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Presentation Title

Spin coherent transport and interference in semiconductors

Abstract

Spin-orbit interaction (SOI) plays an important role for electrical manipulation of electron spins in semiconductors. In III-V compound semiconductor two dimensional electron gas (2DEG), the dominant mechanisms for SOI are the Rashba SOI caused by a structural inversion asymmetry and the Dresselhaus SOI caused by a bulk inversion asymmetry. The strength of SOI can be controlled by the gate electric field on top of 2DEG. Spin dynamics in semiconductors is governed not only by SOIs but also by Zeeman effect. Quantum correction to conductivity such as weak anti-localization (WAL) is very sensitive to the spin dynamics. It is interesting to study how these SOIs and Zeeman effect compete each other in spin coherent transport.

Spin relaxation obtained from WAL in gate fitted InGaAs wire structures revealed strong anisotropy along wire directions and large suppression by decreasing the Rashba SOI parameter. These features are explained by competition between the Rashba and the Dresselhaus SOIs. We proposed a novel way to detect the ratio between Rashba and Dresselhaus SOIs under in-plane Zeeman field. To understand the effect of the in-plane magnetic field, we will discuss the angular dependence of in-plane Zeeman fields on magnetoconductance.

The effect of in-plane Zeeman field on Aharonov-Casher (AC) spin interference was investigated using InGaAs ring arrays. We found the in-plane Zeeman field provides three distinctive features: (i) suppression of negative back ground in AC oscillations, (ii) suppression of AC oscillation amplitudes, and (iii) phase shift of AC oscillations. The competition between SOI and Zeeman effect gives rise to additional dephasing due to spin induced time reversal breaking. The suppressions of negative back ground and AC oscillations can be attributed to the additional dephasing. We will discuss the origin of the phase shift of AC oscillations by in-plane Zeeman field.