Molecular Quantum Dynamics via State Resolved Spectroscopies

My research to date has focused on elucidating the structure and dynamics of exotic molecules through novel high resolution spectroscopies.

I will first discuss my graduate work, where I used a high resolution variant of anion photoelectron spectroscopy to study the reactive surfaces of benchmark bimolecular reactions. Photodetachment of an anion similar in geometry to a neutral transition state yields a spectrum that can show discrete quantum resonances bound or quasibound along the reaction coordinate. High-level quantum dynamical calculations yield excellent agreement with our experimental results, allow assignment of structure, and demonstrate the utility of transition state spectroscopy experiments as standards for complete ab initio treatment of increasingly complex reactions.

I will then discuss my postdoctoral work, where I have harnessed frequency comb spectroscopy in combination with cryogenic buffer gas cooling in order to measure the rovibrational structure of buckminsterfullerene (C\textsubscript{60}), a molecule of great fundamental interest and a longstanding spectroscopic challenge. Frequency combs are light sources consisting of thousands of evenly spaced, sharp frequency “teeth.” Cavity-enhanced frequency comb spectroscopy (CE-FCS) matches a comb’s evenly spaced spectral structure to the resonant modes of an optical cavity. This method allows for simultaneous detection across the comb spectrum, extremely high frequency resolution, and high sensitivity afforded by cavity enhancement. Our CE-FCS measurements of C\textsubscript{60} represent the first direct probe of its internal structure at the single quantum state level and establish it as by far the largest molecule for which a state resolved spectrum has been reported.