Potential spin liquid system explored with pulsed magnetic fields

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In quantum spin liquids, the electron spins do not freeze into classical ordering patterns. Instead of the spins form quantum superpositions of different spin states. *In certain spin liquids, quasiparticles can emerge that are fractionalized patterns of spins. These emergent quasiparticles can be used to store and manipulate quantum information*.

In this collaboration, researchers utilized a variety of magnetic, structural, and electrical measurements to explore a Co-based Kitaev honeycomb system. *The short duration of pulsed magnetic fields were needed to create highly sensitive measurements of the electric polarization, which is a symmetry-sensitive probe that can distinguish different magnetic orders, as well as the magnetocaloric effect, which detects phase transitions by measuring magnetic entropy changes*.

These experiments identify regions the temperature versus magnetic field phase diagram in which different spin ordering states exist and where spin liquid behavior exists. In one region, there is no bulk electric polarization, even though the dielectric constant (**Fig 1a**) shows strong electric dipoles forming in response to magnetic ordering. By symmetry, this is incompatible with the so-called "triple Q" magnetic state and favors another ("zig zag" state) at zero field. *The phase diagram (**Fig 1b**) shows many magnetic ordering states, as well as a proposed quantum spin liquid (**labeled "III" in Fig 1b**).*

It is important to identify new spin liquid candidates, because they can potentially host topological quasiparticles. These quasiparticles could enable resilient quantum computing that avoids problems that plague existing approaches, such as sensitivity to the environment.

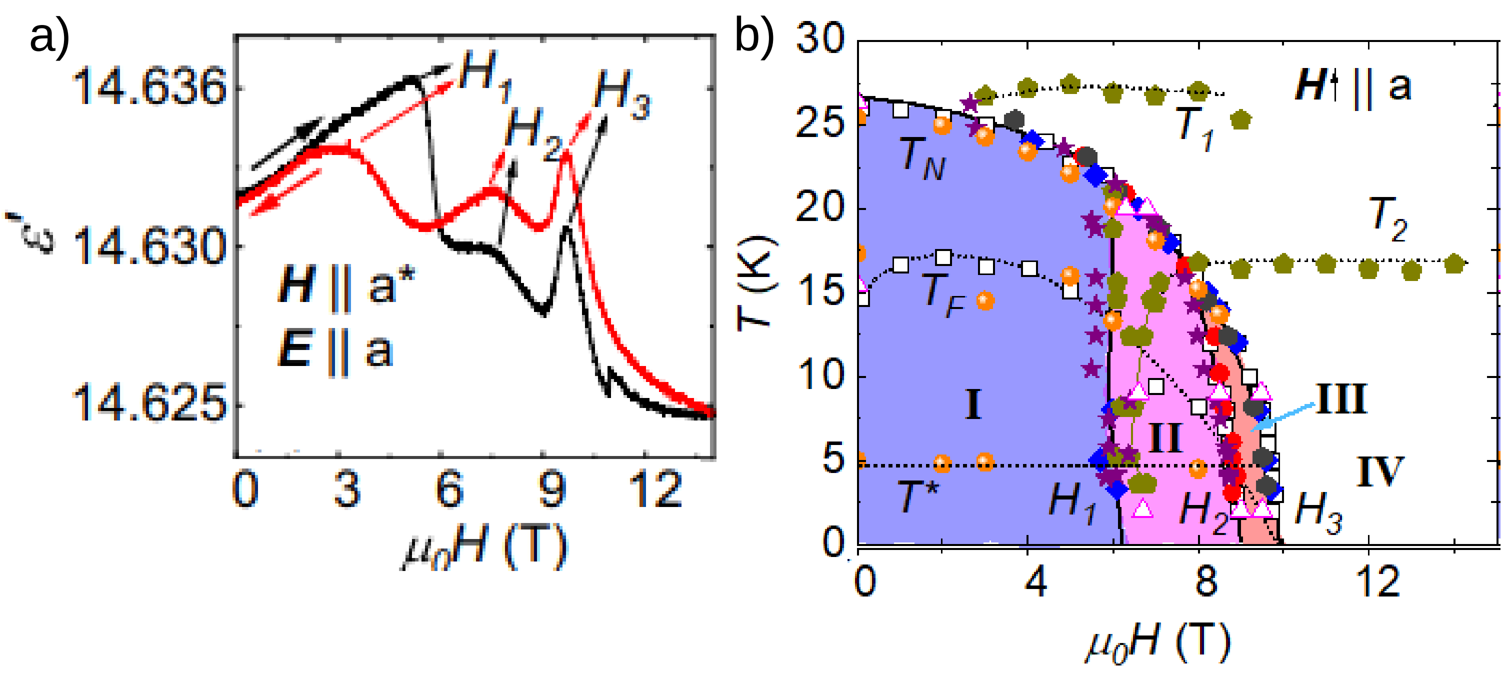

Fig 1 Physical properties of the the spin liquid compound with spins on a honeycomb lattice, $Na_2Co_2TeO_6$. **a)** Dielectric constant vs magnetic field showing electric dipoles emerging at magnetic phase transitions, but no net polarization, which constrains the symmetry of the phases. **b)** Phase diagram in temperature (T)-field (H) space showing regions of spin ordering and possible spin liquid behavior.

Facilities and instrumentation used: NHMFL Pulsed Field Facility

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