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# Effects of boundary proximity on monodispersed microbubbles in ultrasonic fields



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### ABSTRACT

Microbubbles have demonstrated the potential to redraw the boundaries of biomedical applications and revolutionize diagnostic and therapeutic applications. However, the ability to distinguish the acoustic response from a cluster of microbubbles in close proximity to the vessel endothelial cell from those that are not is a challenge that needs to be addressed. To address this, the present paper modifies the Keller-Miksis model to include the effects of a boundary. The acoustic responses are analysed via techniques from dynamical systems theory such as Poincaré plots and bifurcation diagrams. It is found that the presence of a boundary causes an intermittent route to chaos while microbubbles far from the boundary result in a period-doubling route to chaos as the single control parameter pressure amplitude is varied. The route to chaos is altered via antimonotonicity with increasing bubble-wall distance. It has also been found that the effects of coupling are significant as it alters the chaotic threshold to occur at lower driving pressure amplitudes. The results also suggest that the increase in coupling effects between microbubbles near a boundary lowers the pressure amplitude required for chaos and lowers the natural frequency of the cluster.

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