Coalescence of bubbles in air and non-Newtonian fluids

Despite the significant importance of the coalescence of individual bubbles for the growth, structure and microscopic properties of foams, very few studies have dealt with the detailed fluid mechanics of the fusion of liquid films. These investigations will now be carried out.

When two soap bubbles are brought together, the liquid films of the bubbles deform at a small distance from each other: the bubbles form a dimple and thus enclose a tiny volume of air. At the crests of the dimple the distance between the bubbles is smallest, such that the liquid bridge can form there. The two individual films of the bubbles merge into a single one. The rim of the spreading film is accelerated for a short moment. During this time a Rayleigh-Taylor instability sets in which leads to an instability of the rim of the liquid film. The velocity of the rim is higher in the dimple area because the curvature in this area is greater. After coalescence, two bubbles remain which share a common film.

In this research project the fluid mechanics during the fusion of two Newtonian and non-Newtonian soap bubbles shall be experimentally recorded, described and compared with numerical models. The Rayleigh-Taylor instability occurs within one microsecond. The assumed wavelength of the instability is only a few micrometers. In order to achieve the above-mentioned goal, the spatial and temporal resolution of the experiment must be significantly improved: Among other things with a quasi-two-dimensional configuration of the experiment to enable the observation of instability from the side view (not as previously in a top view) as well as the use of an ultra-high-speed camera and a long-range microscope. At the same time, the experiments will be compared with external numerical models.

A further goal is to investigate the coalescence of gas bubbles in a soap solution, since so far only work in pure water or salty solutions has been carried out. The presence of surface-active substances will have a significant influence on the physics of coalescence in this system. Important information to be obtained from the experimental work is the coalescence time of the bubbles as a function of their collision velocity and the coalescence time as a function of the viscosity ratio between bubble and soap solution (with Newtonian and non-Newtonian liquids). For this purpose, a suitable method shall be established to determine the beginning of the interaction of the bubbles, i. e. at which distance the bubbles interact when they are moved towards each other from a sufficient distance.