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Crossover between the Hikami and spin-resolved band limits of weak anti-localization in two-dimensional electron gases[1] YASUFUMI ARAKI, GURU KHALSA, ALLAN H. MACDONALD, Department of Physics, University of Texas at Austin — We investigate the quantum interference corrections to transport which lead to weak localization (WL) or weak anti-localization (WAL) for the case of spin-independent disorder scattering in two-dimensional electron gases with spin-orbit interactions of arbitrary strength. We formulate our theory in terms of microscopic linear response including multiple scattering by the disorder potential to derive the current-current response function when Rashba (or Dresselhaus) spin-orbit coupling is included in the electronic band structure. We analyze the crossover from the weak spin-orbit coupling limit in which spin-splitting of the bands is not resolved, to the strong spin-orbit coupling limit of clearly spin-split bands. In the weak and strong spin-orbit coupling limits we generally recover the well-known WL and WAL behavior first predicted by Hikami, Larkin and Nagaoka, although the degeneracy of spin triplet channels is lifted leading to a more complex crossover between the traditional WL and WAL limits. Our results can be summarized by a phase diagram in spin-orbit coupling strength and temperature (or the coherence length from inelastic scattering), with several regions separated by different crossover lines.

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