Scale-invariance in quantum spin liquids

Kimberly Modic (MPI for Chemical Physics of Solids)

Host: Zhanybek Alpichshev

Quantum spin liquids are a new state of matter in which electron spins become strongly entangled and maintain a fluid-like state down to low temperatures. In the search for quantum spin liquids, hopes of realizing the Kitaev model have directed a surge of interest towards 2D and 3D honeycomb networks of effective spin 1/2 moments. It has already been shown that the edge-shared octahedra surrounding the magnetic ions mediate at least some degree of the prerequisite exchange interactions. While a unique spin-anisotropy in the exchange interactions leads to enhanced magnetic frustration, all candidate materials order antiferromagnetically at low temperatures. Nevertheless, experimental efforts gained momentum when a continuum of excitations was identified in RuCl$_3$ by way of neutron scattering and Raman spectroscopy. This feature, characteristic of a spin liquid, persists outside of the ordered state up to a temperature scale that is of order the exchange interaction energy scale ($J \sim 150$ K). We use a newly-developed probe of magnetic anisotropy resonant torsion magnetometry to explore the competition between the intrinsic energy scales of the exchange interactions in RuCl$_3$ and the external parameters of temperature and magnetic field. Performing measurements up to 65 T, we introduce a Zeeman energy that is comparable to the largest exchange interactions in the system. Over the entire temperature-field phase diagram, we observe a robust and peculiar angle dependence of the magnetic anisotropy that rules out conventional paramagnetism, even at the largest available magnetic fields. While this behavior attests to the presence of a large, underlying $J$ in RuCl$_3$, we find that the measured magnetic anisotropy is entirely controlled by the thermal and magnetic energy scales. Such a scale-invariant response indicates that the effective exchange interaction energy scale has been driven to zero by strong correlations present in the high-field spin liquid state.

Tuesday, January 29, 2019 10:00am - 11:00am
IST Austria Campus Big Seminar room Ground floor / Office Bldg West (I21.EG.101)

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