

TANGLED VORTEX LINES

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ABSTRACT

Turbulent streamlines, vortex lines or magnetic field lines are usually chaotic, twisted, even apparently linked or knotted. In this lecture I shall address the problem of the complexity of turbulence in the context of quantum fluids, physical systems such as superfluid helium and atomic Bose-Einstein condensates which are studied in the laboratory at temperatures close to absolute zero. In quantum fluids, any rotational motion is constrained by quantum mechanics to individual (discrete) vortex lines of fixed (quantised) strength [1]. This is unlike what happens in ordinary fluids, where vorticity is a continuous field. *Quantum turbulence*, created by stirring a quantum fluid, is thus conceptually simpler than ordinary turbulence, consisting of a tangle of individual vortex lines rather than a disordered continuous vorticity field. After describing some surprising similarities between quantum turbulence [2] and ordinary turbulence in terms of energy spectrum and velocity statistics, I shall show how the geometry and the topology of quantum turbulence can be quantified in a relatively simple way [3, 4].

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- [2] Barenghi C.F., Skrbek L., and Sreenivasan K.R. 2014 Introduction to quantum turbulence, *PNAS USA* **111** (Suppl. 1), 4647.
- [3] Cooper R.G., Mesgarnzhad M., Baggaley A.W. and Barenghi C.F. 2019 Knot spectrum of turbulence, *Sci. Reports* **9**, 10545.
- [4] Barenghi C.F. 2022 Tangled vortex lines: dynamics, geometry and topology of quantum turbulence, In *Knotted Fields* (ed. R.L. Ricca & X. Liu), to appear, Springer. arXiv:2207.04260v1.