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Orbital character of Fermi surfaces of the iron-based superconductor $BaFe_2(As_{1-x}P_x)_2$

Teppei YOSHIDA[1,2], Shin-ichiro. IDETA[1], Takahiro SHIMOJIMA[3], Walid MALAEB[4], Hakuto SUZUKI[1], Ichiro NISHIi[1], Kei SHINADA[3], Atsushi FUJIMORI[1,2], Kyoko ISHIZAKA[3], Shik SHIN[4], Sung-Kwan MO[5], Zahid HUSSAIN[5], Zhi-Xun SHEN[6], Yosuke NAKASHIMA[7], Hiroaki ANZAI[8], Masashi ARITA[8], Akihiro INO[7],Hirofumi NAMATAME[8], Masaki TANIGUCHI[7,8], Hiroshi KUMIGASHIRA[9], Kanta ONO[9], Shigeru KASAHARA[10,11], Takasada SHIBAUCHI[11], Takahito TERASHIMA[10], Yuji MATSUDA[11], Masamichi NAKAJIMA[1], Shinichi UCHIDA[1,2], Yasuhide TOMIOKA[2,12], Toshimitsu ITO[2,12], Kunihiro KIHOU[2,12], Chul-Ho LEE[2,12], Akira IYO[2,12], Hiroshi EISAKI[2,12], Hiroaki IKEDA[2,11] and Ryotaro ARITA[2,3]

[1]Department of Physics, University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan
[2]JST, Transformative Research-Project on Iron Pnictides (TRIP), Chiyoda, Tokyo 102-0075, Japan
[3]Department of Applied Physics, University of Tokyo, Tokyo 113-8656, Japan
[4]Institute of Solid State Physics, University of Tokyo, Kashiwa 277-8581, Japan
[5]Advanced Light Source, Lawrence Berkeley National Lab, Berkeley, California 94720, USA
[6]Department of Applied Physics and Stanford Synchrotron Radiation Laboratory, Stanford University, Stanford, California 94305, USA
[7]Graduate School of Science, Hiroshima University, Higashi-Hiroshima 739-8526, Japan
[8]Hiroshima Synchrotron Center, Hiroshima University, Higashi-Hiroshima 739-0046, Japan
[9]KEK, Photon Factory, Tsukuba, Ibaraki 305-0801, Japan
[10]Research Center for Low Temperature and Materials Sciences, Kyoto University, Kyoto 606-8502, Japan
[11]Department of Physics, Kyoto University, Kyoto 606-8502, Japan and
[12]National Institute of Advanced Industrial Science and Technology, Tsukuba 305-8568, Japan

Introduction

Most of experimental results on the iron-pnictide superconductors have so far indicated that the superconducting gap opens on the entire Fermi surfaces (FSs), most likely a s_{+-}-wave gap, in contrast to the *d*-wave superconducting gap in the high-T_c cuprate superconductors. While majority of the iron-based superconductors possess nodeless gaps, some systems such as $BaFe_2(As_{1-x}P_x)_2$ [1], show signatures of line nodes in the superconducting gap. According to the spin-fluctuation-mediated mechanism, when the three-dimensionality of the FSs is taken into account, "horizontal" line nodes may appear in the strongly warped part of the hole FS [2] which has $3z^2$-r^2 orbital character. Thus, determination of the orbital character in the FSs is important to understand the Cooper pairing in this system. In order to clarify the orbital character of the FSs of $BaFe_2(As_{1-x}P_x)_2$, we have performed a polarization-dependent ARPES study.

Experimental condition

High-quality single crystals of $BaFe_2(As_{1-x}P_x)_2$ with x=0.34 (T_c=30 K) were grown using the self-flux method. Angle-resolved photoemission (ARPES) experiments were carried out at BL 10.0.1 of Advanced Light Source (ALS). A Scienta SES-R4000 analyzer and a linearly-polarized light were used with the total energy resolution of ~15 meV. The crystals were cleaved *in situ* at T=10 K in an ultra-high vacuum of ~2 x10^{-11} Torr.

Results and discussion

We have performed FS mapping in k_x-k_z plane with different polarization vector by changing the photon energy as shown in Fig. 1. The electric polarization vectors are parallel and perpendicular to the sample surface in Figs. 1(a) and 1(b), respectively. The observed shapes of the FSs are consistent with our previous ARPES study [3]. Considering the matrix element effect in these geometries, while the signal from the *xy* and *yz* orbital character are enhanced in Fig1.(a), that from the *xz* and $3z^2$–r^2 orbital character is enhanced in Fig1.(b). Therefore, the present result clearly indicates that the three-dimensional outer hole FS around the Z point has *xz* and $3z^2$–r^2 orbital character, consistent with the band calculation result [3].

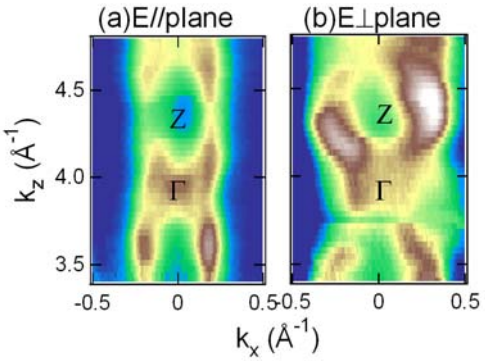

Fig.1: Fermi surface mapping in k_x-k_z plane for $BaFe_2(As_{1-x}P_x)_2$ (x=0.34, T_c=30K) obtained by changing the photon energy. Hole Fermi surfaces around the center of the Brillouin zone (BZ) are mapped with in-plane (a) and out-of-plane (b) vector.

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*yoshida@wyvern.phys.s.u-tokyo.ac.jp