Archetypal optical conductivity of topological semimetals observed in real systems

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Linear-in-frequency interband optical conductivity, $\sigma^{IB}(\omega)$, is a hallmark of an ideal (i.e., possessing only linear bands, which cross at the Fermi level) there-dimensional (3D) Weyl or Dirac semimetal [1,2]. In ideal nodal-line semimetals, $\sigma^{IB}(\omega)$ is expected to be flat at low enough frequencies due to effectively two-dimensional (2D) electronic bands [3,4]. In real systems, Fermi levels are rarely located at the Dirac or Weyl nodes. Thus, free-electron Drude contribution usually affects the optical conductivity appreciably, masking the interband portion of the optical conductivity at low frequencies. Additionally, parabolic bands are often present in topological semimetals in the vicinity of Fermi level. Thus, interpreting the optical conductivity data becomes challenging. We have found two topological semimetals, GdBiPt and ZiSiS, in which experimental $\sigma_1(\omega)$ follows the idealistic model frequency dependence, $\sigma^{IB}(\omega) \propto \omega^{(d-2)/z}$ [1-4], surprisingly well and in a broad frequency range, see the Figure below. The linear increase of $\sigma_1(\omega)$ in GdPtBi strongly suggests 3D linear bands, crossing near the Fermi level – in contrast with the currently adopted band structure (touching parabolic bands) [5], but in qualitative agreement with earlier ARPES results [6]. The flat $\sigma_1(\omega)$ in ZrSiS evidences 2D linearly dispersing electronic bands [7]. In the talk, constraints on the band structure of GdPtBi and ZrSiS imposed by the optical-conductivity results will be discussed.

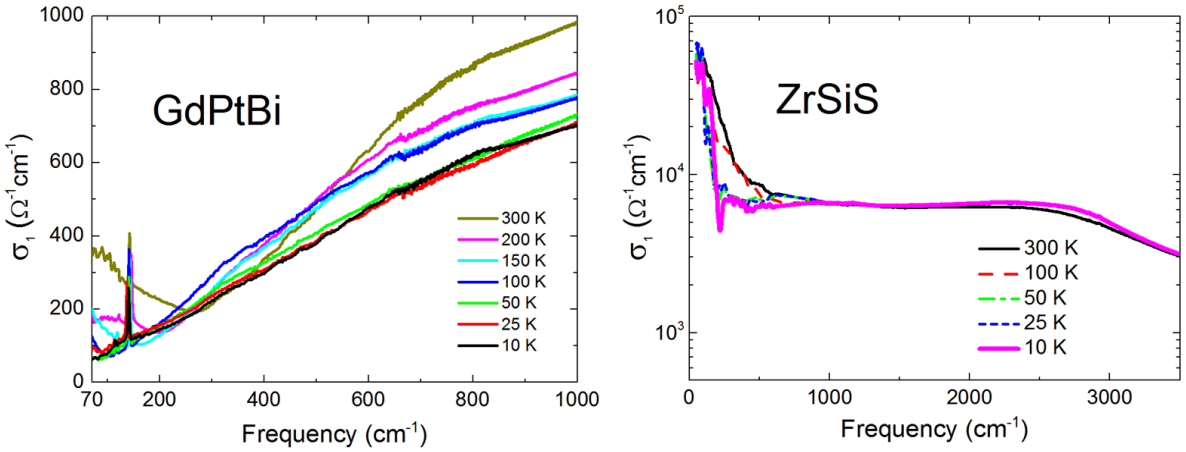

Figure. Optical conductivity (real part) of GdPtBi (left) and ZrSiS (right). In both compounds, neither the narrow Drude modes, nor contributions from non-linear bands affect the "archetypal" interband conductivity of Dirac elections appreciably.

References

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