Temperature dependence of quasiparticle transport in Bismuth observed by ballistic electron and phonon propagation

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Electon focusing patterns originating from ballistic electron transport in single crystalline materials are observed in transmission. Ballistic conditions are reached by using very pure single crystals and cooling the sample to 4 K so that the electron mean-free-path reaches the sample dimensions of about 300 μm. Spatial resolved excitation of quasiparticles by low temperature scanning electron microscopy and detection by a stationary point contact is used for imaging of the propagation patterns.

The effects of electron-phonon and electron-electron interactions are demonstrated for bismuth by observation of the thermal dependence of the spatially resolved transport properties of quasiparticles in the range of 5 K to 100 K. Ballistic carrier propagation governed by electron focusing is dominant for low temperatures. For rising temperatures a complex scenario resulting from thermally induced quasiparticle interaction is demonstrated.

The developed technique based on electron microscopy offers the possibility to investigate the transport properties of electrons and other quasiparticles in real space with microscopic resolution.