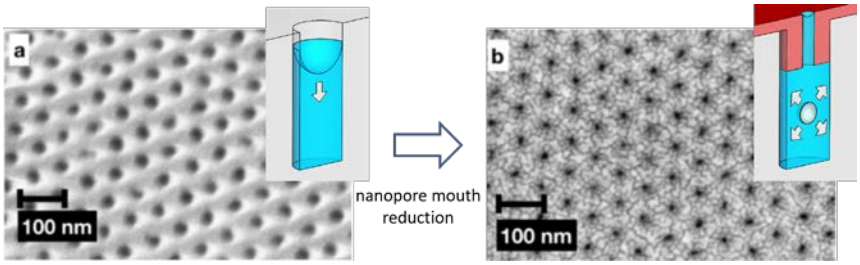
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2021-2022

Cavitation in nanoconfinement

General Scope: Cavitation, the thermally activated nucleation of a vapor bubble in a stretched liquid, is a ubiquitous phenomenon, from engineering to natural sciences. Away from surfaces, cavitation is expected to obey the homogeneous Classical Nucleation Theory (CNT). Up to recently, precise checks only relied on transient, acoustically driven, cavitation. We recently provided the first experimental verification of the CNT using a static method, based on an extension of the so-called artificial tree technique [1] to nanoporous membranes [2,3]. Our result opens the way to further studies, such as understanding the influence of nanoconfinement on cavitation, and, using helium as a fluid, the possible influence of quantum effects on cavitation.



Left: in native nanopores, evaporation unfolds through meniscus recession. Right: after pore mouth reduction, the meniscus is pinned and cavitation is induced

Research topic and facilities available: The candidate will develop a new cryogenic set-up to detect cavitation of liquid helium using a capacitive detection scheme. He/she will use this set-up to study cavitation down to 1 K deep into the superfluid phase, in a region where previous experiments using acoustically driven cavitation yield unexplained results. In parallel, the influence of confinement on cavitation will be explored in the normal phase.

Possible collaboration and networking:
This project involves an on-going collaboration with partners in Paris (LPENS and INSP). Its future development may involve collaboration with colleagues in Lyon (ILM) and Grenoble (LiPhy).

Possible extension as a PhD: yes

Required skills: A solid background in condensed matter physics is required. The candidate should have a broad interest for fundamental physics and experimental techniques, be self-motivated and have a strong curiosity about new phenomena.

Starting date: Any time in the year
Contact: Panayotis Spathis Institut Néel - CNRS
e-mail : panayotis.spathis@neel.cnrs.fr
More information : https://neel.cnrs.fr/equipes-poles-et-services/helium-du-fondamental-aux-applications-helfa

[1] Wheeler T. D. and Stroock A. D., The transpiration of water at negative pressures in a synthetic tree, Nature 455, 208 (2008).
[2] Doebele V., et al, Direct observation of homogeneous cavitation in nanopores, PRL 125, 255701 (2020)
[3] Bossert M., et al, Evaporation process in porous silicon: cavitation vs pore-blocking (2021), to appear in Langmuir