Chez Pierre

Presents ...

Tuesday, April 15, 2014
12:00pm
MIT Room 4-331

Special Chez Pierre Seminar

J. C. Séamus Davis

Cornell University, Brookhaven National Lab, St Andrews University

"Visualizing the d-form factor modulations of intra-unit-cell broken-symmetry that comprise the cuprate density waves "

The electronic structure of the CuO_2 plane in high-temperature superconductors has proven extremely challenging to understand. As holes are introduced, the antiferromagnetic state disappears, yielding to the enigmatic 'pseudogap' state whose fundamental broken symmetry (if any) is unresolved. In fact, two apparently distinct forms of electronic symmetry breaking, one of intra-unit-cell rotational symmetry (Q=0 nematic) and the other of lattice translational symmetry ($Q\neq0$ density wave), are reported extensively. If, and how, such distinct broken symmetries could coexist has not been addressed or reconciled.

When we image these two broken-symmetry states simultaneously with the coherent *k*-space topology, for $Bi_2Sr_2CaCu_2O_{8+d}$ samples spanning the phase diagram $0.06\leq p\leq0.23$, we find that the electronic symmetry breaking tendencies weaken with increasing p and disappear close to p_c=0.19. Concomitantly, the coherent *k*-space topology undergoes an abrupt transition, from 'Fermi arcs' to conventional closed contours, at the same p_c. Thus, the famous *k*-space topology transformation in cuprates is linked intimately with the disappearance of the electronic symmetry breaking at a concealed critical point. Moreover the co-evolution and contiguous disappearance at of the signatures of the two apparently distinct broken symmetries implies that they are microscopically closely related.

K. Fujita *et al* http://arxiv.org/abs/1403.7788 (to appear ***Science***, April 2014)

To explore that issue, we introduce a novel electronic structure visualization technique that examines each atomic site inside every CuO_2 unit cell, and how they vary spatially. We then demonstrate by direct sublattice segregated and phase-resolved visualization that the cuprate density wave consists essentially of a broken rotational symmetry inside each unit cell that is modulated spatially such that the relative phase of the two oxygen atoms is always p. This harmonious explanation for the coexistence of the two symmetry-breaking phenomena implies that the fundamental broken symmetry of the pseudogap state is a density wave modulating the intra-unit-cell states with a robust *d*-form factor.

K. Fujita *et al* http://arxiv.org/abs/1404.0362. (to appear ***PNAS***, May 2014)