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Diffuse interfaces with compressible fluids, phase transition and capillarity

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Conventional models of capillary fluids with phase transition consider linked thermodynamics and capillarity. Such coupling has serious consequences, such as:

- sound propagation, undefined in some critical regions,
- very thin interfaces, causing serious issues in practical computations.

In the present talk an approached based on hyperbolic systems with relaxation is promoted to solve interfaces with phase transition and surface tension. The method deals with arbitrary pressure and density jumps.

The diffuse interface model consists in a set of balance equations of mass for each phase and momentum and energy for the mixture. When simple contact is considered (in the absence of heat diffusion), a volume fraction equation is needed as well. In this frame each phase is compressible and governed by its own (convex) equation of state, preserving sound propagation. The two equations of state are rendered compatible through appropriate constants determined from the phase diagram. Phase change is modeled through Gibbs free energy relaxation terms. Capillarity is modelled through mass fraction gradients at interfaces and is consequently decoupled of thermodynamics.
Examples of cavitating, flashing and boiling flows with and without shocks are shown.

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