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Loop-Current Order in Several Families of Cuprates

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In high temperature copper oxides superconductors, a novel long range 3D magnetic order associated with the pseudogap phase has been identified in two different cuprate families - $\text{YBa}_2\text{Cu}_3\text{CuO}_{6+x}$ (YBCO),¹ $\text{HgBa}_2\text{CuO}_4$ (Hg1201)² - over a wide region of temperature and doping. That magnetic order, evidenced using polarized neutron diffraction, respects the translation symmetry of the lattice and can be described as a $Q=0$ antiferromagnetism with active role of in-plane oxygens atoms. Such a magnetic order can be associated with orbital moments in the circulating currents phase proposed by C. Varma. Similar magnetic ordering is observed in the archetypal cuprate $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ (LSCO) system below 120 K for $x=0.085$.³ In contrast to the previous reports, the magnetic ordering in LSCO is **only** short range with an in-plane correlation length of ~ 10 Å and is bidimensional (2D). Such a less pronounced order suggests an interaction with other electronic instabilities. In particular, LSCO also exhibits a strong tendency towards stripes ordering at the expense of the superconducting state. Additional polarized neutron diffraction measurements have been performed in YBCO.⁴ At lower doping (8.5 %), the magnetic order is observed at lower temperature (~ 150 K) than the generally assumed value for the pseudogap. It tends to vanish for dopings where the nematic electronic liquid crystal phase sets up. Recently, two others cuprates families have been studied: $\text{Bi}_2\text{Ca}_2\text{SrCu}_2\text{O}_{8+\delta}$ (Bi2212) and electron doped $\text{Nd}_{2-x}\text{Ce}_x\text{CuO}_4$ (NCCO). In both families, a magnetic order related to the pseudogap phase has been also observed. The recent results will be discussed during the talk.

¹B. Fauqué, Y. Sidis, V. Hinkov, S. Pailhès, C.T. Lin, X. Chaud, and P. Bourges, *Phys. Rev. Lett.* **96**, 197001 (2006).

²Y. Li, V. Balédent, N. Barisić, Y. Cho, B. Fauqué, Y., Sidis, G. Yu., X. Zhao, P. Bourges, and M. Greven, *Nature* **455**, 372 (2008).

³V. Balédent, B. Fauqué, Y. Sidis, N. B. Christensen, S. Pailhès, K. Conder, E. Pomjakushina, J. Mesot, and P. Bourges *Phys. Rev. Lett.* **105**, 027004 (2010).

⁴V. Balédent, D. Haug, Y. Sidis, V. Hinkov, C.T. Lin and P. Bourges, preprint