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An Eulerian-based Bubble Dynamics Model for Computational Fluid Dynamics ASISH BALU, MICHAEL KINZEL, Pennsylvania State Univ —

Cavitation dynamics of nuclei are largely governed by the Rayleigh-Plesset Equation (RPE). This research explores the implementation of a one-way coupling to the solution of the RPE to a computational fluid dynamics (CFD) simulation in an Eulerian-framework. In this work, we used transport equations (i.e., advection) of the bubble radius and bubble growth rate, both of which are governed by advection mechanisms and coupling to the RPE through the CFD pressure field. The method is validated in the context of hypothetical pressure fields by prescribing a temporally varying pressure. Then, it is extended to one-way coupling with cavitation development in three different flow situations: (1) flow over a cylinder, (2) bubble formation during a bottle collapse event, and (3) cavitation in a tip vortex. In the context of these flows, the CFD simulations replicate an equivalent MATLAB-based solution to the RPE, thus validating the model. Additionally, an analytical formulation for appropriate upper and lower bounds for the bubble's physical properties is presented. These boundary values allow the CFD solver to run at larger time steps, therefore increasing the rate of convergence as well as maintaining solution accuracy. The results from this work suggest that Eulerian-based RPE cavitation models are practical and have the potential to simulate large numbers of bubbles that challenge Lagrangian methods.

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