Disorder-Enriched Magnetic Excitations in a Heisenberg-Kitaev Quantum Magnet, $Na_2Co_2TeO_6$

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Quantum spin liquids represent an intriguing phase of matter that can arise in magnetic materials with certain structures, where quantum fluctuations impede the formation of long-range magnetic order, even at the lowest temperatures. Kitaev's spin-½ honeycomb model has attracted a lot of interest as it predicts exotic features that could be utilized in future quantum computing schemes. The compound $Na_2Co_2TeO_6$ has emerged as a potential Kitaev spin-liquid candidate in which the magnetic interactions between the low-energy effective spin-½ degrees of freedom associated with the cobalt (Co) atoms are highly directional. It is this property and the trigonal symmetry of the lattice that is central to the Kitaev physics.

In this highly collaborative experimental and theoretical study, involving researchers from China and multiple US universities, a combination of far-infrared transmission and high-field electron paramagnetic resonance (EPR) spectroscopy has been employed to investigate the low-temperature magnetic excitations of $Na_2Co_2TeO_6$ across a wide range of energies (0.2−15 meV) and magnetic fields (≤ 17.5T); *the work combines capabilities from two MagLab facilities, the Electron Magnetic Resonance and DC Field facilities. The measurements reveal extremely rich spectra with a surprisingly large number of modes. Theoretical calculations find that disorder associated with the partial occupancy of sodium (Na) sites within the lattice plays a crucial role in generating these modes.*

This comprehensive study has resulted in a detailed understanding of the magnetic excitations in $Na_2Co_2TeO_6$, revealing the key role of disorder associated with the sodium atoms immediately surrounding the cobalt spins. More generally, *the work emphasizes the importance of understanding (and possibly controlling) disorder in the spin environment in the search for materials hosting Kitaev physics with potential for future practical applications.*

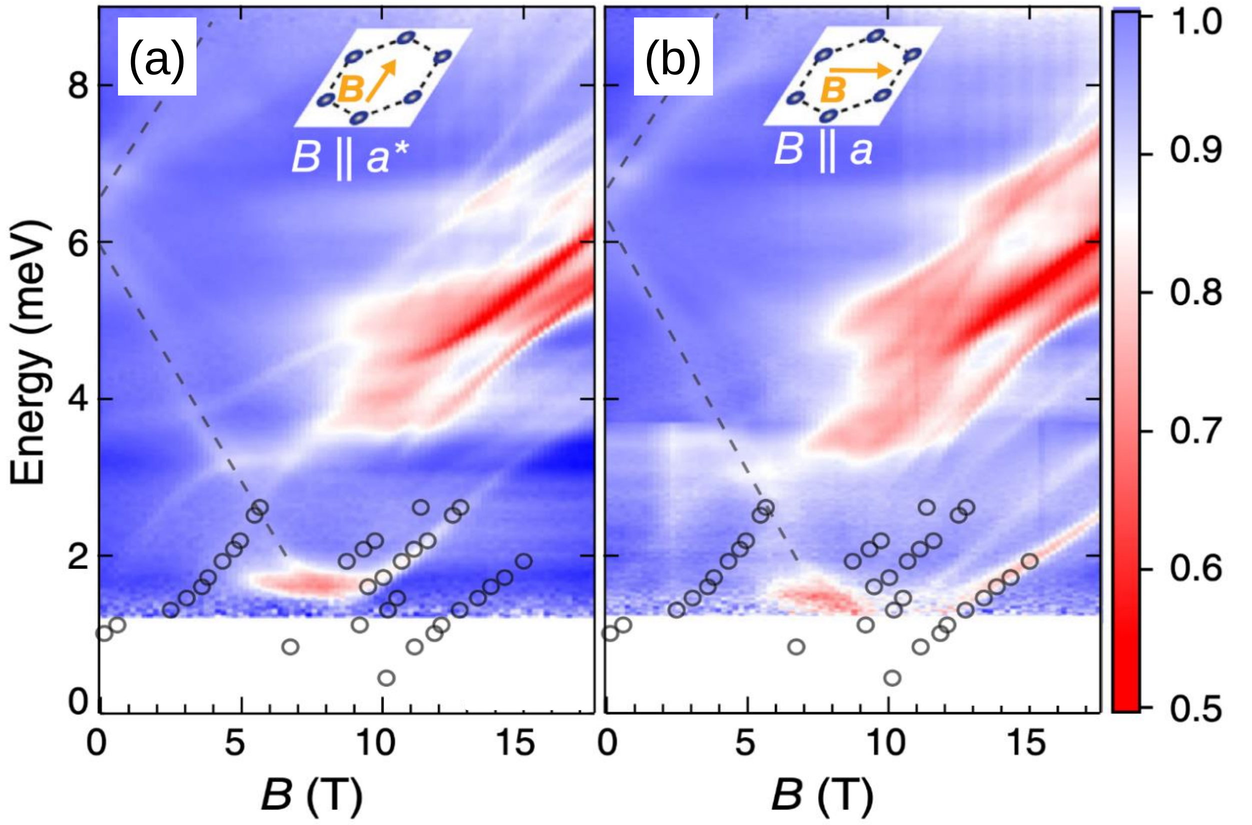

Figure: Normalized far-infrared transmission (see color legend) measured on a single-crystal of $Na_2Co_2TeO_6$ at T = 5K, with the applied magnetic field **B**∥a^* (panel a) and **B**∥a (panel b). Black circles are excitation modes extracted from the EPR spectra measured on powdered samples at T = 5K. Dashed lines are guides to some of the weaker excitation modes.

Facilities and instrumentation used: Joint EMR/DC-Field Facility Operation (15/17 T Transmission EPR Spectrometer and FTIR Spectrometer in SCM3).

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