CSU PHYSICS COLLOQUIUM

"Pathways toward unconventional light-induced states in quantum materials "

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120 Engineering (Hammond Auditorium)

Abstract

Phase transitions instigated by an ultrashort laser pulse usher in a new era for materials engineering in the femto- (10-15) to pico-second (10-12 s) regime, a time window that is commensurate with nanoscopic dynamics of electrons, spins, and lattice ions. Rapid advances in tabletop ultrafast techniques—such as time-resolved photoemission, diffraction, and core-level absorption—have enabled us to examine complex interactions and out-of-equilibrium states with unprecedented details. In this talk, I will discuss two important pathways for manipulating nonequilibrium phases of matter in quantum materials, which feature (i) competing orders, and (ii) strong Coulomb interaction between electrons and holes. More specifically, an ultrashort light pulse can (i) unleash a hidden order that is suppressed in equilibrium due to phase competition, and (ii) change the dimensionality of an ordered state by modifying excitonic correlations. I will explain the microscopic mechanisms behind these unconventional light-induced states, highlighting the roles of photoinduced topological defects, order parameter fluctuation, and Coulomb screening by excited mobile carriers. These points will be illustrated using examples from materials that exhibit a charge density wave—a spontaneous modulation of electron density accompanied by a periodic lattice distortion—which serves as a model platform to illustrate general principles underlying ultrafast light-matter interaction in strongly correlated systems.

Biography

Alfred Zong is an experimental condensed matter physicist. He is interested in understanding and controlling nonequilibrium properties of quantum materials by using advanced time-resolved diffraction and spectroscopies. Currently, he is a Miller Postdoc Fellow at UC Berkeley. He obtained his PhD in Physics from MIT, and both M.S. in Computer Science and B.S. in Physics from Stanford University. His dissertation titled "Emergent States in Photoinduced Charge-Density-Wave Transitions" won the Springer Theses award, and his research was recognized by the University of Chicago Quantum Creators Prize in 2021