Fluids and Space Engineering Seminar

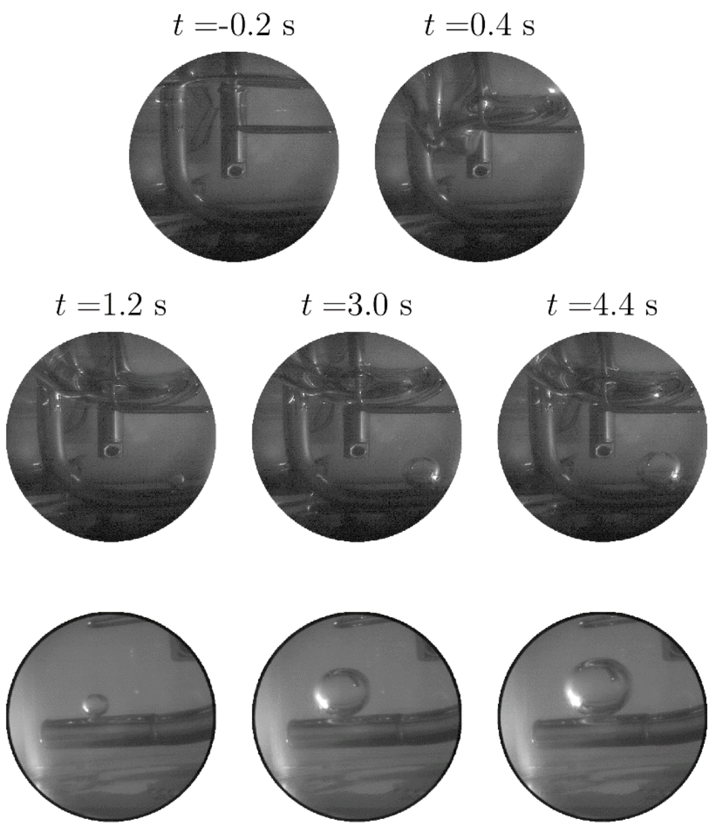
Date: Thursday, May 11, 2023 at 14:15 h
Location: ZARM, Room 1730

Vapor Bubble Growth in Liquid Methane in a Microgravity Environment

Niklas Weber

Department of Fluid Mechanics

University of Bremen, Center of Applied Space Technology and Microgravity (ZARM)



Bubble growth at an artificial nucleation site caused by a depressurization.

Spacecraft using cryogenic fuels are currently in development to extend the duration of missions from hours to weeks and months. To mitigate the pressure rise caused by the transfer of thermal energy into the tank from the environment or introduce a subcooling into the bulk liquid to allow for transfer, venting maneuvers are a possible operation. These maneuvers transfer thermal energy from the liquid to the vapor through phase change. A following repressurization can then introduce the required subcooling in the bulk liquid. Depressurization maneuvers will introduce a superheat in the bulk liquid, that was previously at the saturation temperature of the initial pressure, and thus lead to large-scale phase change occurring both at the free surface and at favorable nucleation sites at the tank wall. Here, the dynamics of vapor bubble growth are different from nucleate boiling because the superheat is spatially uniform. To ensure that behavior on the technical scale can be modelled, data on the scale of a single nucleation site was gathered.

The results shown here aim to investigate the phase change process at a single nucleation site caused by either depressurization or heating. Microgravity ensures comparable conditions to spaceflight applications and allows for extended observation time due to the absence of buoyancy. The use of a cryogenic fluid allows for a range of scaling parameters that is close to spaceflight applications.