Selected Publications


Many chemical reactions and dynamics happen in the femtosecond (10⁻¹⁵ sec) to picosecond time regime (10⁻¹² sec). The only way to directly study systems at such short timescale is through ultrafast laser spectroscopy. In ultrafast laser spectroscopy, short laser pulses of tens or hundreds of femtoseconds duration are used to excite and probe the relevant chemical and biological systems.

ULTRAFAST MID INFRARED VIBRATIONAL SPECTROSCOPY

We use polarization controlled mid infrared (3μm to 5μm) pump-probe experiments to measure the vibrational excited state dynamics and rotational anisotropy of molecular systems. Systems that we are interested in include metal carbonyl clusters (See Figure below) and carotenoids in biological light harvesting systems.

2D COHERENT OPTICAL SPECTROSCOPY: TECHNIQUE DEVELOPMENT AND APPLICATIONS

Multidimensional optical spectroscopy is the optical analog of multidimensional nuclear magnetic resonance (NMR) spectroscopy such as COSY and NOESY. The femtosecond time resolution of ultrafast laser spectroscopy allows experimentalist to look at structural fluctuations of molecular systems at a much higher time resolution than NMR spectroscopy.

Using novel techniques in optical pulse shaping and phase cycling schemes, we are applying 2D spectroscopy in understanding the excitonic energy transfer (EET) processes in Light Harvesting complexes in photosynthetic systems.

OPTICAL PULSE SHAPING

Using nonlinear optical techniques, we are developing new optical pulse shaper designs in the ultraviolet and mid infrared with full control of the optical pulses’ amplitude, phase and polarization profiles. These shaped pulses can be applied to Multidimensional Optical Spectroscopy and Optical Quantum Control experiments.