Dynamical processes and transient structures underlying energy conversion: x-ray spectroscopies from fs to μs
Ultrafast optical spectroscopy of molecules using quantum light

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Keywords: X-ray spectroscopy, quantum, light

Quantum states of the light, e.g., single photons, entanglement and squeezing, open up a new avenue for spectroscopy by utilizing the quantum optical fields as novel control knobs and through the variation of photon statistics. With the advancements of quantum optical technology and X-ray source technology, imaging and controlling the electron and vibrational motions of molecules can be achieved, towards unprecedented resolution and precision, not accessible by the classical light pulses [1]. Two key issues emerge at nanoscale: quantum states of photons and strong matter-light interaction. The underlying physics is still an open issue for molecules and spectroscopy.

In this talk, I will present an overview of our recent work on multidimensional spectroscopic probes for ultrafast dynamics of molecular polaritons. Several spectroscopic signals will be covered: multidimensional coherent probe, photon-coincidence counting, and Raman spectra with quantum optical fields [2,3,4]. Microscopic models for molecular polaritons using density matrix will be incorporated for a unified understanding of the spectroscopic signals.