GRK 2905
Ultrafast
Nanoscopy

Seminar

Thursday May, 15, 3.15 pm, PHY 5.0.21

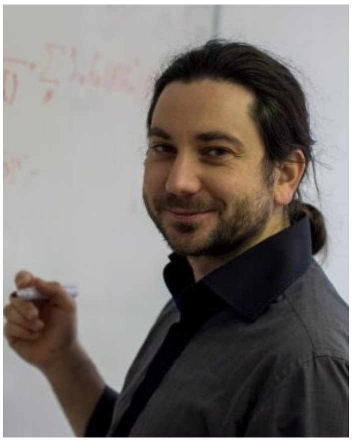
Intraband motion corrections to the spectrum of excitons in transition metal dichalcogenide monolayers

Non-Hermitian quantum physics has become an essential field of study as it can reveal insightful information about realistic systems beyond the scope of Hermitian quantum physics. Certain non-Hermitian systems exhibit spontaneous PT-symmetry breaking exceptional points with unconventional spectral properties and topological features exclusive to these systems. In this presentation, I want to discuss the unconventional scaling behaviour near such exceptional points through a non-Hermitian quantum XY spin-chain. I will review the problems one might encounter while dealing wiDepartment of Condensed Matter Physics, Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic

Transition metal dichalcogenide (TMD) monolayers are among the most intriguing two-dimensional materials for optoelectronic applications due to their unique valley-dependent electronic properties. In particular, the superposition of intravalley exciton states at the nonequivalent ±K points can be considered a qubit, which has potential applications in various quantum technologies. The manipulation of such qubits for dark intravalley excitons using intense magnetic fields was demonstrated in 2019 [1]. Subsequently, similar control over bright excitonic states using non-resonant circularly polarized light was both experimentally observed and theoretically explained [2,3]. In the latter, the theoretical analysis relied on the Semiconductor Bloch equations (SBE), where the dominant interband transition terms were considered.

However, as it turned out, this approximation is valid for small intensities of applied optical pulses and needs to be reconsidered for more intense pulses. In this work, we analyze the solutions of the SBE, incorporating the previously neglected intraband term, which governs electron dynamics within the separate bands. We develop a new perturbation technique and calculate corrections to the shifts of intravalley exciton energies in TMD monolayers [4]. The possibility of experimentally measuring these results is also discussed.

[1] M. R. Molas et al, Phys. Rev. Lett. 123, 096803 (2019)
[2] A. O. Slobodeniuk et al, npj 2D Mater. Appl. 7, 17 (2023)
[3] A. O. Slobodeniuk et al, Phys. Rev. B 106, 235304 (2022)
[4] A. O. Slobodeniuk, T. Novotny, https://arxiv.org/abs/2501.06885



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