between vibrational modes in bubble break-up
SAMUEL D. OBERDICK, LIPENG LAI, WENDY W. ZHANG, University of Chicago — Recent works reveal that the dynamics near the break-up of an underwater bubble does not evolve into a singular, universal form independent of initial conditions. Instead, any initial azimuthal distortion excites vibrations in the neck shape that dominate the final break-up. Here we investigate how the final break-up is affected by the presence of several different vibrational modes. Approximating the Hamiltonian evolution of the interface as integrable by treating the amplitudes and the phases of the vibrations as action-angle variables gives a simple model of the break-up dynamics. We find that the outcomes of the model are in reasonable agreement with simulation results for most initial distortions. The cross-section of the bubble neck shrinks radially while vibrating. The first break-up occurs when two opposing sides of the interface osculate, creating a smooth contact. One consequence of this vibration-induced break-up is that there exists narrow intervals of initial distortions that evolve into “near-miss” events. In such an event, the two sides of the vibrating interface nearly osculate but pull back just in time. For such initial conditions, the simulated evolution deviates significantly from the model prediction. The action-angle variable approximation also fails.

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