Commensurability peaks in antidot graphene lattices

P.Canteli
J. Salvador-Sánchez[1], V. Clericò[1], J. Estrada-Álvarez[2], A. Pérez-Rodríguez[1],E. Díaz[2], F. Domínguez-Adame[3], E. Diez[1], M. Amado[1]
[1]Nanotechnology Group, Department of Fundamental Physics, University of Salamanca, Spain
[2]GISC-QNG Department of Materials Science, Complutense University of Madrid, Spain
p.canteli@usal.es

Commensurability oscillations in magnetotransport, resulting from the interplay between cyclotron orbits and periodic patterning [1,2], are foundational in mesoscopic physics. Achieving similar control in two-dimensional materials like graphene has been challenging due to the need for ballistic transport over large scales [3]. Here, we present the observation of magnetoresistance peaks in high-quality perforated graphene (antidot lattices), where collective electron motion – a key ingredient for the emergence of hydrodynamic flow - is evident. We find that scattering between states bound to individual or grouped antidots drives these commensurability features and superlattice effects, such as Aharanov-Bohm oscillations and change in Shuvnikov de Has oscillations. Our findings provide key insights for advancing experiments in nanostructured graphene.

References

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[2] S. R. Power, M.Rishøj Thomsen, A.-P. Jauho, and T. G. Pedersen, Phys. Rev. B 96, 075425 (2017).
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Figures

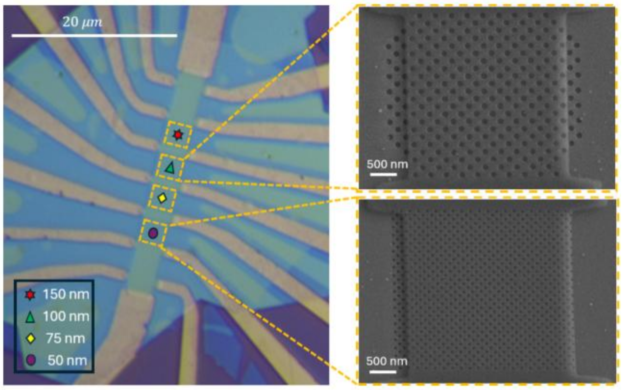

Figure 1: 16-terminal Hall bar device with four distinct areas with staggered antidots of diameters Φ = 50, 75, 100, and 150 nm and two pristine regions. The two insets display scanning electron micrographs on sacrificial h-BN flakes with fully-etched antidot regions of Φ = 100 nm and Φ = 50 nm.

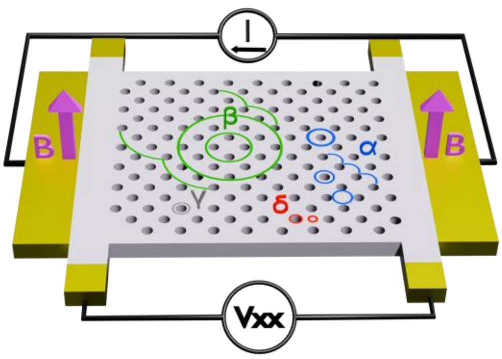

Figure 2: Simulation of the possible electron trajectory across an antidot superlattice