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Excitons and magnons in CrSBr

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CrSBr is a van der Waals antiferromagnetic semiconductor where optical excitations, namely, neutral and charged excitons, are strongly coupled to magnetic order, making it a particularly rich platform for studying the interplay between excitons, charge carriers, and spin excitations. In this talk, I will give an overview of recent studies of excitonic states and exciton–magnon interactions in few-layer CrSBr.

I will first discuss neutral and charged excitons in CrSBr bilayers, including their binding energies, and briefly addressing the light-matter coupling and the electron–hole exchange interaction [1]. Exciton binding energies reach $\sim 100\ldots 200$ meV while the trion binding energies are on the order of 20 meV scale. Electrostatic doping provides an additional control knob, giving rise to bound exciton–charge complexes and doping-induced changes of the magnetic state, while optical spectroscopy enables spatially resolved probing of magnetic domains [2].

I will then focus on the remarkable transport properties of excitons in antiferromagnetic CrSBr. Experiments reveal ultrafast and nearly isotropic exciton propagation, strongly enhanced near the Néel temperature, as well as transient contraction and expansion of exciton clouds and superdiffusive transport in bilayers [3]. These observations can be understood in terms of exciton–magnon scattering and drag by nonequilibrium magnon currents. The theory of exciton–magnon interaction is presented and a novel orbital mechanism related to mixing of the intra- and interlayer excitons is discovered. A microscopic kinetic theory shows that the underlying two-magnon processes can lead to sub-picosecond scattering times and efficiently transfer the characteristic transport properties of magnons to excitons [4].

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