Valley-selective optical Stark effect of exciton-polaritons in a monolayer semiconductor

Trevor LaMountain
Jovan Nelson, Erik J. Lenferink, Akshay A. Murthy, Samuel H. Amsterdam, Tobin J. Marks, Mark C. Hersam, Vinayak P. Dravid, and Nathaniel P. Stern
Northwestern University, Evanston, USA
trevorlamountain2020@u.northwestern.edu

Light provides a high-speed coherent medium for measurement and manipulation of electronic quantum states. Exploiting the optical selection rules of transition metal dichalcogenide monolayers (TMDs), the optical Stark effect allows for valley-selective control of energy levels using sub-resonant optical pulses. Recent discoveries have revealed that microcavity exciton-polaritons in TMDs preserve valley features [1] while also incorporating many of the favorable properties of light [2,3]. Here, we use polarization-dependent transient reflectance to demonstrate that the optical Stark effect can also be used for valley-selective manipulation of energy levels in WS_2 exciton-polaritons. In the differential reflectance spectra we observe a simultaneous shift of both polariton branches when pump and probe are co-polarized, and no appreciable shift when they are cross-polarized. We find excellent agreement between measured data and a Lorentz oscillator model over a wide range of experimental parameters. The extracted polariton shift confirms the expected linear power dependence of the optical Stark effect. The polarization-dependent Stark shift of TMD exciton-polaritons provides a new tool for state control in coherent valleytronics.

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References

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Figures

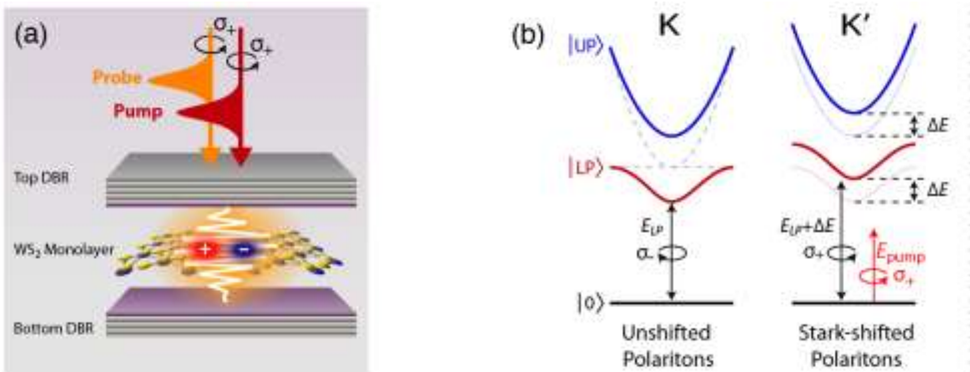

Figure 1: (a) Schematic of polarization-dependent transient reflectance measurement of WS_2 polaritons. (b) Schematic of valley-selective optical Stark shift of polaritons. Polarization-dependent optical selection rules of TMD cause the Stark shift to only effect one valley.