# Phase coherent transport in graphene nanoribbons

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Phase coherent effects in graphene are determined by the combined action of several scattering mechanisms. In the past, extensive studies have been performed on those effects in bulk graphene [1], [2], [3]. Little attention, however, has been devoted to phase coherent behavior in graphene nanoribbons (GNRs) where lateral confinement creates a crossover from 2D to 1D behavior and additional scattering is introduced at the edges of the ribbons.

Here we study the magnetotransport of graphene nanoribbons at low temperatures, focusing on interference effects which lead to corrections to the resistance or conductance. In graphene weak localization is often suppressed and generally more complex than in diffusive metals [1 - 3]. In the case of graphene nanoribbons, however, edge scattering becomes the most important mechanism leading to the observation of weak localization. Another correction to the conductivity are universal conductance fluctuations (UCFs), which appear when the phase coherence length is comparable to the sample length. Both effects allow us to extract the phase coherence length $L_\Phi$ in an independent way.

Here we have studied the magnetoconductance of individual graphene nanoribbons and arrays of GNRs. Fig. 1 shows the magnetotransport data collected for a 40 nm wide GNR (Fig. 1a) and for an array of GNRs (Fig. 1b), respectively. Each ribbon of the array has a width of 40 nm and a spacing of 30 nm to the next. For all temperatures from T = 1.7 K to 48 K Fig. 1a displays clear weak localization for low field region ($|B<1.5T|$) and universal conductance oscillations. With decreasing temperature the amplitude of the oscillations increases. For lower temperatures large universal conductance fluctuations overlay the weak localization feature. Consequently the phase coherence length can no longer be determined by fitting the weak localization. In order to investigate weak localization also at low temperatures arrays of graphene nanoribbons were fabricated. As expected the parallel arrangement of the nanoribbons leads to a suppression of the universal conductance fluctuations via ensemble averaging, whereas weak localization is not suppressed (Fig. 1b). Thus the phase coherent effects can be separated. By extracting $L_\Phi$ from weak localization we can compare and verify results obtained from the amplitude of the UCFs and the autocorrelation function of UCFs for single GNRs.

## References

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## Figures

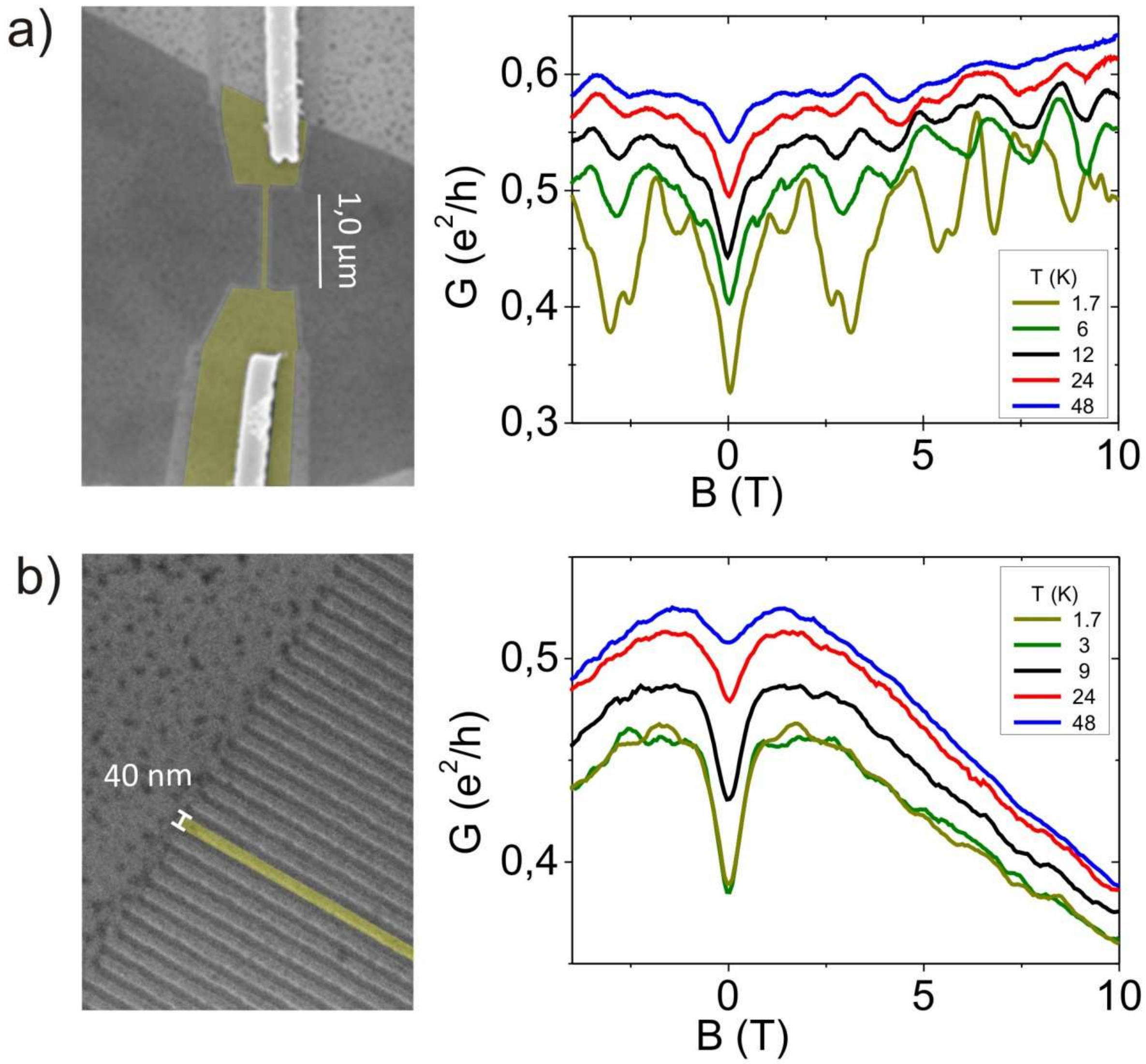

**Fig.1** *(a) SEM image of a 40 nm wide and 1 µm long graphene nanoribbon (colored in yellow). The conductance G as a function of magnetic field B shows quantum interference phenomena like universal conductance fluctuations and weak localization for temperatures from T = 1.7 K to 48 K.*

*(b) SEM image of a sector of a 3.2 µm wide array of 46 GNRs (one ribbon is colored in yellow). The ribbons of the array have a width of 40 nm and a length of 1µm, each with a spacing of 30 nm to the next ribbon. The magnetotransport data clearly shows a suppression of the universal conductance fluctuations for all temperatures, whereas the weak localization feature is not affected.*