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TOPICAL REVIEW

Angle-resolved photoemission spectroscopy (ARPES): probing electronic structure and many-body interactions

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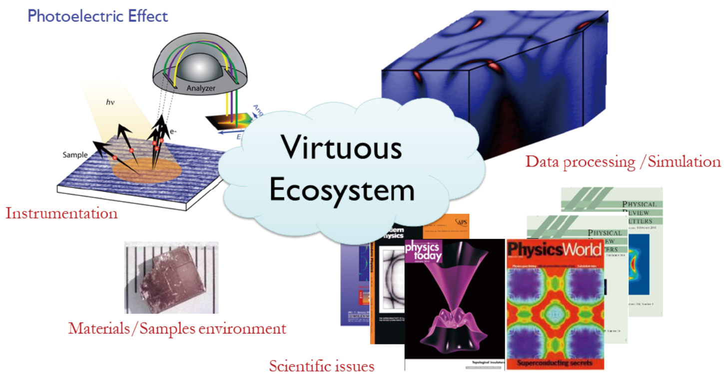
https://doi.org/10.61109/cs.202405.130

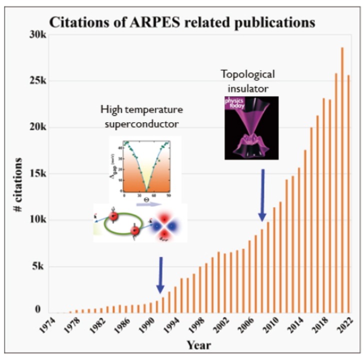
Citation: Z.-X. Shen, Angle-resolved photoemission spectroscopy (ARPES): probing electronic structure and many-body interactions, *Coshare Science* **02**, 04 (2024)

Author introduction

The significant enhancements in resolution, coupled with the expansion of modalities and meticulous alignment of problems, have propelled Angle-Resolved Photoemission Spectroscopy (ARPES) into the forefront as a primary tool for probing electronic structure and many-body effects in solids. The author stands as a pioneering figure in this advancement, marked by numerous groundbreaking discoveries and influential mentorship of key figures within the field.

Dr. Shen is the Paul Pigott Professor in Physical Sciences at Stanford University. His work has been recognized by many important awards, including the Centennial Lecture of the American Physical Society, the Kamerlingh Onnes Prize, the E.O. Lawrence Award, the Oliver E. Buckley Prize, Einstein Professorship Award, William and Flora Hewlett Foundation Fellow and Tage Erlander guest professor. In 2015, Dr. Shen was elected as a member of the National Academy of Sciences. In 2017, he was elected as a fellow of the American Academy of Arts and Sciences, and a foreign member of the Chinese Academy of Sciences.





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TOPICAL REVIEW

Angle-resolved photoemission spectroscopy (ARPES): probing electronic structure and many-body interactions

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Abstract Complex phenomenon in quantum materials is a major theme of physics today. As better controlled model systems, a sophisticated understanding of the universality and diversity of these solids may lead to revelations well beyond themselves. Angle-resolved photoemission spectroscopy (ARPES), formulated after Einstein's photoelectric effect, has been a key tool to uncover the microscopic processes of the electrons that give rise to the rich physics in these solids. Over the last three decades, the improved resolution and carefully matched experiments have been the keys to turn this technique into a leading experimental probe of electronic structures and many-body effects.

Drawing upon examples spanning from novel superconductors and topological materials to magnetic and one-dimensional materials, we illustrate ARPES's pivotal role in testing ideas, benchmarking theoretical frameworks, uncovering unexpected phenomena, and elucidating the fingerprints of many-body interactions. Moreover, we demonstrate how the integration of modern ultrafast UV lasers and spin polarimetry has empowered photoemission spectroscopy to capture essential microscopic quantities of electrons— energy, momentum, spin, and temporal dynamics—yielding invaluable insights from a wealth of rich and precise information.

Keywords band structure, electron correlation, unconventional superconductors, topological insulators

Acknowledgements The works are supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, Division of Materials Sciences and Engineering, under Contract No. DE-AC02-76SF00515.

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Submitted: 1 April 2024; Accepted: 13 May 2024; Published Online: 23 May 2024

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