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State of the art: laser photoemission study on high temperature superconductors

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The mechanism of high temperature superconductivity in the copper-based and iron-based superconductors remains a prominent and challenging issue in condensed matter physics. Angle-resolved photoemission spectroscopy (ARPES), as a powerful technique to directly probe the electronic structure of materials, has played a key role in studying high temperature superconductors. In this talk, I will first briefly introduce the present status of high temperature superconductivity research. Then I will introduce the angle-resolved photoemission (ARPES) technique. I will present our latest progress on the development of vacuum ultra-violet laser-based angle-resolved/spin resolved photoemission systems with ultra-high instrumental resolutions. I will highlight our recent ARPES studies on the electronic structure and superconductivity of the copper-based superconductors by utilizing our laser-based ARPES. These include the observation of a metal-superconductor transition and nodal gap in the underdoped Bi2201 superconductors, coexistence of two energy-scales in the superconducting state of Bi2212 superconductor, and quantitative determination of pairing interactions in Bi2212 superconductor. Finally, I will present our results on the iron-based superconductors that include the revelation of distinct electronic structure, superconducting gap structure and high temperature superconductivity in single-layer FeSe/$SrTiO_3$ films, dichotomy of electronic structure and superconductivity between single-layer and double-layer FeSe/$SrTiO_3$ films, observation of an insulator-superconductor transition in FeSe/$SrTiO_3$ films, and distinct electronic structure and superconductivity in single crystal bulk (Li,Fe)OHFeSe superconductor. I will end by presenting discussions on these results and future perspective on the study of high temperature superconductors.

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