MAR13-2012-020258

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Ultrafast quasiparticle dynamics and pair recombination in cuprate high-temperature superconductors

CHRIS JOZWIAK, Lawrence Berkeley National Lab

Understanding how superconductivity emerges from other competing phases and how this balance evolves through the phase diagram is one of the biggest challenges in the field of high-T_C superconductors. By using high resolution time- and angle-resolved photoemission spectroscopy (tr-ARPES) we are able to directly probe the effects of optical excitation on the electronic structure of cuprate superconductors, and study the resulting quasiparticle, superconducting gap, and Cooper pair formation dynamics near their natural time scales. In particular, we observed a pump-induced meltdown of quasiparticles, which occurs only within the energy scale defined by a particular boson mode. This meltdown was observed only below T_C, suggesting a link between superconductivity and quasiparticles in momentum space where the superconducting gap is zero. We observed that the excited quasiparticle decay dynamics were strongly pump-fluence dependent and consistent with the picture that the observed dynamics reflect actual Cooper pair formation. Further, these quasiparticle recombination dynamics were strongly momentum dependent, increasing away from the superconducting nodes. Direct measurements of momentum dependent superconducting gap dynamics and the evolution of other non-equilibrium spectral phenomena through the phase diagram further illustrate the power of this unique time- and momentum-resolved spectroscopy. These results reveal new windows into the nature of the pairing interaction in high-T_C superconductors.