Emergent Quantum Inductance in a Chiral Orbital Current State: Next-Generation Quantum Materials and Applications

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Chiral orbital currents (COC) circulating along the edges of the crystal unit cells underpin an array of novel phenomena in ferrimagnetic Mn3Si2Te6. Two types of inductances are well known, namely, geometrical and kinetic inductance. The former arises from a changing magnetic flux inside a coil that generates an electromotive force (emf) to oppose the change; the latter results from the kinetic energy needed by each electron that contributes to a current flowing in a superconductor. Here, I report a novel type of quantum inductance that originates from coherent COC enabled by a combined effect of a rising, low frequency alternating current (AC) and a constant magnetic field applied along the magnetic hard c-axis. The coherent COC, along with induced orbital moments, rigidly couple to the lattice and act as an effective, atomic-scale “coil” that induces a large emf in response to decreasing AC. The COC “coil” is also responsible for strong diamagnetic responses, which are unprecedented in any magnets, and a distinct drop in electrical resistivity below 5 K. The phenomenon of inductance is widely used in today's technology. The significance of this discovery cannot be overstated, both fundamentally and technologically.

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