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Plasmons in Topological Insulators GODFRY GUMBS, Department of Physics and Astronomy, Hunter College, City University of New York, 695 Park Avenue, New York, NY 10065, USA, OLEKSIY ROSLYAK, Department of Physics and Astronomy, Hunter College, City University of New York,695 Park Avenue, New York, NY 10065, USA, DANHONG HUANG, Air Force Research Laboratory, Space Vehicles Directorate, Kirtland Air Force Base, NM 87117, USA — A theory is presented for calculating the plasmon mode dispersion relation in three-dimensional topological insulators (TI). There are two-dimensional (2D) conducting surface states. The conducting states localized close to the surface of the semi-infinite slab have a well defined Dirac cone. The bulk energy gap is large and comparable with room temperature. We investigate plasmon excitations of those surface bound electrons in the long wavelength limit employing the random-phase approximation. Results from our calculations show that for a quasi-1DTI, the plasmon dispersion relation is given by $\omega_p \approx q\,(1-\omega_0 \ln(q))$ where $\omega_0 = \frac{2e^2}{\pi\epsilon_0}\frac{3}{10}$. On the other hand, for the conventional 1DEG, the plasmon dispersion satisfies $\omega_p \approx q\sqrt{-\omega_0 \ln(q)}$, with $\omega_0 = 2n_{1D}e^2/\epsilon_0 m$ and n_{1D} denoting the linear electron density. The plasmons in 1DTI are density-independent as they are in metallic armchair graphene nanoribbons but obey different dispersion relation. The material parameters we chose correspond to $\mathtt{Bi}_2\mathtt{Te}_3$ crystals.

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