Unconventional magnetic order in the pseudo-gap state of high-Tc cuprates

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Abstract

There has been a long-standing debate among condensed-matter physicists about the origin of the pseudo-gap state in high-temperature superconducting cuprates. Two theoretical approaches have been opposed: in the former, the pseudo-gap state is a precursor of the superconducting state, in the later, it corresponds to another state of matter, competing with superconductivity. Supporting the second scenario, polarized neutron diffraction has revealed the existence of a 3D long range magnetic phase, hidden inside the pseudo-gap state of underdoped YBa2Cu3O6+x, HgBa2CuO4+δ and Bi2Sr2CaCu2O8+δ [1-4]. In these systems, its ordering temperature Tmag matches the pseudo-gap temperature T* deduced from resistivity measurements. This magnetic phase can be described as an Intra-Unit-Cell antiferromagnetic state: time reversal symmetry is broken, but lattice translation invariance is preserved. The occurrence of such a magnetic state has been predicted in the circulating current theory of the pseudo-gap proposed by C.M. Varma [4]. In this theory, staggered current loops give rise to orbital-like magnetic moments within CuO2 unit cell. In addition, the theory predicts specific discrete collective magnetic excitations [6] and two quasi non-dispersive excitations have been recently observed in the pseudo-gap state of HgBa2CuO4+δ in inelastic neutron scattering measurements [6]. In weakly underdoped La2-xSrxCuO4+$\delta$and YBa2Cu3O6+x [8], the Intra-Unit-cell magnetic order weakens upon approaching the insulating antiferromagnetic state and competes with other spin (and/or charge) instabilities.

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