Semiclassical theory of potential scattering for massless Dirac fermions

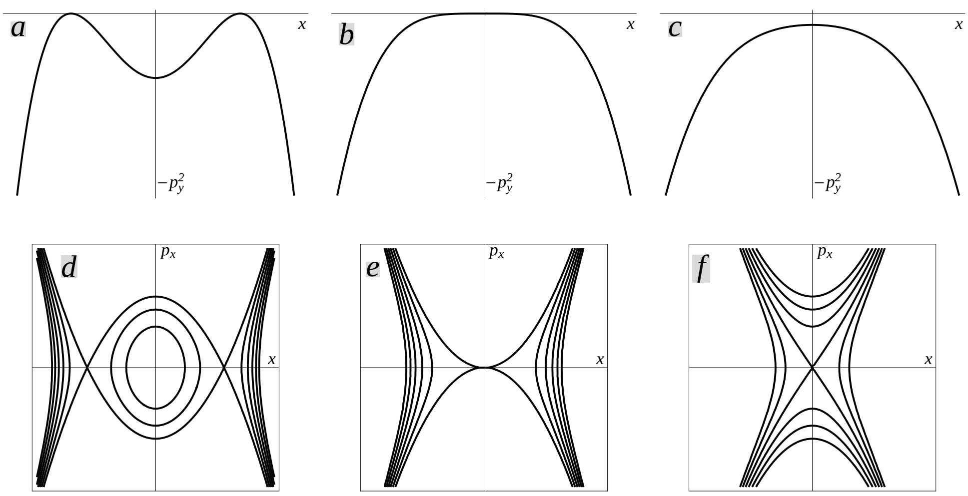
Timur Tudorovskiy

Radboud University Nijmegen, Institute for Molecules and Materials, Heyendaalseweg 135, 6525 AJ Nijmegen, The Netherlands

Two-dimensional massless Dirac fermions are effective charge carriers in graphene and topological insulators. The potential scattering for these particles drastically differs from the conventional one. The most pronounced example, illustrating the difference, is the Klein paradox, i.e. the total transmission of the Dirac fermion normally incident on any one-dimesional potential barrier.

We present a systematic semiclassical theory of potential scattering for massless Dirac fermions under the assumption that the potential depends on a single Cartesian variable. We distinguish three different regimes of scattering. To find the reflection and transmission coeffcients in these regimes, we apply the Wentzel-Kramers-Brillouin (WKB), or semiclassical, approximation. We use the method of comparison equations to extend our prediction to nearly normal incidence, where the conventional WKB method should be modified due to the degeneracy of turning points. We compare our results to numerical calculations and find good agreement.

The talk is based on our recent work: K. J. A. Reijnders, T. Tudorovskiy, M. I. Katsnelson, **arXiv:1206.2869v2 [cond-mat.mes-hall]**.



Classical phase portraits for different regimes of potential scattering of the massless Dirac fermion