Inoperando nanoARPES on van der Waals heterostructures

Jyoti Katoch[1], Aalok Tiwari[1], Sandy Adhitia Ekahana[1,2], Souvik Sasmal[1], I-Hsuan Kao[1], Chris Jozwiak[2], Eli Rotenberg[2], Aaron Bostwick[2], Simranjeet Singh[1]

[1]Department of Physics, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213, USA
[2]Advanced Light Source, E. O. Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA

Van der Waals (vdW) heterostructures offer an unprecedented platform for engineering the physical properties of two-dimensional (2D) materials through control of twist angle, strain, and environmental interactions. The advent of state-of-the-art angle-resolved photoemission spectroscopy with nanoscale spatial resolution (nanoARPES), combined with its ability to probe fully functional devices, has opened new avenues for directly visualizing exotic electronic phenomena in these systems.

In this talk, I will present our work leveraging cutting-edge in-operando nanoARPES to directly map the electronic properties of vdW heterostructures and their functional devices. I will show the direct momentum-resolved evolution of flat-band dispersion in twisted bilayer graphene systems, systematically varying the displacement field and carrier density via electrostatic gating. Time permitting, I will show our recent work on studying the intrinsic electronic structure and tunability of electronic states in atomically thin Weyl semimetals (WSMs) like $TaIrTe_4$. Known to be a Weyl semimetal in the bulk form and a quantum spin Hall (QSH) insulator in the monolayer, we investigate the tunability of the electronic structure of bilayer $TaIrTe_4$ via electrostatic gating as well as alkali metal doping.

Keywords: bilayer $TaIrTe_4$, Inoperando nanoARPES, Twisted double bilayer graphene.

Acknowledgement: Work supported by the DOE award no. DE-SC0020323 and DE-SC0025490.