Electron-electron interaction in graphene ribbons in the presence of a magnetic field

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Zigzag graphene ribbons show highly localised edge states that are sensitive to electron-electron interactions, which is not the case for armchair ribbons. However, independently of the ribbon geometry, a magnetic field induces chiral edge states where electron-electron interactions could play an important role.

In this poster, we first show the effect of electron-electron interactions on the energy bands of graphene ribbons in the absence of a magnetic field and for different chemical potentials and temperatures. We then repeat the calculations in the presence of high magnetic fields and go deep into the physics of some of the effects shown in ref. [1]. For zigzag ribbons, we observe a behaviour similar to that in the absence of a magnetic field, but with an additional shift of the bands, which corresponds to spin-valley locked states. We also observe an effect on the flat Landau levels, with a band inversion for zigzag ribbons and the opening of a small gap for armchair ribbons. This occurs only at very low temperatures and chemical potentials close to the charge neutrality point, see the figure. This behaviour is not related to the edge states induced by the magnetic field, but to the peculiar localized nature of the bulk Landau level states on the two sublattices.

We simulate the electron-electron interaction through a Hubbard term [2] and its induced spin-dependent potential by the chemical-potential- and the temperature-dependent orbital occupation evaluated by the Green's function [3]. The magnetic field is introduced by the Peierls phase factor [4].

References

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[2] O. V. Yazyev, Report on Progress in Physics, 73 (2010) 056501
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Figures

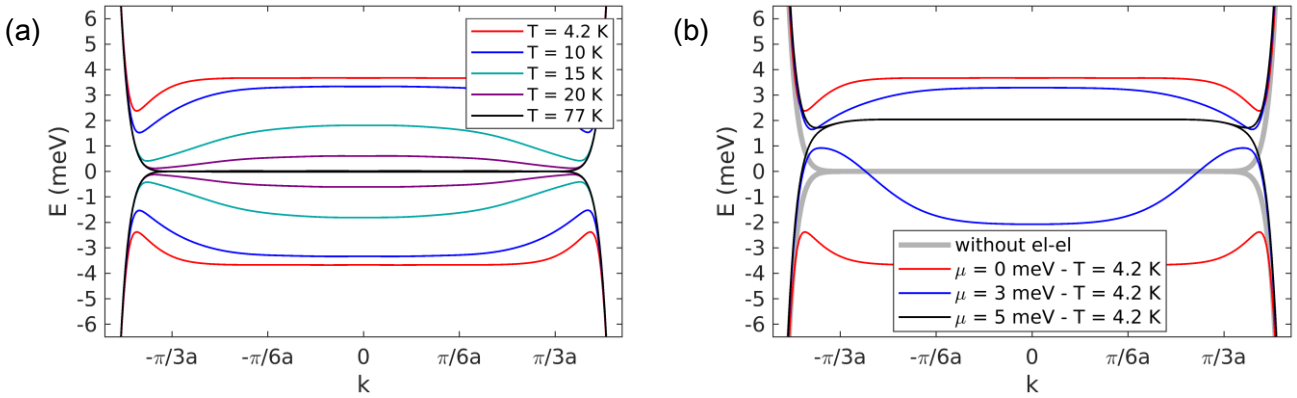

Figure 1: (a) Energy bands of a 50 nm wide armchair band in the presence of a 100 T orthogonal magnetic field at different temperatures. The electron-electron coupling opens a small gap at the zero Landau level, whose width decreases with temperature until it disappears completely. (b) Same as (a) at 4.2 K and varying the chemical potential. The energy gap is deformed and disappears when the chemical potential is increased.