Unconventional domain tessellations and their consequences in twisted trilayer van der Waals systems

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In this talk, we present a comprehensive structural analysis and the unique electronic properties of marginally twisted trilayer graphene (MTTG), a minimal multilayer configuration beyond twisted bilayer systems [1]. We demonstrate a complete catalog of reconstructed moiré-of-moiré structural phases by manipulating two twist angles. Our findings reveal cascades of spontaneous symmetry breaking as a function of the twist angles, resulting in a diverse array of large-scale moiré lattices, including triangular, kagome, and corner-shared hexagram-shaped domain patterns [1]. Furthermore, our analysis emphasizes the crucial role of long-range interactions across entire layers, alongside the well-known contributions of twist angles and strain between adjacent layers, in realizing various domain lattices. Building on our results for MTTG, we apply our methods to twisted trilayer hexagonal boron nitride (TTBN), demonstrating how external fields can control domain lattices and the associated arrays of localized states at the vertices of moiré-of-moiré lattices [2]. The diverse tessellation of distinct domains, whose topological network can be adjusted by modifying the twist angles and external gate voltages, positions twisted trilayer systems as a platform for exploring the interplay between emerging quantum properties and controllable nontrivial lattices.

References

[1] D. Park, C. Park, K. Yananose *et al.*, Nature, *in press*, arXiv:2402.15760 (2025).
[2] K. Yananose, C. Park, Y.-W. Son, *submitted*, arXiv:2504.14925 (2025).