Unconventional Magnetism Seminars

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Majorana fermions in the Kitaev honeycomb magnet

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Quantum spin liquid is a disordered but highly-entangled magnetic state with fractional spin excitations. The most common type of fractional spin excitations are fermionic spinons, well known from one- and some two-dimensional quantum magnets. In the exactly solved Kitaev honeycomb spin model, a spin instead fractionalizes into two types of anyonic quasiparticles: a pair of gauge fluxes and a Majorana fermion [1]. I will present a nuclear magnetic resonance experiment on the most promising Kitaev magnet α-$RuCl_3$ that allowed us to observe two contributions to the spin excitation gap [2]: a finite zero-field contribution, which matches the predicted size of the gauge-flux gap, and a theoretically predicted contribution growing as a cube of the applied magnetic field, which is a hallmark of Majorana fermions [1]. As both types of fractional excitations survive in a broad range of temperatures and magnetic fields, α-$RuCl_3$ is perfectly suited for future investigations of Majorana fermions.

[1] A. Kitaev, Ann. Phys. **321**, 2 (2006).

[2] N. Janša, A. Zorko, M. Gomilšek, M. Pregelj, K. W. Krämer, D. Biner, A. Biffin, Ch. Rüegg, and M. Klanjšek, Nature Physics **14**, 786 (2018).