Weak antilocalization of chiral carriers: 
HgTe quantum wells vs. topological surface states

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HgTe quantum wells (QWs) and surfaces of three-dimensional topological insulators exhibit chiral carriers in a single valley \([1,2]\). In the presence of disorder they experience weak antilocalization (WAL), which has been observed in recent transport experiments. In this work we conduct a comparative study of the WAL in HgTe QWs and topological surface states. One of the essential differences between these systems comes from a finite band gap (effective Dirac mass) in HgTe QWs in contrast to gapless (massless) surface states in topological insulators. We demonstrate that in HgTe QWs the effective mass leads to the suppression of the WAL \([3]\) and, eventually, to the antilocalization-localization crossover characterized by the change of the sign of the quantum conductivity. This behavior has an analogy with ferromagnetic semiconductors and is absent for topological surface states. On the other hand, we find that the topological surface states exhibit specific magnetoconductivity in a parallel magnetic field due to their exponential decay in the bulk.