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Andreev reflection in graphene[1]

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Relativity and superconductivity have no common ground in ordinary matter, because the velocity of electrons is only a small fraction of the velocity of light. The unusual band structure of a single layer of carbon atoms (graphene) contains negatively and positively charged particles that move as relativistic electrons and positrons. The electron-like particles in the conduction band can be converted into positron-like particles in the valence band when they are reflected by a superconductor. (The missing charge of $2e$ enters the superconductor as a Cooper pair.) This *inter*band reflection process can be distinguished from the usual *intra*band Andreev reflection, because the reflection angle has the opposite sign. A new phenomenology of graphene–superconductor junctions is predicted, including an anomalous scaling of the supercurrent with the length of the junction and the existence of charge-neutral modes propagating along the interface.

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