Pairing strength and symmetries of 122 iron selenides in comparison with iron pnictides

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High temperature superconductivity with comparable transition temperatures has been observed in the vicinity of an antiferromagnetic phase, in both 122-alkaline iron selenides and 122-iron pnictides. In contrast to iron pnictides, where the parent state is an antiferromagnetic semimetal, the parent state of 122-iron selenides is a large moment, antiferromagnetic insulator. This provides a clear indication of strong electronic correlations. The 122-selenides possess only electron pockets, while the pnictides have both hole and electron pockets. In addition, the observed block spin magnetic order in 122-selenides can not be explained by Fermi surface nesting. At the same time, the comparable $T_c$ suggests a commonality in the underlying mechanism for superconductivity in the two classes of materials. Motivated by these observations and considerations, we present a comparative strong coupling analysis of the pairing strength and symmetries in these two classes of materials [1,2], the analysis of appropriate five orbital $t-J_1-J_2$ models, reveals a similar pairing phase diagram for both materials, with $A_{1g} s(x^2y^2)$ and $B_{1g} d(x^2-y^2)$ as two dominant pairing channels. The pairing amplitudes in both materials are of comparable strength, making it natural for a comparable maximum $T_c$ . In contrast to the pnictides case, an $A_{1g} s(x^2+y^2)$ state is not competitive, making the dominant pairing channels fully gapped. We also discuss the magnetism of the vacancy-ordered insulating 122 iron selenides [3], showing that the observed block-spin state occurs over a wide parameter range. The predicted magnetic excitation spectrum has been verified by inelastic neutron scattering experiments. Our study also reveals some commonality with the magnetism of the parent iron pnictides [4].

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