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Guest Lecture

Title: "Charge Dynamics in Broken-Symmetry Correlated States"

Speaker: Prof. Dr. Leonardo Degiorgi

Address: Laboratory for Solid State Physics, ETH Zurich, Switzerland

Date: Friday, 4th of April 2014
Time: 14:30
Place: Seminar Room CBEG02 (387, Photonics); Gußhausstraße 27

Abstract:

Understanding the interplay of broken-symmetry correlated states, of which spin and charge density waves (SDW and CDW) or superconductivity are primary examples, is among the most intriguing open questions of modern solid-state physics. Broken-symmetry correlated states fundamentally affect the excitation spectrum as well as charge dynamics, which can be revealed by optical methods like infrared spectroscopy.

First, I will show from a broad perspective what can be learned from optical investigations. As an example, I will focus my attention on one family of the novel iron-pnictide and chalcogenide superconductors, which provide an interesting arena in order to study the impact of electronic correlations with respect to the emergence of structural/magnetic and superconducting phase transitions. I will report on the electrodynamic response collected over a broad spectral range and as a function of temperature in $Ba(Fe_{1-x}Co_x)_2As_2$ compounds for Co-doping spanning the whole phase diagram. For compounds with $x<0.025$ we observe the opening of a pseudogap, due to the SDW phase transition. For compounds with $0.051<x< 0.11$ we detect the superconducting gap, while at $x=0.18$ the material stays metallic at all

temperatures. Our data reveal clear-cut evidence for moderate electronic correlations for $0<x<0.061$, which then crossover to values appropriate for a regime of weak interacting and nearly-free electron metals for $x>0.11$.

Finally, I will emphasize a set of very recent optical data, addressing the ferro-elastic transition in the underdoped regime of quite all families of iron-pnictide and chalcogenide superconductors. The tetragonal-to-orthorhombic structural phase transition at T_S, coincident or preceding the onset of an antiferromagnetic ground state at T_N, indeed breaks the four-fold rotational symmetry of the tetragonal phase, implying the onset of a nematic phase. I will report on an optical reflectivity study of $Ba(Fe_{1-x}Co_x)_2As_2$ in the underdoped regime, detwinned by uniaxial and *in-situ* tunable pressure acting as an external symmetry-breaking field. A remarkable optical anisotropy as a function of the applied pressure, very much reminiscent of a hysteretic-like behavior, has been discovered. Its temperature dependence supports the analogy between pressure and external magnetic field with respect to the electronic anisotropy in iron-pnictides and magnetization in ferromagnets, respectively. Scenarios for the structural and magnetic transitions that are generally based on the involvement of spin-orbital coupling are thus proposed to set the stage for the emergence of high-temperature superconductivity in the iron-pnictides.