BEP project for Applied Mathematics/Applied Physics double degree

Analytic solution for magnetohydrodynamic and thermocapillary flow in a liquid layer

Analytic solutions to simplified problems are still used for validation of numerical models. Within our section, we have derived an analytic solution for a liquid layer that is subjected to a potential difference and a spatially non-uniform magnetic field. The resulting current and Lorentz force, deforms the interface to a certain degree.

Within our department, we are working on simulations of liquid metal flows. In such flows, large temperature gradients lead to large gradients in surface tension, which creates a strong force driving the flow of liquid metal (Marangoni force). Sen and Davis [1] have analyzed the flow and free surface subjected to such a Marangoni force, but did not include Lorentz forces in their derivation.

In some industrial applications (e.g. welding), both Marangoni forces and magnetic flow control are important. Therefor, the task of the student will be to combine the Marangoni and Lorentz force and mathematically derive expressions to describe the behavior of the liquid-gas interface and the flow. This will result in a solid basis for further research on thermocapillary and magnetohydrodynamics forces.

[1] Sen, Asok K., en Stephen H. Davis. “Steady thermocapillary flows in two-dimensional slots”. *Journal of Fluid Mechanics* 121 (1982): 163.

Project details

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Prerequisites: Good analytical skills are required. The course WI4019 “*Non-linear differential equations”* is not required, but will likely help you in completing this project.

Extensions: This project is also suitable for a MSc project, when the task of the student will be extended with numerical work on the test case.