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Engineering valley coherence in van der Waals heterostructures

Abstract:

Of particular interest recently is the exciton in two dimensional transition metal dichalcogenides (TMDCs). In these systems, the exciton has been shown to have a large binding energy on the order of hundreds of meV. Interestingly, electronic bandstructure of monolayer TMDCs consists of two inequivalent yet degenerate valleys (K and K') in $k-$space for which the optical selection rule is sensitive to the helicity ($\sigma_{\pm}$) of the exciting photon. This selection rule is inherited by excitons associated with these two valleys when Coulomb interaction is taken into account. There have been several proposals to use this ``valley degree of freedom'' for the development of optoelectronic devices analogous to those in the field of spintronics.

In order to harness this valley degree of freedom in TMDCs, it is important to be able to actively control the coherence between excitons in the two valleys. In this work, we demonstrate how this valley coherence can be achieved by creating a heterostructure of the TMDC with other two dimensional materials. In this talk I will discuss some general results on exploring the parameter space of optical conductivity tensor of such a heterostructure which will lead to the highest values of valley coherence and coherence times. This analysis will help the community in designing the appropriate 2D heterostructures with the optimal optical conductivity tensor for maximum valley coherence. Subsequently we will present our recent results on applying this technique to show tunability of the coherence using certain commonly available 2D semiconductor heterostructures.

References

[1] Engineering quantum interference in van der Waals heterostructures, Muralidhar Nalabothula, Pankaj Jha, Tony Low, Anshuman Kumar, arXiv:1910.03952

Figures

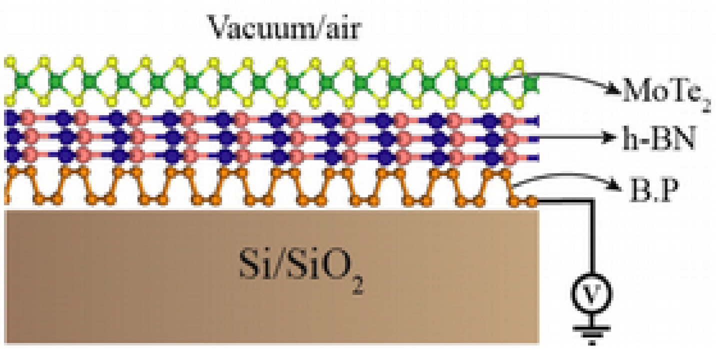

Figure 1: Schematic of the proposed device for achieving valley coherence