Exciton Condensation in Twisted Bilayer Graphene

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We introduce a novel two-dimensional electronic system within twisted bilayer graphene, positioning it as a prime platform for studying interlayer-coherent excitonic condensates. The system's atomic proximity between layers ensures strong interlayer interactions, while the notable twist angle naturally restricts interlayer electron tunneling[1]. Harnessing these features, we identify a succession of odd-integer quantum Hall states with interlayer coherence at both the lowest[2] and second Landau levels[3]. Remarkably, the energy gaps for these states near 1 K, distinctly outperforming those in GaAs systems. Additionally, we observe R_{xx} minima together with R_{xy} plateaus at a filling factor approximately equal to 1/3 in the zero-displacement field limit, suggesting half-filled Landau levels for composite Fermion from the top and bottom graphene. Our temperature and magnetic field-dependent studies further corroborate these emerging quantum Hall states.

[1] Y. Kim et al., Physical Review Letters **110**, 096602 (2013)
[2] Y. Kim et al., Nano Letters **21**, 4249-4254 (2021)
[3] D. Kim et al., Nano Letters **23**, 163-169 (2023)