Tension cell for measuring bubble dynamics

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Scientific Context :

The phase change transition from liquid to vapor by pressure decrease is known as cavitation. Despite of its crucial role in several engineering and scientific fields having a societal impact (cracking molecules, mechanical destruction or even spatial activities because of the cryogenic pumps), the physics of this complex mechanism is not well described. One of the reason is the experimental difficulty of measuring the thermodynamical parameters of random events. We propose here an original approach aiming in controlling the growth and the collapse of a single cavitation bubble precisely located in order to carefully analyze the driven thermodynamical parameters.

Vapor bubble nucleation and growth is driven by a pressure drop below the liquid vapor pressure. Producing and exciting a bubble for single bubble experiments is most commonly done with the help of pulsed ultrasound in the liquid. Other options are the tube arrest method and a pulsed laser, both of which create a pressure wave to create the bubble. However, none of these methods allow for a precise and fast control of the growth and collapse time (interface dynamics). In addition, this different approaches generate a so-called acoustic cavitation that behaves differently from the most classical hydrodynamic cavitation that is produced, because of the Bernoulli's principles, when a fluid is accelerated.

Missions :

Our approach uses a high force piezoelectric transducer to exert tension on a confined small volume of liquid. A particle would be placed in the liquid to serve as a nucleation point and at the same time as a probe for monitoring the physical parameters of the bubble (temperature, pressure ...). The presence of the particle will lower the cavitation threshold and allows for a predictable positioning of the inception bubble. The study on single bubble will be pursued in parallel with a study of the thermodynamic properties of hydrodynamic cavitation on lab-on-chips micro-channel by using optical probes of temperature and pressure. Thus the single bubble experiments will serve as a model to understand the thermodynamic behavior of the more complex flow.

Outlooks :

The project can be extended to a PhD through doctoral school funding depending on the student examination success.

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