Optically pumped nuclear polarization and its resistive detection
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Nuclear spins in a single quantum well are polarized by optical pumping and its polarization is detected by a shift of the resistance peak of the SPT (spin-phase-transition) at Landau level filling factor ν = 2/3. The sample used in this experiment is a 30-μm wide and 100-μm long Hall bar, which was processed from a wafer containing an 18-nm $GaAs/Al_{0.33}Ga_{0.67}As$ quantum well (QW). The SPT peak is shifted to a positive and negative direction in σ^+ and σ^- illumination, respectively. Application of resonant-frequency rf magnetic-field induces the peak shift, confirming optically pumped nuclear polarization is really detected by the resistance measurement. The effective nuclear magnetic field B_N is determined by

$$B_N = -A\left(\langle S_Z\rangle - \langle S_Z\rangle_{eq}\right)$$

where $\langle S_z \rangle$ is electron spin polarization produced by optical illumination and $\langle S_z \rangle_{eq}$ represents thermal equilibrium electron spin polarization. The B_N is controlled by polarity, power, and time of laser illumination. As shown in Fig. 1, the optical nuclear polarization well reflects the electron-spin-resolved Landau level interband transitions. The negative B_N by σ^- illumination means $\langle S_z \rangle_{eq}$ is not 1/2 even for the low temperatures due to electron-electron interactions. The filling factor dependence of B_N can be understood by not fractional quantum Hall states but the effect of electron spin polarization through excitons and trions.

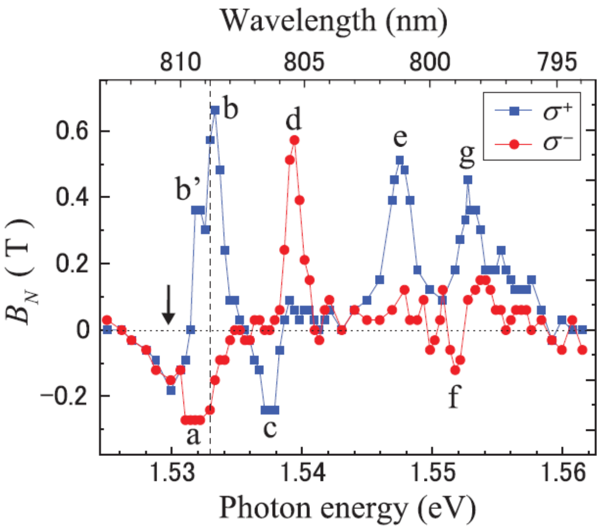

Fig. 1 Photon energy dependence of optical nuclear polarization with P = 1.6 W/cm^2 and pumping time of 150 sec. The squares and circles represents theσ^+ and σ^- illumination, respectively. The optical pumping was carried out at filling factor of around 0.3.

Representative publications:

1. K. Akiba, S. Kanasugi, K. Nagase, and Y. Hirayama, Appl. Phys. Lett. 99, 112106 (2011).
2. K. Akiba, T. Yuge, S. Kanasugi, K. Nagase, and Y. Hirayama, Phys. Rev. B87, 235309 (2013).
3. K. Akiba, S. Kanasugi, T. Yuge, K. Nagase, and Y. Hirayama, Phys. Rev. Lett. 115, 026804 (2015) [editor's suggestion].