Chair: Physics of Fluids group

# Numerical simulation of a "Lava lamp"

## Description

Lava lamps are fascinating toys that can capture your eyes for hours with the slow sinuous motions of colourful blobs. Behind the innocent appearance, however, there are a lot of interesting fluid mechanics whose modelling are challenging (and rewarding in terms of learned physics).

The system is made of two immiscible fluids illuminated from below by an incandescent lamp. Since the fluids have different transparency they absorb the light, and consequently heat up, at different rates. As a result, the more opaque fluid expands more and starts rising because of buoyancy. However, the more it rises the more it moves far from the heat source thus becoming cooler than the fluid below and sinking.

In order for a physical model to capture the described dynamics multiphase flows with interface tracking and heat exchange are needed. These features are already implemented in some of the numerical codes available to the Physics of Fluids group with phase-field method. An important extension is needed to describe with enough fidelity the "lava lamp" mechanism: In fact, the light is emitted from the incandescent lamp as rays that decay along the way crossing the fluid layer, thus a model for the absorption of light cast in rays is needed. The physics behind the sinuous motions of colourful blobs are fascinating and deserve further exploration.

Figure 1: A snapshot of the lava lamp. [from Youtube]

## Assignment

In this project we conduct direct numerical simulations of multiphase flow with heat exchange, and aim at understanding the driven physics behind the blob motion (the key control and response parameters) and build a model to describe the flow motion. We will also extend the simulation capabilities of a code for multiphase by adding a model for the absorption of light cast in rays and (if time permits) a mechanism of ray-tracing to determine which regions are illuminated by a light source and which are in the shade.


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