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Binding Energy of Interlayer Excitons in Twisted Bilayer Graphene HIRAL PATEL, Department of Physics, OREGON STATE UNIVERSITY, LUJIE HUANG, CHEOL-JOO KIM, Department of Chemistry, and Chemical Biology, Cornell University, JIWOONG PARK, Kavli Institute at CORNELL UNIVERSITY, Department of Chemistry at UNIVERSITY OF CHICAGO, MATT GRAHAM, Department of Physics, OREGON STATE UNIVERSITY — When two sheets of graphene are stacked at off axis angle, 2p orbitals hybridize, giving angle-tunable absorption resonances. By comparing the ultrafast intra-band and multi-photon transient absorption spectra, our results agree best with recent theoretical simulations which predict that overlapping interlayer 2p orbitals interfere deconstructively to produce symmetrized bound exciton states that are decoupled from lower lying continuum states. We further map out the excited state manifold of exciton fine states using 2-photon photoluminescence microscopy. Our spectral analysis suggests that the observed photoluminescence emission from a bright exciton state is thermally populated by a lower-lying, long lived dark-exciton state. For this dark state, both our ultrafast transient absorption and two-photon photoluminescence studies support a large binding energy of the order of 0.6 eV. We believe twisted bilayer graphene is the first 2D metallic material that can form stable, strongly bound excitons upon resonant excitation. Such strong excitonic effects coupled with enhanced hot carrier lifetimes suggest possible new routes for hot carrier extraction from an otherwise predictable 2D metallic system.

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