New phenomena in transport through suspended graphene devices

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Some of the most interesting electronic properties of graphene –and of its multilayers– occur when the Fermi level is positioned very close to the charge neutrality point, where valence and conduction bands touch. For devices where graphene is in direct contact with a substrate, the possibility to position the Fermi level close to the charge neutrality point is limited by the presence of charge inhomogeneity, which so far has not be reduced below ~5 10^{10} cm^{-2} even in the best systems. In suspended graphene devices –where graphene is not in direct contact with a gate dielectric material– this limit can be improved by nearly a factor of 50, enabling the observation of new phenomena. Here, I will discuss transport experiments that we have performed on devices of this high quality, by probing transport in a multi-terminal configuration –something that had not been successfully done until now. After giving some background about suspended graphene devices and presenting the characterization of our structures, I will discuss two main topics. The first is the fractional quantum Hall effect in graphene bilayers, where the phenomenon occurs in new regimes, resulting in predicted exotic states, whose manifestations seems to be present in our data. The second is the opening of a gap at charge neutrality induced by electron-electron interactions that is known to occur in bilayers, and that we now observe also in four-layer graphene. Our experimental results suggest the presence of an even-odd effect of interactions with layer thickness that persists even in multilayers that are so thick to be normally considered to be graphite, as long as no structural defects are present.