INSTITUT NEEL, Grenoble (France)

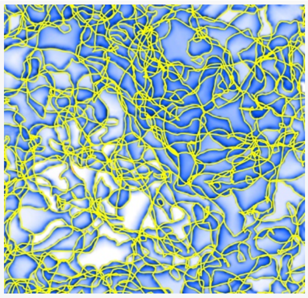
Master 2 internship + PhD thesis fellowship – (2019-2022)

Quantum turbulence & Superfluid vortices dynamics

Context :

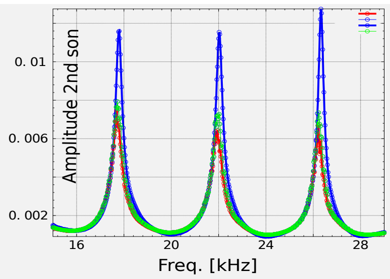
Below 2.17 K, liquid helium acquires spectacular quantum properties, among which viscous free flow and quantization of vorticity. It is therefore expected that its turbulence, called "Quantum Turbulence" or “Superfluid Turbulence”, differs from its classical counterpart.

Surprisingly, several studies suggest that the only difference between classical and quantum turbulences is concentrated at micro and nanoscales. At such small scales, in the absence of an efficient viscous-dissipation mechanism, a tangle of energy-containing atomic-diameter quantum vortices is predicted to stack up, but this effect has never been measured directly.



Tangle of superfluid vortices (simulations Baggaley et al.)

The uncertainty about the physics at play at such scales is a central limitation in our ability to perform simulations of very intense quantum turbulence.



Resonance modes of a miniature 2^nd^ sound cavity, with a flow passing through it, and carrying many (red) or few (blue) quantum vortices.

Project :

The objective of the Master M2 internship and following Thesis is to: (1) explore experimentally the micro/nanoscale of quantum turbulence, (2) develop a analytical model accounting for the physics at play

A key experimental tool will be our new-generation probe of quantum-vortices, named "second sound tweezer" and based on the attenuation of thermal waves by quantum vortex (see figure). These thermal waves stand in an open micro-cavity, cut across by the flow. They will be operated in our superfluid wind tunnel TOUPIE and in the collaborative SHREK experiment.

Collaboration : This study is part of a inter-laboratory ANR collaboration aimed at improving HPC quantum flow simulations (Centrale Lyon / CNRS / ENS / Grenoble-Alpes Univ./ Poitier Univ./ Rouen Univ.)

Keywords : Hydrodynamics, Turbulence, Quantum fluids, Superfluid, Nanotechnologies, Micro-fabrication, Instrumentation, Signal processing, Closure model

Application: The applicant should have a major in Physics or Fluid Mechanics (from university, engineer school or equivalent). Please send CV + records of academic exam results + recommendation letter.

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