Numerical Simulation for Quantum Turbulence in Atomic Gases

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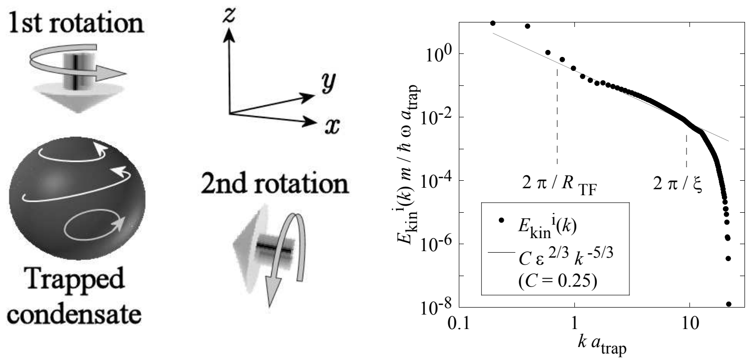
Understanding turbulence has been one of the greatest scientific challenges. Classical turbulence is believed to consist of eddies that constantly nucleate, diffuse, and disappear, and therefore cannot be well defined. In contrast, quantum turbulence is comprised of well-defined quantized vortices and is an ideal prototype for studying turbulence [1].

Although superfluid helium has previously been the only known example of quantum turbulence, we propose quantum turbulence in trapped Bose-Einstein condensates as an alternative example. In contrast to superfluid helium, trapped BECs allow control of almost all physical parameters and direct observation of quantized vortices. By using the Gross-Pitaevskii equation, we numerically studied quantum turbulence in a trapped BEC under combined rotations around two axes (Fig. 1(a)), and confirmed the Kolmogorov law (Fig. 1(b)), the most important statistical law in turbulence [2]. We expect that trapped BEC systems will ultimately allow controllable turbulence.



(a) (b)

Fig. 2: (a) Schematic sketch of the rotation. The first rotation is applied along the z-axis and the second rotation is applied along the x-axis. (b) Wave number k dependence of the energy spectrum $E^{i}_{kin}(k,t)$.

[1] W. F. Vinen and R. Donnelly, Physics Today **60**, 43 (2007).
[2] M. Kobayashi and M. Tsubota, arXiv:cond-mat/0703603.