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Competing phases in iron-based superconductors[1]

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A common aspect of high temperature superconductivity in both cuprates and iron-based superconductors is that it always appears in the vicinity of other competing phases, whose suppression brings the full emergence of superconductivity. In iron-based superconductors, the competing phases take the form of collinear spin-density-wave phase and nematic phase. Characterization of these competing phases and associated phase transitions is essential to establishing a comprehensive understanding of the phase diagram of high temperature superconductors and ultimately the mechanism of unconventional superconductivity. In this talk, I will present our angle-resolved photoemission study of different family of iron-based superconductors. Our early data on detwinned $Ba(Fe_{1-x}Co_x)_2As_2$ and NaFeAs not only revealed a symmetry breaking orbital anisotropy in the nematic phase, but also identified the spectroscopic signatures associated with each phase transition in our ARPES spectra [1,2]. More recent results from underdoped $Ba_{1-x}K_xFe_2As_2$, on the other hand, provided the direct spectroscopic evidence for the coexistence and competition between SDW phase, nematic phase, and superconducting phase [3]. Finally, our latest data on multilayer FeSe film demonstrate the presence of a nematic state without long range magnetic order, suggesting the importance of orbital degree of freedom in driving the nematicity. [1] M. Yi, D. H. Lu, J.-H. Chu, J. G. Analytis, A. P. Sorini, A. F. Kemper, B. Moritz, S.-K Mo, R. G. Moore, M. Hashimoto, W.-S. Lee, Z. Hussain, T. P. Devereaux, I. R. Fisher, and Z.-X. Shen, Proc. Natl. Acad. Sci. 108, 6878 (2011). [2] M. Yi, D. H. Lu, R. G. Moore, K. Kihou, C.-H. Lee, A. Iyo, H. Eisaki, T. Yoshida, A. Fujimori and Z.-X. Shen; New Journal of Physics 14, 073019 (2012). [3] M. Yi, Y. Zhang, Z.-K. Liu, X. Ding, J.-H. Chu, A. F. Kemper, N. Plonka, B. Moritz, M. Hashimoto, S.-K. Mo, Z. Hussain, T. P. Devereaux, I. R. Fisher, H. H. Wen, Z.-X. Shen, and D. H. Lu; Nature Communications 5, 3711 (2014).

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