Magnetic Multipole Orders in Ring Exchange Models

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Motivated by quantum spin liquid observed in solid ^{3}He films, we studied the two-dimensional ring-exchange model with competing ferromagnetic two-spin interaction and antiferromagnetic four-spin ring-exchange interaction. Previous theoretical studies argued the appearance of quantum disordered phase between ferromagnetic and antiferromagnetic phases.

We presented a new scenario for the breakdown of ferromagnetic order. Dynamical effects lead to the formation of magnon bound states, which undergo Bose-Einstein condensation, giving rise to magnetic multipole order. This scenario was explored in some detail for the ring exchange model on a square lattice and a triangular lattice. On a square lattice, two-magnon bound states are most stable, giving rise to bond-centered spin nematic (quadratic) order. In particular, we presented numerical evidence confirming the existence of a state with d-wave nematic correlations but no long range spin order, lying between the saturated ferromagnetic and antiferromagnetic phases [1]. On the other hand, in the ring-exchange model on a triangular lattice, we found that three-magnon bound states are most stably formed, leading to the appearance of magnetic octupole order [2].

[1] N. Shannon, T. Momoi, and P. Sindzingre, Phys. Rev. Lett. **96**, 027213 (2006).
[2] T. Momoi, P. Sindzingre, and N. Shannon, in preparation.