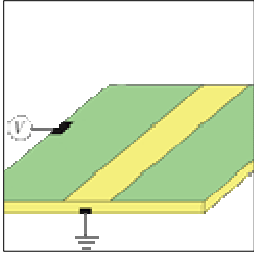


# Dirac connection



## Pseudodiffusive transmission of nodal Dirac fermions through a clean $d$ -wave superconductor

J. K. Asbóth, A. R. Akhmerov, A. C. Berceanu, and C. W. J. Beenakker - *Phys. Rev. B* 80, 224517 (Published December 18, 2009)

*Illustration: J. K. Asbóth et al., Phys. Rev. B (2009)*

In response to a voltage, the electrical current in a pure sheet of graphene diminishes as  $1/L$ , where  $L$  is the length over which the current is transmitted. This form of scaling, called pseudodiffusive because of its similarity to diffusion in a random potential, occurs when  $L$  is less than the width of the sheet and the mean free path.

In graphene, pseudodiffusion occurs because the electrons behave like massless Dirac fermions. Now, in a paper appearing in *Physical Review B*, János Asbóth and collaborators at Leiden University in the Netherlands calculate the transmission of electrons and holes between two normal-metal electrodes, separated over a distance  $L$  by a clean  $d$ -wave superconductor. Asbóth *et al.* find that the transmitted electrical and thermal currents both have the pseudodiffusive  $1/L$  scaling characteristic of massless Dirac fermions—regardless of the presence of tunnel barriers at the metal-superconductor interfaces—as long as  $L$  is larger than the superconducting coherence length and smaller than the width of the superconductor and the mean free path. This occurs because the  $d$ -wave superconductor forms ballistic conduction channels for coupled electron-hole excitations that are described by an anisotropic two-dimensional Dirac equation analogous to that of graphene. This finding is likely to spur experimental efforts to search for pseudodiffusive transmission in clean single crystals of high- $T_c$  cuprates.

Source: <http://physics.aps.org/synopsis-for/10.1103/PhysRevB.80.224517>