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Radial oscillation of a gas bubble in a fluid as a problem in canonical perturbation theory JAMES STEPHENS, University of Southern Mississippi — The oscillation of a gas bubble is in a fluid is of interest in many areas of physics and technology. Lord Rayleigh treated the pressure developed in the collapse of cavitation bubbles and developed an expression for the collapse period. Minnaert developed a harmonic oscillator approximation to bubble oscillation in his study of the sound produced by running water. Besides recent interest in bubble oscillation in connection to sonoluminescence, an understanding of oscillating bubbles is of important to oceanographers studying the sound spectrum produced by water waves, geophysicists employing air guns as acoustic probes, mechanical engineers concerned with erosion of turbine blades, and military engineers concerned with the acoustic signatures developed by the propeller screws of ships and submarines. For the oceanographer, Minnaert's approximation is useful, for the latter two examples, Lord Rayleigh's analysis is appropriate. For the case of the airgun, a period of twice Rayleigh's period for the "total collapse" of the cavitation bubble is often cited as a good approximation for the period of an air bubble ejected from an air gun port, typically at ∼2000 psi), however for the geophysical example, numerical integration is employed from the outset to determine the dynamics of the bubble and the emitted acoustic energy. On the one hand, a bubble can be treated as a harmonic oscillator in the small amplitude regime, whereas even in the relatively moderate pressure regime characteristic of air guns the oscillation is strongly nonlinear and amplitude dependent. Is it possible to develop an analytic approximation that affords insight into the behavior of a bubble beyond the harmonic approximation of Minnaert? In this spirit, the free radial oscillation of a gas bubble in a fluid is treated as a problem in canonical perturbation theory. Several orders of the expansion are determined in order to explore the dependence of the oscillation frequency with bubble amplitude. The expansion to second order is inverted to express the time dependence of the oscillation.

James Stephens
University of Southern Mississippi

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