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Structure, magnetic order and excitations of the Fe(Se,Te) superconductor system

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The Fe(Se,Te) material, instead of being chalcogen deficient as initially proposed, in general has excessive Fe at an interstitial site [1]. It shares the similar ferminology of the LaFeAsO and $BaFe_2As_2$ types of Fe-based superconducting materials. Therefore, the same spin-density-wave (SDW) antiferromagnetic (AF) order at the nesting wave-vector textbf$Q_N = (pi, 0)$ was expected for the parent compound $Fe_{1+y}Te$. However, we observe using neutron scattering technique that the AF order is characterized by a completely different propagating vector textbf$Q_M = (deltapi, deltapi)$, which is along the diagonal direction of the Fe "square"-lattice instead of along one of its edges, and the *delta* is tunable from an incommensurate value to a commensurate 1/2 by excessive Fe y [1]. This result casts doubt on the prevailing SDW picture for magnetic transition in these Fe-based materials, and prevents premature exclusion of other alternative mechanism such as on-site correlations or orbital ordering. Even with a textbfQ_M-type AF order in the parent compound, a spin resonance excitation mode is observed in superconducting $FeSe_{0.4}Te_{0.6}$ at the energy $\hbar\Omega_0$=5.3 k_{BT_c} and around $\mathbf{Q_N}$ [2]. Our results support the theoretical proposal that the superconducting symmetry of the Fe-based superconductors is of the s^{pm} type, with the gap function of opposite signs on the hole and electron Fermi surfaces respectively [2]. Interestingly, while the intensity of the resonance mode behaves like an order parameter, the gap energy itself looks temperature independent. This is corroborated by the temperature dependence of the superconducting gap observed in ARPES measurements.

[1] W. Bao, Y. Qiu, Q. Huang et al., Phys. Rev. Lett. textbf102, 247001 (2009).
[2] Y. Qiu, W. Bao, Y. Zhao et al., Phys. Rev. Lett. textbf103, 067008 (2009).