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

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Abstract

Atomically thin materials are a promising platform for optoelectronics and spin/valley related phenomena, due to their reduced dimensionality, crystal symmetry and the possibility to arrange them in heterostructures. In semiconducting monolayer transition metal dichalcogenides (TMDs), due to the missing inversion symmetry and strong spin-orbit interaction, spin and valley degrees of freedom are coupled [1]. The resulting valley dependent optical selection rules make TMD monolayers and heterostructures ideal candidates for future valleytronics applications [2]. Confinement to a single layer and reduced dielectric screening result in a strong Coulomb interaction [3]. Excitons dominate the optical response and spin/valley properties [4], with clear differences from what expected from individual carriers. The non-linear optical response in layered materials and graphene is significant and can be modified by tuning the electronic properties [5]. This also allows external control of the non-linear optical generation [5]. I will outline recent progress on the exciton properties in monolayer TMDs [4]. I will discuss the spin-forbidden dark excitons [6] and related biexciton species [7] as examples to illustrate the unique spin and valley properties in monolayer TMDs. I will then discuss second and third harmonic generation from TMDs and Graphene [8], showing that the harmonic generation efficiency can be enhanced by over one order of magnitude by controlling the interplay between input fundamental frequency and Fermi energy.

References

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