On a Thermodynamically Consistent Diffuse-Interface Model for Incompressible Two-Phase Flows with Chemotaxis

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We consider a hydrodynamic system of Navier–Stokes/Cahn–Hilliard type, which describes the motion of a two-phase flow of two incompressible fluids with unmatched densities coupled with a soluble chemical species. This thermodynamically consistent diffuse-interface model incorporates both the chemotaxis effects induced by the chemical species and the mass transport processes within the mixture. For the two-dimensional initial-boundary value problem, we will discuss the existence of global finite energy solutions and global weak solutions, as well as the existence and uniqueness of global strong solutions for sufficiently regular initial data. In particular, we show that the density of the chemical substance stays bounded for all time if its initial datum is bounded. This implies a significant distinction from the classical Keller–Segel system: diffusion driven by the chemical potential gradient can prevent the formation of concentration singularities.