Spin Device

Spin Transistor utilizing Rashba SO interaction

Assistant Prof. Makoto KOHDA (Tohoku University) 1. The newly proposed spin transisitor -Spin-Orbit Interaction : A proposed Device Structure No need for external B fields (Bex) and magnetic materials Side gated QPC V_{SGL} $\varepsilon_{SOI} = \pm \alpha k_F = \pm \frac{1}{2} g \mu_B B_{eff}$ ₩V_{TG} Effective B field $B_{eff} \propto \frac{p \times E}{2m_0 c^2}$ Cr/Au VSGR Semiconductor 2DEG B E>0 E = 0Al2O3 InGaAs Small Beff Large B 2DEG 2. Mechanism to induce Spin Polarization and Spin Rectification Effect $H = \tilde{\alpha}\vec{\sigma} \cdot (\vec{p} \times \vec{E}) + \frac{1}{2}g\mu_{B}\vec{\sigma} \cdot \vec{B}_{ex} = g\mu_{B}\vec{\sigma} \cdot \vec{B}_{eff} + \frac{1}{2}g\mu_{B}\vec{\sigma} \cdot \vec{B}_{ex}$ Side Gate Bex>0T Bex=0T Bex=0T Bex>0T Beff direction Beff direction Bex lowers down Bex raises up spin Vage spin energy level energy level above Electron Electric Electric Motion below Fermi Energy Fermi Energy. . No current generation Down spin Field Field Electron Motion generation Fermi Energy -Vsd +Vsd Spin Polarization VSGL Spin Polarization Direction and Direction and Electron Flow Electron Flow VSGR Electron Gate Electric Motion Side Gate •)Field Drain Electrode Electron Electric Au/Cr Gate Electrode(100nm) Motion Field Al2O3 Gate Insulator(150nm) Beff InAIAs Barrier Layer InGaAs 2DEG InAIAs Barrier Layer InAIAs Barrier Layer InP Substrate

Spin Polarization Mechanism



Source Electrode





Spin Polarization induced by effective magnetic field B_{eff} (The inset shows an image of a QPC channel region taken by a SEM.)

Spin Rectification Mechanism

VSGR

Maximum spin polarization is 70% at 0.5(2e²/h)



Spin Polarization at 0.5 (2e²/h) structure

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