Impact of vacancies on the transport in twisted bilayer graphene quantum point contacts

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Quantum point contacts (QPC), short one-dimensional conductors that can be electrostatically defined or etched in two-dimensional materials, are the center of attention for their prospective applications in spin, valley and charge nanodevices. Although fabrication by etching generally produces defects and roughness which hinder the properties of the pristine materia, recent cryoetching techniques overcome these problems and have demonstrated the fabrication of low-defect graphene QPCs via etching processes, in which quantization of electron transport was experimentally observed. This is especially important for the study of twisted bilayer graphene QPCs, where the interplay of moiré and edge localization should be studied in systems with well-defined edges.

In this work we provide a theoretical background to those systems. We study the electronic transport properties of a twisted bilayer graphene QPC consisting of a bilayer flake contacted by two monolayer graphene nanoribbons which act as leads. Numerical simulations are carried out with the help of the package Kwant for quantum transport, using a tight-binding model. The conductance and the spatial distribution of electronic states in the QPC are computed. Conductance quantization presents a strong dependence with the rotation angle between layers and the electron-hole symmetry is broken in pristine samples.

Despite the progress on fabrication techniques, some defects or impurities might be present in experimental devices, so furthermore we study the effect on the conduction caused by adding vacancy defects to the system. Remarkably, the electron-hole symmetry is partially recovered due to the effect of vacancies.

References

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Figures

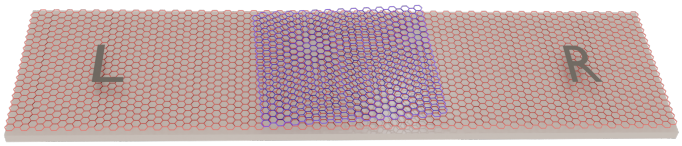

Figure 1: Sketch of the device

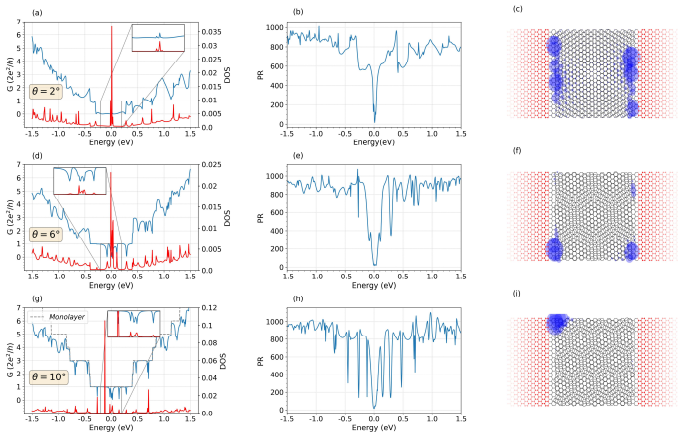

Figure 2: Conductance, Participation Ratio and Local Density of States of the system.