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Study the valley polarization in monolayer WSe_2 by polarization-resolved photoluminescence spectroscopy

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Atomically-thin transition metal dichalcogenides (TMDs) such as MoS_2 and WSe_2 have attracted much attention as novel 2D semiconductors with remarkable physical properties and applications[1-4]. The monolayers of the TMDs are non-centrosymmetric materials with a direct band-gap located at the energy-degenerate K and K' valleys in momentum space. The structural inversion asymmetry in the 1L(monolayer)-TMDs gives rise to coupling of electron spin and valley degree of freedom; this characteristic enables valley-selective optical excitation using circular-polarized incident photons [1]. Therefore, the 1L-TMDs are promising materials for "Valleytronics", future optoelectronics technology using valley degree of freedom of electrons.

Here we study temperature dependence of polarized photoluminescence (PL) in 1L-WSe_2 [2] to understand spin-valley relaxation mechanism between the degenerate K and K' valleys. In the experiment, circular polarization of the incident photons was set to be σ^+ polarization (corresponding to selective excitation of K' valley), and σ^+ and σ^- components of the PL signals were separately detected. Figure 1 shows the polarization-resolved PL spectra at 15 K and the peaks of exciton, trion1, and trion2 are labeled respectively. The PL intensity of the σ^+ emission is larger than that of σ^- emission under the σ^+ excitation condition, suggesting spin-valley polarization in 1L-WSe_2 at 15 K. Temperature dependence of the observed valley polarization and its mechanism will be discussed.

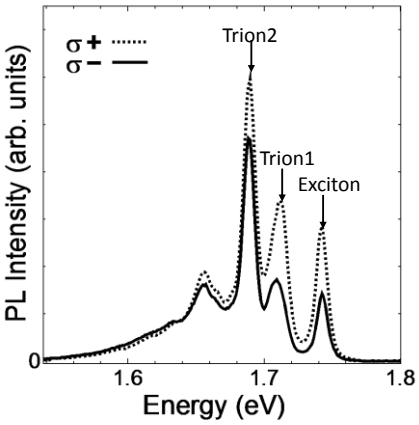

Fig.1 Polarization-resolved PL spectra of 1L-WSe_2 at 15 K.

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