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Thermodynamically Consistent Physical Formulation and an Efficient Numerical Algorithm for Incompressible N-Phase Flows[1] SUCHUAN DONG, Purdue University — This talk focuses on simulating the motion of a mixture of N (N¿=2) immiscible incompressible fluids with given densities, dynamic viscosities and pairwise surface tensions. We present an N-phase formulation within the phase field framework that is thermodynamically consistent, in the sense that the formulation satisfies the conservations of mass/momentum, the second law of thermodynamics and Galilean invariance. We also present an efficient algorithm for numerically simulating the N-phase system. The algorithm has overcome the issues caused by the variable coefficient matrices associated with the variable mixture density/viscosity and the couplings among the (N-1) phase field variables and the flow variables. We compare simulation results with the Langmuir-de Gennes theory to demonstrate that the presented method produces physically accurate results for multiple fluid phases. Numerical experiments will be presented for several problems involving multiple fluid phases, large density contrasts and large viscosity contrasts to demonstrate the capabilities of the method for studying the interactions among multiple types of fluid interfaces.

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