Probing Topological Chern Transition in TDBG through Berry Curvature Dipole Sign Change: A Comparative Study of ABBA and ABAB Stacked Systems

Surat Layek[1*]

Subhajit Sinha[1], Pratap Chandra Adak[1], Atasi Chakraborty[2], Heena Agarwal[1], Kamal Das[2], Koyendrila Debnath[3], L. D. Varma Sangani[1], Kenji Watanabe[4], Takashi Taniguchi[4], Umesh V. Waghmare[3], Amit Agarwal[2], and Mandar M. Deshmukh[1]

[1]Tata Institute of Fundamental Research, Mumbai, India.

[2]Indian Institute of Technology, Kanpur, India.

[3]Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India.

[4]National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan.

*surat.layek@tifr.res.in

Twisted double bilayer graphene (TDBG) offers electric field tunable topological bands, making it an ideal platform to study the effects of band topology and valley Chern transition therein. We study the role of the Berry curvature dipole (BCD) in TDBG by studying its effects on electronic transport. Our work investigates the topological transition of the Z_2 index of flat bands by studying Berry Curvature Dipole from the non-linear Hall effect in twisted double bilayer graphene (TDBG).

In addition, by probing the BCD, we investigate the differences between TDBG with ABAB and ABBA stacking configurations, which have very similar band structures but exhibit different chirality and undergo different Chern transitions under the influence of a perpendicular electric field. Our analysis shows that the differences in the Chern transitions can be attributed to the different stacking configurations, highlighting the importance of understanding the role of stacking in the topological properties of TDBG.

References

[1] Sinha, S., Adak, P.C., Surya Kanthi, R.S. *et al.*, *Nat. Commun.* **11**, 5548 (2020).

[2] Sinha, S., Adak, P.C., Chakraborty, A. *et al.*, *Nat. Phys.* **18**, 765–770 (2022).

[3] Adak, P.C., Sinha, S., Giri, D. *et al.*, *Nat. Commun.* **13**, 7781 (2022).