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Similarity solution for strong exploding shock waves in water JIA ZHANG, HAO LIN, Rutgers University — In single bubble sonoluminescence, strong bubble oscillations often lead to the generation of spherical shock waves which expand outward in the surrounding media. These shock waves offer valuable information to help diagnose the cavitation events at the center. In this work, the similarity behavior of these waves is investigated using analyses and simulations. A fitted analytical equation of state (EOS) is first extracted from a tabular EOS for water (LANL), and then incorporated into the Euler equations. A similarity solution for the flow variables behind a shock wave is derived following the theory by Taylor (1950). Numerical simulations are performed using the original tabular EOS, to compare with and validate the analytical solution. The result indicates that the shock wave propagation can be divided into three regimes. 1. A strong-shock regime where the wave-front location scales to the 2/5 power of time, and the similarity solution well-describes the flow dynamics. 2. A sonic regime where the shock wave weakens and propagates with the local speed of sound. 3. A transition regime connecting the two above. Based on these results, a time-of-flight theory is developed, from which the energy of the initial shock wave can be estimated given the arrival time of the shock wave-front at a defined detector location.

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