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Valley selective high field magneto-spectroscopy of monolayer $MoSe_2$ JONATHAN LUDWIG, Florida State University and National High Magnetic Field Lab, Y. LI, Stanford University and SLAC National Accelerator Lab, Z. LU, Florida State University and National High Magnetic Field Lab, X.X. ZHANG, Stanford University and SLAC National Accelerator Lab, X. CUI, J. HONE, Columbia University, T.F. HEINZ, Stanford University and SLAC National Accelerator Lab, D. SMIRNOV, National High Magnetic Field Lab — Monolayer transition metal dichalcogenides (TMDs) have recently emerged as a new class of direct bandgap 2D semiconductors with valleys at the $\pm$K points in the Brillouin zone. Due to the broken inversion symmetry in monolayer TMDs, this valley degree of freedom can be selectively addressed by optical helicity. We report on circularly polarization resolved photoluminescence on gated monolayer $MoSe_2$ in perpendicular and parallel magnetic fields up to 30T. In a perpendicular field at low carrier density, the PL energies of both the trion and exciton experience a linear shift with a slope of $\approx \pm 2\mu_B/T$ for the $\pm$K valleys, demonstrating valley degeneracy lifting. This is in contrast to the measurements in parallel field, where no such linear splitting occurs. In addition, we report quadratic corrections to the linear magnetic field dependence of the trion and excition energy in the perpendicular configuration.

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