Materials Science & Engineering Seminar Series

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Presents

Ultrafast Optical Probing of Correlated Polar Metals

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ABSTRACT: There is considerable interest today in quantum materials. While all materials obey quantum mechanics, there is specific interest in phenomena that go beyond the independent single electron approximation, and arise in strongly correlated electron systems, strong spin-orbit coupled systems, and topologically protected systems. In this talk, I will present an interesting state of matter called polar metals in a correlated electron system, $Ca_3Ru_2O_7$. The talk will present the origin of the counterintuitive polar displacements in a bulk metal, and show that it has domains and domain walls, much like an insulating ferroelectric. The walls have built in electrical potential of tens of meV, on the order of switching voltages for a modern-day transistor of 60 meV/decade. By using low fluence ultrafast optics, one can gently perturb the Fermi surface and study ultrafast dynamics of quasiparticles. Of the two metal insulator transitions, seen in this system, the 30K transition is still a mystery; we reveal that it is not a true transition, but a crossover related to the evolution of a pseudogap competing with a drop in the carrier scattering rate upon cooling. A rich range of electron structure, transport properties and thermodynamic parameters are extracted from such an optical study.

BIOGRAPHY: V. Gopalan is a Professor in Materials Science and Engineering, with a courtesy appointment in Physics at Penn State University. He received his Ph.D in Materials Science and Engineering from Cornell University in 1995, and subsequently was a postdoctoral scholar in Carnegie Mellon University, Electrical and Communications Engineering for a year, followed by a director funded postdoctoral fellow at Los Alamos National Laboratory, before joining Penn State in 1999. Gopalan's area of research interest is in electronic materials, new linear and nonlinear optical techniques of probe them, and in optical devices. His current interests are in quantum materials as applied to quantum communications. He is the associate director for the NSF-MRSEC Center for Nanoscale Science at Penn State, and currently heads a large multi-institutional DOE team on ultrafast optical and X-ray studies of complex oxides. He has received many awards for excellence in research and mentoring from the American Ceramics Society (Robert R Coble, Richard M. Fulrath), Penn State University (Wilson Award for Excellence in Research, Faculty Scholar Medal, Faculty Mentoring award, Student selected MatSE Faculty of the year), and the National Science Foundation (CAREER, CREATIV). He is a fellow of the American Physical Society.

Doherty Hall 2210, 11:30AM
Friday, October 12, 2018