Chiral gauge field and axial anomaly in a Weyl semi-metal

ABSTRACT

Weyl fermions are two-component chiral fermions in (3+1)-dimensions. When coupled to a gauge field, the Weyl fermion is known to have an axial anomaly, which means the current conservation of the left-handed and right-handed Weyl fermions cannot be preserved separately. Recently, Weyl fermions have been proposed in condensed matter systems named as “Weyl semi-metals”. In this paper we propose a Weyl semi-metal phase in magnetically doped topological insulators, and study the axial anomaly in this system. We propose that the magnetic fluctuation in this system plays the role of a “chiral gauge field” which minimally couples to the Weyl fermions with opposite charge for the two chiralities. We study the anomaly equation of this system and discuss its physical consequences, including one-dimensional chiral modes in a ferromagnetic vortex line, and a topological plasmon-magnon coupling.