Common Physical Properties of New Iron-based Superconductors

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Introduction

The consensus is that for all members of the recently discovered iron-based superconductors the essential physics takes place inside the quasi-two-dimensional (2D) FeAs(P)-layers. We have considered: 1) the classes of superconducting order parameters (superconducting (SC) gaps) allowed by the tetragonal symmetry [1]; 2) the origin of the 1st order character for intertwined structural and magnetic transitions at higher temperatures in the parent (i.e., underdoped) systems [2].

Results and Discussion

1) At enumeration of possible symmetries of SC order in the model with the Fermi surface topology now broadly accepted in the literature, the multi-band energy spectrum for pnictides becomes important. Indeed, at the symmetry group transformations the gaps on different Fermi surfaces go over into each other. Among SC classes there exists the symmetry class analogous to the $d_{x^2-y^2}$- pairing popular in the cuprates' literature. Its realization in oxypnictides would leave the whole internal (hole) pocket not gapped. Experimentally, the presence or absence of gapless excitations remains controversial issue according to available ARPES results. Another unresolved issue is the mechanism responsible for the increase in T_c-the temperature of SC transition- with doping: in the microscopic theory T_c exponentially depends on density of states (DOS). Meanwhile, for the 2D FeAs-planes DOS should not vary with doping. We take it as an indication of the important role of interactions [1].

2) Transition into the low temperature antiferromagnetic phase is ascribed in the literature to instability of the electronic spectrum of parent (undoped) iron-pnictides with respect to formation of spin density wave (SDW) provided the Fermi surfaces for electrons and holes display some congruency ("nesting"). Badly understood is the cause for the 1st order character of the transition. Another unexplained fact is that in the oxi-pnictides of the ReFeAsO-type the structural change from the tetragonal to the orthogonal symmetry precedes the onset of the SDW formation. We have shown that the leading role in these phenomena belongs to the magnet-elastic couplings (quadratic striction).

Conclusions

Properties of the new iron-based systems are qualitatively well described in terms of the itinerant multi-band model with the energy spectrum that bears some "nesting" features among the Fermi surfaces.

Acknowledgements

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References

[1] Barzykin, V., *et al*., JETP Letters, **88**, 131 (2008); arXive:0806.1933 (2008).
[2] Barzykin, V., *et al*., (2008); (manuscript under preparation).