INTERACTIVE SIMULATION OF ULTRASONIC CAVITATION DYNAMICS: A COMPREHENSIVE STUDY OF THE RAYLEIGH-PLESSET EQUATION

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Abstract

This study presents a comprehensive interactive simulation framework for modeling ultrasonic cavitation dynamics based on the Rayleigh-Plesset equation. The developed web-based simulation tool enables real-time visualization of cavitation bubble behavior under varying acoustic conditions, providing insights into the complex nonlinear dynamics of bubble oscillations. The simulation incorporates key physical parameters including pressure amplitude, frequency, fluid density, surface tension, viscosity, and ambient pressure, allowing for systematic investigation of their effects on cavitation phenomena.

The interactive platform demonstrates the transition between stable oscillations, transient cavitation, and violent bubble collapse, offering educational and research applications in sonochemistry, biomedical ultrasound, and industrial cleaning processes. Validation against theoretical predictions shows excellent agreement for small-amplitude oscillations and captures the essential physics of large-amplitude bubble dynamics.