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Impact of electric fields on surface states in topological semimetals

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We investigate the consequences of applying electric fields perpendicularly to thin films of topological semimetals. In particular, we consider Weyl and Dirac semimetals [1,2] in a configuration such that their surface Fermi arcs lie on opposite edges of the films [3,4]. We develop an analytical approach based on perturbation theory and a single-surface approximation and we compare our analytical results with numerical calculations. The effect of the electric field on the dispersion is twofold: it shifts the dispersion relation and renormalizes the Fermi velocity (see **Figure 1**), which would, in turn, have direct effects on quantum transport measurements. Additionally, it modifies the spatial decay properties of surface states which will impact the connection of the Fermi arcs in opposite sides of a narrow thin film.

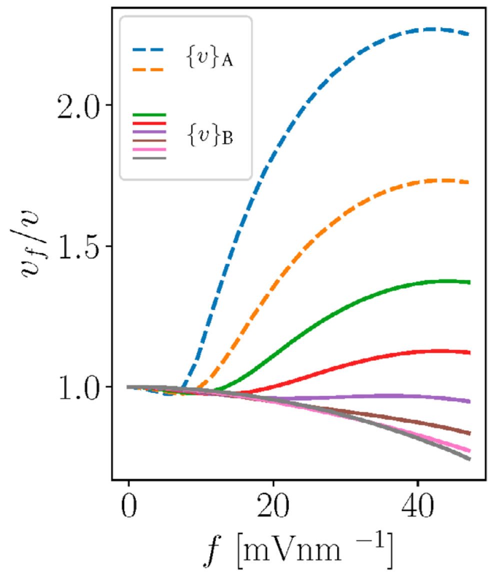

Figure 1*. Evolution of Fermi velocity in units of its bare value as a function of the electric field in a slab of width $w = 50\ nm$. The other parameters of the system Hamiltonian K are $m_0 = 0.35$ eV and $m_0 = 0.35$ eV nm^2, where $K = \left(m_0 - m_1\boldsymbol{k}^2\right)\sigma_z + vk_z\sigma_x + v\,k_y\sigma_y$. The values of the velocities plotted are $\{v\}_\mathrm{A} = \{0.8, 1.0\}$ eV nm and $\{v\}_\mathrm{B} = \{1.2, 1.4, 1.6, 1.8, 2.0, 2.4\}$ eV nm.*

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