Aktuelle Fragen
der Nanophysik

Montag, 01.07.2019 um 15:15 Uhr
Ort: Seminarraum 87, Wilhelm Klemm-Straße 10

On-situ control of quantum states by carrier capture in 2D materials

Roberto Rosati
Chalmers University of Technology
Department of Physics
Gothenburg, Sweden

The monolayers of transition metal dichalcogenides (TMDC) have attracted wide attention due to their two-dimensional (2D) character and interesting optical and electronic properties [1]. Hybrid 2D-0D systems can be formed, e.g. by means of strain [2], resulting in bound states with specific spectral characteristics and well localized in space: A superposition of these could generate quantum states which, if controllable, could pave the way for on-situ quantum computing.

In order to populate localized states, the carrier capture by emission of optical phonons can be exploited. Adopting a recently introduced Lindblad single-particle approach, which combines computational affordability and ability of catching most of the relevant features of the carrier capture [3], in this work we study the phonon-induced capture from an electronic wave packet in a MoSe2 monolayer into the localized states of a 0D potential. The resulting combination of non-trivial spatio-temporal dynamics and locality of the carrier capture induces oscillations of the captured spatial distribution thanks to the formation of quantum coherences: These can be controlled by changing the orientation between wave packet and elliptical 0D potential [4] (see Fig. 1), or exploiting more wave packets. These oscillations define a spatial polarization, i.e., a spatial qubit: We will discuss how to control the latter in the case of the 0D confinement potential resulting from a nanobubble, similar to those formed when a monolayer is put on a substrate [5].

Our results show that the carrier capture allows the generation and on-situ control of spatial qubits, which may guide future experiments in the field of quantum information processing.

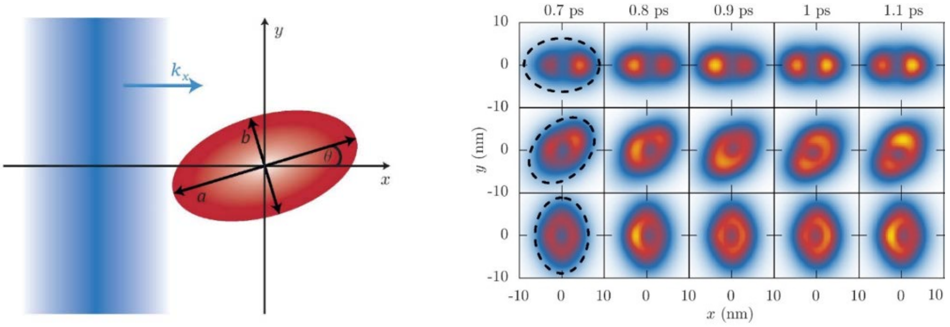

Fig. 1: Sketch of a wave packet impinging on a 0D potential (left) and induced spatio-temporal oscillations of the captured distribution (right) for different relative oscillation (top to bottom, dashed black line indicating the 0D potential).

[1] T. Mueller, and E. Malic, npj 2D Mater. Appl. 2, 29 (2018).
[2] J. Kern et al., Adv. Mater. **28**, 7101 (2016).
[3] R. Rosati, D. E. Reiter, and T. Kuhn, Phys. Rev. B **95**, 165302 (2017).
[4] R. Rosati, F. Lengers, D. E. Reiter, and T. Kuhn, Phys. Rev. B **98**, 195411 (2018).
[5] C. Carmesin et al., Nano Lett. **19**, 3182 (2019).