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Unraveling the Ground State and Field-Induced Properties of the Quantum Dimer Magnet Yb2Si2O7

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Quantum dimer magnets represent a textbook example of quantum magnetism, where nearest-neighbor spins entangle to form spin singlets (dimers). The excitations of the quantum dimer magnet are a triplet of Stot = 1 states, referred to as triplons. An applied magnetic field causes the lowest energy triplet state (Sz = 1) to be driven to degeneracy with the singlet ground state, resulting in Bose-Einstein condensation (BEC) of the triplons. Typically, the magnetic field induced BEC state for quantum dimer magnets presents as a symmetric dome in the field vs. temperature phase diagram and the system can be effectively mapped to a BEC of triplons in the vicinity of the transitions into and out of the dome. Here we will discuss Yb2Si2O7 which exhibits a monoclinic lattice that forms distorted honeycomb layers of magnetic Yb3+ ions that eludes magnetic order down to 50 mK, entering a quantum dimer magnet state. In Yb2Si2O7, an asymmetric dome was observed in the phase diagram and the critical magnetic fields to enter the BEC are significantly smaller than those of other quantum dimer systems. Theoretical explanations of the asymmetric dome in the phase diagram have differed, particularly focusing on possible anisotropy in the exchange interactions and g-tensor. We will present new inelastic neutron scattering measurements on Yb2Si2O7 that aim to quantify the strength and anisotropy of the magnetic exchange interactions. We have combined multiple measurements of the field polarized spinwaves along different crystallographic directions and linear spinwave theory to fit the magnetic exchange interactions in Yb2Si2O7. These fits provide further evidence that the exchange is highly symmetric (Heisenberg or XXZ-type), contrary to theoretical predictions. We will also discuss our measurements and fitting of the crystal field excitations to determine the crystal field ground state and g-tensor anisotropy of the Yb3+ ions. With these results, we aim to provide the necessary ground state parameters to effectively understand the perplexing field-induced state of Yb2Si2O7 and provide the foundation for future studies to tune the ground state towards novel quantum phases.

Keyword-1

quantum magnetism

Keyword-2

neutron scattering

Keyword-3

Bose Einstein condensation

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