

Exploring the Multiverse of f -electron Quantum Materials

Filip Ronning

Los Alamos National Laboratory

Materials are the foundation of the world around us. New materials are important for developing new technologies, but they are also part of a materials multiverse - providing us with opportunities to explore new fundamental physics. Every material possesses a unique low energy Hamiltonian, and as such, is its own universe. f -electrons possess both strong Coulomb repulsions and strong spin orbit coupling. These properties lead to a rich variety of novel interactions, phases, and excitations. In this talk I will introduce how various fascinating physics emerges in f -electron materials, including heavy fermions, unconventional superconductors, spin liquids, topological Kondo insulators, Weyl semimetals, Majorana fermions, and the new physics we hope to discover. I will finish by describing how our exploration on novel f -electron materials has led to the discovery of very clean narrow band gap insulators, which we are attempting to develop into ultrasensitive light mass dark matter detectors.

Bio: Filip Ronning is the Director of the Institute of Materials Science at Los Alamos National Lab. He received his B.A. in Physics from Cornell University and subsequently his Ph.D. from Stanford University in 2001 for angle resolved photoemission work on strongly correlated oxides. Following two years at the University of Toronto he joined Los Alamos National Lab, where he remains today. His scientific interests include (but are not limited to) topological matter, quantum spin systems, heavy-fermion physics, unconventional superconductivity, quantum criticality, low-dimensional physics, spin-orbit coupled systems, and other new states of matter. He is a fellow of the American Physical Society, and is a LANL Distinguished mentor.