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Chiral anomaly observed as an axial current in two topological quantum materials

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Electrons in topological materials behave like massless particles (called Weyl fermions). They are either right- or left-handed (the spins are locked parallel or antiparallel to their velocity). In parallel applied electric and magnetic fields, one population grows while the other shrinks. This leads to a new kind of electrical current called an "axial" current. The Princeton MRSEC group has observed this new effect (called the chiral anomaly) in two distinct topological metals, Na_3Bi and GdPtBi *(1,2)*. At low temperatures, the appearance of the axial current causes the resistance to fall steeply with magnetic field (see Fig. 1).

The chiral anomaly first appeared (1968) in the decay of elementary particles, the π-mesons. Chirality ("handedness") is an essential property of quantum phenomena. The Princeton results illustrate how the same field theory describes phenomena with vastly different energy scales (meV to GeV).

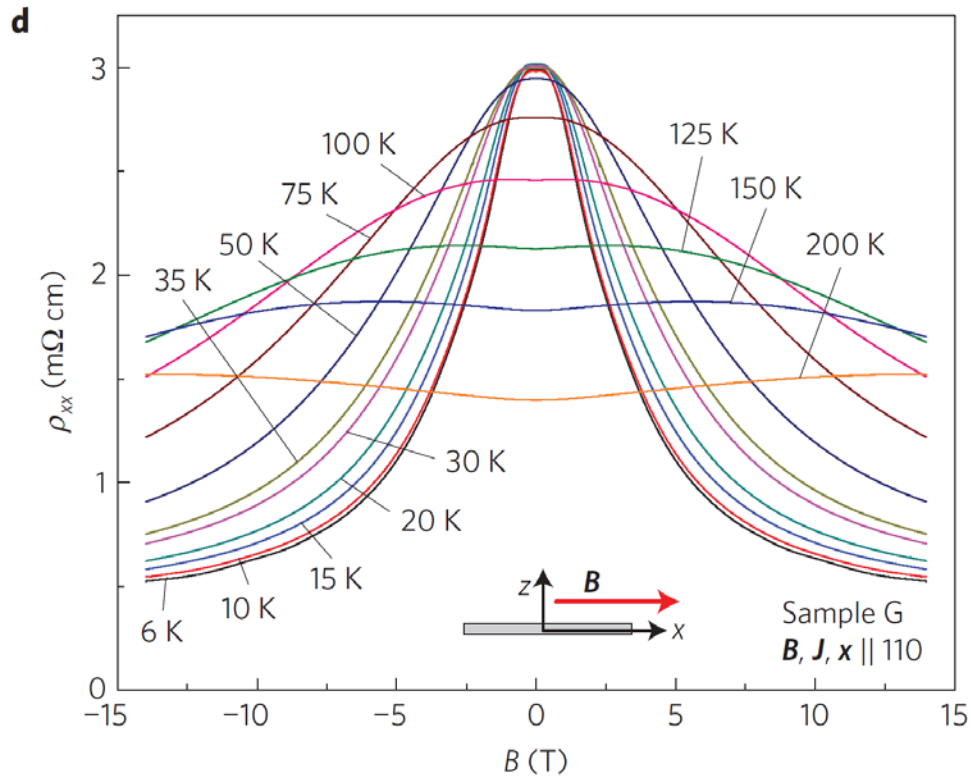

Figure 1: Curves showing how the resistance at selected temperatures falls with increasing magnetic field B in GdPtBi. The decrease reflects the emergence of the axial current, an effect called the chiral anomaly (Ref. 2). The curves in Na_3Bi (1) are remarkably similar.

1. J. Xiong *et al., Science* **350**, 413 (2015).
2. M. Hirschberger *et al., Nat. Mat.* **15**, 1161 (2016).

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