Abstract Submitted
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Optimal control of the nonspherical oscillation of encapsulated microbubbles for ultrasound imaging and drug delivery[1] FATHIA F. ARIFI, MICHAEL L. CALVISI, University of Colorado, Colorado Springs — Encapsulated microbubbles (EMBs) were originally developed as contrast agents for ultrasound imaging but are more recently emerging as vehicles for intravenous drug and gene delivery. Ultrasound can excite nonspherical oscillations, or shape modes, that can enhance the acoustic signature of an EMB and also incite rupture, which promotes drug and gene delivery at targeted sites (e.g., tumors). Therefore, the ability to control shape modes can improve the efficacy of both diagnosis and treatment mediated by EMBs. This work uses optimal control theory to determine the ultrasound input that maximizes a desired nonspherical EMB response (e.g., to enhance scattering or rupture), while minimizing the total acoustic input in order to enhance patient safety and reduce unwanted side effects. The optimal control problem is applied to nonspherical models of both a free gas bubble and an EMB, which are solved numerically through pseudospectral collocation methods using commercial optimization software. Single frequency and broadband acoustic forcing schemes are explored and compared. The encapsulation greatly increases the acoustic effort required to incite rupture. Furthermore, the acoustic effort required to incite rupture depends on the shape mode that is forced to become unstable.

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