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Graphene nanodrums as valleytronic devices

We investigate the electronic transport in graphene nanoelectromechanical resonators (GrNEMS), known also as graphene nanodrums or nanomembranes. We demonstrate that these devices, despite small values of out-of-plane strain, between 0.1 and 1%, can be used as efficient and robust valley polarizers and filters. Their working principle is based on the pseudomagnetic field generated by the strain of the graphene membrane. They work for ballistic electron beams as well as for strongly dispersed ones and can be also used as electron beam collimators due to the focusing effect of the pseudomagnetic field. We show additionally that the current flow can be estimated by semiclassical trajectories which represent a computationally efficient tool for predicting the functionality of the devices.

References

[1] W. Ortiz, N. Szpak, T. Stegmann: Graphene nanodrums as valleytronic devices, arXiv:2202:01739

Figures

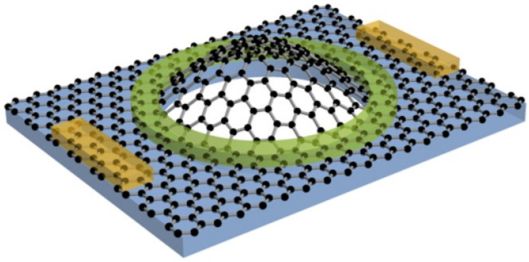

Figure 1: A graphene membrane deposited on an insulating substrate with a circular cavity forming a nanodrum. Current is injected and detected at the edges of the system.

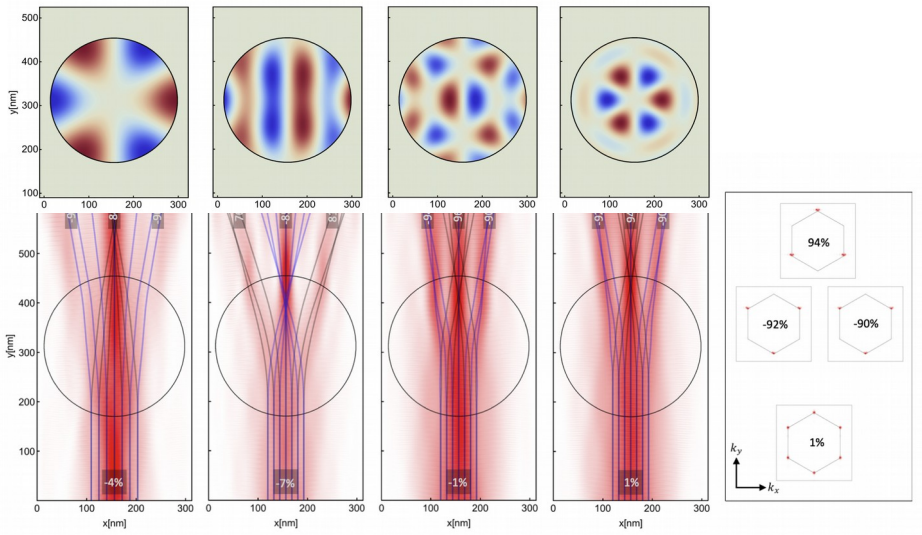

Figure 2: Nanodrum modes with pseudomagnetic field generated by the strain (top). Current flow split into three beams due to the pseudomagnetic field (bottom). Black and blue solid lines are semi-classical trajectories. The valley polarisations are measured in the Fourier space (right).