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Spin transistor action via tunable adiabaticity

Spin-transistors, employing spin-orbit interaction like Datta-Das prototypes [1], principally suffer from low signal levels due to limitations in spin injection efficiency, fast spin relaxation and dephasing processes. Here we present an alternative concept to implement spin transistor action where efficiency is improved by keeping spin transport adiabatic. To this end a helical stray field B, generated by ferromagnetic Dysprosium stripes, is superimposed upon a two-dimensional electron system in CdMnTe, containing magnetic Mn ions. Due to the giant spin splitting, occurring at low temperatures and small B in these material systems, the B-helix translates into a spin-helix and the electron spins follow adiabatically the imposed spin texture. Within this approach the transmission of spin-polarized electrons between two contacts is regulated by changing the degree of adiabaticity, i.e. an electron's ability to follow the spin helix. This is done by means of a small applied homogeneous magnetic field while the degree of adiabaticity is monitored by the channel resistance. Our scheme allows spin information to propagate efficiently over typical device distances and provides an alternative route to realize spintronics applications. We note that our concepts are not restricted to a particular choice of materials, temperature, methods of spin injection, manipulation as well as detection.

[1] H. C. Koo et al., Control of spin precession in a spin-injected field effect transistor. Science **325**, 1515 (2009)

In close collaboration with Christian Betthausen, Tobias Dollinger, Henri Saarikosi, Valeri Kolkovsky, Grzegorz Karczewski, Tomasz Wojtowicz, and Klaus Richter,

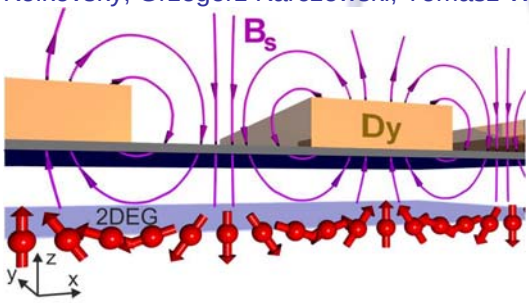

Fig. 1: Schematic view of the experiment in the absence of an external magnetic field. A helical stray field gets generated by Dy stripes and causes, due to the giant Zeeman splitting in CdMnTe quantum wells, a spin splitting of order 1 meV at low temperatures. In the adiabatic transport regime electron spins in the 2DEG (spheres with arrows) keep aligned with the stray field Bs of the stripes and a spin helix forms.

10. Februar 2012, 14:00 Uhr

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