Quasiparticle interferences and chirality texture in twisted bilayer graphene

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The rich physics of magic angle twisted bilayer graphene (TBG) results from the Coulomb interactions of electrons in nearly flat bands of non-trivial topology [1]. While the bands' dispersion of TBG can be characterized by ARPES, accessing their topology remains an experimental challenge. Here, we perform STM/STS measurements on a moiré pattern (MP) in a TBG tilted by 4.3°, focusing on a point-like impurity (Fig. 1a). We observe in the low-energy LDOS map (Fig. 1b) quasiparticle interferences (QPIs) resulting from intravalley backscattering processes off the impurity, between Dirac cones of graphene layers 1 and 2. Those QPIs show up in the Fourier transform of the LDOS, as incomplete rings centered at the corners of the mini-Brillouin zone (mBz) associated to the MP (Fig. 1c). Measuring the radius of these rings at various energy reveals the Fermi-velocity renormalization expected for low-angle TBG [2,3]. Rationalized by tight binding calculations and T-matrix theory, our work shows that the QPIs are strongly impacted by the relative chirality of the Dirac cones of layer 1 and 2 in each valley, as intuited in Ref. [4]. We find that within a given valley, the two Dirac cones have the same electronic chirality, as expected in the continuum model derived for TBG [2,3], discarding other "simplified" models [5]. Eventually, our work provides a full picture of the band structure of low-angle TBG below and above the Dirac-cones crossing of the TBG [6].

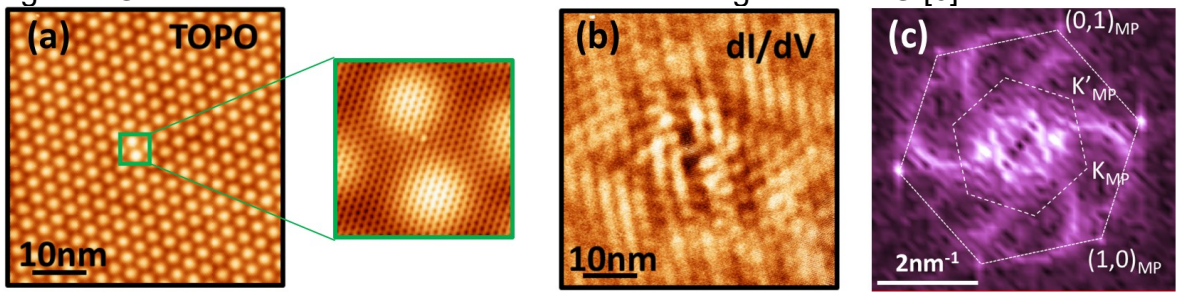

Figure 1: (a) STM constant current image of a 4.3°-TBG, exhibiting a triangular moiré pattern (MP) with period 3.3 nm. The image encompasses an impurity located within the green boxed region. Sample bias V_S = +0.30V, tunneling current I_T = 0.14nA. (b) LDOS map at E_F + 0.30 eV of the same area, with characteristic QPIs at the moiré scale surrounding the impurity. (c) 2D Fast Fourier transform of (b), exhibiting incomplete rings centered at the corners K_{MP} and K'_{MP} of the mBz associated to the MP.

References

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