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Antiferromagnetic phase in iron-based superconductors: selection of magnetic order, spin excitations, competition with superconductivity

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Recent discovery of superconductivity in the iron-based layered pnictides with Tc ranging between 26 and 56K generated enormous interest in the physics of these materials. The superconductivity has been discovered in oxygen containing RFeAsO (R=La, Nd, Sm) as well as in oxygen free AFe2As2 (A=Ba, Sr, Ca). Like the cuprates, the pnictides are quasi-two-dimensional systems, their parent material shows antiferromagnetic long-range order below 150K and superconductivity occurs upon doping of either electrons or holes into the FeAs layers. In my talk I will analyze the properties of the magnetically ordered state. In particular, I will discuss the selection of the stripe magnetic order in the unfolded BZ within itinerant description. Selecting one hole and two electron pockets we find that SDW order is highly degenerate if electron pockets are circular and interactions involved are between holes and electrons only. Repulsive charge interactions between two electrons as well as ellipticity of the electron pockets break the degeneracy and select metallic $(0, \pi)$ $[(\pi,0)]$ SDW state in the unfolded BZ – the same order as seen in the experiments. I will argue that the SDW state remains a metal even for the case of a perfect nesting because one combination of the two hole operators and one combination of two electron operators decouple from the SDW mixing. We also demonstrate that the quasi-one-dimensional nanostructure identified in the quasiparticle interference (QPI) is a consequence of the interplay of the magnetic $(\pi, 0)$ spin-density wave (SDW) order with the underlying electronic structure. Finally, we address the salient experimental features of the magnetic excitations in the spin-density-wave phase of iron-based superconductors. We use a multiband random-phase approximation treatment of the dynamical spin susceptibility. Weakly damped spin waves are found near the ordering momentum and it is shown how they dissolve into the particle-hole continuum. We show that ellipticity of the electron bands accounts for the anisotropy of the spin waves along different crystallographic directions and the spectral gap at the momentum conjugated to the ordering one. *Work done with A. V. Chubukov, J. Knolle, R. Moessner, and A. Akbari.

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