

Report of the PhD activities – MAP-Fis

Initially, a review of the application of several variational methods to the study of excitons in layered materials was done. This was performed in the context of the MAP-Fis doctoral program essay, and a colloquium has been published in European Physics Journal B shortly after (December 2020).

Afterwards, the polarizability of excitons in a WSe₂ monolayer-based quantum dot was studied from a fully microscopic perspective. The transition to the excitonic 2p states was considered, which are optically dark but can be accessed via pump-probe experiments. A good agreement was found between the theoretical calculations and recent experimental measurements. This work was then published in the Journal of the Optical Society of American B (June 2021).

Following from this work, interlayer excitons were considered in a van der Waals heterostructure-based quantum dot consisting of a WS₂/WSe₂ bilayer. The same regime as in the JOSA-B paper was considered, and a quick comparison was performed against recent pump-probe experimental measurements. A model for the study of the non-linear polarizability was studied, focusing on the third-order regimes, namely two-photon absorption and third-harmonic generation. This allowed for the discussion of the selection rules for interlayer excitons and also for the discussion on the observability of each individual peak in future pump-probe experiments. A seminar on this topic was presented in the MAP-Fis annual conference on the 9th July 2021 and a subsequent paper has been published in Physical Review B in November 2021.

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