APS WK6: X-ray scattering of Emergent Quantum Phenomenon in 2-D layered Materials.

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Two-dimensional (2D) layered materials exhibit exotic scientific phenomena and are of great potential interest for nano-scale electronic devices due to their unique physical properties as superconductors and topological insulators etc. These intriguing phases are triggered by various ways such as defects, electrostatic doping, thickness, and mechanical stress and strain. 2D materials are particularly suitable for strain engineering since they can tolerate large structural distortions. Critically, strain can modify their atomic and electronic structure as well as lattice phonon vibrations. However, due to the atomically thin nature of 2D materials, uncontrolled intrinsic/extrinsic deformation happens in multiple length scales during the strain process, so it is important to identify heterogeneous deformations and the coupling between them. Furthermore, the emerging new functionalities can result from either homogeneous strain or its variation. Therefore, it is essential to understand their nano- and microscopic properties. Fortunately, APS-U can provide the critical capabilities of flux and coherence to allow for the measurement of the local structural variation as well as the electronic states with nano scale accuracy. This workshop aims to bring together leading experimentalists, and theorists to present their latest research and discuss how to combine resonant x-ray scattering with APS-U to conduct future 2D material studies of inhomogeneous phases under in-situ mechanical strain. Here, we introduce the development of cryogenic temperature experimental environments with nanometer stability and positional control. Through this workshop we will discuss systematic strategies to measure the distribution of elastic strains at the sub-micron length scale within deformed single crystals and correlate with their complex physical behaviors within individual grains. These developments will provide new opportunities to the community to study the complex phenomena of heterogeneous systems enabling a powerful shift of how we investigate these phenomena that is currently beyond our capabilities.