k-space indirect interlayer excitons in MoS_2/WSe_2 van der Waals heterostructures

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In heterobilayers of transition metal dichalcogenides (TMDCs) a new type of exciton emerges, where electron and hole are spatially separated. These interlayer excitons allow exploration of many-body quantum phenomena and are ideally suited for valleytronic applications. Mostly, a basic model of fully spatially-separated electron and hole stemming from the *K* valleys of the monolayer Brillouin zones is applied to describe such excitons. Here, we combine photoluminescence spectroscopy and first principle calculations to expand the concept of interlayer excitons. We identify a partially charge-separated electron-hole pair in MoS_2/WSe_2 heterostructures residing at the *Γ* and *K* valleys. We control the emission energy of this new type of *k*-space indirect, yet strongly-bound exciton by variation of the relative twist angle (see Figure). These findings represent a crucial step towards the understanding and control of excitonic effects in TMDC heterostructures and devices.

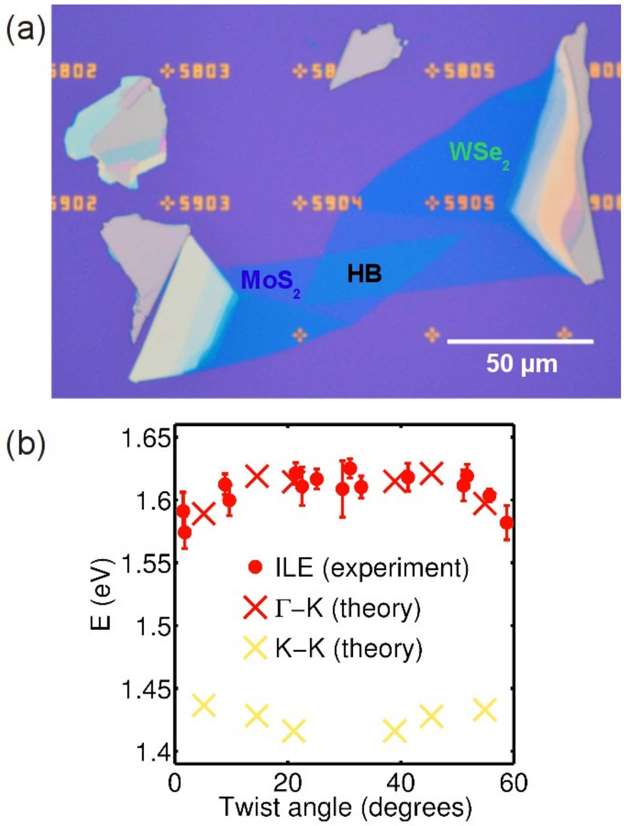

Figure: (a) Optical micrograph of a sample with a twist angle of 58.7°. Monolayer and heterobilayer (HB) regions are indicated. **(b)** Interlayer exciton (ILE) energies and calculated transition energies for HB with different twist angles. The Γ-K and K-K values are calculated with density functional theory. The trend of Γ-K is in quantitative agreement with the experiment.

References
[1] Kunstmann et al. (2018), submitted.