Nuclear effective magnetic fields as the origin of spin dephasing of localized electrons in a single $MoSe_2$ layer

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Spin related phenomena in 2D van der Waals semiconductors such as transition metal dichalcogenides attracted a lot of attention. The optical experiments reported exceptionally long spin lifetimes for resident carriers [1]. However, the main mechanisms of their spin relaxation and spin dynamics remain understudied.

In this work we use single laser beam pump-probe approach [2] to study the low-temperature spin polarization of resident electrons in a monolayer $MoSe_2$ on a EuS film, Fig. 1(a). Under resonant trion excitation, Hanle (spin depolarization) and spin polarization recovery effects, Fig. 1(b), are observed. We show that they are significantly impacted by the static random fluctuations of an effective magnetic field (strength of several mT), arising from contact spin interactions [3] namely hyperfine interaction of localized electrons with the $MoSe_2$ nuclei. From the angular dependence of spin polarization in a magnetic field, Fig. 1(c), the strong anisotropy of both the intervalley electron g-factor and the spin dephasing time were determined. A value of the in-plane g-factor $|g_x| \approx 0.1$ is comparable to its dispersion, which is confirmed by time-resolved pump-probe Kerr rotation. This g-factor is attributed to randomly localized electrons within the $MoSe_2$ layer.

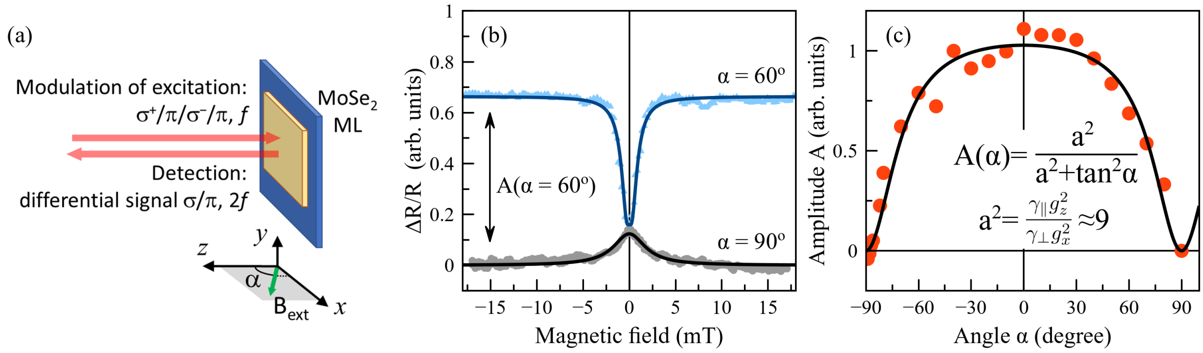

Figure 1: (a) Schematics of the experiment. Spin pumping of the resident electrons is accomplished via excitation of negatively charged excitons (trions) with circularly polarized light. Differential reflectivity between circularly and linearly polarized excitation ΔR, measured in the experiment, is proportional to the resident electron spin density S_z along the z-axis. (b) Differential reflectivity $\Delta R/R \propto S_z$ as a function of magnetic field for different angles α. (c) Angular dependence of amplitude $A(\alpha)$.

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