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"Superfluidity, vortices and quantum turbulence in atomic systems"

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Résumé de la thématique du minicolloque :

Superfluity and related phenomena were very early associated to Bose-Einstein condensation (BEC), while superfluid helium was the prototype system for the study of Quantum Turbulence (QT). Although the strong (and hardly controllable) interactions in superfluid helium make this system different from Einstein's ideal gas model of BEC, the two systems share similar features when complex vortex interactions lead to QT (also called vortex tangle turbulence).

The study of quantum fluids with vortices and QT is nowadays a central topic in various fields of physics, such as low temperature physics, fluid dynamics of non-viscous flows, quantum physics, statistical physics, cosmology, etc. The quantum-mechanical understanding of superfluidity owes much to Feynman [1], who introduced the notion of quantized vortices through which a quantum gas can acquire angular momentum without vorticity anywhere, except at a singularity, the vortex core. Historically, Tisza and then Landau first developed the phenomenological *two-fluid theory* [2] for superfluid He, which enabled connections with classical turbulence, and most notably with Kolmogorov's theories [3,4]. Turbulence, a complex fluid behavior of nonlinear and statistical nature [5-9], appears in many physical systems, from laboratory to geophysical and astrophysical scales. Classical turbulence is still an open problem, and Quantum Turbulence (where experiments in dilute systems lacked until recently [10-14]) even more so, as the quantized nature of vortices induces severe restrictions in the dynamics of the superfluid.

The concept of "quantum simulators" emerged recently as a driving force in the fields of quantum atomic gases and light fluids. These platforms form very "clean", almost defect-free systems, offering powerful tools: precise control of fundamental parameters, direct access to the wavefunction, as well as a fine-tuning of dissipation and disorder. Quantum simulators can mimic complex systems in controllable conditions. Superfluidity and related phenomena, including QT, are prone to quantum simulation.

The aim of this mini-colloquium is to bring together theorists and experimentalists working on quantum turbulence in various branches of physics, ranging from quantum gases and superfluid helium to optics and condensed matter. This will hopefully trigger discussions of recent results, sharing the knowledge in this subject and possibly initiate new collaborations. Experimental, theoretical and numerical contributions from atomic physics, optics and condensed matter physics are welcome in this mini-colloquium.

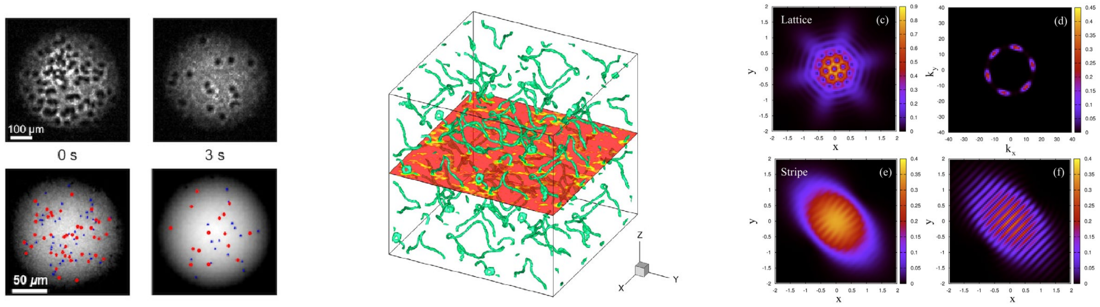

Figure 1. Vorticity and turbulence in quantum fluids (images from [7-9])

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