251 Edge states in moire structures of graphite.

E. Suárez Morell[1], S. Hevia[2], P. Vargas[1], P.Haberle[1], L. Chico[3]

[1]*Departamento de Física, Universidad Técnica Federico Santa María, Casilla 110-V, Valparaíso, Chile*

[2]*Departamento de Física, Pontificia Universidad Católica de Chile, Avda. Vicuña Mackenna 4860, Macul, Santiago, Chile,*

[3]*Departamento de Teoría y Simulación de Materiales, Instituto de Ciencia de Materiales de Madrid (ICMM), Consejo Superior de Investigaciones Científicas (CSIC), C/ Sor Juana Inés de la Cruz 3, 28049 Madrid, Spain*

email address corresponding author: eric.suarez@usm.cl

In this work we address the origin of bead-like edge states in moiré patterns in graphite structures. Although the phenomena have been known for a while a proper treatment of these anomalies has not yet been addressed. We analyze Scanning Tunneling Microscopy (STM) images of these edge states in highly oriented pyrolytic graphite (HOPG), showing that the bright spots at the edges are not located at the AA sites, as it is the case for the the moiré pattern of the bulk. Instead, they are associated with the AB sites, as it corresponds to edge states of chiral edges.

We found that the same behavior is observed in smaller structure like graphene bilayer ribbons. Therefore we explain it with simulations of the local density of states of twisted ribbons and with a qualitative analysis of the energy of the states of chiral ribbons, which present a distinct edge state localization related to the occurrence of AA and AB-stacked regions at their edges.

We model the bilayer graphene structures within the tight-binding approximation including only the Pz orbitals. Within each layer, we consider a fixed nearest-neighbor intralayer hopping parameter and for the layer-layer interaction we employ a distance-dependent hopping.

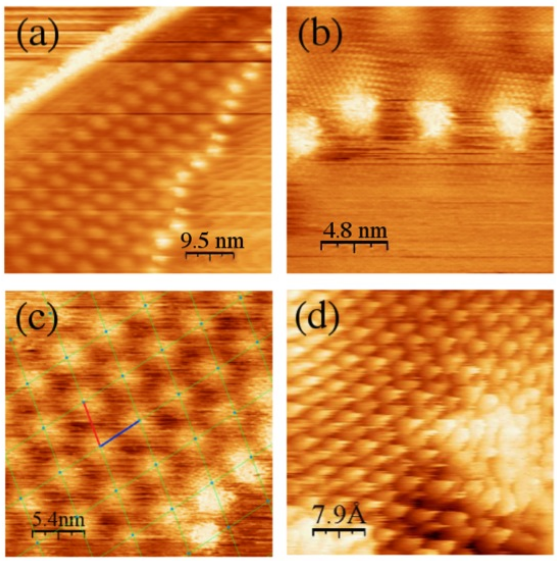

Fig. 1 *STM images of HOPG. The moire pattern can be clearly observed. The periodicity of the superlattice is 4 nm. The bead-like edge states are visible in (b) and we encourage the reader to notice that they are not following the same pattern as in the bulk. In (d) the moiré bright spot and the graphite layer can be observed simultaneously.*

References

[1] E. Suárez Morell et al. PRB 89, 205405 (2014).

[2] Wing-Tat Pong, et al. *Surface Science 601,498 (2007)*.

[3] Hai-Lin Sun et al, Surface Science 542, 94 (2003)