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Valley Polarization of Dark Excitons in Tungsten Diselenide CHAW KEONG YONG, JASON HORNG, IQBAL BAKTI UTAMA, FENG WANG, Department of Physics, University of California, Berkeley — The recently discovered monolayer transition metal dichalcogenides (TMDs) provide a platform to explore new coupled spin-valley physics. Here, we used femtosecond transient absorption (TA) spectroscopy to directly probe the ultrafast recombination dynamics of electrons and holes in both K and K' valley in monolayer tungsten diselenide (WSe_2). Following circularly polarized excitation with femtosecond pulse, we observed the A excitons and B excitons exhibit opposite valley polarization and persists to few 10s-picosecond timescales. The conduction band of B-exciton is lying below that of A-exciton in monolayer WSe_2, allows the initially photoexcited electrons in the K valley of A-exciton relax to the conduction band of B-exciton in the K' valley in sub-100 femtosecond timescales to give opposite valley polarization for electron and hole. For TMDs with B-exciton conduction band lying above that of A-exciton, such opposite valley polarization of electrons and holes diminishes. Our results shed light for the importance of energetics in the control of valley polarization in atomically thin TMDs.

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