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The Nature of Bubble Entrapment in a Lamb-Oseen Vortex[1]
RYAN KELLY, MARCOS BOTTO, DAVID GOLDSTEIN, SAIKISHAN SURYANARAYANAN, University of Texas at Austin, ROBERT HANDLER, George Mason University — We are interested in bubble trajectories in the presence of a vortex as a step in understanding the bubble dynamics in turbulent, wall-bounded flows. Specifically, we have studied trajectories of non-deforming bubbles through a Lamb-Oseen vortex by solving modified Maxey-Riley equations for low-Reynolds-Number flows with lift. We found that, under appropriate physical conditions, a bubble will spiral around inside the vortex core with a decaying periodic nature until it comes to a quasi-equilibrium state at a particular equilibrium point which varies with time. The bubble spends most of its time in the core close to these points until the core dissipates enough for the bubble to escape. To study this entrapment, we look at quasi-steady-state solutions, which are a system of nonlinear algebraic equations that can be solved numerically. These equations reveal where these equilibrium points will be at a given time, as well as at what time the bubble will escape the vortex. The nature of these equilibrium points, the periodic spiraling, and the bubble trap times will be discussed in terms of nondimensional parameters and related to the properties of a turbulent boundary layer.

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Ryan Kelly
University of Texas at Austin

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