Parity anomaly related effects in magnetically-doped topological materials

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Recent experimental progress in condensed matter physics enables the observation of signatures of the parity anomaly (failure of the existence of single Dirac fermion in two spatial dimensions) in Dirac-like materials [1,2,3]. Using effective field theories and analyzing band structures in external out-of-plane magnetic fields (orbital fields), we show that topological properties of quantum anomalous Hall (QAH) insulators are related to the parity anomaly [2]. We demonstrate that the QAH phase survives in orbital fields, violates the Onsager relation, and can be therefore distinguished from a quantum Hall (QH) phase [2,3]. As a fingerprint of the QAH phase in increasing orbital fields, we predict a novel transition from -1 to 1 Hall plateau, caused by scattering processes between counter-propagating QH and QAH edge states [2,4]. This transition can be especially important in paramagnetic QAH insulators, such as (Hg,Mn)Te/CdTe quantum wells in which exchange interaction and orbital fields compete [2,5]. Furthermore, we predict new features related to the parity anomaly in ferromagnetic QAH systems [5].

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