Two-phase fluids and topology optimization with the diffuse interface approach

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In the first part of the talk we briefly introduce the concept of phase fields for the simulation of two-component systems. Here, a two-phase system might be a fluid consisting of two immiscable components, or the topology of some object, where the components are material and void.
Thereafter we discuss the simulation of a two-phase fluid using a thermodynamically consistent model and propose an energy stable discretization scheme. A proper spatial resolution of the equations is guaranteed by residual based error estimation based on the full system of equations.
Thereafter we apply this diffuse interface concept to the optimization of objects in Navier--Stokes flow.
The resulting optimality conditions are solved by a gradient flow approach, that leads to equations that are similar to the ones for the two-phase flow simulation.
Again residual based adaptive meshing is applied for the spatial resolution of the sought structure.
We finish the talk with a brief outlook on current and future plans for the algorithmic treatment of the topology optimization problem.