

Ultrafast All-Optical Probe of Broken Time-Reversal Symmetry in Monolayer WSe₂

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Abstract

We investigate broken time-reversal symmetry (TRS) and its effect on the spin-valley degree of freedom in monolayer transition metal dichalcogenides. Introducing a valley imbalance at the $\pm K$ points breaks TRS. We probe this using the SHG ratio η , i.e. comparing second harmonic signals under circularly vs. linearly polarized excitation. Analytical and numerical solutions show circular light couples selectively to the $\pm K$ valleys, while linear light probes the Γ point. This symmetry contrast explains the experimentally observed deviation from the expected SHG ratio of 2.