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Spin generation by strong inhomogeneous electric fields ILYA FINKLER, HANS-ANDREAS ENGEL, EMMANUEL RASHBA, BERTRAND HALPERIN, Harvard University — Motivated by recent experiments [1], we propose a model with extrinsic spin-orbit interaction, where an inhomogeneous electric field $\mathbf{E}$ in the x-y plane can give rise, through nonlinear effects, to a spin polarization with non-zero s_z, away from the sample boundaries. The field $\mathbf{E}$ induces a spin current $\mathbf{j}_s^z = \hat{z} \times (\alpha \mathbf{j}_c + \beta \mathbf{E})$, where $\mathbf{j}_c = \sigma \mathbf{E}$ is the charge current, and the two terms represent,respectively, the skew scattering and side-jump contributions. [2]. The coefficients α and β are assumed to be E- independent, but conductivity σ is field dependent. We find the spin density s_z by solving the equation for spin diffusion and relaxation with a source term $\nabla \cdot \mathbf{j}_s^z$. For sufficiently low fields, j_c is linear in E, and the source term vanishes, implying that $s_z = 0$ away from the edges. However, for large fields, σ varies with E. Solving the diffusion equation in a T-shaped geometry, where the electric current propagates along the main channel, we find spin accumulation near the entrance of the side channel, similar to experimental findings [1]. Also, we present a toy model where spin accumulation away from the boundary results from a nonlinear and anisotropic conductivity.
[1] V. Sih, et al, Phys. Rev. Lett. **97**, 096605 (2006).
[2] H.-A. Engel, B.I. Halperin, E.I.Rashba, Phys. Rev. Lett. **95**, 166605 (2005).

Ilya Finkler
Harvard University

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