Understanding the structural origin of materials’ functionality is often challenging to obtain via equilibrium states but promising to unveil through the observation of non-equilibrium processes. The successful development of femtosecond laser systems and pump-probe techniques in the past three decades has enabled us to probe ultrafast dynamics in a variety of materials. Particularly, taking advantages of strong interaction with matter during scattering, ultrafast electron diffraction (UED) technique provides unique opportunities to study the non-equilibrium dynamics. In this talk, we will demonstrate a few UED projects to address the intriguing coupling between electronic degrees of freedom and lattice in quantum materials. One of the projects is the exploration of structural dynamics in superionic Cu$_2$S nanomaterials. Through a structural phase transition in Cu$_2$S, we followed the transient states along the transition pathway and identified distinct time scales for crystal symmetry change and lattice expansion. Based on the UED observations, we argue that the mechanism of the structural phase transition in Cu$_2$S is dominated by electron-phonon coupling [1, 2]. In addition, we will show crystal refinement work using UED results during the pump-probe processes in a 1T-TaSeTe single-crystal sample to understand charge-density-wave (CDW) formation mechanism and charge-lattice interaction in this material.


Bio

Dr. Tao received her B.S. in Physics at Peking University in 1997, M.S. at Arizona State University in 2000 and Ph.D. at University of Illinois at Urbana-Champaign in 2005. She moved to Oak Ridge National Laboratory and had conducted postdoctoral research from 2005 to 2007. Dr. Tao is now a physicist working in Condensed Matter Physics & Materials Science Division at Brookhaven National Laboratory, sponsored by US Department of Energy. Her research interests are focusing on the structure-property relationship in strongly correlated systems and functional nanomaterials, characterized by transmission electron microscopy and ultrafast electron diffraction techniques. She is a recipient of DOE Early Career Award in 2015.