Proposal of a PhD position – AOE Department

Funding: ½ GRA position

Supervisor: Olivier Coutier-Delgosha, Ass. Prof. in the AOE dept / CREATe research center

Labs: see https://ocoutier.wixsite.com/cavitationlab

Discipline area: Fluid mechanics – Multiphase flows

Preferred qualifications: A strong motivation for experimental work and a good background in fluid mechanics are required. A previous significant experience in some experimental work would be appreciated.

Project summary: the project is focused on the investigation of the mechanisms of implosion of a cavitation bubble. This is a very fast and violent phenomenon, involved in many naval, aerospace, and mechanical applications, which induces both high temperatures and pressures in the gas inside the bubble. Temperatures as high as 5000°C have been indirectly measured, and temperatures as high as 1M °C have been even predicted by numerical models. Pressures up to several GPa are also expected but have never been measured so far. These extreme conditions are due to the high gas compression at the end of the bubble collapse, which occurs much faster than any thermal exchange, so the transformation is almost adiabatic. The challenge of this project is to develop and apply an appropriate instrumentation to measure these quantities, as well as the bubble composition evolution. A device for temperature measurements, based on the use of ultra-fast cold wires, has been developed in the last 3 years and will be optimized in the scope of the present project. As for the pressure, the objective is to use some fast response pressure sensitive paint combined with high speed imaging. After the instrumentation will be operational, it will be applied to various single bubble and multiple bubbles configurations, using an existing and unique setup in the lab where two bubbles can be generated with a controlled size, delay and respective distance, using two high intensity pulsed lasers. This setup will enable to investigate the complex mechanisms of bubble / bubble interactions, and the effects of these interactions on the wall erosion, which is a well-known phenomenon associated with cavitation. In addition to cavitation in water, ionic liquids may be also studied, as the collapse of cavitation bubbles in such liquids is a major challenge in medical applications like drug delivery.

This project will be performed in collaboration with other on-going projects currently funded in the lab by ONR and NSF.

Specific requests: no nationality request / only open to PhD students - MS students, if interested, are welcome to contribute to the project, but will not be funded.