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Effective g-factors of excitons in van der Waals semiconductors

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Abstract

The future application of few-layer semiconductors, such as transition metal dichalcogenides (TMDCs), as building blocks for opto-electronic devices relies on a full understanding of the light-induced strongly bound electron-hole pairs (excitons) in these materials. Through the investigation of Zeeman and diamagnetic shifts in the excitonic peaks under high magnetic fields, magneto-photoluminescence has been proven an important experimental tool for unravelling the angular momentum character of electron and hole states in few-layer materials. However, unexpected values for the g-factors of these states have been consistently observed in monolayer and heterobilayers of TMDCs, which motivates us to develop accurate theoretical models for explaining these experimental observations.
In this talk, I will present a theoretical approach for predicting the angular momentum (and, consequently, the g-factor) of excitonic states in monolayer and bilayer semiconductors within a multi-scale approach, involving a combination of ab initio and continuum model tools. [1] As we will discuss in details, this model has been successfully used to explain experimentally observed Zeeman shifts (i) of ground and excited exciton states in monolayer WSe2, [2] (ii) of hybrid exciton states, with k-space direct and indirect components, in monolayer WS2, [3] and (iii) of excitons confined by moiré patterns in a MoSe2/WS2 van der Waals bilayer.

References

[1] T. Wozniack et al., Phys. Rev. B 101, 235408 (2020).

[2] S.-Y. Chen et al., Nano Lett. 19, 2464 (2019).

[3] E. Blundo et al. Phys. Rev. Lett. 129, 067402 (2022).

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