On the free fall of a drop in an unbounded liquid reservoir

Mads Kyed (mads.kyed@hs-flensburg.de)
Hochschule Flensburg University of Applied Sciences

We consider the equations governing the motion of a three-dimensional liquid drop moving freely in an unbounded liquid reservoir under the influence of a gravitational force. Both the fluid in the drop and in the reservoir are assumed to be Navier-Stokes liquids. Moreover, the liquids are assumed to be immiscible. Surface tension proportional to the mean curvature determines the sharp interface between them. Provided the (constant) densities in the two liquids are sufficiently close, existence of a steady-state solution to the resulting free boundary problem is shown.

A particular challenge of the problem is to identify an appropriate linearization of the nonlinear system. Indeed, as will be demonstrated in the talk, a steady-state solution cannot be obtained as a perturbation to the canonical Stokes linearization. Instead, a linearization around a non-trivial state is carried out that results in a two-phase Oseen problem with a coupling condition on the interface expressed in terms of the Laplace-Beltrami operator.