Flat Bands and Correlated Electronic States in Two Dimensional Atomic Crystals

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Abstract
Stacking two-dimensional atomic 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 essentially "flat" energy bands, where the quenched kinetic energy facilitates the emergence of correlated electronic states, including superconductivity, Mott insulators or ferromagnetism. This talk will highlight two examples where the electronic ground state and Fermi surface topology depend sensitively on the filling of the flat bands: twisted graphene bilayers that develop a flat band at a "magic" twist-angle [1,2], and buckled graphene layers in which a strain-induced periodically modulated pseudo-magnetic field creates a post-graphene material with flat electronic bands [3].

References

[1] G. Li, A. Luican, J.M. B. Lopes dos Santos, A. H. Castro Neto, A. Reina, J. Kong and E.Y. Andrei, Nature Physics, 6 (2010) 109
[2] Y. Jiang, J. Mao, X. Lai, K. Watanabe, T. Taniguchi, K. Haule, E. Y. Andrei, Nature 573, (2019) 91
[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, arXiv:2006.01660, Nature in print (2020)

Figures

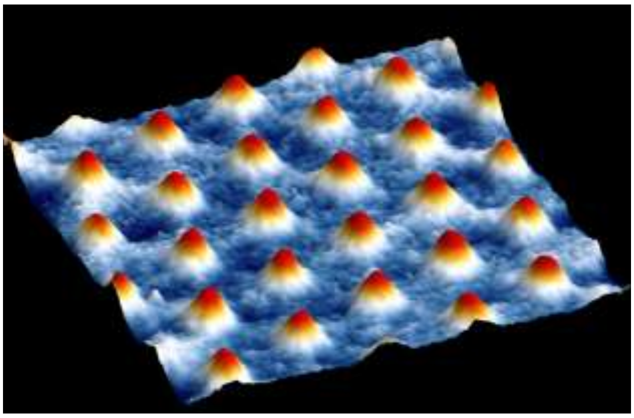

Figure 1: Stiff membranes under compressive stress can relax their stored energy by undergoing a buckling transition from an initially flat geometry to a periodic structure of out of plane dimples. In graphene, these out of plane distortions mimic the effect of very large magnetic fields, which are unattainable with today's magnet technologies, leading to dramatic changes in the material's electronic properties. The image shows the topography of the buckling structure obtained with scanning tunnelling microscopy.