Fermi arc and superconducting gap in cuprates revealed by ARPES

Atsushi Fujimori
Department of Physics, University of Tokyo
Bunkyo-ku, Tokyo 113-0033, Japan
fujimori@phys.s.u-tokyo.ac.jp

In this talk, I summarize recent ARPES results on the Fermi arc formation above T_c and the opening of the superconducting gap on the Fermi arc below T_c in single-layer to triple-layer cuprates [1-4]. In the under-doped to optimally regions, the nodal pairing gap and the antinodal pseudogap coexist and show distinct material dependences. That is, the nodal pairing gap at optimal doping is proportional to optimal T_c while the antinodal gap shows little correlation with optimal T_c. The arc length is nearly proportional to the hole doping level and hence to the superfluid density. The magnitude of the superconducting gap at both ends of the Fermi arc, which increases with the nodal pairing gap magnitude and the Fermi arc length, is found to be proportional to T_c at all doping levels in all the cuprate families. This leads to a universal relationship T_c ~ arc length x nodal pairing gap [5,6], reminiscent of Uemura's relation.

In the over-doped regions, where the nodal pairing gap extends to the antinodal region without any sign of two-gap behavior, the Fermi arc still remains short and a pseudogap exits in the antinodal region. This pseudogap, which we refer to as the "off-nodal" pseudogap, may have a different origin from the antinodal pseudogap of the underdoped to optimally doped cuprates and may be attributed to superconducting or pairing fluctuations in the strong coupling superconductors. The Fermi arc is then defined as the portion of the Fermi surface where the quasi-particle is too strongly damped to sustain the off-nodal pseudogap.

This work has been done in collaboration with T. Yoshida, S. Ideta, M. Hashimoto, K. Takashima, K. Kojima, S. Uchida, H. Eisaki, S. Komiya, Y. Ando, H. Anzai, Y. Fujita, Y. Nakajima, A. Ino, M. Arita, H. Namatame, M. Taniguchi, M. Kubota, K. Ono, D.H. Lu, and Z.-X. Shen.

References:
[1] T. Yoshida *et al.*, Phys. Rev. Lett. **103** (2009) 037004.
[2] K. Tanaka *et al.*, Science **314** (2006), 1910.
[3] W. S. Lee *et al.*, Nature **450** (2007) 81.
[4] S. Ideta *et al.*, arXiv:0905.1223.
[5] P.A. Lee and X.-G. Wen , Phys. Rev. Lett. **78**, 4111 (1997).
[6] M. Oda *et al.*, J. Phys. Soc. Jpn. **69**, 983 (2000)