

Long time behaviors of advective Cahn-Hilliard Equation

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Mixing and dissipation enhancement are two closely related concepts in the study of incompressible fluid flows, with broad applications across disciplines. In this talk, I will first introduce the key ideas and recent developments in these areas. I will then explain how these concepts can be applied to the study of the advective Cahn–Hilliard equation (ACHE), which describes phase separation in a binary alloy under the influence of advection. We establish two main results. First, on two- and three-dimensional torus, we show that if the underlying flow is sufficiently mixing—quantified in terms of dissipation time—then phase separation is completely suppressed, and the solution converges exponentially to its spatial mean in the L^2 sense. Second, we show that in the presence of strong shear flows on the two-dimensional torus, the ACHE exhibits a dimension-reduction phenomenon: its long-time dynamics asymptotically approaches that of a one-dimensional Cahn–Hilliard equation. I will conclude the talk by discussing several open problems and possible extensions.

Keywords: Phase separation, Cahn-Hilliard equation, Dissipation enhancement