Aktuelle Fragen
der Nanophysik

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Bright and dark three-particle states in two-dimensional materials


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The family of 2-dimensional (2D) layered materials such as MoS_2, WSe_2 etc. is continuously growing, providing new challenges in understanding their fundamental properties and offering novel and unique functionalities relevant for future applications. In this talk, I will discuss our recent investigations on Coulomb-bound three-particle states (trions) in two-dimensional materials using optical and high-field magneto-optical spectroscopy, and *GW*-BSE *ab initio* calculations. In the first part of the talk, I will describe how the Fermi-Dirac statistics of the bright and dark trions governs the optical absorption and luminescence of 2D materials. The Fermi distribution of the trions under high magnetic fields up to 30 T is used to determine the extent of the coupling of lowest conduction bands (or their g-factors) to the magnetic fields [1]. By studying the thermal distribution of trions in the optical absorption and emission in MoS_2, $MoSe_2$, WS_2, and WSe_2 monolayers, we find the energetic positions of optically inaccessible dark trions [2]. In the second part of the talk, I will discuss our discovery of an excited-state of a trion in a monolayer WS_2 using absorption spectroscopy [3]. Our results are important for understanding the spin-valley-resolved single-particle and the three-particle bandstructure of the 2D materials.

[1] Koperski et al., 2D Materials **6**, 015001 (2018)
[2] Arora et al., submitted (2020), preprint at arXiv:1911.06252
[3] Arora et al., Phys. Rev. Lett. **123**, 167401 (2019)