

Excitons in moiré heterostructures

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Van der Waals crystals of two-dimensional semiconducting transition metal dichalcogenides have evolved as an increasingly significant material platform in condensed matter research. With access to a variety of single-crystal monolayers, a wide range of van der Waals heterostructures can be assembled into rationally designed vertical stacks with emergent flat bands of correlated electrons and tailored optical properties of strongly bound excitons. In my talk, I will discuss our recent insight into the roles of layer constituents, atomic registry and twist angle for the formation of excitons with distinct spin-valley degrees of freedom and layer character. In particular, I will highlight the effect of charge carrier doping on moiré excitons in MoSe₂-WS₂ heterobilayers with canonical moiré superlattices [1] and present contrasting phenomena in MoSe₂-WSe₂ heterostacks subject to mesoscopic reconstruction [2,3].

[1] B. Polovnikov, J. Scherzer, S. Misra, X. Huang, C. Mohl, Z. Li, J. Göser, J. Förste, I. Bilgin, K. Watanabe, T. Taniguchi, A. S. Baimuratov, and A. Högele, Coulomb-correlated states of moiré excitons and elementary charges on a semiconductor moiré lattice at integer and fractional fillings, *arXiv:2208.04056* (2022).

[2] S. Zhao, Z. Li, A. Rupp, J. Göser, I. A. Vovk, S. Yu. Kruchinin, K. Watanabe, T. Taniguchi, I. Bilgin, A. S. Baimuratov, and A. Högele, Excitons in mesoscopically reconstructed moiré heterostructures, <https://doi.org/10.1038/s41565-023-01356-9> *Nature Nanotechnology* (2023).

[3] Z. Li, F. Tabataba-Vakili, S. Zhao, A. Rupp, I. Bilgin, Z. Herdegen, B. März, K. Watanabe, T. Taniguchi, G. Schleder, A. S. Baimuratov, E. Kaxiras, K. Müller-Caspary, and A. Högele, Lattice reconstruction in MoSe₂-WSe₂ heterobilayers synthesized by chemical vapor deposition, *arXiv:2212.07686* (2022).