Session 22V

The Potemkin Gap 22V1

Robert B. Laughlin

Department of Physics, Stanford University, Stanford, CA 94305 U.S.A.

Whether or not coulomb interactions cause cuprate superconductivity, they are enormous and cause the Mott effect - insulation and a 2 eV energy gap at half filling. This is the terrible loose end of the cuprate problem, for it makes no sense (and is inconsistent with experiment) that this gap should simply disappear when the sample is doped to superconductivity. In this talk I will discuss a beautiful solution of this dilemma implicit in the old RVB ideas, namely that the state in question is not an insulator at all but a superconductor with an extremely small, disorder-sensitive, superfluid density. Since spin order can coexist perfectly well with superconductivity, this effectively gives us two distinct classes of coulombic vacuum, one with superconductivity and one without. Which kind one gets depends on details. The feature at 2 eV in the former case is not a true gap but a resonance - a Potemkin gap.

Angle Resolved Tunneling Spectroscopy – A New Window on the Cuprates 22V2

J. C. Davis[a], J. E. Hoffman[a], K. McElroy[a], D. H. Lee[a], H. Eisaki[b], S. Uchida[b]

[a]*Department of Physics, University of California, Berkeley, CA 94720–7300, USA.*
[b]*Department of Superconductivity, University of Tokyo, Tokyo 113–8656, Japan.*

When elastic impurity scattering mixes the electronic eigenstates $\vec{k}_1$ and $\vec{k}_2$, an interference pattern appears in the norm of the wavefunction at the wavevector $\vec{q}=\vec{k}_2-\vec{k}_1$. This can be observed by STM as conductance modulations of wavelength $\lambda=2\pi/|\vec{q}|$. We describe STM experiments on the high-T_c superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$ in which large real-space conductance maps with very high spatial resolution are Fourier analyzed to yield the energy dependence of the wavevectors $\vec{q}(E)$ associated with different scattering process. The conductance modulations are found to vary strikingly with quasiparticle energy E. Comparison with ARPES shows the data to be consistent with quasiparticle interference. The momentum-space location of the quasiparticles and their associated gap $\Delta(\vec{k})$ can then be determined.