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Pairing strength and symmetries of 122 iron selenides in comparison with iron pnictides[1]

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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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[1] Rong Yu, Pallab Goswami, Qimiao Si, Predrag Nikolic, and Jian-Xin Zhu, "Pairing strength and symmetries of 122 iron selenides in comparison with iron pnictides," to be published; arXiv:1103.3259.
[2] Pallab Goswami et al, "Superconductivity in Multi-orbital $t-J_1-J_2$ Model and its Implications for Iron Pnictides," Europhys. Lett. **91**, 37006 (2010).
[3] Rong Yu, Pallab Goswami, and Qimiao Si, "The magnetic phase diagram of an extended J_1-J_2 model on a modulated square lattice and its implications for the antiferromagnetic phase of $K_yFe_xSe_2$," Phys. Rev. B **84**, 094451 (2011).
[4] Pallab Goswami et al, "Spin Dynamics of a J_1-J_2 Antiferromagnet and its Implications for Iron Pnictides," Phys. Rev. B **84**, 155108 (2011).

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