

Laminar-turbulent transition in a superfluid helium boundary layer

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PhD may follow: Yes

Summary :

The aim of this training period is the experimental study of the transition to turbulence in a superfluid He (below 2.17K) boundary layer at the surface of an oscillating plate. Superfluid helium is often described a mixture of two independent components: the normal component is viscous and governed by the standard Navier-Stokes equation while the superfluid component is inviscid.

The way those two components interact to form a boundary layer is poorly documented. In particular, below a critical Reynolds number (often associated to a velocity in the literature), it is expected that only the normal component is influenced by the presence of the moving plate. It is one of the hypothesis we shall address during the training period.

Full description :

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The work shall be divided into 3 parts:

* First the student will have to improve the experimental apparatus, mainly the automation of the driving motor and the guide system for the oscillating plate.

* Then the measurements, mainly based on "second sound acoustics" which is a powerful way to detect the appearance of turbulence. The vorticity in a superfluid boundary layer can be detected thanks to the attenuation of the temperature waves (second sound) it will provoke. Those waves, superfluid specific, are the manifestation of the propagation of heat. In our experiment we observe spontaneous standing second sound waves when the flow is switched on and one of the aims of the training period will be to determine their origin. For this purpose, the second sound detection which is currently achieved using an electro-acoustic receiver (known to also convert first into second sound) will be backed with a second thermometric sensor.

* Finally the student is expected to process the experimental data using whatever programming language he prefers (Python, Matlab/Octave, etc.). This is a very important part part of the task.

Requested skills :

Fluid dynamics, Computer programming. Basics in electronics.