



# MAX PLANCK LECTURE ON NON-EQUILIBRIUM QUANTUM PHENOMENA

## Spin, Charge, and Phonon Coupling Effects in 2D Materials

The coupling between spin, charge, and lattice degrees of freedom plays an important role in a wide range of fundamental phenomena. 2D material is an emerging platform for studying these coupling effects. In this talk, I will present a couple examples along this direction. I will firstly discuss the observation of antiferromagnetic exciton and multiple exciton phonon bound states in zigzag antiferromagnet  $\text{NiPS}_3$ .

I will then present the observation of valley phonons, i.e. phonons with momentum vectors pointing to the corners of Brillouin zone, and their interaction with spins in a monolayer semiconductor  $\text{WSe}_2$ . We identified the efficient intervalley scattering of quasi particles in both exciton formation and light emission process. These understandings enable us to unravel a series of photoluminescence peaks as valley phonon replicas of neutral and charged dark excitons.

Xiaodong Xu



Dep. of Physics, Dep.  
of Materials Science  
and Engineering,  
Univ. of Washington,  
Seattle, USA

Hosts:  
Andrea Cavalleri,  
Angel Rubio

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