Title: The wagon-wheel effect in graphene-based materials: Can apparently innocuous oscillations impact so many physical properties?

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Abstract:

The key signature of any symmetry-breaking perturbation that arises due to the presence of impurities and/or defects is the appearance of spatial fluctuations in quantities like the local density of states (LDOS) and the carrier density, both of which oscillate away from the location of the perturbation. However, in graphene these oscillations are hidden by their commensurability with the lattice parameter of graphene, analogously to the optical illusion known as the wagon-wheel effect. Surprisingly, the absence of such oscillations can have a dramatic effect in a number of electronic properties of graphene and its derivative materials, as shown in this talk. For a start, these simple oscillations, or lack thereof, can explain the sublattice asymmetry seen in impurity-doped graphene where dopants prefer to bind to carbon atoms occupying one of the two sublattices of graphene even though both are absolutely equivalent. Another manifestation of the wagon-wheel effect is that the bonding symmetry with which a dopant binds to graphene may determine how good a scatterer this dopant is. As a result, certain impurities tend to be completely invisible causing no scattering whatsoever, with direct implications for the designing of efficient sensors. Finally, in addition to explaining the aforementioned physical properties, we argue that the wagon-wheel effect can also be explored to improve the accuracy of electronic structure calculations in graphene-related materials.