Field-induced spin dynamics in triangular-lattice antiferromagnet $CsYbSe_2$

S. E. Nikitin

Paul Scherrer Institut, CH-5232 Villigen, Switzerland

Geometrically frustrated magnets provide an intriguing playground for the investigation of novel phenomena in condensed matter physics. Among these, one of the most intensively studied models is the triangular-lattice antiferromagnet (AFM) with nearest-neighbour coupling, which shows different ordered and quantum disordered ground states, depending on the interaction symmetry and the applied magnetic field [1, 2]. Recent theoretical progress has made it possible to compute the full excitation spectrum at zero field [3, 4], but good model materials with no disorder or distortions, and only weak interlayer coupling remain, rare. As a result, the rare-earth-based delafossite compounds have attracted considerable recent attention because of their potential for realising the triangular-lattice AFM [5, 6].

In this work we studied $CsYbSe_2$, one member of the delafossite family, by means of inelastic neutron scattering (INS) in fields up to 5 T, as well as by ESR and complementary thermodynamic probes. We found that the zero-field ground state exhibits incipient magnetic order at our lowest temperatures (40 mK), in contrast to theoretical and experimental claims of a quantum spin-liquid state, albeit with a spectrum of highly damped, continuum-like excitations. The applied magnetic field produces a long-range ordered phase over the range, 3–5 T, of the collinear $M_S/3$ plateau state, where the INS spectrum evolves into relatively sharp spin-wave modes. We performed large-cluster DMRG calculations of the Heisenberg model on the triangular lattice in a magnetic field, which reproduce all the essential features of the observed spectra, including damping of the magnon modes in the non-collinear, low-field states and multiple sharp magnon modes in the field-induced plateau state. Our results indicate that the rare-earth delafossites do constitute a faithful realisation of the triangular-lattice AFM with only weak spin anisotropies, and we provide a comprehensive theoretical and experimental overview of the field-induced spin dynamics in this system.

[1] Z. Zhu et al., Phys. Rev. Lett. 120, 207203 (2018).
[2] P. A. Maksimov et al., Phys. Rev. X 9, 021017 (2019).
[3] E. A. Ghioldi et al., Phys. Rev. B 98, 184403 (2018).
[4] F. Ferrari and F. Becca, Phys. Rev. X 9, 031026 (2019).
[5] M. Baenitz et al., Phys. Rev. B 98, 220409 (2018).
[6] M. Bordelon et al., Nature Phys. 15, 1058-1064 (2019).