SAPIENZA
UNIVERSITÀ DI ROMA

Seminario - Vortex rings lifetime enhanced by friction interaction in superfluid helium -

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Helium II is characterised by a two-fluid nature where the two fluid components, the superfluid and the normal fluid, interact via a mutual friction force arising from the relative motion of superfluid vortices with respect to the normal component. The physical and numerical modelling of this friction force and its impact on the normal fluid motion is a long-standing open issue in low-temperature physics.

To make progress, in this seminar I will present a novel algorithm, named FOUCAULT (Fully cOUpled loCAl model of sUperfLuid Turbulence) [1], for the numerical simulation of quantum turbulence in helium II at non-zero temperatures. Peculiar to our method is the modelling of the mutual friction force via a classical, low-Reynolds number approach and its regularisation employing a theoretical framework developed in the context of active particles in classical turbulence [2]. In addition, our innovative numerical architecture allows the resolution of a wider range of flow length scales compared to the previous literature.

We employ this novel algorithm to study the behaviour of toroidal superfluid vortex bundles. We observe that while in ordinary systems friction slows down the speed of structures reducing their lifetime, in superfluid helium the mutual friction can enhance the lifetime of vortex structures, also as a result of vortex collective interactions. This behaviour is consistent with experimental observations [3] and in contrast to predictions of previous numerical models.

(Joint work with Giorgio Krstulovic, Carlo Barenghi and Andrew Baggaley)

[1] L. Galantucci, A. Baggaley, C. Barenghi, G. Krstulovic. *A new self-consistent approach of quantum turbulence in superfluid helium*, Eur. Phys. J. Plus 135, 547 (2020)
[2] P. Gualtieri, F. Picano, G. Sardina, C.M. Casciola. *Exact regularized point particle method for multiphase flows in the two-way coupling regime*, J. Fluid Mech. 773, 520 (2015)
[3] H. Borner, T. Schmeling, and D. Schmidt. *Experiments on the circulation and propagation of large-scale vortex rings in He II*, Phys. Fluids 26, (1983).