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Temperature dependence of dynamical magnetism in the iron chalcogenide superconductors: neutron scattering evidence for orbital selective Mottness.[1]

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Inelastic neutron scattering studies of the temperature-dependent magnetism in FeTe [1], the antiferromagentic parent material of superconducting family, presented perhaps the first experimental indication of the orbital-selective electron localization in the iron chalcogenides. The follow-up neutron diffraction study [2] have established that development of the electronic coherence at low temperature leads to a ferro-orbital order where electrons delocalize in ferromagnetic zig-zag chains. These observations explain the "bicollinear" antiferromagnetism, the transition to metallic state observed in bulk resistivity, as well as the loss of magnetic susceptibility, which is consistent with the overall loss of local magnetic moment [1]. Further support for the physics of orbital-selective, temperature- and doping-dependent hybridization in 11 iron chalcogenide superconductors was obtained by studying dynamical local magnetic correlations in sulphur-doped FeTe1-xSx [3], which is located at the boundary of the superconducting state in their phase diagram. The observed liquid-like magnetic response is described by the coexistence of two distinct disordered magnetic phases with different local structures, whose relative abundance depends on temperature. The remarkable competition of these electronic spin-liquid polymorphs suggests new understanding of electronic nematicity and nonFermi-liquid behavior in a chalcogenide material on the threshold of unconventional superconductivity. Finally, recent polarized neutron surveys of the temperature-dependent magnetic response of FeTe and the optimally doped FeTe0.55Se0.45 also indicate the unusual and temperature-dependent orbital composition of the observed dynamical magnetism. [1] I. A. Zaliznyak, Z. Xu, J. M. Tranquada, G. Gu, A. M. Tsvelik, M. B. Stone, "Unconventional temperature enhanced magnetism in iron telluride", Phys. Rev. Lett. 107, 216403 (2011). [2] D. Fobes, I. A. Zaliznyak, Z. Xu, R. Zhong, G. Gu, J. M. Tranquada, L. Harriger, D. Singh, V. O. Garlea, M. Lumsden, B. Winn, "Ferro-orbital ordering transition in iron telluride $Fe_{1+y}Te$", Phys. Rev. Lett. 112, 187202 (2014). [3] I. Zaliznyak, A. T. Savici, M. Lumsden, A. Tsvelik, R. Hu, C. Petrovic."Spin-liquid polymorphism in a correlated electron system on the threshold of superconductivity", Proc Natl Acad Sci USA, www.pnas.org/cgi/doi/10.1073/pnas.1503559112 (2015)

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