論文の内容の要旨

論文題目　Photoemission study of the iron-based superconductor $FeTe_{1-x}Se_x$

（鉄系超伝導体 $FeTe_{1-x}Se_x$ の光電子分光による研究）

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Since the discovery of the iron-based superconductor fluorine-doped LaFeAsO with a $T_c$ of 26 K, a lot of efforts have been poured out trying to understand the mechanism of superconductivity in this new type of high-$T_c$ materials. It also drives the scientific community to synthesize new superconductors with higher $T_c$. Among the iron-based high-$T_c$ superconductors, the binary 11 family of $Fe_{1+y}Te_{1-x}Se_x$, having the simplest crystal structure, offers the possibility of providing valuable information about the origin of superconductivity in iron-based superconductors.

This research sought to investigate the electronic structure and elucidate the strength of electron correlation in the simplest kind of iron-based superconductor, the $Fe_{1+y}Te_{1-x}Se_x$ 11 system. For the first part, we carried out resonance photoemission experiments on the compounds of single crystals $Fe_{1+y}Te_{1-x}Se_x$ ($x$ = 0, 0.4) and polycrystalline FeSe ($x$ = 1) samples, using the photon energies around the Fe $3p \rightarrow 3d$ absorption region. We found out that, like most of the other iron-based superconductors, the density of states near the Fermi level ($E_F$) down to the binding energy of around 2 eV is mostly dominated by the Fe $3d$ states. We also found out that Fe $3p \rightarrow 3d$ resonance occurs at $h\nu$ ~ 55 eV and we're able to deduce the Fe $3d$ partial density of states (PDOS) for all the

samples. The near $E_F$ peak structure in FeSe which splits into two features in compounds with Te content can be explained by considering the electron correlations in these materials. By comparing the PDOS spectra with angle-resolved photoemission (ARPES) results, the peak structure can be attributed to the dominant Fe $3dz^2$ states. We obtained the mass renormalization value of around 2 – 3 for $dz^2$, which shows moderate electron correlation consistent with the calculation based on the dynamical mean field theory and previous photoemission results.

For the second part, we performed high-resolution ARPES measurements for the single crystals $Fe_{1+y}Te_{1-x}Se_x$ ($x$ = 0, 0.1, 0.2, 0.4). Around the highly symmetric zone center Γ, we found three band dispersions near $E_F$, consistent with the band calculations. This electronic structure is in essence very similar to other iron-based superconductors. The mass renormalization factors obtained from photoemission measurements for the different bands are consistent with the calculation and with other previous experimental data. This result further confirms the strong orbital dependence of the mass renormalization in 11 system. The *dxy* orbital is the most strongly correlated while the *dyz* and *dxz* shows moderate electron correlations. As for the composition dependence, only the *dxz* orbital band exhibits strong Se concentration dependence, while the *dyz* and *dxy* orbital bands did not show significant changes in the band position, mass renormalization or strength of electron correlation.

In conclusion, the electronic structure of the simplest iron-based superconductor $Fe_{1+y}Te_{1-x}Se_x$ is in general the same as the other families of iron-based superconductors. However, it was revealed from our photoemission data that the electron correlation is relatively stronger in the 11 systems. Furthermore, the mass renormalization also exhibits strong orbital dependence in this class of materials. The bands near $E_F$ should show moderate to strong electron correlations, while the deeper binding energy bands, say $dz^2$, would exhibit weak to moderate degree of electron correlations.