# Disorder induced delocalization in magic-angle twisted bilayer graphene [1]

**Pedro Alcázar Guerrero[12]**
Viet-Hung Nguyen[3], Aron W. Cummings[1], José-Hugo García[1], Jean-Christophe Charlier[3], Stephan Roche[14]

*[1] ICN2, ICN2Building(UAB Campus), Bellaterra, Spain*
*[2] Departament of Physics (UAB Campus), Bellaterra, Spain*
*[3] ICMN, Université Catholique de Louvain(Chemin des étoiles 8 B-1348), Louvain la Neuve, Belgium*
*[4] ICREA, Barcelona, Spain*
pedro.alcazar@icn2.cat

Flat bands in Moiré systems, and their localization in real space, have been connected with exotic correlated physics, such as the superconducting and Mott insulating phases of Magic-Angle Twisted Bilayer Graphene (MATBLG) [2-4]. This happens because the vanishing kinetic energy and the real-space localization trigger a dominant Coulomb interaction.

The role of the Moiré superlattice potential in this phenomenon is well known, but the roles of structural (twist-angle) and electrostatic disorder remain unclear.

In this presentation we will discuss what is known about the effect of disorder on MATBLG, and present simulation results showing that the inclusion of electrostatic disorder in MATBLG can lead to delocalization in the flat bands, increasing the electronic mean free path. This suggests that even weak disorder can have a strong impact on the Coulomb interactions that drive the exotic physics of these systems.

## References

[1] PA Guerrero, VH Nguyen, AW Cummings, JH García, JC Charlier, S Roche, arXiv:2401.08265
[2] Y Cao, V Fatemi, S Fang, K Watanabe T Taniguchi, E Kaxiras, PJ Herrero, Nature, 566 (2018) 43
[3] P Stepanov et al, Nature, 583 (2020) 375
[4] R Bistritzer, AH McDonald, PNAS, 108 (2011) 12233

## Figures

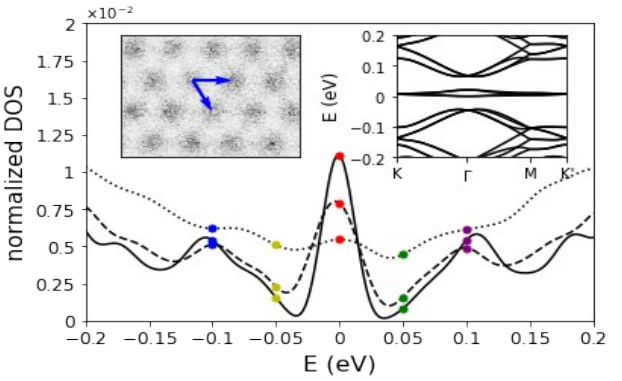


**Figure 1:** Density of states of MATBLG for increasing disorder strengths (solid → dashed → dotted). The left inset shows the localization pattern in the clean case. The right inset shows the band structure of the clean system.

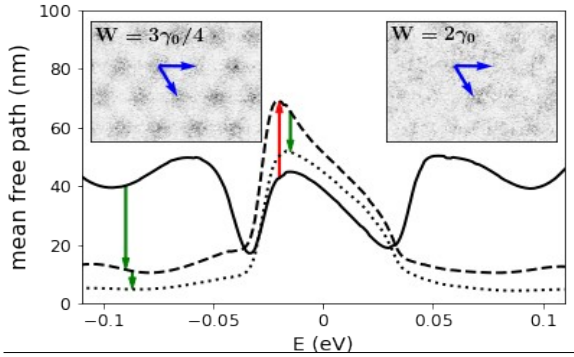


**Figure 2:** Mean free path of electrons for increasing values of disorder (solid → dashed → dotted) An increase in disorder initially leads to an increase in the mean free path in the flat bands, with the usual trend recovered once its contribution dominates the Moiré potential. Insets show local densities of states for intermediate (left) and strong (right) disorder.