Spin Hall effect

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The Spin Hall effect (SHE) and related transport phenomena originating from the coupling of the charge and spin currents due to spin-orbit interaction were predicted [1] in 1971. Following the suggestion in [2], the first experiments in this domain were done at Ioffe Institute in St. Petersburg [3], providing the first observation of what is now called the inverse spin Hall effect. As to the SHE itself, it had to wait for 33 years before it was experimentally discovered by two groups [4] in Santa Barbara (US) and in Cambridge (UK). These experiments triggered an intense experimental and theoretical research effort resulting in hundreds of publications.

The phenomenon consists in spin accumulation at the lateral boundaries of a current-carrying non-magnetic conductor, the spin directions being opposite at the opposing boundaries. No magnetic field is needed. The boundary spin polarization is proportional to the current and changes sign when the direction of the current is reversed. It exists in relatively wide *spin layers* determined by the spin diffusion length, typically on the order of 1 μm. I will discuss the phenomenology of spin-charge coupling, the underlying microscopic mechanisms, and the existing experimental results obtained in semiconductors and in metals at cryogenic, as well as at room temperatures. I will also address a related, but as yet unknown phenomenon, the *swapping* of spin currents, which is due to the correlation between spin rotation during a scattering event and the direction of scattering.

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3. A. A. Bakun *et al.*, *JETP Lett.* **40**, 1293 (1984).
4. Y. K. Kato *et al.*, *Science* **306**, 1910 (2004); J. Wunderlich *et al.*, *Phys. Rev. Lett.* **94**, 047204 (2005).