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Probing Anistropic Excitonic Wavefunctions in Black Phosphorus using Scanning Tunneling Microscopy AYELET NOTIS, CARLOS ARGUELLO, ETHAN ROSENTHAL, ABHAY PASUPATHY, Columbia University — Black phosphorus is a layered, van der Waals semiconductor that has several structural similarities to graphite. Ultrathin black phosphorus (phosphorene) is conjectured to have a thickness-tunable bandgap and high carrier mobility, making it attractive for electronic and optical applications. Unlike graphene which is a true planar structure, phosphorene layers have a pronounced c-axis corrugation. This causes the electronic structure to be anisotropic, with different effective masses, carrier velocities and dielectric constants parallel and perpendicular to the direction of the corrugation. This has been predicted to lead to anisotropic wavefunctions for hydrogenic states and excitons in the material. In this talk, we present recent scanning tunneling microscopy and spectroscopy (STM and STS) studies investigating the topographic features and electronic structure of black phosphorus. We show that the primary charge defects are acceptors. By studying the local electronic structure in the vicinity of these defects that create hydrogenic states within the bandgap, we directly probe excitonic wavefunctions and their anisotropy in this material. We will describe spatially-resolved measurements of the bandgap and its inhomogeneity in the presence of defects.

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