S_{++}-wave Superconductivity near the Ferro-orbital QCP in Iron Pnictides

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We investigate the electronic states and the superconductivity in the two-dimensional 16-band *d-p* model extracted from a tight-binding fit to the band structure of iron pnictides,[1] in the presence of both the Coulomb interaction between Fe *d*-electrons and the electron-lattice coupling g with the orthorhombic mode which is crucial for reproducing the recently observed ultrasonic softening of the elastic constant C_{66}.[2] Due to the cooperative effects of these interactions, the ferro-orbital order with different occupations of d_{yz} and d_{zx} orbitals occurs and induces the tetragonal-orthorhombic structural transition at T_s, together with the stripe-type antiferromagnetic (AFM) order below T_N. For a large g case, we obtain the phase diagram consistent with the doped iron pnictides with $T_s > T_N$ for $x > 0$, where the s_{++}-wave superconductivity is mediated by the ferro-orbital fluctuation which is largely enhanced near the ferro-orbital QCP at x_c with $T_s \to 0$. On the other hand, for a small g case, the simultaneous phase transition occurs at $T_s = T_N$ even for $x > 0$, where the $s_{\pm}$-wave superconductivity is mediated by the AFM fluctuation. Both the *s*-wave states with full superconducting gaps are consistent with most of the experiments but only the former is considered to account for the small T_c-suppression against nonmagnetic impurities.

[1]Y. Yanagi, Y. Yamakawa, N. Adachi, and Y. Ōno, J. Phys. Soc. Jpn. **79**, 123707 (2010).
[2]R. M. Fernandes *et al.*, Phys. Rev. Lett. **105**, 157003 (2010); M. Yoshizawa *et al.*, arXiv:1008.1479.