Strange insulator in an extremely wide doping range in graphene

Zheng HAN
Institute of Opto-Electronics, Shanxi University, Taiyuan, China
Vitto.han@gmail.com

Abstract

It is a long standing prediction that correlated electron-hole states can occur in semiconductors with very small band gap or semimetals with very small band overlap, when cooled to a sufficiently low temperature, yielding a non-conducting Bose condensate. Such electron-hole paring degenerated quantum insulators are endowed with enriched intrinsic physics with Hamiltonians closely resembling that in superconductivity, and have attracted continuous attention since decades. However, owing to the dielectric screening and the recombination of electrons and holes, excitonic insulators remained largely unexplored in solids, especially in transport measurements.

In this talk, we will introduce our recent progresses in the experimental observation of an exotic insulator behavior: by bring bernal-stacked bilayer graphene into contact with a few-layered antiferromagnetic insulator CrOCl, the resulted vertical heterostructures can give rise to an extraordinarily robust ground state of exciton-enhanced insulator [1]. The consequential over 1 GOhms insulator can be readily killed by tuning the displacement field and effective doping, and the system recovers to a high mobility graphene with a sheet resistance of less than 100 Ohms. I-V curves as well as temperature- and magnetic field-dependences point such strange insulator to an excitonic-enhanced insulator behaviour, which is attributed to the subtle coupling of graphene-CrOCl interface. Such interfacial coupling can be a simple yet very powerful technique in effectively engineering the quantum electronic states.

References

[1] arXiv preprint arXiv:2110.02921.