Interplay between spin Coulomb drag and spin-orbit coupling in intersubband spin plasmons in quantum wells.

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An intense research effort is underway to improve our understanding of spin dynamics, especially in relation to nanocircuits and their components, such as quantum wells and wires. In this context the theory of spin Coulomb drag (SCD) was recently developed[1]. This theory analyzes the role of Coulomb interactions between different spin populations in spin-polarized transport. Coulomb interactions transfer momentum between different spin populations, so that the total momentum of each spin population is not preserved. This provides an *intrinsic* source of friction for spin currents, a measure of which is given by the spin-transresistivity. SCD can become substantial in semiconductors, where the spin-transresistivity can be larger than the Drude resistivity. In fact, the recent experimental observation of SCD by Weber *et al.*[2] shows that the effect dominates spin diffusion currents over a broad range of parameters, in beautiful agreement with theoretical predictions[1]. The SCD is bound to become one of the most serious issues in spin polarized transport, since, due to its intrinsic nature, it cannot be avoided even in the purest material.

We have recently analyzed[3] the dependence of the spin-transresistivity over frequency – which is important both for AC spintronics applications and spin-resolved optical experiments. We showed that SCD contributes substantially to the linewidth of intersubband spin plasmons in parabolic quantum wells. It is though of paramount importance to understand how this prediction is affected by the presence of spin-orbit coupling, a major source of decoherence for spin dynamics in semiconductors. In particular it has been shown[4] that, spin-orbit coupling induces a wave-vector dependent splitting of the longitudinal and transverse spin density excitations in quantum well structures. In this paper we consider the combined effect of SCD and spin-orbit coupling on collective intersubband spin-excitations in quantum wells, and demonstrate that even in the presence of spin-orbit coupling, the linewidth enhancement due to SCD remains sizable. We extend our calculations to finite wave-vector excitations (important for experimental applications) and show that, by tuning the system parameters, one effect can clearly dominate the other. This property allows to optimize parameters for prospective experiments. Our results suggests that the SCD effect could be measured by means of inelastic light scattering, i.e. in a pure optical way. While previous experiments[2] established the importance of SCD in relation to spin transport, the experiment we propose would establish unequivocally the influence of SCD on optical excitations.

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