GaAs 量子井戸中をドリフトするスピン波束の位相速度

Phase velocity of drifting spin wave packets in GaAs quantum well

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The transportation of precisely controlled electron spins in semiconductors will be a key technology for future semiconductor spintronics devices. For accurate control of the spin dynamics during transport, it is beneficial to uncover the transient spin dynamics of drifting spin wave packets in diffusion suppressed spin-orbit coupled systems. However, the dynamic change in the spin phase velocity expected in a moving wave packet has yet to be clarified. Here, we investigated the phase velocity of drifting spin packets locally injected into a GaAs QW [1-3], focusing especially on the effect of the spin diffusion [4].

We modeled a spin dynamics of locally injected electron spins using a spin drift-diffusion (SDD) equation, which predicted that the spin phase velocity (v_p) in a wave packet has a negative value just after electron excitation and converges to a small positive value over time [Fig. 1]. We observed this trend in magnet-optic Kerr rotation measurements involving drifting spins injected optically into a GaAs QW.

We also performed a numerical simulation using Monte Carlo method. Regardless of the D_s values, all the plots merge into a single curve described as SDD model, and agreed with the experimental data [Fig. 2].These results indicated that the spin phase velocity can be characterized by $R(t)$, which is the ratio between the present and initial packet sizes. This study will be useful when designing spin devices that require the precise control of drifting spins.

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Fig. 1

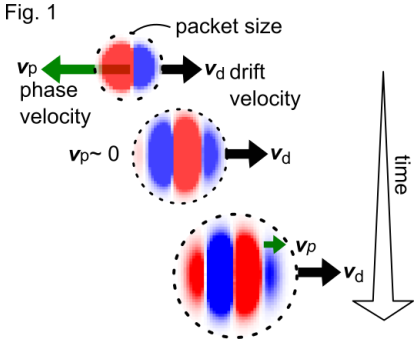

Fig. 1. Schematic view of the dynamics of a drifting spin wave packet. The red and blue regions indicate positive and negative S_z,

Fig. 2

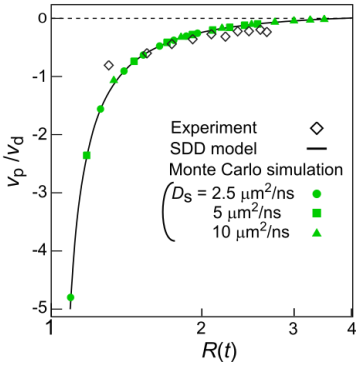

Fig. 2. Phase velocities divided by drift velocities plotted as a function of R for the experimental result, SDD model and Monte Carlo simulation.

References

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