Electrostatic Modulation of Interdot Tunnelling in Bilayer Graphene Quantum Dots

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We investigate two gate-defined quantum dots in bilayer graphene, where a tunable gate-induced electric field controls the bulk gap. The design also allows for the manipulation of the confining potential and the dots' filling through tunable finger-gates and a back-gate [1]. Using an atomistic model, we demonstrate that varying the electric field modulates interdot tunnelling. Our results show that the tunnelling oscillates as the electric field changes and, in typical cases, can be tuned to nearly zero, similar to the bonding-antibonding tunnelling quench observed in InAs quantum dot molecules [2]. This effect occurs in the tunnelling between orbitals of the same valleys in the two dots and should be observable in transport experiments. Additionally, we present an analytical model to explain how the external electric field modulates tunnelling by controlling the interference pattern in the overlap of the corresponding wavefunctions.

References

[1] Banszerus L Möller S, Icking E, Watanabe K, Taniguchi T, Volk C, Stampfer C, Nano Letters, 20.3 (2020) 2005-2011.
[2] Doty MF, Climente JI, Korkusinski M, Scheibner M, Bracker AS, Hawrylak P, Gammon D, Physical Review Letters, 102.4 (2009) 047401.

Figures

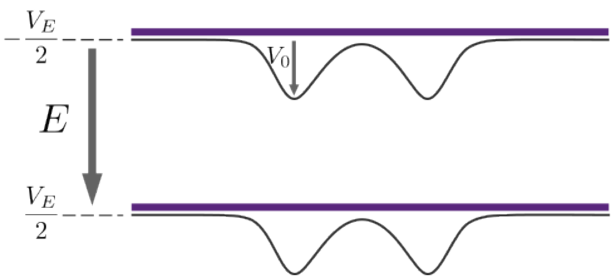

Figure 1: Schematic side view of the system, with the thick purple lines representing the graphene layers. The thin black curves under each layer represent the electric potential profile with a tunable depth V_0. A tunable bias V_E generates an electric field between the layers, opening a gap between the valence and conduction states.

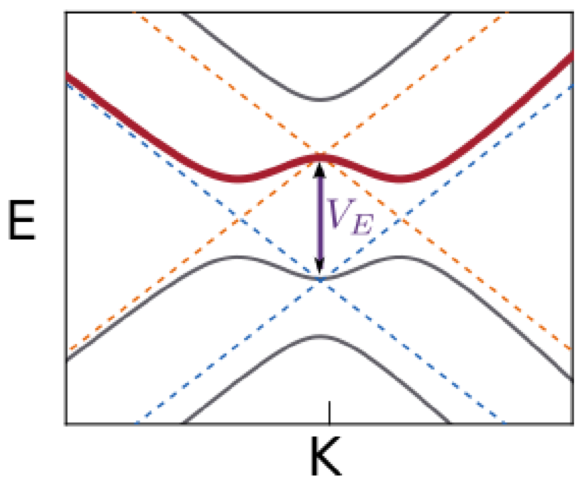

Figure 2: Schematic of the bulk band structure near the K point, illustrating how the interlayer electric field opens a gap and creates a Mexican hat shape in the lower conduction band (thick red curve).