Wannier excitons in two-dimensional topological insulators with strong spin-orbit coupling

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Thanks to extensive studies in the past two decades, the role of topology in the band structure of noninteracting electrons is well understood. In real materials, however, electronic correlations often give rise to new phenomena which can significantly alter the ground-state properties of the noninteracting system. The question of whether and how the single-particle topology manifests itself in such cases is object of active ongoing research at both the theoretical and experimental level. The aim of this talk is to give an inexhaustive overview of the effects of electronic topology on Wannier excitons in two-dimensional semiconductors with strong spin-orbit coupling. In these materials, the nontrivial momentum-space winding of the underlying electrons and holes strongly modifies the Coulomb interaction between them. The resulting excitonic band structure is greatly modified with respect to that arising from the same model in a trivial regime. In particular, Berry-phase effects leave a clear imprint on the exciton binding energies by lifting the accidental angular-momentum degeneracy present in the hydrogen-like Wannier picture. The optical properties are also affected by the underlying topological single-particle Hamiltonian, with *s*- and *d*-wave excitons coupling selectively to left- or right-circularly polarized light. If time permits, I will discuss the possibility and peculiarities of exciton condensation and squeezing in the presented model.

References

[1] L. Maisel Licerán, F. García Flórez, L. D. Siebbeles, and H. T. Stoof. *Sci. Rep.* **13**(1), 6337 (2023)
[2] J. Zhou, W. Y. Shan, W. Yao, and D. Xiao. *Phys. Rev. Lett.* **115**(16), 166803 (2015)

Figures

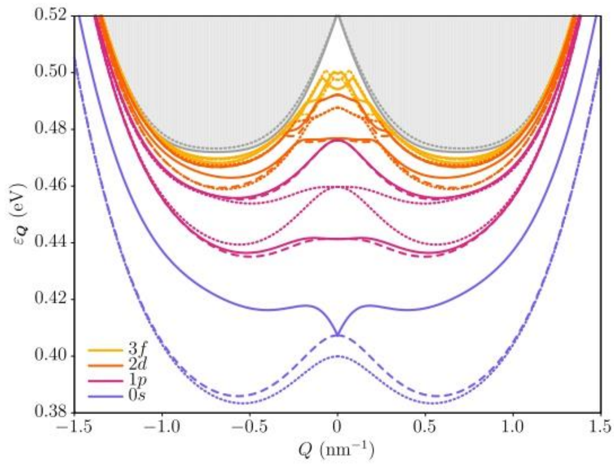

Figure 1: Exciton band structure in the *topological* regime of the underlying single-particle Hamiltonian, strongly deviating from the hydrogen-like spectrum shown below.

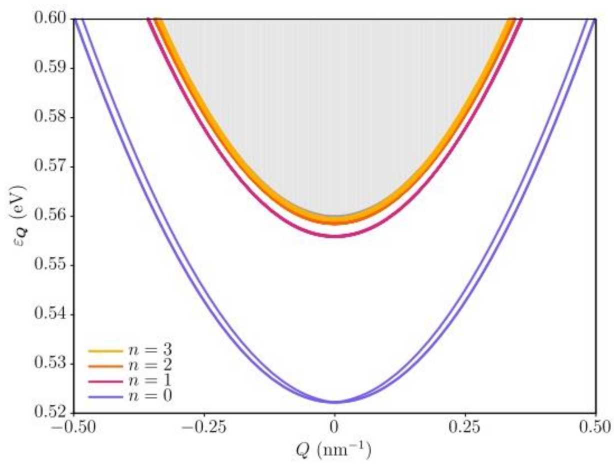

Figure 2: Exciton band structure in the *trivial* regime of the underlying single-particle Hamiltonian. A hydrogen-like spectrum is obtained.