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Exciton Physics of 2D Semiconductors

The consequences of Coulomb interaction of charge carriers have been in the focus of the solid-state research for many decades. In semiconductors, they remain of paramount importance for the fundamental understanding of electrical and optical excitations with major implications for basic science and technology. Recently, a variety of atomically-thin nanostructured materials, such as semiconducting transition metal dichalcogenides were found to exhibit a number of highly intriguing phenomena, including formation of tightly bound electron-hole pair states, or excitons, efficient light-matter coupling and spin-valley locking. In these systems, the Coulomb interaction governs both the fundamental physics and can be harnessed to manipulate key properties and the response to external fields and perturbations.

In this talk, I will provide an introduction to the field of exciton physics in two-dimensional van der Waals semiconductors. I will review fundamental concepts governing their properties and determining their structure, including discussion of experimental techniques employed for their study. Closely related topics of the electrical and optical tunability, including external control of the electronic structure through the dielectric design of the environment will be addressed. Finally, I will present the results from optical transport microscopy of monolayer materials, discuss the influence of efficient interactions and strong non-linearities in the exciton propagation.