B.S. Senior Year – Fall Semester Lab

CEM 495 Molecular Spectroscopy

Description: Experiments in electronic and vibrational spectroscopies.

Credit: 2 Credits (1 hour lecture and 4 hours laboratory per week)

Prerequisite: CEM 262, (CEM 483 or CEM 484), (CEM 395 or CEM 499) and completion of Tier I writing requirement.

Recommended Background: Physics and one year of physical chemistry

An informal report is submitted for the first experiment and an oral presentation is given for one of the last three. Students write formal laboratory reports for the other four experiments. For all experiments, an oral quiz is administered during the data analysis lab session. Propagation of error is used to determine the error in all calculations.

1. **UV-Visible Spectroscopy**

   (Spectroscopy basics: Examination of spectrophotometers (Spec 20, Beckman double beam, and AA); generation of spectral response curve; quantitative spectrophotometry; investigation of the effects of slit width and grating blaze density on monochromator resolution using Oriel components)

Condensed Phase Spectroscopies

2. **Molecular Fluorescence Spectroscopy**

   (Collection and comparison of absorption spectra with fluorescence excitation and emission spectra; investigation of primary and secondary absorption; construction of a fluorescence spectrometer using Oriel components)

3. **Infrared and Raman Spectroscopy**

   (Collection of IR and Raman spectra; comparison of spectra, selection rules and spectrometers; semi-empirical AM-1 and *ab initio* calculations of vibrational frequencies using SPARTAN; construction of a Raman spectrometer using Oriel components and a Verdi diode laser)

4. **Fluorescence Lifetimes**

   (Evaluation of static and collisional quenching effects using steady state measurements and fluorescence lifetimes determined using pulsed nitrogen laser)

Gas Phase Spectroscopies

5. **Rotational-Vibrational Absorption Spectroscopy**

   (FTIR spectra HCl/DCl, HBr/DBr; use of quantum mechanical theory and curve fitting to determine molecular parameters including bond lengths, fundmental vibrational frequencies, and bond force constants)

6. **Vibrational-Electronic Absorption & Emission Spectroscopy**

   (Collection of rovibronic absorption and emission spectra of iodine using spectrometers build from Oriel components and a Verdi laser (emission); application of quantum mechanics to determine parameters associated with the ground and first excited electronic state potential energy wells (including dissociation energies, harmonic vibrational frequency, and anharmonicity factors); comparison of the parameters for the two states)