Localisation and Finite-Size Effects in Graphene Flakes

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We show that electron states in disordered graphene, with an onsite potential that induces inter-valley scattering, are localised for all energies at disorder as small as $1/6$ of the band width of clean graphene. We clarify that, in order for this Anderson-type localisation to be manifested, graphene flakes of size $\sim 200 \times 200$ nm^2 or larger are needed. For smaller samples, due to the surprisingly large extent of the electronic wave functions, a regime of apparently extended (or even critical) states is identified. Our results complement earlier studies of macroscopically large samples and can explain the divergence of results for finite-size graphene flakes.