Aktuelle Fragen
der Nanophysik

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In-plane anisotropy of the photon-helicity induced linear Hall effect in few-layer WTe_2

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Using Hall photovoltage measurements, we demonstrate that a linear transverse Hall voltage can be induced in few-layer WTe_2 under circularly polarized light illumination. By applying a bias voltage along different crystal axes, we find that the photon-helicity induced Hall effect coincides with a particular crystal axis. Our results are consistent with the underlying Berry curvature exhibiting a dipolar distribution due to the breaking of crystal inversion symmetry. Using time resolved optoelectronic autocorrelation spectroscopy, we find that the decay time of the detected Hall voltage exceeds the electron-phonon scattering time by orders of magnitude but is consistent with the comparatively long spin lifetime of carriers in the momentum-indirect electron and hole pockets in WTe_2. Our observation suggests that a helicity induced non-equilibrium spin density on the Fermi surface after the initial charge carrier relaxation gives rise to a linear Hall effect.

Hybridized indirect excitons in MoS_2/WS_2 heterobilayers

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Ensembles of indirect or interlayer excitons (IXs) are intriguing systems to explore classical and quantum phases of interacting bosonic ensembles. IXs feature enlarged lifetimes due to the reduced overlap of the electron-hole wave functions [1,2]. A field effect structure with few layer hexagonal boron nitrite (hBN) as insulator and few-layer graphene as gate-electrodes facilitates an electric field control of the IXs in a MoS_2/WS_2 heterobilayer [2]. A multiplet structure in the IX emission band can be observed even at room temperature. Stark shift measurements reveal the presence of a finite out-of plane dipole of the IXs. Due to a different strength of the dipole and a distinct temperature dependence, we identify the IXs to stem from optical interband transitions with electrons and holes in different valleys of the heterostructures [2]. We observe a field dependent level anti-crossing for the energetically lowest emission line, forming hybridized indirect excitons at low temperatures [2,3]. We discuss this behavior in terms of a finite coupling of the electronic states of the two TMDC monolayers. Our results demonstrate the design of novel nano-quantum materials prepared from artificial van der Waals solids with the possibility to in-situ control their physical properties via external stimuli such as electric fields.

[1] Bastian Miller, Alexander Steinhoff, Borja Pano, Frank Jahnke, Alexander Holleitner, Ursula Wurstbauer, Nano Lett., **17(9),** 5229-5237 (2017).
[2] Jonas Kiemle, Florian Sigger, Michael Lorke, Bastian Miller, Kenji Watanabe, Takashi Taniguchi, Alexander Holleitner, Ursula Wurstbauer, arXiv:1812.10697 (2018).
[3] Shiyuan Gao, Li Yang, Catalin D. Spataru, Nano Lett., **17(12)**, 7809-7813, (2017).