Pseudogap and rotonic dispersion in a two-dimensional dipole system

Keun Su Kim
Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul, Republic of Korea
keunsukim@yonsei.ac.kr

Many fascinating quantum phenomena, such as a high-temperature superconductivity, were found in a two-dimensional (layered) insulator doped by foreign dopants. Although these dopants have been often neglected in theoretical models for the sake of brevity, it is true that they remain in actual materials. More importantly, these dopants seem to be arbitrarily distributed at first glance, but they may form a short-range order characterized by broad peaks in the structure factor arising from an average distance between dopants. In this talk, I will introduce our latest works using angle-resolved photoemission spectroscopy (ARPES) on the effect of short-range order to the electronic structure. The material system is a two-dimensional layered insulator (black phosphorus) doped by alkali metals. It could be modelled by a two-dimensional fluid of dipoles that consist of doped electrons and dopant ions. We found the short-range order of dopants is responsible for the pseudogap [1] and the aperiodic (rotonic) dispersion [2]. If time permits, I will also briefly discuss on sublattice quantum phases and Fermi arcs [3], and the direct measurement of a full quantum metric tensor in solids [4].

References

[1] S. H. Ryu, M. Huh, D. Park et al., Nature 596 (2021) 68.
[2] S. Park et al., Nature 634 (2024) 813.
[3] Y. Chung, M. Kim, Y. Kim et al., Nature Phys. 20 (2024) 1582.
[4] S. Kim et al., Science (2025), accepted.