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Zilch currents and chiral kinetic theory for vector particles

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The chiral vortical effect (CVE) is believed to be intrinsically related to the anomalies of the axial current and the topological properties of the system. It was suggested that the CVE can be generalized to systems of higher-spin particles and, particularly, to photons. However, there is no local gauge invariant definition of photonic helicity current. This problem can be overcome with an appropriate choice of the polarization measure. Recently, it was shown that there is a vortical effect in photonic zilch current (ZVE), which can play the role of a local gauge invariant helicity separation measure. In this work we study the zilch current in terms of chiral kinetic theory and show that the ZVE can be related to the non trivial topological properties of the system in momentum space manifested through the Berry phase. We also show how the ZVE arises in terms of the Wigner-function formalism for vector particles.

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