Bright and dark excitons in thin layers of transition metal dichalcogenides and their heterostructures

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Optical properties of TMDs, including their thin layers, are imposed by the conservation of the total angular momentum. Monolayers of TMDs host different types of excitons, bright excitons that couple to light and propagate perpendicular to the layer plane, and the spin-"dark" excitons, coherent superpositions of excitations in the two valleys, which propagates within the plane of the layers. The first part of the talk will be dedicated to the description of optical properties of bright and dark excitons in monolayers of TMD encapsulated in hexagonal boron nitride. I will show how to image dark excitons and how can we probe their properties experimentally.

Monolayers can be stacked on top of one another in the form of van der Waals heterostructures to create artificial hetero- or homo- bilayers. These artificial structures can host different types of exciton complexes, in particular interlayer excitons for which electrons and holes are in different layers. Recently, it was realized that the twist angle between the two layers can strongly modify the electronic properties of the stack and can also be used to generate a lateral modulation of the potential through a moiré pattern. In a second part, I will describe optical properties of a WSe2/MoSe2 heterobilayer in which the two layers have been aligned with an angle close to 60° (2H stacking) to create a well defined band structure together with a moiré potential. The conservation of the total angular momentum in these heterostructures leads to a very specific and efficient electron-phonon interaction, when the phonons involved are chiral and carry an angular momentum. I will show how these particular structures, combined with the use of high magnetic fields, allow for a rich spectroscopy of interlayer exciton scattering mechanism.