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Two-particle and single-particle spin-dependent interactions in topological insulators[1] MARIUS RADU, YULI LYANDA-GELLER, Department of Physics, Purdue University, West Lafayette IN 47907 — We derive single-particle and two-particle interaction Hamiltonians describing physics of two-dimensional topological insulators based on HgTe-CdTe quantum well structures by using $\mathbf{k} \cdot \mathbf{p}$ theory and extended Kane model. We include contributions from upper conduction band with orbital states of p-symmetry that bring about the terms describing lack of inversion symmetry in host semiconductors. Single-particle Hamiltonian and two-particle Hamiltonian contain important spin-dependent diagonal and off-diagonal terms. We demonstrate how these terms affect spin currents, interference effects in conductance such as weak localization and anti-localization, and contribute to spin relaxation and dephasing. The spin-dependent interaction terms couple orbital motion of one particle with evolution of spin of the other particle. Such particle-particle interactions do not conserve spin and lower the symmetry of exchange interactions, leading, e.g., to Dzyaloshinskii-Moriya exchange term.

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