PCSI

Room Canyon/Sugarloaf - Session PCSI-1SuA

2D Heterostructure Design

Moderator: Edward Yu, The University of Texas at Austin

2:35pm **PCSI-1SuA-2 Optical Properties of Semiconducting Moiré Crystals**, ***Xiaoqin Elaine Li,*** Univ of Texas at Austin **INVITED**

In van der Waals (vdW) heterostructures formed by stacking two monolayers, lattice mismatch or rotational misalignment introduces an in-plane moiré superlattice. The periodic atomic alignment variations between the two layers impose both an energy and optical selection rule modulations as illustrated in Fig. 1A-B. Optical properties of such moiré superlattices have just begun to be investigated experimentally [1-5]. In this talk, I will discuss how the properties of the interlayer excitons in a twisted transition metal dichalcogenide (TMD) heterobilayer are modified by the moiré potential. Specifically, we studied $MoSe_2/Wse_2$ bilayers with small twist angles, where electrons mostly reside in the $MoSe_2$ and holes nominally in the Wse_2 monolayer because of the type-II band alignment. We observe multiple interlayer exciton resonances with either positive or negative circularly polarized emission (Fig. 1C). We attribute these resonances to the ground and excited exciton states confined within the moiré potential. The twist angle dependence, recombination dynamics, and temperature dependence are consistent with this interpretation. These results highlight the versatile and tunable optical properties of semiconducting moiré crystals.

3:15pm **PCSI-1SuA-10 Berryogenesis: Spontaneous Out-of-Equilibrium Plasmonic Magnetism**, ***Justin Song,*** Nanyang Technological University Singapore, Singapore **INVITED**

Spontaneous symmetry breaking lies at the heart of the description of interacting phases of matter. Here we argue that a driven interacting system subject to a linearly polarized (achiral) driving field can spontaneously magnetize (acquire chirality). In particular, we find when a metal is driven close to its plasmon resonance, it hosts strong internal ac fields that enable Berryogenesis: the spontaneous generation of a self-induced Bloch band Berry flux, which supports and is sustained by a circulating plasmonic motion, even for a linear polarized driving field. This non-equilibrium phase transition occurs above a critical driving amplitude, and depending on system parameters, can enter the spontaneously magnetized state in either a discontinuous or continuous fashion. Berryogenesis relies on nontrivial interband coherences for electronic states near the Fermi energy generated by ac fields readily found in a wide variety of multiband systems. We anticipate that graphene devices, in particular, which can host high quality plasmons, provide a natural and easily available platform to achieve Berryogenesis and spontaneous non-equilibrium (plasmon-mediated) magnetization in present-day devices, e.g., those based on graphene plasmonics. If we have time, we will also discuss other manifestations of non-trivial quantum geometry in Dirac systems.

3:55pm **PCSI-1SuA-18 UPGRADED: Investigation of Graphene/Ge(110) Interface**, ***Miriam Galbiati,*** Technical University of Denmark, Denmark

Investigating the interfacial properties between graphene and traditional semiconductors is crucial to develop novel electronics [1]. In this framework, the Graphene/Ge(110) has received a great deal of attention over the last couple of years [2–7]. These studies focus on the structure of Graphene/Ge(110) interface and notably on the possible reconstructions of Ge surface as shown by scanning tunnelling microscopy (STM). However, no insights into the electronic properties of this interesting system are today available.

Here, we investigate the evolution of the system´s interface upon annealing in vacuum at different temperatures. We use low-temperature STM to probe the surface structure with atomic precision. At each stage, images at different applied biases are collected and interestingly, graphene becomes transparent at high biases. When growing graphene by chemical vapour deposition, hydrogen that is used during growth passivates the Ge surface, stabilizing the (1x1) phase (i.e., unreconstructed surface) [5]. Annealing the sample at 350°C leads to desorption of hydrogen and STM and low energy electron diffraction (LEED) reveal that the surface of Ge(110) reconstructs into a (6x2) phase, never observed for bare Ge. Upon further annealing above 700°C, STM shows that the Ge surface modifies back into the (1x1) phase. At this point, due to the lack of hydrogen, the (1x1) is stabilized by graphene forming chemical bonds with Ge atoms underneath [2]. Indeed, the Ge surface remains in the (1x1) phase even if further annealing at temperature above 350°C is performed. To gain insights into the electronic properties, we perform angle resolved photoemission spectroscopy (ARPES) after each thermal annealing step. The ARPES data show how graphene's doping changes upon thermal annealing, signature of a different interaction with the Ge substrate.

[1] J. Lee, Science, 344(2014).

[2] J. Tesch, Carbon, 122(2017).

[3] G.P. Campbell, Phys. Rev. Mater., 2(2018).

[4] J. Tesch, Nanoscale, 10(2018).

[5] D. Zhou, J. Phys. Chem. C., 122(2018).

[6] H.W. Kim, J. Phys. Chem. Lett., 9(2018).

[7] B. Kiraly, Appl. Phys. Lett., 113(2018).

Author Index

Bold page numbers indicate presenter