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Please replace the previous abstract I submitted to this mini-symposium(Log DFD16-2016-002776) with this abstract (there were some typos in the previous abstract).

Abstract for an Invited Paper
for the DFD16 Meeting of
the American Physical Society

Nonspherical dynamics and shape mode stability of ultrasound contrast agent microbubbles

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Ultrasound contrast agents (UCAs) are shell encapsulated microbubbles developed originally for ultrasound imaging enhancement. UCAs are more recently being exploited for therapeutic applications, such as for drug delivery, gene therapy, and tissue ablation. Ultrasound transducer pulses can induce spherical (radial) UCA oscillations, translation, and nonspherical shape oscillations, the dynamics of which are highly coupled. If driven sufficiently strongly, the ultrasound can induce breakup of UCAs, which can facilitate drug or gene delivery but should be minimized for imaging purposes to increase residence time and maximize diagnostic effect. Therefore, an understanding of the interplay between the acoustic driving and nonspherical shape mode stability of UCAs is essential for both diagnostic and therapeutic applications. In this work, we use both analytical and numerical methods to analyze shape mode stability for cases of small and large nonspherical oscillations, respectively. To analyze shape mode stability in the limit of small nonspherical perturbations, we couple a radial model of a lipid-coated microbubble with a model for bubble translation and nonspherical shape oscillation. This hybrid model is used to predict shape mode stability for ultrasound driving frequencies and pressure amplitudes of clinical interest. In addition, calculations of the stability of individual shape modes, residence time, maximum radius, and translation are provided with respect to acoustic driving parameters and compared to an unshelled bubble. The effects of shell elasticity, shell viscosity, and initial radius on stability are investigated. Furthermore, the well-established boundary element method (BEM) is used to investigate the dynamics and shape stability of large amplitude nonspherical oscillations of an ultrasonically-forced, polymer-coated microbubble near a rigid boundary. Different instability modes are identified based on the degree of jetting and proximity to the boundary. This insight is used to develop diagrams that delineate regions of stability from instability based on the breakup mechanism, in parameter ranges of ultrasound frequency and amplitude relevant to medical applications.