Acoustic cavitation is self similar

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Acoustic cavitation describes the response of bubbles and gaseous nuclei to a change in pressure and plays a central role in a large variety of engineering applications and natural phenomena, such as sonochemical processes and medical treatments. The classical theory of acoustic cavitation (Neppiras & Noltingk, 1951) characterizes the cavitation threshold in terms of a critical (negative) pressure and a critical bubble radius, assuming a quasi-static pressure change. Reducing the ambient pressure, a bubble grows towards a new equilibrium radius. If the bubble thereby passes the critical radius R_c, often called the *Blake radius*, the Laplace pressure can no longer stabilize the bubble and the bubble grows by orders of magnitude. This theory of acoustic cavitation assumes, however, that the pressure change is sufficiently slow such that transient inertial effects can be neglected.

In this work, we revisit the threshold for the onset of acoustic cavitation, taking into account transient variations of the ambient pressure using a Rayleigh-Plesset model in which the bubbles are assumed to be spherical. After determining the number of independent dimensionless groups required to fully describe the problem, we conduct a systematic analysis of the pressure-driven bubble behavior, revealing that acoustic cavitation is self similar. Moreover, we deduce a definitive cavitation threshold based solely on intrinsic system properties, offering a robust criterion beyond the classical quasi-static assumption. Together, these findings provide a fundamental perspective on the universality of cavitation onset across different pressure conditions.

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