Effect of a Rigid Wall on Acoustic Microstreaming Generated by an Oscillating Gas Bubble

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CFA2014/73
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Stationary vortical flows that develop around acoustically excited bubbles in a liquid are a well-known phenomenon. This phenomenon, called acoustic microstreaming, is used in many technical applications such as ultrasonic cleaning, stimulation of chemical reactions, intensification of heat and mass exchange, etc. Interest in this phenomenon is also motivated by the use of microbubble-mediated ultrasound in medicine where acoustic microstreaming is believed to play an important role in such applications as hemolysis, sonothrombolysis and sonoporation. The existing theory of acoustic microstreaming is restricted to the case of a bubble in an infinite liquid. In our study, analytical equations are derived that describe acoustic microstreaming around a gas bubble undergoing radial and translational oscillations in the presence of a rigid wall. Numerical simulations are then performed to compare acoustic microstreaming generated by a bubble in the presence of a wall to that generated by the same bubble in an infinite liquid. It is shown that the presence of the wall leads to a considerable increase in the intensity of acoustic microstreaming if the bubble is driven near resonance, taking into account that the presence of the wall changes the bubble resonance frequency. This effect is a consequence of changes in the amplitude and the phase of the bubble oscillations that are caused by the presence of the wall. These changes occur in a way that favors increasing the intensity of acoustic microstreaming.