Electron orbital dynamics in solids

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For a long time, it has been believed that electrons' orbital angular momentum is quenched in solids unless it is induced by the spin-orbit coupling in magnetic materials. Contrary to the common belief, recent studies have revealed that electron eigenstates may have finite orbital angular momentum even without the spin-orbit coupling if the inversion symmetry is broken [1]. In centrosymmetric systems, on the other hand, electron eigenstates do not have orbital angular momentum unless the spin-orbit coupling is strong. Nevertheless, a flow of electrons with finite orbital angular momentum is generated in a transverse direction when an electric field is applied (orbital Hall effect) [2,3]. The first part of this talk presents recent progress in the orbital Hall effect detection [4] and the orbital current relaxation [5]. The second part aims to develop bridges between the electron orbital and other degrees of freedom such as electron spin and lattice. Device applications will also be discussed.

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[5] J. Sohn et al., Phys. Rev. Lett. 132, 246301 (2024)