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Coulomb Interaction in the Spin-Hall Effect[1]

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The spin-Hall effect is the generation of a steady spin current perpendicular to an externally imposed d.c. electric field. The effect is driven by spin-orbit interactions but its details are influenced by several processes like electron-impurity scattering, electron-electron scattering, and spin precession. In this talk I describe our recent work on the role of electron- electron scattering in the spin Hall effect in an n-type [110] GaAs quantum well, where spin precession is absent. We have studied the spin Hall conductivity (SHC) by a combination of the Boltzmann equation and the Kubo formula for the spin current [1],[2]. The two main contributions to the SHC – "skew scattering" (SS) and "side-jump" (SJ) – respond very differently to the inclusion of Coulomb interactions. The SS contribution is significantly reduced by the spin Coulomb drag – the Coulomb friction between electrons of opposite spin orientations. At the same time, the SJ contribution remains completely unaffected by Coulomb scattering. The different behaviors of the SS and SJ contributions result in a Coulomb- induced reduction of the spin accumulation at the edges of a spin Hall bar, even when the spin current is zero. We have also pointed out that the relative size of the SJ and SS contributions depends on mobility and we have proposed an experiment to distinguish between the two [2]. [1] E. M. Hankiewicz and G. Vignale Phys. Rev. B 73, 115339 (2006) [2] E. M. Hankiewicz, G. Vignale and M. E. Flatté cond- mat/0603144 (PRL in press)

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