Modeling and computation of phase field mixture flows

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ABSTRACT

The prototypical phase-field models for incompressible fluid mixtures are the Navier-Stokes Cahn-Hilliard models. Over the last few decades, many NSCH models with non-matching densities have been proposed. Even though these phase-field models aim to represent the same physical phenomena, they seem to differ at first sight. The first objective of this talk is to present a modeling framework that unites these NSCH models.

From the perspective of mixture theory, NSCH models may be understood as reduced models. Namely, the evolution equations for the diffusive fluxes are replaced by constitutive models. The second objective of this talk is to present a new incompressible phase-field model that guarantees full compatibility with mixture theory by replacing the energy-dissipation law with the second law of thermodynamics for mixtures. We compare this model, analytically and computationally, to existing NSCH models with non-matching densities. We conclude the talk by discussing structure-preserving finite element discretizations, and showing relevant benchmark computations such as a rising air bubble in water and the contraction of a liquid filament.