Current flow paths in deformed graphene:
from quantum transport to classical trajectories in curved space

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Abstract

We compare two fundamentally different approaches to the electronic transport in deformed graphene: a) current flow paths obtained with the non-equillibrium Green's function (NEGF) method from the tight-binding model with local strain, b) classical trajectories for relativistic point particles moving in a curved surface with pseudo-magnetic field. The connection between them is established in the long-wave limit via an effective Dirac Hamiltonian in curved space. Geometrical optics approximation applied to focused current beams allows to directly compare the wave and the particle pictures. We obtain very good numerical agreement between the quantum and the semiclassical approaches for a fairly wide set of parameters, improving with the increasing size of the systems. Combination of the curvature and the pseudo-magnetic field paves the way to new interesting transport phenomena such as bending or focusing (lensing) of currents depending on the shape of the deformation. It can find applications in designing ultrasensitive sensors or in nanoelectronics.

References

[1] T. Stegmann and N. Szpak, arXiv:1512.06750

Figures