Thermodynamically Consistent Phase Field Models of Multi-component Compressible Fluid Flows

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Abstract: We present a systematic derivation of thermodynamically consistent hydrodynamic phase field models for compressible viscous fluid mixtures using the generalized Onsager principle. By maintaining momentum conservation while enforcing mass conservation at different levels, we obtain two compressible models. When the fluid components in the mixture are incompressible, we show the compressible model reduces to the quasi-incompressible model via a Lagrange multiplier approach. Several equivalent approaches to arrive at the quasi-incompressible model are discussed. Finally, we conduct a linear stability analysis on all binary models and show the differences of the models in near equilibrium dynamics.