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Angle Resolved Photoemission Spectroscopy at Synchrotron Light Source

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Angle-resolved photoemission spectroscopy (ARPES) is a widely recognized experimental probe to study the electronic band structure of a material. It has shown its practical applications in several scientific disciplines such as solid-state and condensed matter physics, material science and engineering, as well as in surface science. ARPES is based on the photoelectric effect, in which an incoming photon of sufficient energy ejects an electron from the surface of a material. ARPES is the most direct method that measures simultaneously the kinetic energy and the angular distribution (or momentum) of the photoemitted electrons from a sample illuminated by light.

ARPES experimental setup is a complex structure consisting of mainly a monochromatic light source to deliver a narrow beam of photons, a sample holder connected to a manipulator used to position the sample of a material, and an electron spectrometer. Synchrotron radiation or laboratory light sources (gas-discharge lamp or laser light source) are used as the incident light for ARPES experiments. A synchrotron offers the advantages of covering a wider spectral range with an intense and highly polarized continuous spectrum. A laboratory source provides only discrete emission lines of specific elements. Thus, synchrotron radiation sources, together with their built-in beamlines, are superior to laboratory sources because the wide energy range of their photons allows, for example, a detailed investigation of the valence photoemission spectra. Recent advances in synchrotron science, instrumentation and data analysis drove a paradigm shift in using ARPES to study novel materials such as quantum materials, which had a huge impact on physics and other scientific fields.

In this presentation, I will discuss some of our recent ARPES studies on quantum materials and correlated electron systems that were done at synchrotron light source. Lastly, I will discuss how an ARPES beamlines at AfLS could potentially be leading tools pushing the frontier of solid-state and condensed matter physics, material science and engineering researches; thus helping to set the intellectual agenda by testing new ideas and making discoveries that will be done on the African continent.

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