Effective Theory of Quasicrystalline Twisted Bilayer Graphene

Pilkyung Moon[1]
Mikito Koshino[2], Young-Woo Son[3]

[1]*NYU Shanghai, Shanghai, China*
[2]*Osaka University, Toyonaka, Japan*
[3]*Korea Institute for Advanced Study, Korea*

pilkyung.moon@nyu.edu

The recently realized bilayer graphene system with a twist angle of 30° offers a new type of quasicrystal ("QC-TBG") which unites the dodecagonal quasicrystalline nature and graphene's relativistic properties [1].

In this talk, we introduce a concise theoretical framework that fully respects both the dodecagonal rotational symmetry and the massless Dirac nature, to describe the electronic states of the system [2]. We find that the electronic spectrum consists of resonant states labeled by 12-fold quantized angular momentum, together with the extended relativistic states. The resulting quasi-band structure (Fig. 1) is composed of the nearly flat bands with spiky peaks in the density of states, where the wave functions exhibit characteristic patterns which fit to the fractal inflations of the quasicrystal tiling (Fig. 2). We also demonstrate that the 12-fold resonant states appear as spatially-localized states in a finite-size geometry, which is another hallmark of quasicrystal.

The theoretical method introduced here is applicable to a broad class of "extrinsic quasicrystals" composed of a pair of two-dimensional crystals overlaid on top of the other with incommensurate configurations.

References

[1] S. Ahn*, P. Moon*, T.-H. Kim* et al., Science **361**, 782 (2018).
[2] P. Moon*,†, M. Koshino*, Y.-W. Son (submitted, arXiv:1901.04701)

Figures

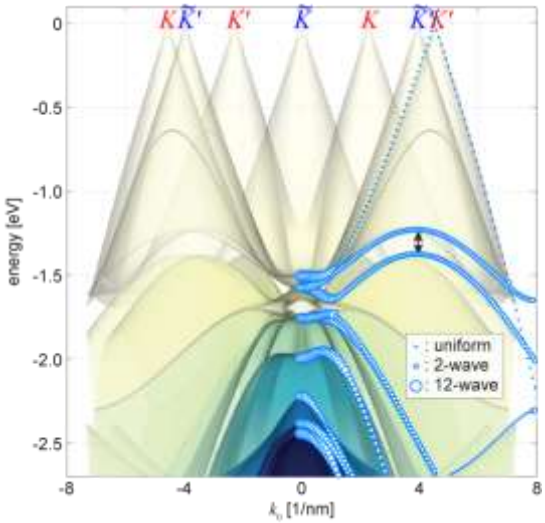

Figure 1: Electronic structures of QC-TBG. Blue dots show the degree of hybridization of waves.

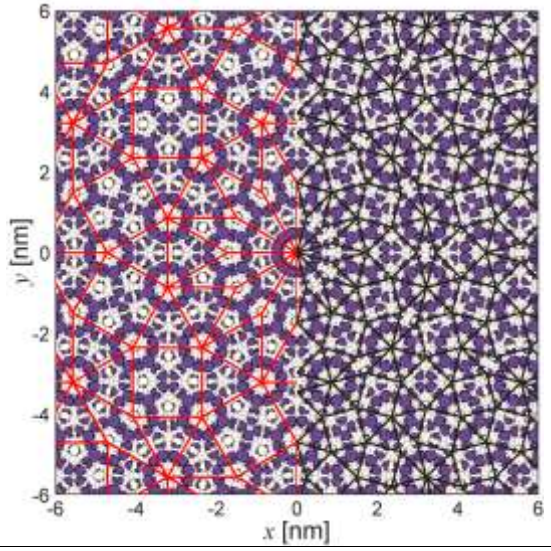

Figure 2: Electron density distribution of the resonant states of QC-TBG (purple circles) where the area of the circle is proportional to the squared wave amplitude. Red and black lines indicate the fourth and third generations of the Stampfli tiling, respectively.