Optical Properties of Semiconducting Moiré Crystals

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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.

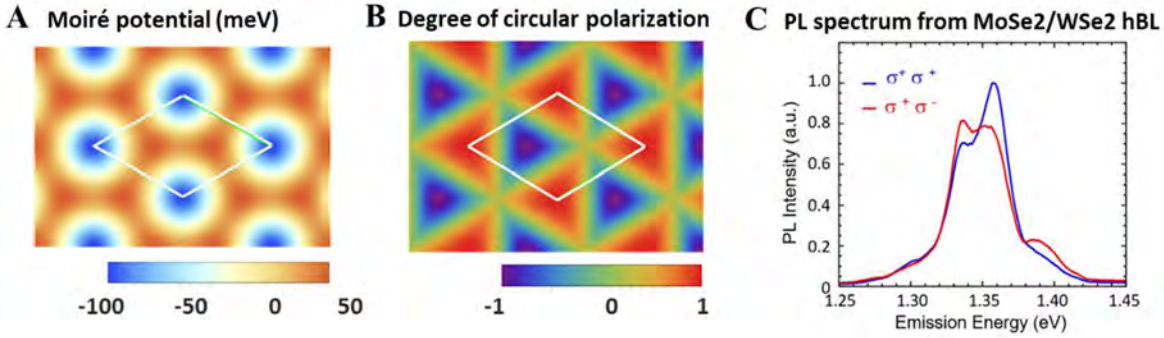

Fig. 1: Calculated (**A**) energy modulation and (**B**) spatially varying optical selection rules of a 2D moiré crystal in a TMD bilayer. (**C**) Measured PL spectra of interlayer excitons in a stacked $MoSe_2/WSe_2$ bilayer with a small twist angle of 1°.

[1] Nature **567**, 71-75 (2019);

[2] Nature **567**, 66-70 (2019);

[3] Nature **567**, 76-80 (2019);

[4] Nature **567**, 81-86 (2019)

[5] Nano Letters, 18, 7651, (2018)