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Towards the Lifshitz point in elemental bismuth: Light electrons gone heavy at the metal-insulator transition? [1]

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I present a detailed pressure and temperature- dependent optical study of single-crystal bismuth using infrared reflectivity and ellipsometry. In the ambient pressure optical conductivity, an anomalous temperature dependent mid-infrared absorption feature is observed. An extended Drude model analysis reveals that it can be connected to a sharp upturn in the scattering rate, the frequency of which exactly tracks the strongly temperature dependent plasmon frequency. We interpret this absorption and increased scattering as direct optical evidence for a charge carrier interaction with a collective mode of purely electronic origin, here electron-plasmon scattering. The observation of a "plasmaron" as such is made possible by the exceptional properties of semi-metal bismuth, but it is also likely relevant to the low energy transport and thermodynamic properties of other semi-metals, like graphite and graphene. As a function of pressure, we observe massive changes in bismuth's optical and infrared conductivity as the material approaches a Lifshitz-like metal/insulator transition in which the charge density approaches zero. This study shows the anomalous effects of interactions in a low carrier density system and particularly one such as this one in which Galilean invariance is broken.

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