Spin-glass-like behavior of spin turbulence in spinor Bose-Einstein condensates

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We numerically study spin turbulence (ST) in spin-1 spinor Bose-Einstein condensates with ferromagnetic and antiferromagnetic interaction by solving the Gross-Pitaevskii equation. In the previous study[1] for ST with ferromagnetic interaction, the directions of the spin density vectors were found to be spatially disordered but temporally frozen. This behavior of ST is similar to that of spin glass. In this study, to characterize the "spin-glass-like" behavior, we calculate the order parameter of the spin glass. In ST with ferromagnetic interaction, we confirm the growth of the order parameter, which indicates that ST behaves like spin glass. On the other hand, in ST with antiferromagnetic interaction, we find that the order parameter does not grow. This means that spin density vectors temporally fluctuate, not being frozen. We suppose that whether the order parameter grows or not is caused by the different property of the dispersion relation in the low wave number region.

1. K. Fujimoto, and M. Tsubota, *Phys. Rev. A* **85**, 053641 (2012)

Section: QG - Quantum gases

Keywords: spinor Bose-Einstein condensate, turbulence, quantum gases