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Chirality: from particles and nuclei to quantum materials

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Abstract: Chirality is an ubiquitous concept in modern science, from particle physics to biology. In quantum physics, chirality is linked to the topology of gauge fields due to the quantum chiral anomaly. While the quantum anomaly is usually associated with the short-distance behavior, recently it has been realized that it affects also the macroscopic behavior of fluids with chiral fermions. In particular, the local imbalance between left- and right-handed fermions in the presence of magnetic field induces the non-dissipative transport of electric charge ("the Chiral Magnetic Effect"). In heavy ion collisions, there is an evidence for the effect from the experiments at Relativistic Heavy Ion Collider and the Large Hadron Collider. Very recently, the Chiral Magnetic Effect has been discovered in ZrTe₅ and other materials possessing chiral quasi-particles. These observations open a path towards applications.