Acoustic cavitation and bubble dynamics

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High intensity acoustic fields in liquids lead to rupture of the liquid and the formation of cavities or bubbles, a phenomenon called acoustic cavitation. Cavitation bubbles in ultrasonic standing wave fields aggregate in the form of dendritic filaments. These structures form due to attractive and repulsive forces exerted by the acoustic field and the interaction between the oscillating bubbles. The aggregations rearrange on a time scale slow in relation to the fast bubble oscillations. High and medium speed cinematography is employed to observe bubble motion on both time scales related to the oscillation and the translation of the bubbles. To catch the three-dimensional motion holography and stereoscopic digital videography is used. Via digital picture processing first the three-dimensional position of the bubbles and their sizes are determined. In a second step, the bubbles are tracked from frame to frame to obtain the complete space-time dynamics of bubble aggregations. Examples of bubble tracks in cavitation bubble fields at sound field frequencies around 20 kHz and of velocity distributions are given. Also the emission of light by these bubble structures is monitored. A theoretical model has been constructed simulating bubble motion including interaction forces. Numerical calculations will be compared with observations. The basis of bubble aggregation behaviour stems from individual bubble behaviour. This aspect is also covered presenting our observations with single laser-produced bubbles, in particular their collapse, jet formation under aspherical conditions, light and shock wave emission. Our new approach to single bubble dynamics via molecular dynamics calculations of the molecules moving inside the bubble will be presented.