Optical properties of two-dimensional semiconductors

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Technological breakthroughs have lead to the synthesis of various two-dimensional materials. The graphene and transition metal dichalcogenides monolayers (TMDC MLs), such as MoS_2 and WSe_2, are the most prominent examples of such nanosystems. In TMDC MLs the direct band gaps on the order of 2 eV are formed at the $\boldsymbol{K}_+$ and $\boldsymbol{K}_-$ points at the edges of the Brillouin zone. The strong spin-orbit interaction locks the valley and spin degrees of freedom of individual charge carries and makes selection rules at the interband transitions light helicity dependent. Relatively large effective masses of the charge carriers and relatively weak screening of the Coulomb interaction between the electrons and the holes results in robust excitons, which control the optical of TMDC MLs. Here we review optical and magnetooptical properties of monolayer semiconductors. Particularly, we address the specifics of excitonic series in these materials. Furthermore, we discuss (i) the fine structure of neutral and charged excitons energy spectrum, (ii) the coupled spin/valley dynamics of excitons caused by the long-range exchange interaction between the electron and hole, as well as (iii) the mixing between different excitonic states due to the trigonal symmetry of TMDC MLs.