Ferroelectricity in twisted double bilayer graphene

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Abstract
Ferroelectric van der Waals heterostructures have attracted a lot of research attention, as they could be used on a wide range of device applications, such as non-volatile memory devices or pyroelectric sensors [1]. Experimentalists have constructed such structures using hexagonal boron nitride [2] or transition-metal dichalcogenides [3]. However, there has not been theoretical or experimental reports on single-element ferroelectric materials yet.
In this presentation, I will discuss the possibility of constructing a purely carbon-based ferroelectric structure. In particular, I present marginally twisted double bilayer graphene as a candidate material to observe ferroelectricity. Following previous works [4], we develop a method to compute the ferroelectric polarisation map across the moiré unit cell, as shown in Fig. 1. We find that the ferroelectric dipole moment has a definite orientation in each domain of the unit cell and propose experimental setups that enable us to observe this phenomenon.

References

[1] K. Uchino, Ferroelectric Devices (CRC Press, 2009).
[2] K. Yashuda et al., Science **372**, 1458 (2021).
[3] A. Weston et al., arXiv:2108.06489 (2021)
[4] A. Garcia-Ruiz et al., Phys. Rev. B, **104**, 085402 (2021).

Figures

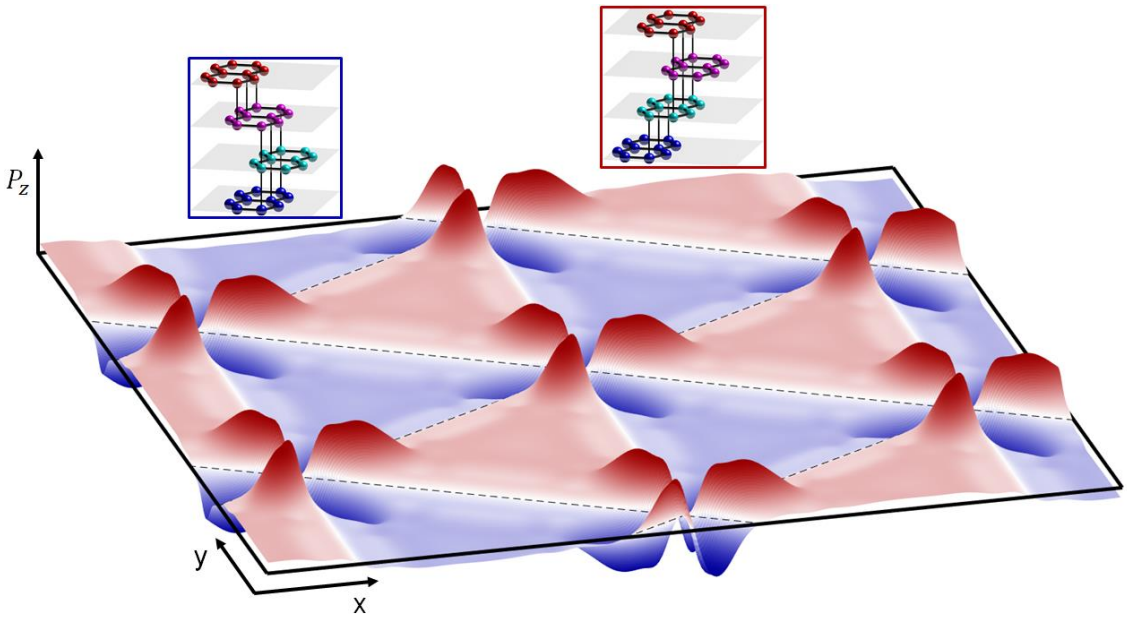

Figure 1: Ferroelectric polarisation across several moiré unit cells of AB/BA-twisted double bilayer graphene, with a twist angle of 0.5º. Inside the red (blue) coloured domains, where the system has a stacking configuration ABCB (ABAC), we observe a definite positive (negative) value for the ferroelectric polarisation.