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Coupled spin-charge transport in two-dimensional electron gases from weak to strong spin-orbit couplings YASUFUMI ARAKI, None, ALLAN H. MACDONALD, Department of Physics, University of Texas at Austin — We investigate the magnetoelectric response of two-dimensional electron gases with spin-orbit interactions of arbitrary strength. Rashba or Dresselhaus spin-orbit coupling in two-dimensional systems gives rise to the coupling of spin and charge transport, which may appear as spin Hall effect, spin-orbit induced torque, direct and inverse Edelstein effects, etc. We derive the diffusion equation for spin and charge densities microscopically with spin-independent disorder scattering and two types of spin-orbit interactions of arbitrary strength, and analyze the crossover in the coupled spin-charge transport from weak to strong spin-orbit coupling regimes. Our calculation connects the traditional perturbative treatment of the spin-orbit coupling in the weak spin-orbit coupling regime, where two spin states are nearly degenerate, to the relaxation time approximation estimate in the strong spin-orbit coupling regime, where the degeneracy is strongly lifted. The crossover becomes nontrivial when the Rashba and Dresselhaus spin-orbit interactions are comparable. Based on those calculations, we will give some comments on the spin-orbit induced torques induced in the heterostructure of ferromagnets and heavy metals.

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