Spatial and Temporal Scaling of Unequal Microbubble Coalescence

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We numerically study coalescence of air microbubble in water, with density ratio 833 and viscosity ratio 50.5, using lattice Boltzmann method (LBM). Focuses are on the effects of size inequality of parent bubbles on the coalescence geometry and time and underlying dynamics of unequal microbubble coalescence. Twelve cases, varying the size ratio of large to small parent bubble γ from 5.33 to 1, are systematically investigated. The "coalescence preference" of coalesced bubble closer to the larger parent bubble is well captured. A power-law relation between the preferential relative distance χ and size inequality γ as $\chi \sim \gamma^{-2.079}$ is consistent to the recent experimental observations. Meanwhile, the coalescence time also exhibits power-law scaling as $T \sim \gamma^{-0.7}$, implying that unequal bubbles coalesce faster than equal bubbles. Such a time scaling of coalescence on size inequality is believed the first-time observation as the fast coalescence of microbubbles is generally hard to be recorded through laboratory experimentation.