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Superconducting energy gap and nodes in the doped BaFe2As2 system

SHIK SHIN, Institute for Solid State Physics, University of Tokyo

Angle resolved photoemission spectroscopy (ARPES) is very powerful to know the solid state properties. We have developed low-temperature high-resolution laser-based ARPES system and recently achieved the highest energy resolution of $\sim$ 100 μeV and the lowest sample temperature of $\sim$ 1.0 K. We would like to show our recent results of superconducting-gap measurements on the iron-based superconductors by laser-ARPES, mainly for $Ba_{1-x}K_xFe_2As_2$ [1-3]. Little Fermi-surface dependent superconducting gap sizes are found for the $Ba_{0.6}K_{0.4}Fe_2As_2$ that has the maximum Tc around 40K [1]. Inter-orbital interaction is important as well as intra-orbital interaction. On the other hand, KFe_2As_2 is an extremely hole-doped compound in $Ba_{1-x}K_xFe_2As_2$ system and no longer has electron Fermi surfaces. Regardless of this, KFe_2As_2 still exhibits superconductivity with Tc of 3.4 K and the existence of nodes in its superconducting gap has been suggested by the several transport measurements. Our ultrahigh-resolution laser ARPES [2] unveils that KFe_2As_2 is a nodal s-wave superconductor with highly unusual FS-selective multi-gap structure: a nodeless gap on the inner FS, an unconventional gap with octet-line nodes on the middle FS, and an almost-zero gap on the outer FS. This gap structure may arise from the frustration between competing pairing interactions on the hole FSs causing the eightfold sign reversal. Our results suggest that the A1g superconducting symmetry is universal in iron-pnictides, in spite of the variety of gap functions.

[1] Shimojima *et al.*, Science **332** (2011) 564.
[2] Okazaki *et al.*, Science **337** 1314 (2012).
[3] Malaeb *et al.*, Phys. Rev.B**86** (2012) 165117.