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Optimized translation of microbubbles driven by acoustic fields.
JEAN TOILLIEZ, ANDREW SZERI, Mech. Eng., Univ. of California, Berkeley —
A single acoustically driven bubble translating unsteadily in a fluid is considered. The inverse Reynolds number is identified as small perturbation parameter in the translation equation. A closed-form, leading order solution for the bubble translation is obtained, assuming nonlinear radial oscillations and a pressure field as the forcing term. The result is the ability to predict and understand the rapid and slow transients of bubble displacement, which is proportional to the average acoustic radiation force. The periodic attractor of the Raleigh-Plesset equation serves as basis for an optimal acoustic forcing designed to achieve maximized bubble translation over one dimensionless period. At moderate acoustic intensity, a maximized radial variance leads to displacement many times larger than the case of purely sinusoidal forcing. Shape stability issues are considered. Together, these results suggest new ways to predict some of the direct and indirect effects of the acoustic radiation force in biomedical applications: e.g., targeted drug delivery and bubble accumulation.

Jean Toilliez
Mech. Eng., Univ. of California, Berkeley

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