Spin turbulence in spin-1 spinor Bose-Einstein condensate with antiferromagnetic interaction

K. Fujimoto and M. Tsubota

Department of Physics, Osaka City University, Japan

We theoretically and numerically study turbulence in spin-1 spinor Bose-Einstein condensates (BECs) with antiferromagnetic (AF) interaction by using the spinor Gross-Pitaevskii equation. In this system, the dynamical instability is caused by the counterflow, leading to the disturbed distribution of the spin density vector, which we call spin turbulence (ST) [1]. Previously, we investigate the ST in spin-1 spinor BEC with ferromagnetic interaction, finding that the spectrum of spin interaction energy exhibits the -7/3 power law [1]. In classical and quantum turbulence, the spectrum of kinetic energy is known to show the Kolmogorov $-5/3$ power law [2,3], but we found another power law in the ST. In this study, we investigate the ST in the spin-1 spinor BEC with AF interaction, showing the -1 and -7/3 power laws in the low and high wave number regions, respectively. These power laws can be obtained by the scaling analysis for the equations of spin density vector and nematic density tensor. However, our numerical calculation finds the -7/3 power law in the high wave number region, while the spectrum in the low wave number region deviates from the -1 power law.

1. K. Fujimoto and M. Tsubota, Phys. Rev. A 85, 033642 (2012); Phys. Rev. A 85, 053641 (2012).
2. U. Frisch, *Turbulence* (Cambridge University Press, Cambridge, 1995).
3. *Progress in Low Temperature Physics*, edited by W. P. Halperin and M. Tsubota, Vol. 16 (Elsevier, Amsterdam, 2009).

Section: QG - Quantum gases

Keywords: quantum gas, spinor Bose-Einstein condensate, spin turbulence