Shedding light on emergent quantum electrodynamics in the quantum spin liquid candidate Ce2Zr2O7

Abstract:

Ce2Zr2O7 (CZO) and the isostructural Ce2Hf2O7, Ce2Sn2O7 have been identified as clear candidates for realizing Quantum Spin Ice (QSI) and have been studied by heat capacity, magnetic susceptibility, muon spin relaxation, and inelastic neutron scattering (INS) measurements [1–3]. The spinon continuum, the key signature of QSI, has been obtained by subtracting the high-temperature background from the low-temperature data in INS. However, this operation leaves no intensity at the quasi-elastic line, where the artificial “photon”, linearly dispersing transverse excitations of the gauge field A(r) with a speed of light c, was predicted in this lattice analog of quantum electrodynamics [4,5]. By careful polarized neutron analysis at the same low temperature, we extracted the magnetic signal in the quasi-elastic line for the first time, which was overwhelmed by the much larger background, including nuclear incoherence scattering and sample holder in previous INS experiments. Surprisingly, the magnetic signals in the quasi-elastic line are not only much larger than the previously observed spinon continuum but also consist of multiple peaks. Our collaborators theoretically investigate the potential explanations using gauge mean-field theory (GMFT) and Gaussian quantum electrodynamics (QED) to model the spinons and emergent photons, respectively. The exhaustive fit of the experimental measurements indicates that the signal cannot be adequately described by only considering thermal spinons but is correctly accounted for by a large thermal bath of photons. The fitting parameters put CZO in the region of π-flux QSI. This lends further overwhelming support to the identification of CZO as a long-sought-after experimental realization of QSI [6].


Bio:

Bin Gao is a research scientist in the group of Prof. Pengcheng Dai from the Department of Physics and Astronomy. He got his Ph.D. at Rutgers University in 2017. His research interests include crystal synthesis, ferroelectrics, multiferroics, neutron scattering, and quantum spin liquid.

Snacks and Coffee will be served during the event. Wine & cheese will be served after the talk. Everyone is welcome to stay around after the seminar for further informal discussions.