Multimode Fabry-Perot interference in suspended graphene

M. Oksanen[1], A. Uppstu[2], A. Laitinen[1], D. J. Cox[1], A. Harju[2], M. F. Craciun[3], S. Russo[3], P. Hakonen[1]

[1]O. V. Lounasmaa Laboratory, School of Science, P. O. Box 15100, FI-00076 AALTO
[2]Department of Applied Physics, School of Science, P. O. Box 11100, FI-00076 AALTO
[3]Centre for Graphene Science, CEMPS,University of Exeter, Exeter EX4 4QF, UK
mika.oksanen@aalto.fi

We report Fabry-Perot type interferences in high-mobility suspended graphene with both shot noise and conductance measurements. Due to the long phase-coherence length in carbon nanomaterials, resonant tunnelling may occur even with relatively long samples. Liang et. al. [1] observed evenly spaced electron-resonances of $\Delta E \sim hv_F/2L$, where h is Plank's constant, v_F is the Fermi velocity and L is sample length – with single-wall carbon nanotubes. Recent experiments on suspended, exfoliated graphene have demonstrated mobilities exceeding 200 000 cm2/Vs [2, 3], which facilitate studies of wavelike transport in graphene. Indeed, oscillations in the conductivity of graphene have been observed, indicating coherent transport and Fabry-Perot like resonances [3, 4]. The observed interference structure is more involved than in SWCNTs, which is caused by the two dimensional nature of graphene, which allows more complex interfering paths. Besides extended, high-quality samples, Fabry-Perot resonances have been investigated under very narrow top gates [5] so that the cavity length is on the order of the mean free path of the carriers and the interference is confined between bordering pn interfaces.

The conditions for Fabry-Perot resonances in rectangular graphene sheets with nonperfect contacts were recently analyzed by Gunlycke and White [6] who showed that, under certain conditions evenly spaced groups of resonances, separated by $\Delta E \sim hv_F/2L$, can emerge. These collective resonances originate owing to simultaneous participation of modes in nonequivalent channels that are facilitated by transversely quantized states with small energy separation. Such collective resonances should not be confused with the ordinary two-channel Fabry-Perot resonances observed in single-wall carbon nanotubes.

Conductance and shot noise measurements were used to analyse the transport resonances generated by contacts as well as pn (nn') junctions. Differential conductance shows faint Fabry-Perot patterns emerging, by taking the derivative of the conductance the visibility is improved (Fig. 1 a)). The separation of the maxima is 4 meV in gate and 8 mV in bias. Because of the negative gate polarity used nn' interfaces are formed, and at positive gate voltages pn interfaces are formed which present a more visible structure.

The Fourier transform of the data was taken at high positive and negative chemical potential (Fig. 1b)). Analysis of the Fourier transform shows peaks corresponding to the different contribution of interferences from the metallic leads and pn (nn') interfaces. Shot noise shows similar results, and the analysis agrees with the findings from the conductance.

References

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Figures

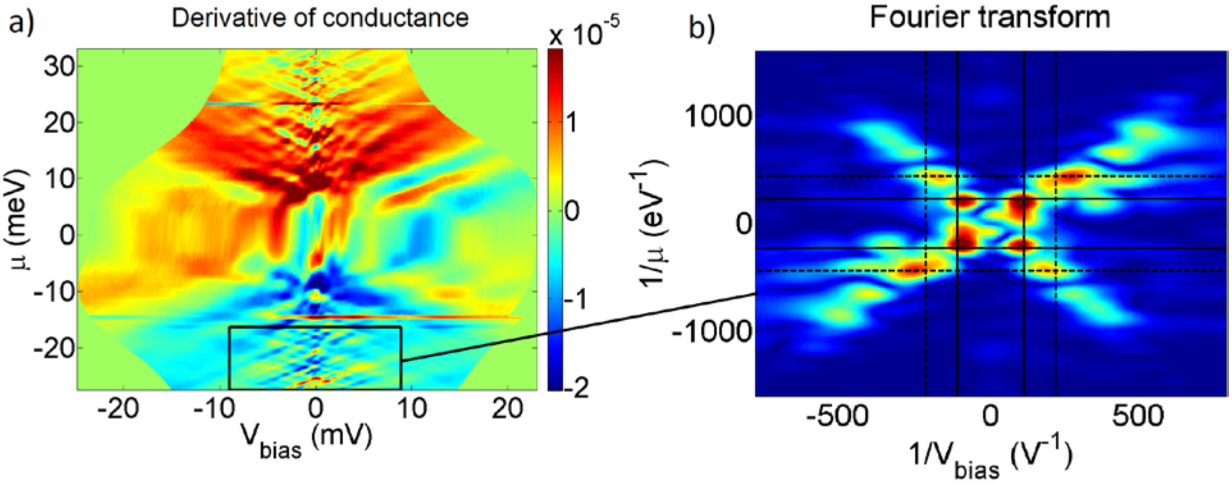

Figure 1. a) Taking the derivative of the conductance with respect to chemical potential gives better visibility of the resonance structure. b) Fourier transform of the data within the rectangle, where the solid lines indicate resonances in the center region of the sample (between pn interfaces), and the dashed lines indicate resonances from the metal contacts.