Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

The Spatiotemporal Evolution of Antibubbles: Insights from Direct Numerical Simulations NAIRITA PAL, Fluid Dynamics and Solid Mechanics, Theoretical Division, Los Alamos National Laboratory, NM 87545, USA, RASHMI RAMADUGU, PRASAD PERLEKAR, TIFR Centre for Interdisciplinary Sciences, 21 Brundavan Colony, Narsingi, Hyderabad 500075, India, RAHUL PANDIT, Centre for Condensed Matter Theory, Department of Physics, Indian Institute of Science, Bangalore 560012, India — Antibubbles, which consist of a shell of a low-density fluid inside a high-density fluid, have several promising applications. We show, via extensive direct numerical simulations (DNSs), in both two and three dimensions (2D and 3D), that the spatiotemporal evolution of antibubbles can be described naturally by the coupled Cahn-Hilliard-Navier-Stokes equations for a binary-fluid. Our DNSs capture elegantly the gravity-induced thinning and breakup of an antibubble via the time evolution of the Cahn-Hilliard scalar order parameter field ϕ, which varies continuously across interfaces, so we do not have to enforce complicated boundary conditions at the moving boundary at the antibubble interfaces. To ensure that our results are robust, we supplement our CHNS simulations with DNS using a sharp-interface Volume-of-Fluid method. We track the thickness of the antibubble and calculate the dependence of the lifetime of an antibubble on several parameters; we show that our DNS results agree with various experimental results in particular, the velocity with which the arms of the antibubble retract after breakup scales $\sigma^{1/2}$, where σ is the surface tension, which has been been obtained theoretically by Sobýanin.

Nairita Pal
Fluid Dynamics and Solid Mechanics, Theoretical Division, Los Alamos National Laboratory, NM 87545, USA

Date submitted: 02 Aug 2020 Electronic form version 1.4