Magnetotransport and Topological Phenomena in Folded Graphene

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The stacking- and folding angle of 2D materials has emerged as an important, novel tuning parameter for the tailoring of physical properties. Especially, folded graphene layers show astonishing electronic and magnetic properties. In these samples, not only the typical electronic properties of twisted graphene layers are observed, but also phenomena due to the folded region, e. g. snake states and zero line modes.

One approach to achieve folded graphene samples is based on atomic force microscopy (AFM) technique [1, 2, 3]. Therefore, we use an AFM tip to cut into a graphene layer to initiate a self-assembly process that involves the folding of the graphene layer and the subsequent growth of a twisted graphene bilayer. From our observations, we conclude that during the growth process, these self-assembled structures move not only forward, but also appear to rotate and lock in at specific commensurate twist angles, see Fig. 1. These rotations and the assignment of twist angles to commensurate configurations suggest a conservation of energy by finding efficient configurations.

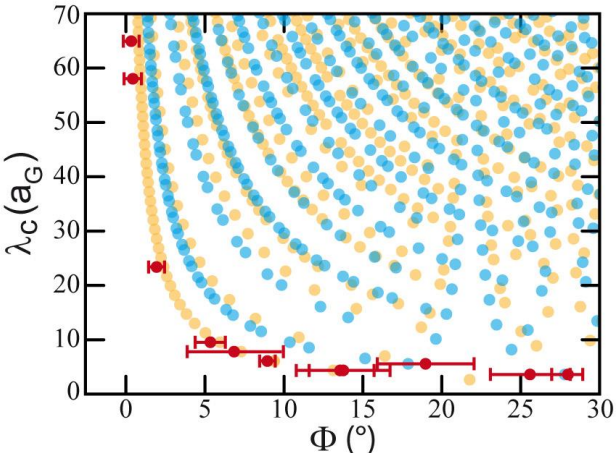

Fig.1 Assignment of twist angles in one-rip structures to commensurate configurations. (a) Yellow (odd configurations) and blue (even configurations) dots indicate wavelength λ_c vs. rotational mismatch Φ for the entirety of commensurate structures (identified via index pairs (n, r) < (100, 100)) within the depicted parameter window. Rotational mismatches found in our samples are depicted as red dots.

In our transport measurements of folded graphene samples, we observe e.g. an additional peak next to the charge neutrality peak, which is independent of the magnetic field. This peak at a certain charge carrier density is attributed to the compressive strain due the folded edge [4, 5]. As a result of the connection of the upper and lower graphene layers via the fold edge, there is a unique situation where an applied magnetic or electric field points in opposite directions in the individual layers. In the region of the folded edge transitions to chiral edge states transport can be observed in a very narrow area.

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