Condensed Matter Seminar

Thursday

October 26

4:00 P.M.

Rm 184 NSH

Spectroscopy of correlated electronic states in single crystals of Cu_xTiSe_2

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$TiSe_2$ is a member of transition metal dichalcogenide family of layered van der Waals materials that has attracted significant interest due to the intricate mechanism that drives its transition from a semiconducting to a charge density wave (CDW) phase. Intercalation of $TiSe_2$ with copper donates electrons to the conduction band near the Fermi surface, producing a metallic phase at room temperature and a superconducting phase at low temperatures with highest superconducting critical temperature of 4.15K. The relationships between these phases are nontrivial, especially considering that both the CDW and superconductivity rely on specific electronic and electron-phonon interactions.

We investigate both transient optical response and atomically resolved scanning tunneling microscopy and spectroscopy of electronic states in Cu_xTiSe_2 as a function of temperature and copper doping from x=0 (semimetal and commensurate charge density wave phases) to x=0.08 (metallic and superconducting phases). We find that the cooperative driving mechanisms for the CDW, the excitonic insulator mechanism and the soft L_1^- phonon mode, decouple at x=0.04, where fluctuations of a quantum critical point were observed in the folded Se-4p band. We also demonstrate a loss of coherence in the A1g phonon signal with increased copper intercalation of the parent lattice, indicating a loss of long-range lattice order. These findings provide compelling evidence that $TiSe_2$ undergoes a quantum phase transition upon Cu intercalation from a state of commensurate charge order without superconductivity to a state with a different symmetry in which new charge order coexists with the superconducting phase.

Superconductivity in $TiSe_2$ is very intriguing by itself as it appears with copper or palladium intercalation or under pressure in the intrinsic system. We will discuss the results obtained in Cu_xTiSe_2 system and the conclusions drawn from complex set of local STM/STS and bulk thermodynamic measurements on single crystals.

PHYSICS