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Two-dimensional Turbulence in Symmetric Binary-Fluid Mixtures: Coarsening Arrest by the Inverse Cascade PRASAD PERLEKAR, TIFR Centre for Interdisciplinary Sciences, 21 Brundavan Colony, Narsingi, Hyderabad, India, NAIRITA PAL, RAHUL PANDIT, Centre for Condensed Matter Theory, Indian Institute of Science, Bangalore 560012, India — We study two-dimensional (2D) binary-fluid turbulence by carrying out an extensive direct numerical simulation (DNS) of the forced, statistically steady turbulence in the coupled Cahn-Hilliard and Navier-Stokes equations. In the absence of any coupling, we choose parameters that lead (a) to spinodal decomposition and domain growth, which is characterized by the spatiotemporal evolution of the Cahn-Hilliard order parameter ϕ, and (b) the formation of an inverse-energy-cascade regime in the energy spectrum $E(k)$, in which energy cascades towards wave numbers k that are smaller than the energy-injection scale k_{inj} in the turbulent fluid. We show that the Cahn-Hilliard-Navier-Stokes coupling leads to an arrest of phase separation at a length scale L_c, which we evaluate from $S(k)$, the spectrum of the fluctuations of ϕ. We demonstrate that (a) $L_c \sim L_H$, the Hinze scale that follows from balancing inertial and interfacial-tension forces, and (b) L_c is independent, within error bars, of the diffusivity D. We elucidate how this coupling modifies $E(k)$ by blocking the inverse energy cascade at a wavenumber k_c, which we show is $\simeq 2\pi/L_c$. We compare our work with earlier studies of this problem.

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