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ARPES Study on the Strongly Correlated Iron Chalcogenides $Fe_{1+y}Se_xTe_{1-x}$

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The level of electronic correlation has been one of the key questions in understanding the nature of iron-based superconductivity. Using Angle Resolved Photoemission Spectroscopy (ARPES), we systematically investigated the correlation level in the iron chalcogenide family $Fe_{1+y}Se_xTe_{1-x}$. For the parent compound $Fe_{1.02}Te$, we discovered "peak-dip-hump" spectra with heavily renormalized quasiparticles in the low temperature antiferromagnetic (AFM) state, characteristic of coherent polarons seen in other correlated materials with complex electronic and lattice interactions. As the temperature (or Se ratio x) increases and $Fe_{1.02}Se_xTe_{1-x}$ is in the paramagnetic (PM) phase, we observed dissociation behavior of polarons, suggestive of connection between the weakening electron-phonon coupling and AFM [1]. Further increase of x leads to an incoherent to coherent crossover in the electronic structure, indicating a reduction in the electronic correlation as the superconductivity emerges. Furthermore, the reduction of the electronic correlation in $Fe_{1+y}Se_xTe_{1-x}$ evolves in an orbital-dependent way, where the d_{xy} orbital is influenced most significantly [2]. At the other end of the phase diagram (FeSe) where the single crystal is not stable, we have studied the MBE-grown thin film which also reveals orbital-dependent strong correlation in the electronic structure [3]. Our findings provide a quantitative comprehension on the correlation level and its evolution on the phase diagram of $Fe_{1+y}Se_xTe_{1-x}$. We discuss the physical scenarios leading to strong correlations and its connection to superconductivity.

[1] Z. K. Liu, et al., Physical Review Letters 110, 037003(2013);
[2] Z. K. Liu, et al., submitted;
[3] M. Yi, et al., submitted.