Chiral Interlayer Quasi-Particle Interference in Twisted Bilayer Graphene

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Abstract

Twisted bilayer graphene has emerged as a versatile platform for exploring novel quantum phenomena driven by moir\'e superlattice effects. Here, we report a detailed theoretical study of quasi-particle interference in twisted bilayer graphene using real-space tight-binding calculations combined with the Kernel Polynomial Method. Our approach enables the computation of the local density of states in the presence of localized defects for both commensurate and incommensurate configurations. Fourier transformation of the local density of states yields quasi-particle interference maps that reveal distinct intra- and intervalley scattering signatures within each graphene layer, along with an interlayer scattering component. This interlayer signal, strongly dependent on the twist angle, diminishes at larger angles and displays a chiral structure that is reversed between the two layers. Importantly, our tight-binding results are corroborated by an effective continuum model, confirming the observed defect-induced scattering mechanisms and interlayer coupling phenomena. These findings provide new insights into the intricate interplay of defects, twist-angle modulation, and interlayer interactions in twisted bilayer graphene, with potential implications for engineering future graphene-based devices.

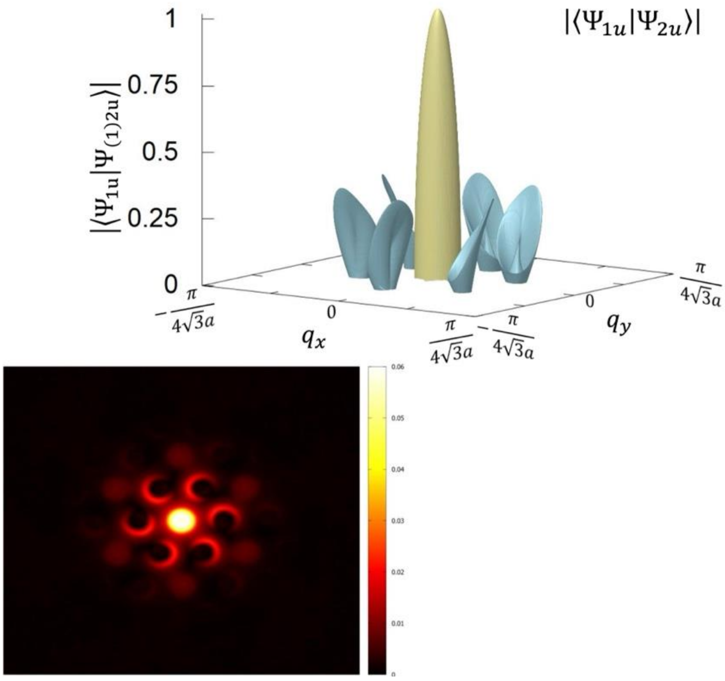

Figure 1: Comparison between the tight-binding QPI and the wave function overlap within the effective model.