Fermi surfaces and superconducting gaps of KFe_2As_2 and $FeTe_{0.6}Se_{0.4}$ using Laser-ARPES

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We investigated the electronic structure of KFe_2As_2 and $FeTe_{0.6}Se_{0.4}$ using high-resolution Laser-ARPES. We discuss the band dispersions, Fermi surfaces and the superconducting gaps of KFe_2As_2 and $FeTe_{0.6}Se_{0.4}$ obtained using polarization-dependent Laser-ARPES [1]. KFe_2As_2 (T_c = 3.4 K) is the extremely hole-doped end-member of the $Ba_{1-x}K_xFe_2As_2$ series and the superconducting order parameter has been debated in the literature. Our results indicate an octet-node superconducting gap [1], in contrast to a d_{x2-y2} gap reported from thermal conductivity studies [2]. For $FeTe_{0.6}Se_{0.4}$ (T_c = 14.5 K), the optimally doped member of the $FeTe_{1-x}Se_x$ series, we studied the band dispersions in an accessible range below and above the Fermi level (E_F) using Laser-ARPES. In addition to a hole Fermi surface with superconductivity, we observe an electron band lying within 1 meV above E_F at the Γ-point, which shows a sharp superconducting coherence peak with gap formation below T_c. The estimated superconducting gap Δ and Fermi energy ε_F indicate an unusual superconductivity in $FeTe_{0.6}Se_{0.4}$ (see also [3], which discusses BCS-BEC crossover). In analogy to composite superfluids in ultra-cold atomic systems, we term it composite superconductivity in $FeTe_{0.6}Se_{0.4}$, consisting effectively of strong-coupling BEC-like behaviour in the electron band and weak-coupling BCS-like superconductivity in the hole band.

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