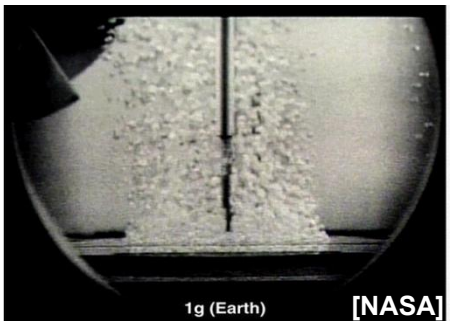
Technische Universität Braunschweig

Institut für Raumfahrtsysteme

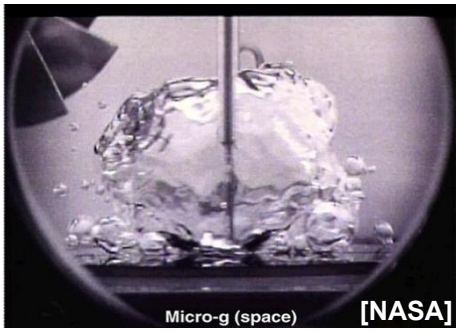
Student thesis announcement (SA/MA)

Numerical Simulation of Nucleate Boiling in Microgravity

Utilizing high-performance cryogenic propulsion for in-space transportation systems significantly advances the capability to execute complex exploration and servicing missions. The limiting factor for cryogenic propellants in space is their low boiling point, which leads to significant propellant loss when stored for long durations. Cryogenic refrigeration aims to overcome this issue by enabling zero boil-off (ZBO) storage of these propellants.



Developing these systems requires the ability to predict cryogenic liquid behavior and its interaction with the storage and refrigeration hardware under microgravity conditions. Of particular interest is the phenomenon of nucleate boiling at insulation penetrations and during the chill-down of storage tanks and feed lines. This proposed thesis focuses on implementing a simulation framework in OpenFOAM to investigate the influence of gravity, orientation, and subcooling on the bubble nucleation, subsequent growth, and detachment.



Tasks:

- Literature research on the mechanisms relevant in nucleate boiling and existing modelling approaches
- Selection of appropriate numerical models to simulate nucleation and subsequent bubble growth at a single nucleation site
- Validation of the selected model using experimental data from literature

Requirements:

- Capable of working in a reliable and self-motivated way
- Prior experience with CFD (ideally OpenFoam)

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