**Correlating atomic-scale structure with electronic properties of 2D materials**

Two-dimensional crystals have received a lot of attention for their promise of a wide range of applications, and as a platform to study fundamentally new physics. Towards new applications, black phosphorus is a particularly exciting material because of its direct and tunable bandgap from 0.4-1.5 eV and high mobility carriers. However, samples degrade rapidly in air and are mysteriously p-doped. In this talk, I will present our recent work that shows atomic vacancies are prevalent and charged in commercial black phosphorus crystals—the likely root of p-doping. Now, vacancies appear to be more important to control than impurities. On the fundamental side, 2D crystals present a unique opportunity to correlate changes in atomic-scale structure with device-scale transport using scanned probe microscopy because they are entirely surface. I will also present our early work correlating local disorder with transport in 2D material devices.