Far-infrared spectroscopic studies on Weyl semimetal TaAs

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The temperature and frequency dependence of the optical response in Weyl semimetal TaAs has been studied systematically. It is found that the optical conductivity of TaAs features a narrow Drude response alongside a linear dependence on frequency. The weight of the Drude peak decreases upon cooling, following a T^2 temperature dependence, in good agreement with theoretical predictions. Two linear components with distinct slopes dominate the low-temperature optical conductivity. A comparison between our experimental results and theoretical calculations suggests that the linear conductivity below ~230 cm^{-1} arises purely from interband transitions near the Weyl points. Strong coupling between an infrared-active phonon and electronic transitions near the Weyl points has also been observed, which demonstrates itself as a Fano resonance in the lineshape. The resulting asymmetry in the phonon line shape, conspicuous at low temperatures, diminishes continuously with increasing temperature. This behavior originates from the suppression of electronic transitions near the Weyl points due to the decreasing occupation of electronic states below the Fermi level (E_F) with increasing temperature, as well as Pauli blocking caused by thermally excited electrons above E_F. Our findings open a route for exploring exotic physical phenomena through phonon properties in Weyl semimetals.

References

[1] B. Xu, Y.M. Dai, L.X. Zhao, K. Wang, R. Yang, W. Zhang, J.Y. Liu, H. Xiao, G.F. Chen, S.A. Trugman, J.-X. Zhu, A.J. Taylor, D.A. Yarotski, R.P. Prasankumar, and X.G. Qiu **Nature Communication** 8, 14933(2017).

[2] B. Xu, Y. M. Dai, L. X. Zhao, K. Wang, R. Yang, W. Zhang, J. Y. Liu, H. Xiao, G. F. Chen, A. J. Taylor, D. A. Yarotski, R. P. Prasankumar, and X. G. Qiu **Phys. Rev. B** 93, 111210(R)(2016).