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Nonlinear spectroscopy with coherently and incoherently shaped laser pulses

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High peak power ultrafast lasers are widely used in nonlinear spectroscopy but often limit its spectral resolution because of the broad frequency bandwidth of ultrashort laser pulses. Improving the resolution by achieving spectrally narrow excitation of, or emission from, the resonant medium has been the focus of many recent developments in ultrafast spectroscopy. Similar to many traditional nonlinear optical methods, state-of-the-art ultrafast spectroscopy relies on the coherence of laser pulses. In my talk, I will show that contrary to the common belief that spectral noise is detrimental to coherent spectroscopic measurements, it can be used for improving the resolution, efficiency and robustness against unavoidable degradation of pulse coherence. Using the example of Coherent Anti-Stokes Raman Scattering (CARS), I will review a few novel approaches to nonlinear ultrafast spectroscopy, in which random or pseudo-random noise is deliberately introduced and successfully used for the retrieval of high- resolution spectral information about the medium of interest.