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# Anisotropic electronic structure of $BaFe_2As_2$ in the electronic nematic phase

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## 1 Introduction

A parent compound of 122-type iron-based superconductors $BaFe_2As_2$ (Ba122) is paramagnetic with the tetragonal structure at room temperature. At structural-transition temperature of $T_S$ = 142 K, Ba122 undergoes a tetragonal-to-orthorhombic structural transition that is coincident with spin-density-wave (SDW) phase transition. In this material, electronic nematicity, in which the rotational $C_4$ symmetry of electronic structure is broken, has been observed in the AFM state close to the superconducting dome in the phase diagram through resistivity [1], optical conductivity [2], and ARPES [3] measurements. Thus the origin of the electronic nematicity is considered as one of a key issues to understand the superconductivity. Recently, it has been reported that the electronic nematicity persists up to 170 K well above the transition temperature [4], indicating the appearance of orbital order [5]. Here, we report the electronic structure of Ba122 in the electronic nematic phase observed by ARPES.

## 2 Experiment

High-quality single crystals of Ba122 were grown by the self-flux method and post-annealed. To observe the intrinsic electronic structure of Ba122, samples were detwinned by applying uniaxial compressive pressure in the a-b plane with a sample holder which is similar to that used in Ref. [6]. ARPES measurements were performed at beamline 28A of Photon Factory using circularly polarized light with the photon energy of 63 eV corresponding to $k_z \sim 2\pi/c$. A SIENTA SES-2002 electron analyzer was used with the total energy resolution of ~ 20 meV. The crystals were cleaved *in situ* at $T$ =20 K, and the measurements were carried out in an ultrahigh vacuum of ~ $4\times10^{-10}$ Torr.

## 3 Results and Discussion

To characterize the ordered state in the electronic nematic phase proposed in Ref. [4], we studied the band structure of Ba122 in the temperature ranges from 20 to 150 K across the transition temperature Ts. Figure 1(a) shows Fermi-surface mapping in the $k_x$-$k_y$ plane. A hole pocket, two electron pockets contiguous to the hole pocket, and small but high-intensity small electron pockets

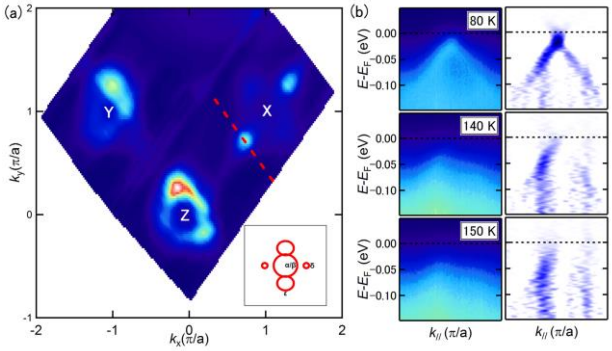


Fig. 1: ARPES spectra of $BaFe_2As_2$. (a) Fermi Surface mapping in $k_x$-$k_y$ plane at 20 K. (b) Evolution of the energy-momentum plots with temperature. The cuts were taken across the Dirac cone near the X point along a red broken line shown by in panel (a). Raw spectra and second-derivative plots of MDCs are shown in left and right panels respectively.

corresponding to crossing points of linear bands forming Dirac cones were observed. The shapes of the Fermi surfaces of Ba122 thus determined are depicted in the inset of Fig. 1(a). Energy-momentum plots at some temperatures across $T_S$ are shown in Fig. 1(b). The Dirac cone is confirmed at 80 K. Although the band dispersions is broadened as the temperature increases, a feature of the Dirac cone persists above $T_S$. The difference of the intensity between the two linear bands seems to be due to matrix element effects. This results suggest that some kind of antiferro-orbital order or its strong fluctuation that has the same translational symmetry as the SDW state persists above the transition temperature.

## References

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