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Spatially Resolved Spectroscopy of Magnetic States in Epitaxial Graphene

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Graphene grown epitaxially on silicon carbide provides a potential avenue toward industrial-scale graphene electronics. A predominant aspect of the multilayer graphene produced on the carbon-terminated $(000\bar{1})$ face of SiC is the rotational stacking faults between graphene layers and their associated moire-pattern superlattice. We use scanning tunneling microscopy (STM) and spectroscopy (STS) in high magnetic fields to obtain detailed information about the massless Dirac fermions that carry charge in graphene. In agreement with prior investigations, we find that for small magnetic fields, the rotational stacking effectively decouples the electronic properties of the top graphene layer from those below. However, in maps of the wavefunction density at magnetic fields above 5 Tesla, we discover atomic-scale features that were not previously known or predicted. A phenomenological theory shows that this high-field symmetry-breaking is a consequence of small cyclotron-orbit wavefunctions, which are sensitive to the local layer stacking internal to the moire superlattice cell.