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Surface Hall response of 3D topological insulators DIMITRIE CULCER, Hefei National Laboratory for Physical Sciences at the Microscale, University of Science and Technology of China, Hefei 230026, Anhui, China, SANKAR DAS SARMA, Condensed Matter Theory Center, Department of Physics, University of Maryland, College Park, Maryland 20742-4111, USA — We determine the Hall conductivity due to the surface states of 3D topological insulators in the presence of a weak perpendicular magnetic field and/or magnetization. We consider electron doping and calculate all known contributions to the Hall current, including the intrinsic, skew scattering and side jump terms. Skew scattering contributes to in the Born approximation, as well as giving the usual contribution of third order in the scattering potential. We identify a side-jump scattering term together with an intrinsic side-jump term, which give contributions of a similar magnitude. The dominant term by several orders of magnitude is of the order of the conductivity quantum, and includes a topological contribution and a renormalization due to scattering. The result is independent of the Rashba spin-orbit constant, as well as of the impurity concentration. It has different signs depending on whether the principal source of scattering is charged impurities or short-range interface roughness. We expect our results to help disentangle surface transport from bulk transport in these materials [1].

[1] D. Culcer, E. H. Hwang, T. D. Stanescu, and S. Das Sarma, Phys. Rev. B 82, 155457 (2010).

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