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Conductance Quantization in Graphene Nanostructures[1]

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Electrical conductances quantized in integer multiples of the fundamental quantum $2e^2/h$ are the hallmark of ballistic quantum transport in nanostructures such as semiconductor quantum point contacts, gold atomic wires, and carbon nanotubes. However, there have been only a few reports of conductance quantization being observed in graphene nanostructures, and the observed behavior presented significant puzzles: Lin *et al.* [Phys. Rev. B **78**, 161409(R) (2008)] and Lian *et al.* [Appl. Phys. Lett. **96**, 103109 (2010)] observed conductance quantization in graphene nanoribbons. However, surprisingly, the conductance steps that they found were orders of magnitude smaller than the ballistic conductance quantum $2e^2/h$. Tombros *et al.* [Nature Physics **7**, 697 (2011)] reported observing conductance quantization in *integer* multiples of $2e^2/h$ in a graphene nanoconstriction with curved boundaries. However, the curvature implies the presence of large numbers of atomic-scale steps along the boundaries. In this respect a graphene constriction differs from semiconductor constrictions whose boundaries, being defined electrostatically, are atomically smooth, and this smoothness is widely believed to be crucial for the observation of conductance quantization. In this talk I will review these experiments and the explanations that we have proposed[2] of the quantized conductance phenomena that have been observed in graphene nanostructures.

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[2]S. Ihnatsenka and G. Kirczenow, Phys. Rev. B **80**, 201407(R) (2009); Phys. Rev. B **83**, 245442 (2011); Phys. Rev. B **83**, 245431 (2011); Phys. Rev. B **85**, 121407(R) (2012); Phys. Rev. B **86**, 075448 (2012).