Gradient-index electron optics in graphene pn junctions

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We investigate the electron transport in smooth graphene pn junctions, generated by gradually varying electrostatic potentials. The numerically calculated coherent current flow patterns can be understood largely in terms of semi-classical trajectories, equivalent to the ones obtained for light beams in a medium with a gradually changing refractive index. In smooth junctions, energetically forbidden regions emerge, which increase reflections and can generate pronounced interference patterns, for example, whispering gallery modes. The investigated devices do not only demonstrate the feasibility of the gradient-index electron optics in graphene pn junctions, such as Luneburg and Maxwell lenses, but may have also technological applications, for example, as electron beam splitters, focusers and waveguides. The semi-classical trajectories offer an efficient tool to estimate the current flow paths in such nano-electronic devices.
For more details, see the preprint [1].

References

[1] E. Paredes-Rocha et al. arXiv:2009.05535

Figures

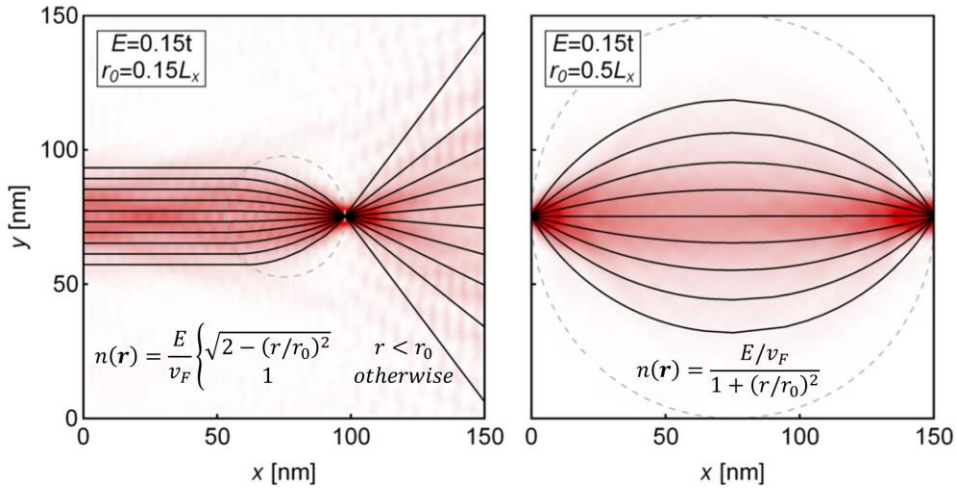

Figure 1: Current flow in graphene with an electrostatic potential that generates a Luneburg lens (left) and a Maxwell's fish-eye lens (right). The corresponding gradient-index is shown on each lens. The black curves are the semiclassical trajectories.