Chair: Physics of Fluids group

Nonlinear oscillations of a microcrevice bubble

Description

Acoustic cavitation is the formation, oscillation and collapse of bubbles induced by acoustic waves. Researchers have found a plethora of industrial and medical applications for this phenomenon, such as ultrasonic cleaning, sonochemistry, lithotripsy or drug delivery. While proven to be extremely useful when utilized carefully, acoustic cavitation can also be detrimental if not properly controlled, e.g. in biomedical context.

One of the ways of controlling cavitation is through introduction of small crevices to the system. As a result of surface tension, such crevices entrap gas bubbles when submerged in a liquid. This allows them to serve as cavitation nucleation sites. At mild ultrasonic driving, these bubbles display (nonlinear) surface mode oscillations, which can be well described analytically. Under strong ultrasonic driving the bubbles grow beyond the bound of their cavity and can ultimately release a cloud of micron-sized bubbles. The exact mechanism of this phenomenon remains unexplained.

The objective of this project is to investigate high amplitude, non-linear oscillations of crevice bubbles in order to understand the physics of the aforementioned phenomenon. Together with our team you will investigate the influence of the crevice shape on the behavior of said gas pockets. You will therefore employ a novel back-illumination technique, utilizing laser-induced fluorescence (Fig. 1), in combination with ultra-high-speed imaging (a few milion frames per second). You will compare the collected data with a theoretical model developed by our team, which you will adapt to new boundary conditions.

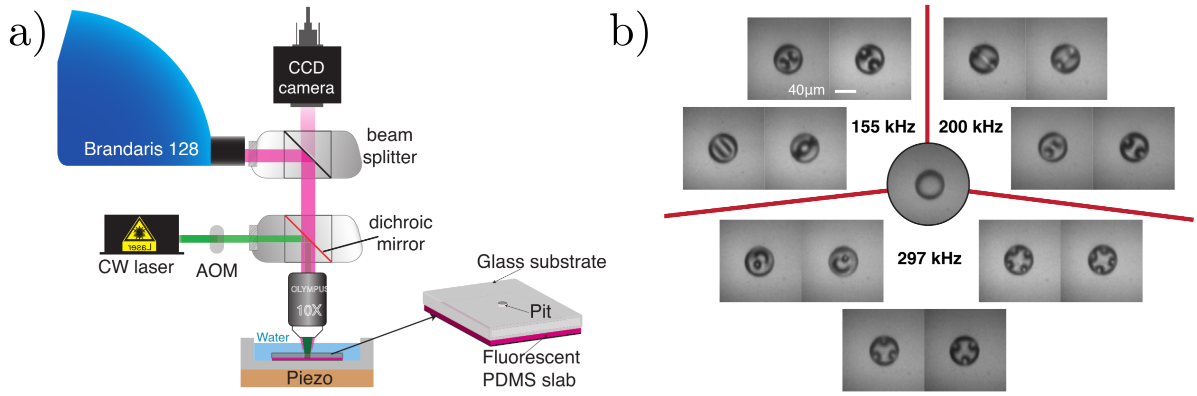

Figure 1: a) Experimental setup to be used in the assignment. b) Examples of surface modes observed on the surface of a bubble trapped in a circular crevice, at three different driving frequencies: 155, 200 and 297 kHz. Presented in the center is the initial state of the bubble.

Assignment

1. Investigate high amplitude, nonlinear oscillations of crevice bubbles in a liquid medium.
2. Research the influence of shape and dimensions of the crevice on said phenomenon.
3. Compare the collected data with the predictions of the theoretical model and simulations (you will adjust the aforementioned to new boundary conditions).

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