Crossed graphene nanoribbon networks for spin-polarized electron quantum optics

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The similarities between the wave nature of electrons propagating coherently in ballistic conductors with photon propagation in optical waveguides has spawned the field of electron quantum optics. A particularly interesting platform for this field is offered by graphene-based systems; electrons can propagate coherently over long distances, inheriting graphene's exceptional properties, while having tunable electronic characteristics. Inspired by optical analogies, one can envision performing electron interferometry in graphene constrictions, which requires the realization of elementary building blocks such as beam splitters and mirrors. Recently, it has been demonstrated that devices formed by two infinite graphene nanoribbons (GNRs) crossing each other at 60° can split the injected electron beam into two outgoing waves with tunable probabilities depending on the GNR width and energy of the incoming electron [1-3]. Moreover, GNRs with zigzag edge topology are expected to host spin-polarized edge states [4], which make these devices even more interesting since we can think of performing spin-polarized electron quantum optics in these setups [5,6].

In this work we propose interesting networks for studying spin-polarized electron quantum interferometry built from crossed GNRs, based on realistic experimental fabrication [7-9]. The possible paths will self-interfere at the outgoing ports, where the resulting interference pattern can be further tuned by an external magnetic field [10] as a consequence of the Aharonov-Bohm effect.

References

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