UNIVERSITÄT DUISBURG ESSEN

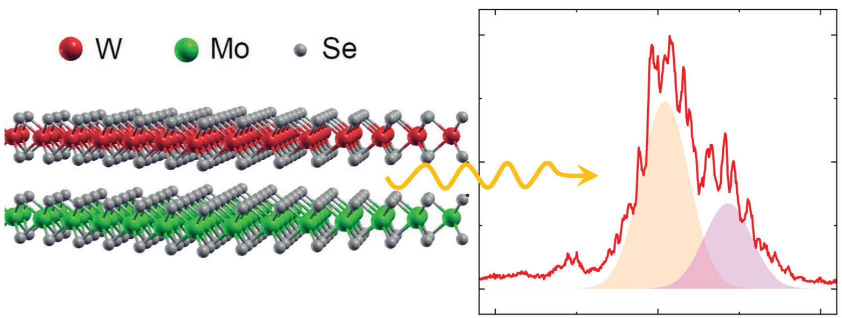
PHYSIK E=

Physikalisches Kolloquium

Mittwoch, 14.05.2025
13:00 Uhr
MC 122 und Zoom

https://uni-due.zoom-x.de/j/64228670246?pwd=RjVQeFNIUkRKRkpiNVpKYXhJaFNLdz09 (gilt für alle Vorträge)

Hybridized excitons in monolayer semiconductors



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In conventional direct-gap semiconductors, excitons typically form at the Γ-point of the Brillouin zone. In contrast, in monolayer transition-metal dichalcogenides (TMD), the multi-valley character in combination with broken inversion symmetry and strong spin-orbit coupling allows for a much enriched exciton landscape close to the K/K'-points, including bright, spin-and valley forbidden dark and interlayer excitons in van der Waals stacks. Furthermore, atomically thin semiconductors can be readily integrated into a wide range of nanophotonic architectures allowing for novel light-matter interaction regimes.
In the introduction of this talk, I will review exciton physics in 2D materials, browsing through work that includes the largest magnets on the planet as well as the highest-Q nanophotonic cavities for 2D materials. For the main part of the talk I will review our recent work on hybridization-induced exciton physics in TMD monolayers and heterobilayer stacks.
The exciton dispersion relation in monolayer, multi-valley semiconductors is governed by the intra- and intervalley electron hole exchange interaction (EHEI), predicting a conventional ~Q2 exciton center-of-mass dispersion relation as well as a nonanalytical ~Q, light-like dispersion relation. In other words, massive excitons can behave like light due to fundamental quantum mechanical effects. I will discuss recent magneto-photoluminescence spectroscopy of excitons in the monolayer semiconductor WSe2 to 25T [1]. Investigating the field dependent line shape of the neutral exciton reveals the emergence of a blue-detuned peak in both field orientations. Analyzing the distinct magnetic field dependent shifts of both peaks allows the identification of the emergent feature as a spin-singlet with a significantly smaller reduced exciton mass as compared to the neutral exciton. The intensity of the emergent feature increases with a rate ~αB2 where α depends on the excess charge density, as expected for the density dependent EHEI. We interpret our observations within a picture of magnetic field induced hybridization between the bright dispersive and dark lightlike exciton dispersion, leading to the brightening of this state.