Unconventional Domain Tessellations in Moiré-of-Moiré Lattices

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Twisted trilayer van der Waals crystals enable the creation of hierarchical moiré-of-moiré lattices by overlapping two moiré patterns through controlled twist angles. At small twist angles, the interlayer and intralayer interactions at two distinct interfaces in the twisted trilayer crystals give rise to an intricate network of domain structures that exhibit exotic electronic properties. In this study, we present a comprehensive structural phase diagram of twisted trilayer graphene (TTG) with atomic-scale lattice reconstruction. Using transmission electron microscopy in conjunction with advanced interatomic potential simulations, we reveal a variety of large-scale moiré lattices, including triangular, kagome, and hexagram-shaped domain patterns.[1] Each domain is enclosed within a two-dimensional network of domain wall lattices. At small twist angles, competing rhombohedral and Bernal stacking orders, separated by a small energy difference, induce unconventional lattice reconstructions characterized by spontaneous symmetry breaking and nematic instability, emphasizing the role of long-range interactions across van der Waals layers.[1] The tunable tessellation of diverse domain networks by adjusting the twist angles establishes TTG as a versatile platform for investigating the relationship between engineered nontrivial domain lattice structures and their emergent physical properties.

[1] D. Park et al., Unconventional domain tessellations in moiré-of-moiré lattices, Nature 641, 896-903 (2025).

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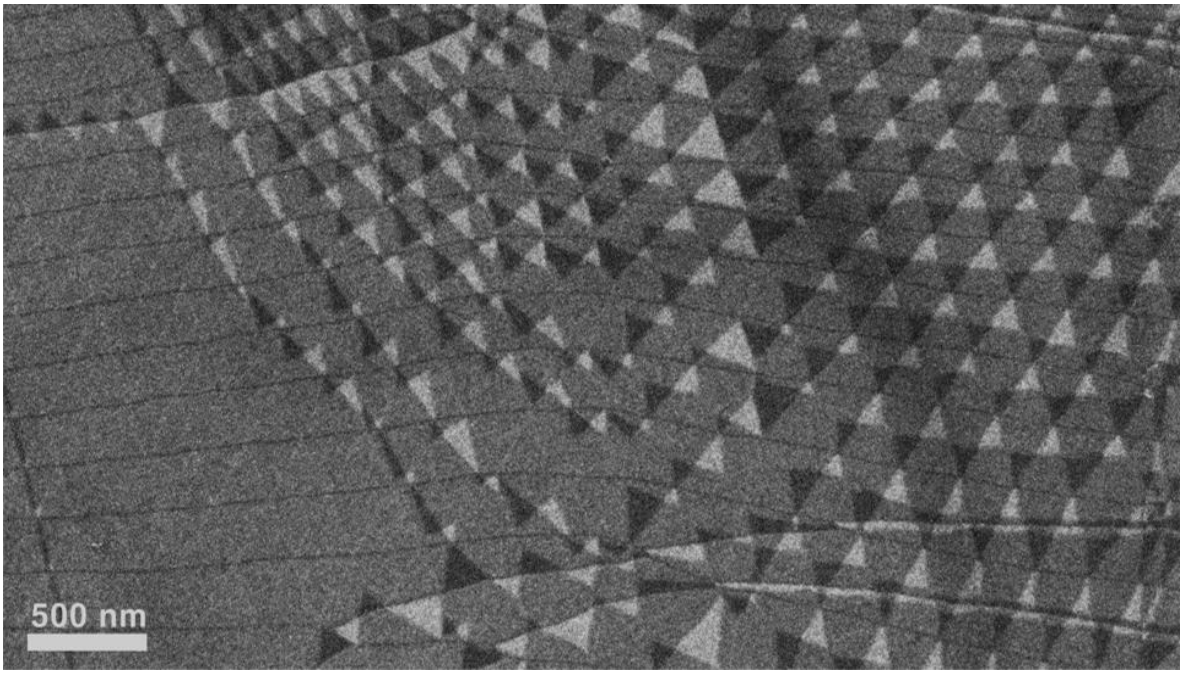

Figure 1: Dark-field transmission electron microscopy image of domain tessellations in the moiré-of-moiré lattice of twisted trilayer graphene.