ACOUSTICS2008/2620 Modeling of the effect of boundaries on ultrasound contrast agent microbubbles response

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Ultrasound contrast agents are coated microbubbles currently extensively studied to target endothelial cells, for local drug delivery. It is therefore important to distinguish acoustically free-floating bubbles from bubbles located close, or targeted to blood vessels. Here, we propose a theoretical study to understand the effect of boundaries on bubble response to ultrasound. We consider the hydrodynamic interaction of a single bubble with a wall, including all possible bubble motions: volumetric oscillations, translation, and nonspherical deformations. We also include the friction in the viscous boundary layer along the wall. We derive the coupled equations of the bubble dynamics using a Lagrangian approach. We predict the bubble response to ultrasound, as a function of various parameters (applied frequency and amplitude, bubble size and coating, bubble/wall distance). We show that our new model predicts a decrease of the resonance frequency as a bubble gets closer to a wall, in agreement with experiments. We reproduce correctly the observed decrease of oscillation amplitude for a close close to the wall, showing that it is due to the coupling between oscillation and translation rather than the friction in the boundary layer. The threshold for nonspherical oscillations is also discussed and compared to experimental measurements.