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Valley-selective optical Stark effect in monolayer WS_2

NUH GEDIK, MIT

Monolayer semiconducting transition-metal dichalcogenides (TMDs) have a pair of valleys that, by time-reversal symmetry, are energetically degenerate. Lifting the valley degeneracy in these materials is of great interest because it would allow for valley specific band engineering and offer additional control in valleytronic applications. In this talk, I will show that circularly polarized light, which breaks time-reversal symmetry, can be used to lift the valley degeneracy by means of the optical Stark effect [1]. We demonstrate that this effect is capable of raising the exciton level in monolayer TMD WS_2 by as much as 18 meV in a controllable valley-selective manner. The resulting energy shift is extremely large, comparable to the shift that would be obtained using a very high magnetic field (approximately 100 Tesla). These results offer a novel way to control valley degree of freedom, and may provide a means to realize new valley-selective Floquet topological state of matter.
[1] E J Sie, J W McIver, Y H Lee, L Fu, J Kong and N Gedik, Nature Materials 14, 290 (2015)