

# Tunable Spin Hall Effect by Stern-Gerlach Diffraction

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The pursuit of spintronics ultimately depends on our ability to steer spin currents and detect or flip their polarization. The 1922 Stern-Gerlach experiment first demonstrated that a magnetic field that is inhomogeneous in real space, acting on the electron spin, splits a beam of atoms. In contrast, the spin Hall effects, which have recently been investigated extensively, rely on magnetic fields that are inhomogeneous in reciprocal space.

We propose a new effect based on simultaneous real- and reciprocal-space magnetic inhomogeneities, combining features of the Stern-Gerlach and both the intrinsic and extrinsic spin Hall effects. The known difficulties of directly observing spin Hall effect are circumvented as spin currents generated from the new effect are well-defined, dissipative, and detectable. Spin-orbit-coupled scatterers are confined in a nanoscale diffraction grating in a 2-dimensional electron system. The diffraction grating can be implemented either by an array of spin-orbit-coupled quantum dots and a uniform external electric field perpendicular to the 2-dimensional electron system or by a uniform layer of spin-orbit-coupled material and a patterned gate to produce an electric-field-induced grating. Simulation results in a specific system in InGaAs/InAlAs 2-dimensional electron system illustrate wide tunability of the system, allowing formation of a periodic "spin lattice" distinct from the "charge lattice", selective polarization flipping, or spin current detection. Similar effects may be produced by photons and neutrons.

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