Dynamic of Laser-Induced Bubbles in a Flowing Liquid

**Objectives:**

1. Build a non-intrusive optical setup to generate on demand one laser-induced bubble in flowing liquid
2. Observe the dynamic of a laser-induced bubble when generated in water flowing around a hydrofoil

**Experimental Setup**

A high energy laser is focused in the water flowing in the LMH cavitation tunnel. The energy of the laser vaporizes the water and a small bubble of vapour (cavitation bubble) is generated.

**Bubbles in Uniform Flowing Water**

First tests have been done without hydrofoil in LMH cavitation tunnel test section. The flow is therefore uniform in the test section. Single laser-induced bubbles have been generated in liquid flowing at different velocities and pressure levels. Spherical bubbles are obtained (the stripe in the left margin of the poster shows the evolution of one of these bubbles). The observed radius of the bubble during the collapse as a function of time is compared to a theoretical model for bubble collapse: the Rayleigh-Plesset model.

The experimental results fit well with the theoretical model (see non-dimensional graph on the right). The bubble generated by the experimental setup behaves in accordance to theoretical predictions. This validates and justifies the use of this experimental setup for bubble observation. The observed collapse and rebound take the shape of a Type 1 bubble. But in addition an instability (i) appears on the front of the bubble.

**Bubbles in Water Flowing around the Hydrofoil**

When a bubble collapses near a solid boundary in water at rest, it has been shown that a liquid microjet is directed towards the solid boundary, opposite and perpendicular to the bubble. Moreover, the observation done in this study showed that, depending on the location where the bubble is generated, the microjet is directed towards the hydrofoil solid surface or not.

**Conclusions**

- A reliable and flexible laser-induced cavitation bubble generator has been build.
- The centre of a bubble generated in uniform flowing water moves at the velocity of the liquid.
- Bubbles generated in uniform flowing water behave according to the prediction of the Rayleigh-Plesset model.
- Observation of bubbles generated near a hydrofoil in flowing water highlights the self-rotation of the bubbles.
- Depending on the position of the generation of a bubble around the hydrofoil, the behaviour of the bubble (lifetime, size, direction of microjet) is different.

- The microjet is not necessarily directed towards the solid boundary (surface of the hydrofoil), it depends on the location where the bubble is generated.
- An inhomogeneous cluster of microbubbles traveling on the hydrofoil (the rebound of a bubble generated upstream to the hydrofoil) reorganizes itself, taking the same shape as a homogenous bubble would take under the same conditions.

**Author:** Marc Tinguely
**Supervisor:** Dr. Mohamed Farhat