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Disorder-induced localised gating in graphene

Thomas Aktor, Antti-Pekka Jauho and Stephen R. Power

Introduction
Gating of individual atoms in graphene would allow extremely precise control of current flow. In practice, however, this is very difficult to achieve. In this work we investigate whether doping or spatially restricted gating can be used to achieve similar control.

Sublattice asymmetric potential

The onsite potential is shifted in one of the sublattices, with an average change (keeping the shift times concentration constant) of: \( c = c_\text{A} = 0.1 \text{eV} \), for a varying concentration of A-atoms \( c_\text{A} \) between 1.0 and 0.2 within a circular region of radius 20 nm. The positive energies are the most interesting.

Sublattice symmetric potential

The onsite potential is shifted in both sublattices, with an average change (keeping the shift times concentration constant) of: \( c = c_\text{A} = 0.2 \text{eV} \), for a varying concentration of A-atoms \( c_\text{A} \) between 1.0 and 0.2 within a circular region of radius 20 nm. The positive energies are the most interesting.

Green's Function of Graphene


Why Patched Green's Functions?
When computing the effect of disorder, the main challenges are the "low" number of atoms that can be considered at once, and the corresponding boundary conditions, typically edges or periodicity.

How does it work?

Step 1:
Take a pristine graphene sheet and cut a hole in it.

Step 2:
Embed a device in the cut-out region:

Step 3:
Probes for current injection and collection:

Step 4:
Apply equations:

Here \( i \) and \( j \) refers to specific sites. The advanced and retarded GPs are denoted as \( \Sigma_n^\text{advanced} \leftarrow \Sigma_n^\text{retarded} \).

Conclusions

- The key features of the DOS for the asymmetrically doped dot are largely independent of \( c_\text{A} \).
- The key features of the DOS for the uniformly gated dot are very dependent on the concentration. The peaks associated with the vortex behavior get completely smeared out.

References