Symmetry-broken electronic states in iron-based superconductors

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The anomalous normal state of high T_c copper oxide superconductors remains a mysterious state of matter. It has been attributed to several mechanisms such as a precursor pairing, a novel form of spin/charge ordering, electron nematicity, and so on. To gain further insights into the relationship between the high T_c superconductivity and these possible symmetry breaking phenomena, the exploration of normal states in other high T_c superconductors, namely iron-based superconductors, is highly desired.

Here we provide the evidences of symmetry-broken electronic states via angle-resolved photoemission spectroscopy (ARPES) in superconducting $BaFe_2As_2$ and FeSe families. Our results reveal an indication of composition-dependent orbital ordering in the isovalent $BaFe_2(As_{1-x}P_x)_2$ system [1], appearing as the inequivalent energy shifts in the *zx* and *yz* iron 3*d* orbitals that breaks the fourfold rotational symmetry of iron square lattice. They persist above the nonmagnetic superconducting dome to the optimally doping, and disappears in the overdoped regime concomitantly with the pseudogap [2]. It thus shows a notable similarity with the anomalous normal states in cuprates. Similar type of *zx* / *yz* orbital ordering, but with the sign change in momentum sapce, is also observed in FeSe [3]. In contrast to these rotational symmetry broken state, a recent result on hole-doped $(Ba,K)Fe_2As_2$ system provides the clear signatures of antiferroic instability existing in the wide doping region including the optimally doping[4]. The nature of these ubiquitous symmetry breaking phenomena in iron-based superconductors will be discussed.

References

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