Multiband Superconductivity in Spin Density Wave Metals

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Understanding the microscopic origin of thermodynamic phases with multiple order parameters (OP) is of great interest for correlated metals where superconductivity coexists with a density-wave state, giving rise to a multiband superconductor. The question of how phase-locking of the superconducting (SC) OP occurs is of particular interest in the electron-doped cuprates where experiments reported coexisting SC and spin density wave (SDW) states, and a transition of the SC OP from a $d_{x^2-y^2}$-wave to either an s- or $(d+is)$-wave symmetry with increasing doping.

In this talk, I discuss the emergence of two-band superconductivity with $d_{x^2-y^2}$- or s-wave symmetry in a commensurate SDW state. I show that the SDW coherence factors renormalize the momentum dependence of the SC gap. This yields an unconventional s-wave OP with a π-phase shift between the two bands, and line nodes along the boundary of the reduced Brillouin zone. In contrast, in the $d_{x^2-y^2}$-wave state, the OP is locked in-phase, with no additional line nodes. While in both cases, superconductivity is stabilized by interband Cooper pair scattering, the s-wave state is suppressed more quickly than the $d_{x^2-y^2}$-wave state with increasing SDW OP. Finally, I will discuss the implications of these results for NMR experiments in coexistence phases.

[1] J.-P. Ismer, I. Eremin, E. Rossi, D. K. Morr, and G. Blumberg, accepted for publication in Phys. Rev. Lett., arXiv:0907.1296.