Electron-phonon coupling at topological insulator surfaces from helium atom scattering experiments

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Electron-phonon coupling plays an important role for a variety of phenomena like the modification of low-energy electronic excitations in metals by the coupling to lattice vibrations, which may influence their transport and thermodynamic properties. Helium atom scattering (HAS) has been shown to be a sensitive probe of electron−phonon interaction properties at surfaces. Benedek and colleagues developed a quantum-theoretical derivation that allows the determination of electron-phonon coupling parameters λ for metals and metallic thin films from experimentally measured temperature-dependent helium diffraction intensities and phonon dispersion curves [1]. By adapting their theory to the case of topological insulators, we were able to extract an averaged λ from the Debye-Waller attenuation of the elastic diffraction peaks measured at surface temperatures between 110 and 355 K [2]. Electron-phonon coupling parameters for the surfaces of Bi_2Se_3, Bi_2Te_3, Bi_2Te_2Se, and Sb_2Te_3 were obtained this way. Moreover at the Bi_2Te_2Se (111) surface, a charge density wave (CDW) was identified that is stabilized by a coupling of Dirac topological electronic states to the crystal lattice via electron-phonon interaction [3].

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