Abstract

Spin- and valley-phenomena, non-linear optics in atomically thin materials

Atomically thin materials provide promising platform for optoelectronics and spin/valley related phenomena studies due to their reduced dimensionality, crystal symmetry and the options of artificial heterostructures. In the semiconducting monolayer transition metal dichalcogenides (TMDCs), because of the missing of inversion crystal symmetry and the strong spin-orbit interaction, the spin and valley degrees of freedom are coupled. The resulting valley dependent optical selection rules ensure these TMDCs monolayers and the related heterostructures remarkable candidates for the future valleytronics application. On the other hand, the 2D confinement of the atomically thin layers and the reduced dielectric screening bring an exceptionally strong Coulomb interaction. The exciton species dominate the optical response and the spin/valley properties, which exhibit clear differences from the individual carriers. The non-linear optical response in layered materials such as Graphene and monolayer TMDCs is generally significant and could be strongly modified by the electronic properties of the material itself. This also provides the available approaches to control the non-linear optical generation externally. In this talk the recent understanding and progress of the exciton properties in monolayer TMDCs will be laid out [1]. I will present our results of the non-linear optical response such as second and third harmonic generation from TMDCs and Graphene [2]. The strategy of controlling the exciton valley coherence state [3], as an example to illustrate the spin and valley properties in monolayer TMDCs, will also be discussed.

References:
[1] Colloquium: Excitons in atomically thin transition metal dichalcogenides, Gang Wang, Alexey Chernikov, Mikhail M. Glazov, Tony F. Heinz, Xavier Marie, Thierry Amand, Bernhard Urbaszek, *Reviews of Modern Physics 90, 021001, (2018)*

[2] Broadband, electrically tunable third-harmonic generation in graphene, Giancarlo Soavi, Gang Wang, Habib Rostami, *et al*., *Nature Nanotechnology 13, 583–588 (2018)*

[3] Control of Exciton Valley Coherence in Transition Metal Dichalcogenide Monolayers, Gang Wang, X. Marie, B.L. Liu, T. Amand, C. Robert, F. Cadiz, P. Renucci, B. Urbaszek, *Physical Review Letters 117, 187401(2016)*