

Dark-Matter Challenges of the Solid State.

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This talk will be part colloquium, part seminar, with an emphasis on questions from the audience.

At the turn of the 20th century, physicists faced an uncanny range of unsolved problems: simple questions, such as why hot objects change color, why matter is hard and why the sun keeps on shining, went unanswered. These problems heralded a new era of quantum physics. One of the truly remarkable lessons of discovery in this heroic era, was the intertwined nature of research: in the lab and in the cosmos, for solving superconductivity really did help answer why the sun keeps on shining, while looking at the stars provided clues as to why matter is hard.

The challenges facing us today, epitomized by our failure to quantize gravity, the mysteries of dark matter and energy, challenge physics to its core. I will discuss the less well-known dark matter challenges of the solid state, epitomized by the strange metals with linear resistivity that accompany high temperature superconductivity, the discovery of insulators with Fermi surfaces, the phenomenon of Quantum criticality and the quantum physics of information. My talk will emphasize these issues with a special focus on heavy fermion materials. I will argue that these laboratory-scale problems challenge our fundamental understanding of emergent quantum matter in ways that are no less intertwined with their cosmological counterparts than they were a hundred years ago.