Transport experiments in twisted double bilayer graphene

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Stacking two layers of graphene with a controlled twist allows to fundamentally alter the material properties. This is possible due to the strong dependence of the band structure on the twist angle. For large twist angles, the wavefunction of the layers are decoupled. The system is then best described as two ultimately close layers of graphene which are only capacitively coupled. Using transport experiment the large twist angle allows to extract fundamental information which are otherwise inaccessible, such as the finite thickness of graphene [1] or the appearance of intrinsic crystal fields [2].
At tiny twist angles, a network of topological states emerges [3]. Superconductivity and correlated insulator states appear at the magic angle (~1.1°). When increasing the twist, the wavefunctions become layer polarized, allowing to tune them with top- and back-gates. This makes the intermediate twist angle (~2.3°) favorable: The small bandwidth and the layer-polarization allow to highly tune the electronic states. We demonstrate extraordinary control over the valley degree of freedom in twisted double bilayer graphene, resulting in a valley filter [4]. Furthermore, we will show the emergence of an intriguing correlated state, formed out of electrons in the top- and holes in the bottom bilayer [5].

References

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Figures

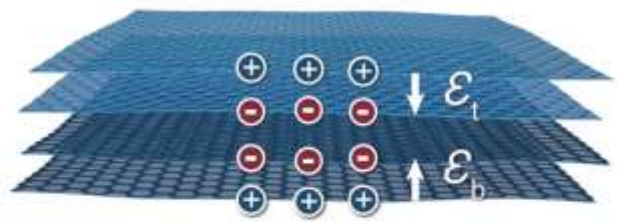

Figure 1: Crystal fields in twisted double bilayer graphene lead to the spontaneous opening of a band gap