Physics Colloquium

Capturing the Nonequilibrium Behavior of Driven Condensed Matter with Scattering-based Imaging

Wednesday

February 8

4:00 P.M.

Rm 118 NSH

Refreshments
in Rm 202 NSH
@ 3:30 pm

Dr. Numan Laanait, Eugene P. Wigner Fellow

Center for Nanophase Materials Sciences and Institute for Functional Imaging of Materials, Oak Ridge National Laboratory

Recent advances in light sources, ranging from the extreme UV to the x-ray regimes, are poised to usher a new era in our understanding of nonequilibrium behavior in the condensed phase. Initiating such investigations necessitates the development of novel experimental probes that capture the spatiotemporal evolution of order parameters.

In this talk, I will present recent studies of nonequilibrium behavior in the condensed phase, enabled by a new type of scattering-based microscopy with synchrotron hard x-rays, known as x-ray diffraction microscopy (XDM). For instance, XDM directly accesses local structural configurations, allowing us to find evidence of correlated orientation disorder in epitaxial thin-films of topological insulators Bi_2Se_3, that are indicative of delocalized charge density fluctuations. By taking advantage of the inelastic interactions of x-rays with matter, I will illustrate how to simultaneously drive liquid/solid interfaces to extreme nonequilibrium, while simultaneously capturing by XDM the propagation of surface reaction fronts, thereby uncovering the presence of front instabilities which dominate the system's response.

One of the most promising directions in the nonequilibrium physics of condensed matter are optically induced phase transitions. I will present recent studies where ultrafast optical pump/XDM probe of multi-ferroic superlattices revealed the emergence of a novel nonequilibrium steady-state characterized by a supercrystal atomic structure, and the onset of jamming-like order parameter fluctuations near field-driven phase transitions.

Finally, I will conclude with an outlook on future opportunities enabled by scattering-based spatiotemporal imaging, ranging from strong-field phenomena in unconventional superconductors to optically-induced electronic phase transitions in strongly correlated materials.