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Spin dynamics in a two-dimensional electron system with generic spin-orbit coupling TUDOR STANESCU, VICTOR GALITSKI, University of Maryland — We study the dynamics of a spin density injected into a two-dimensional electron system with generic spin-orbit interactions. We derive the general spin-charge coupled diffusion equation for a model that includes Rashba as well as linear and cubic Dresselhaus spin-orbit interaction terms. We analyze in detail two regimes: The first regime corresponds to negligible spin-charge coupling and is characterized by standard charge diffusion, decoupled from the spin dynamics. The interplay between different spin-orbit interaction terms leads to interesting phenomena such as a finite momentum enhancement of the spin relaxation time, real space oscillatory dynamics, and anisotropic transport. In the second regime, we include the effects of the spin-charge coupling. The coupling depends quadratically on the overall strength of the spin-orbit interaction and, in addition, it strongly depends on the relative magnitude of the various interaction terms. It is shown that the spin-charge coupling leads to an enhancement of the effective charge diffusion coefficient. In the presence of a boundary, spin-charge coupling leads to a current-induced spin accumulation. In the strong spin-charge coupling limit, we find that the relaxation rates formally become complex and the spin/charge dynamics is characterized by real time oscillations, qualitatively similar to those observed in spin-grating experiments [Weber et al., Nature 437, 1330 (2005)].

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