Quantum materials in extreme magnetic fields

Abstract: Over the past two decades, pulsed magnetic fields have moved from a niche technique to an experimental powerhouse, routinely providing access to fields of up to 100 Tesla—five times what is commercially available. I will describe how we use the world-record magnetic fields available at Los Alamos National Labs to discover new phenomena in quantum materials. In particular, we used pulsed-fields up to 92 Tesla to measure the Fermi surface of the high-Tc superconductor YBa$_2$Cu$_3$O$_{6+x}$ as a function of hole doping. I will show how this experiment provides information about the doping evolution of electron-electron interactions, and how it ties together together several recent experiments in the cuprates. I will also describe our more recent work on the topological Weyl semimetal NbP, where high magnetic fields allow us to access the ‘quantum limit’ where all electrons are confined to a single highly degenerate quantum state (the last Landau level). I will describe what we have learned so far about the unusual quantum limit properties of NbP, and discuss what new physics we might access with future technique developments.

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