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Orbital-dependent electron correlation effects in iron-based superconductors

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The iron chalcogenide superconductors constitute arguably one of the most intriguing families of the iron-based high temperature superconductors given their ability to superconduct at comparable temperatures as the iron pnictides, despite the lack of similarities in their magnetic structures and Fermi surface topologies. In particular, the lack of hole Fermi pockets at the Brillouin zone center posts a challenge to the previous proposal of spin fluctuation mediated pairing via Fermi surface nesting. In this talk, using angle-resolved photoemission spectroscopy measurements, I will present evidence that show that instead of Fermi surface topology, strong electron correlation observed in electron bandwidth is an important ingredient for superconductivity in the iron chalcogenides. Specifically, I will show i) there exists universal strong orbital-selective renormalization effects and proximity to an orbital-selective Mott phase in $Fe_{1+y}Te_{1-x}Se_x$, $A_xFe_{2-y}Se_2$, and monolayer FeSe film on $SrTiO_3$ [1,2], and ii) in $Rb_xFe_2(Se_{1-z}S_z)_2$, where sulfur substitution for selenium continuously suppresses superconductivity down to zero, little change occurs in the Fermi surface topology while a substantial reduction of electron correlation is observed in an expansion of the overall bandwidth, implying that electron correlation is one of the key tuning parameters for superconductivity in these materials. [1] M. Yi et al. Phys. Rev. Lett. 110, 067003 (2013). [2] M. Yi et al. Nat. Comm. 6, 7777 (2015). [3] M. Yi et al. arXiv: 1505.06636.