Charge Density Waves in Underdoped High-Tc Materials

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***Abstract*— In recent years a ubiquitous new phenomenon has been discovered in High-T_c superconductors. This is a "Charge Density Wave" (CDW), which competes with superconductivity and suppresses both the critical temperature ant the upper critical field when the materials are underdoped. The CDW is associated with a "Fermi Surface Reconstruction" which is revealed by a change from a "large" hole-like Fermi surface, containing all the carriers in the overdoped regime, to a "small" electron-like Fermi surface below optimal doping. The CDW gives rise to X-ray diffraction satellites which have intensities ~ 10^{-6} of the lattice Bragg peaks, which explains why they remained unobserved for a quarter century. However the energies associated with the lattice distortions are comparable with those associated with superconductivity, and show that the lattice cannot be ignored in High-T_c materials, even though the mechanism of superconductivity is not the conventional phonon one. We shall describe measurements of CDW signals using synchrotron x-rays, which reveal the actual atomic displacements in an archetypical material YBCO. It is clear that these lattice distortions represent an order which competes with superconductivity. Other authors have shown that pressure suppresses the CDWs and increases the critical temperature in the underdoped regime above that of optimally doped material. It is still not clear whether CDWs represent a complication in these complex materials or a more fundamental property of the CuO_2 planes.**

***Keywords (Index Terms)*– High-temperature superconductors, quantum mechanics, solid-state physics, superconducting transition temperature, yttrium barium copper oxide.**

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