MAR13-2012-020346

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Gap symmetry and nodal structure of iron-based superconductors[1]

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We first analyze the gap symmetry in iron chalcogenides with only electron pockets. Previously, two competing alternatives for the gap symmetry were considered. In the first scenario the order parameter has opposite sign on two pockets which gives rise to a d-wave symmetry. In the second scenario the order parameter has a constant sign, resulting in an s-wave symmetric state. Experimentally, the d-wave is excluded by ARPES, while s-wave scenario is inconsistent with the spin resonance as seen by neutrons. We present the third alternative agreeing with both ARPES and neutron scattering. In contrast to the earlier theories we suggest that the pairing of electrons at different pockets is equally or more important than the usual intra-pocket pairing. The inter-pocket pair momentum (π, π) is supplied by the lattice via the inter-pocket hybridization processes. When the hybridization amplitude exceeds the threshold set by the pocket ellipticity the system is brought into an $s^{\pm}$ state. In this state both intra- and inter-pockets pair condensates are present. We argue that $s^{\pm}$ state is consistent with experiments. We next argue that the hybridization is crucial for the nodal structure of iron pnictides. In these superconductors with both electron and hole pockets the hybridization causes the nodal lines to form a closed nodal loops. This is consistent with ARPES, penetration depth and specific heat measurements.

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