Flat Bands and Correlated Electronic States in Two Dimensional Crystals

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Stacking atomically thin crystals or exposing them to periodic potentials, can radically change their electronic properties. In particular, it is possible to engineer conditions leading to the creation of weakly dispersive energy bands, where the quenched kinetic energy facilitates the emergence of correlated electronic states, including superconductivity, Mott insulators or ferromagnetism. In will highlight two experiments where the electronic ground state and Fermi surface topology depend sensitively on the filling of the flat band which we control by electrostatic gating: twisted graphene bilayers that develop a flat band at a magic twist-angle [1,2], and buckled graphene monolayers in which a strain-induced periodically modulated pseudo-magnetic field creates a post-graphene material with flat electronic bands [3].

[1] Eva Y. Andrei and Allan H. MacDonald,
Graphene Bilayers with a Twist, Nature Materials **19**, 1265 (2020).
[2] S.Wu, Z. Zhang, K. Watanabe, T. Taniguchi, E.Y. Andrei,
Chern Insulators and Topological Flat-bands in Magic-angle Twisted Bilayer Graphene, ,Nature Materials **20**, 488 (2021).
[3] J. Mao, S.P. Milovanović, M. Anđelković., X. Lai, Yang Cao, K, Watanabe, T. Taniguchi, L. Covaci, F.M. Peeters, A.K. Geim, Y. Jiang, E.Y. Andrei,
Evidence of flat bands and correlated states in buckled graphene superlattices,
Nature **584**, 215 (2020).