Intralayer Moiré Excitons in $TaSe_2$/$MoSe_2$ van der Waals heterostructure

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Van der Waals heterostructures (vdWH) are a versatile platform for exploring emergent quantum phenomena [1]. Moiré superlattices formed by twisted van der Waals heterostructures enable control over excitonic states through periodic potential modulation and band structure hybridisation [2]. Here, we investigated twist-angle-dependent intralayer moiré excitons in $TaSe_2$/$MoSe_2$ heterostructures, in which semiconducting $MoSe_2$ is stacked on semi-metallic $TaSe_2$. Temperature-dependent photoluminescence reveals peaks emerging at the lower twist angles, originating from excitons and trions trapped within the moiré potential. The number of emission peaks increases as the twist angle decreases, consistent with the formation of excitonic minibands in an expanded moiré potential at larger periodicities. At higher twist angles, the excitonic features converge toward those of pristine $MoSe_2$, with only the neutral exciton and trion peaks remaining prominent. These observations establish $MoSe_2$/$TaSe_2$ as a model system to study moiré excitons in semiconductor-metal heterostructures. Owing to their interlayer coupling, the intralayer optical response and electronic band structure in the heterostructure can be systematically tuned, enabling access to emergent physical phenomena such as moiré-induced emission, correlated magnetism, unconventional superconductivity, Mott insulating behavior, and topological phase transitions.

References

[1] B.-H. Lin et al., *Remarkably Deep Moiré Potential for Intralayer Excitons in $MoSe_2$/MoS_2 Twisted Heterobilayers*, Nano Lett. **23**, 1306 (2023).
[2] M. Förg, A. S. Baimuratov, S. Y. Kruchinin, I. A. Vovk, J. Scherzer, J. Förste, V. Funk, K. Watanabe, T. Taniguchi, and A. Högele, *Moiré Excitons in $MoSe_2$-WSe_2 Heterobilayers and Heterotrilayers*, Nat. Commun. **12**, 1 (2021).

Figures

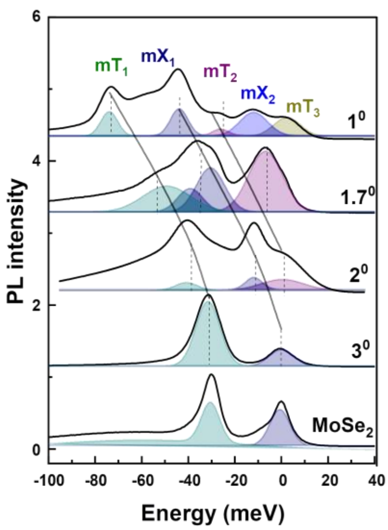

Figure 1: Evolution of photoluminescence spectra with twist angle in $TaSe_2$/$MoSe_2$ van der Waals heterostructure.