Quantum turbulence and nonlinear instability in quantum fluids

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Abstract:

We will discuss quantum turbulence and related nonlinear instability. In quantum condensed systems appear quantized vortices through the order parameters (macroscopic wave functions), and turbulence consisting of quantized vortices is called quantum turbulence (QT). Quantized vortices and QT were discovered in superfluid helium in the 1950's, while they have become one of the most important themes in low temperature physics [1]. The recent striking output would be the confirmation of the Kolmogorov law (K41) of the energy spectra through the Gross-Pitaevskii model [2]. Nowadays QT is studied actively in superfluid ^{4}He and ^{3}He, even in cold atoms [3]. In this talk, we will first introduce the recent main motivations and the results in QT. Then we will discuss some current topics on nonlinear instability in quantum fluids. One is quantum Kelvin-Helmholtz instability (KHI) in two-component Bose-Einstein condensates [4]. KHI is well known in classical fluids, while we discuss characteristic phenomena of quantum KHI in quantum fluids. The other is realization of steady state in thermal counterflow QT in superfluid ^{4}He [5]. This system reminds us of the pioneering work by Schwarz [6], which had some difficulties. By considering the full interaction between vortices, we overcame the difficulties to obtain the steady state.

References:

1. *Progress in Low Temperature Physics*, ed. W. P. Halperin and M. Tsubota (Elsevier, Amsterdam, 2008) Vol.16.
2. M. Kobayashi and M. Tsubota, Phys. Rev. Lett. 94, 065302 (2005): J. Phys. Soc. Jpn. 74, 3248-3258 (2005).
3. E. A. L. Henn *et al.*, Phys. Rev. Lett. 103, 045301 (2009).
4. H. Takeuchi, N. Suzuki, K. Kasamatsu, H. Saito and M. Tsubota, arXiv:0909.2144.
5. H. Adachi, S. Fujiyama and M. Tsubota, arXIv:0912.4822; Phys. Rev. B (in press).
6. K. W. Schwarz, Phys. Rev. B 38, 2398 (1988).