Weak and strong field optical response in ultrathin films of topological insulator

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Topological insulators are the class of materials that have insulating energy gaps in the bulk and the gapless surface states on the sample boundary that are protected by time-reversal symmetry. The gapless surface state band is a Dirac point where the electron dispersion is gapless and linear as the characteristic of Dirac fermions. This unconventional electronic phase in topological insulators is driven by strong spin-orbit interaction (SOI). New emergent behaviors ranging from the helical spin texture to dissipation less transport in topological insulators offer new perspectives for achieving future technologies in the field of electronics and spintronics.

In this study, the linear and nonlinear optical response of a topological insulator Bi_2Se_3 is investigated by time-dependent density functional theory with the inclusion of SOI. The electron dynamics along with the saturable absorption and high harmonic generation are examined at weak and strong laser fields. This theoretical study provides insight into the weak and strong-field-driven dynamics of Dirac-Fermions in the ultrathin films of the topological insulators.

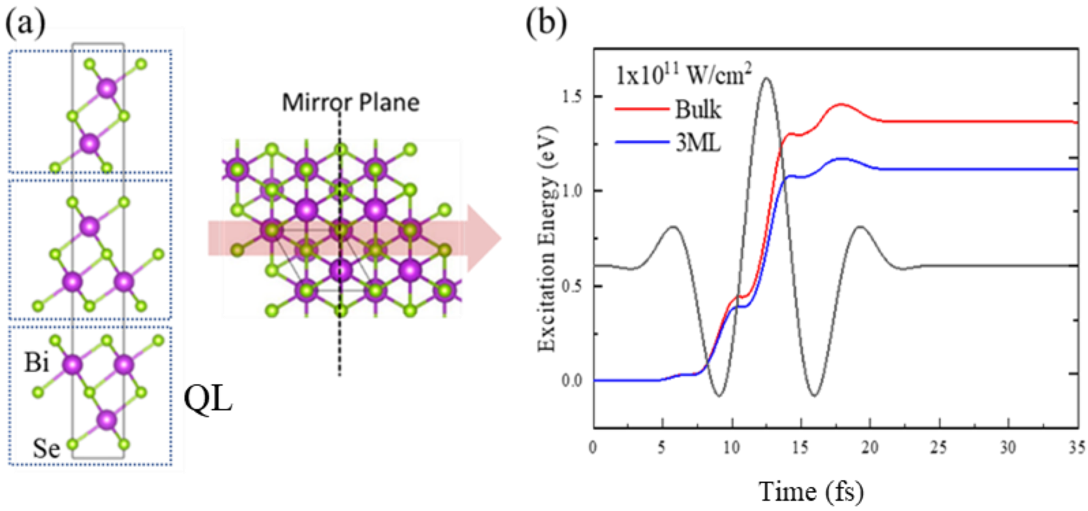

Fig. 1 (a) Side and top view of the crystal structure of Bi_2Se_3. The crystal is composed of alternating layers of Bi and Se atoms, aligned along the z-direction. The building unit of the lattice is formed by quintuple layers (QL). (b) Temporal development of excitation energies against the incident electric field for Bulk and ultrathin films of Bi_2Se_3.