THE VORONOI IMPLICIT INTERFACE METHOD FOR MULTIPHASE MULTIPHYSICS

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Many scientific and engineering problems involve interconnected moving interfaces separating different regions, including dry foams, crystal grain growth, and multi-cellular structures in man-made and biological materials. Producing consistent and well-posed mathematical models that capture the motion of these interfaces, especially at degeneracies, such as triple points and triple lines where multiple interfaces meet, is challenging.

Joint with Robert Saye of UC Berkeley, we have built the Voronoi Implicit Interface Method (VIIM), which is an efficient and robust mathematical and computational methodology for computing the solution to two and three-dimensional multi-interface problems involving complex junctions and topological changes in an evolving general multiphase system. We demonstrate the method on a collection of problems, including geometric coarsening flows under curvature, incompressible flow coupled to multi-fluid interface problems, and biological cell cluster growth under competing effects of geometry, fluid dynamics, and elasticity.

Finally, we compute the dynamics of unstable foams, such as soap bubbles, evolving under the combined effects of gas-fluid interactions, thin-film lamella drainage, and topological bursting.