ANALYSIS OF PINCH-OFF SINGULARITIES

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How a fluid thread breaks is a fundamental problem in science [1] and has wide ranging ramifications in technological applications including inkjet printing, DNA and protein arraying, and emulsion formation [2]. The physics of thread breakup when the thread is a pure incompressible Newtonian liquid and the ambient fluid is a dynamically passive gas are now fairly well understood [3, 4, 5]. By contrast, the physics of breakup are either unclear or poorly sorted out when the ambient fluid is a liquid, the thread fluid is not Newtonian, the interface between the thread and the ambient fluid is covered with a surfactant, or pinch-off occurs in the presence of an external field. In this talk, high-accuracy, three-dimensional but axisymmetric finite element computations are employed to probe the physics of breakup in these situations (see, e.g., [6, 7]). Several examples will be given to illustrate that one-dimensional slender-jet analyses cannot be used in a number of these more complex pinch-off problems. The accuracy of the computational predictions are confirmed by demonstrating excellent agreement between them and experiments and local scaling theories of pinch-off.

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Keywords: Drop breakup, interface rupture, pinch-off singularities