Excitons in marginally twisted transition-metal dichalcogenide heterobilayers

Isaac Soltero,
Ludmila Szulakowska, James McHugh, Mikhail Kaliteevski, Vladimir Enaldiev and Vladimir Fal'ko
[1]*Department of Physics and Astronomy, University of Manchester, Oxford Road, Manchester M13 9PL, United Kingdom*
[2]*National Graphene Institute, University of Manchester, Booth Street E., Manchester M13 9PL, United Kingdom*
Isaac.solteroochoa@manchester.ac.uk

Twisted bilayers of two-dimensional semiconductors are versatile platforms for engineering quantum states for charge carriers. Among the systems of particular interest are twistronic $MoSe_2/WSe_2$ and MoS_2/WS_2 heterostructures which feature type-II band alignment between monolayer conduction and valence bands and have been subject of studies of quantum dot confinement for electrons and excitons. It was also noted that twisted interfaces of these heterostructures undergo significant reconstruction, resulting in the formation of large stacking domains separated by a network of dislocations, which have a strong impact on the localization of quasiparticles across moiré superlattices [1]. In this work, we present multiple exciton confinement regimes in lattice reconstructed highly aligned $MoSe_2/WSe_2$ and MoS_2/WS_2 bilayers, originated from the fine tuning of the twist angle between layers. The proposed scenarios correspond to quantum dots and wires driven by the strain build-up along the dislocation network, considered though a multi-scale model of electrons and holes states on the moiré superlattice.

References

[1] I. Soltero, M.A. Kaliteevski, J.G. McHugh, V. Enaldiev, V.I. Fal'ko, Nano Lett. **24** (2024) 1996-2002