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Untersuchungen zur Struktur und Dynamik freitragender flüssiger Filme

In this thesis, the dynamics of three systems was studied by means of an ultra-fast camera:

- the bursting of thin liquid films,
- the catenoid collapse and
- oscillations of bubbles.

During the investigations of the rupture of thin films the liquid crystal 8CB (4′-Octyl-biphenyl-4-carbonitrile) was used preliminary, which was in the smectic A phase in the performed experiments. With this substance it was possible to observe the film thicknesses by means of a contactless method even during the rupture process. The film thicknesses of smectic bubbles were of the order of 1 µm.
The established model of the bursting of thin films was verified.
Recordings with the highest possible frame rate of 10^5 images per second confirmed the assumption that the liquid behaves like a non-viscous substance during rupture. A discrepance of the linear dependency of the rupture velocity on time could not be shown, even at this high frame rates. Further, an increase of the film thickness was detected during rupture, which was also observed in case of films made of a tensile solution.
Another phenomenon, observed specifically for films made of 8CB, is the scattering of transmitted light. This scattering is caused by the travelling of transversal waves in the smectic film. These travelling waves can only be found in smectic materials due to their inner structure and cannot be detected in soap films.

The investigation of the catenoid collapse was only performed with the substance 8CB. The catenoids were spanned between two rings with a radius of 4 mm.
The influence of both the air and film inertia on the dynamics of collapsing catenoids was studied. The dependence on film inertia was pinted out by the analysis of the collapse with different film thicknesses. The influence of the surrounding air was seperately studied by observing the collapse of a catenoid placed in a plexiglass box, which could be evacuated.
The film and air inertia also reflect in the shape of the catenoid during the collapse. Three different shapes of the catenoids during collapse were found. In the first scenarium, air was included into the catenoid, which resulted in a satellite bubble. The second appearance was the formation of a filament. In this case, all the air inside the catenoid could escape. In the third case, a mixture of both shapes could be observed.

The third part of this thesis deals with the oscillation of soap bubbles. The bubbles were placed in a plexiglass box and swam on a layer of butane. At the fusion of two bubbles, a so called Plateau border formed out, which stimulated bubble oscillations as it bursted.
It was proven in the experiments that the assumption of rotational symmetric bubbles holds. A seperation of the bubble shape into spherical harmonics resulted in an oscillation of each mode for $n > 0$. The frequencies of the modes depended strongly on the average bubble radius. A dependency of the frquency of the second mode on the average bubble radius ($R >$ 14 mm) was found. These frequencies of 9 analysed bubbles fitted well to the values calculated by the model of Lamb.
The results emphasize the occurance of a couling of the single modes. The reason of this coupling is not verified, yet.
The damping of the second mode depended strongly on the average bubble radius. For radii higher than 14 mm (smaller bubbles were not analysed) the damping increased linearly with the bubble radius.