Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Dynamics of a localized spin excitation close to the spin-helix regime[1] GIAN SALIS, MATTHIAS WALSER, PATRICK ALTMANN, IBM Research - Zurich, CHRISTIAN REICHL, WERNER WEGSCHEIDER, Solid State Physics Laboratory, ETH Zurich — The time evolution of a local spin excitation in a (001)-confined two-dimensional electron gas subjected to Rashba and Dresselhaus spin-orbit interactions of similar strength is investigated theoretically and compared with experimental data. Specifically, the consequences of a finite spatial extension of the initial spin polarization are studied for non-balanced Rashba and Dresselhaus terms and for finite cubic Dresselhaus spin-orbit interaction. We show that the initial out-of-plane spin polarization evolves into a helical spin pattern with a wave number that gradually approaches the value q_0 of the persistent spin helix mode. In addition to an exponential decay of the spin polarization that is proportional to both the spin-orbit imbalance and the cubic Dresselhaus term, the finite width w of the spin excitation reduces the spin polarization by a factor that approaches $\exp(-q_0^2 w^2/2)$ at longer times. This result bridges the gap between the formation of a long-lived helical spin mode and a spatially homogeneous spin decay described by the Dyakonov-Perel mechanism.

[1]This work is financially supported by NCCR QSIT

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Date submitted: 15 Nov 2013 Electronic form version 1.4