# Rotating counterflow in Helium II: from waves to quantum turbulence


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**Résumé**

Discovered in 1937, He II is a key system for studying superfluid dynamics, which remains not fully understood. Superfluid phases have exotic properties, including the presence of topological defects known as quantum vortices. Counterflow quantum turbulence, which demonstrates energy transfer through vortex reconnections occurring in vortex tangles, has no classical counterpart.

Our experimental apparatus, the CryoLEM (Cryogenic Lagrangian Exploration Module), is a temperature-controlled, rotating cryostat designed for the direct visualization of vortices in He II through the injection of micron-size solid H2 or D2 tracers that stabilize on vortices (1,2). A heater located in the experimental volume enables us to study counterflow regimes under rotation.

The hydrodynamical regimes of rotating He II in counterflow were first studied in (3). By imposing a heat flux in the fluid, they observed an increase in vortex line density above a flux threshold, interpreted as a transition to turbulence. We demonstrate that the regime below this threshold is characterized by a wave-like deformation of the vortex lattice (see Figure 1). The presence of inertial waves on the lattice becomes evident by analyzing its energy spectrum. There are indications of Kelvin waves that require further investigation.

We also observe that the regime above the threshold corresponds to a turbulent state of interacting vortices. To understand the role of the counterflow in this transition, we investigate the temperature dependence of this threshold. For T > 2 K, the extrapolated results from (3) align well with our findings.



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(2) J. Vessaire *et al.*, Rev. Sci. Instrum. (2026).

(3) C.E. Swanson *et al.*, Phys. Rev. Lett. **50**(3), 190 (1983).


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