Discipline	Big picture/ applications:	Day-to-day work:	Current projects for undergraduates:	Prerequisites:	Expected time-commitment:	Website:
AMO or Condensed Matter Henry Everitt	Ellipsometry is a technique that uses the polarization of light to probe the properties of matter. My lab has a one-of-a-kind ellipsometer that operates in the terahertz spectral region. We use this instrument to measure the reflection, absorption, and transmission of all kinds of materials in this spectral region.	This is mostly an experimental project, and day-to-day work involves aligning the instrument, mounting samples, measuring them, and analyzing the results. The analysis can involve the development of models that reveal the underlying physics responsible for the measured optical response.	The principal project is to move beyond reflection, absorption, and transmission measurements to full ellipsometric measurements that capture the full polarimetric response of materials. Materials of interest range from ordinary dielectric materials to tailored terahertz metamaterials to exotic materials fabricated by colleages at Rice and elsewhere. Because of the uniqueness of the instrument, almost amy measurement on almost any material could be publishable.	No specific courses are required. Having freshman physics, including optics and electromagnetism is essential. Some programming experience (MatLab, Mathematica, Python, C++, etc.) is extremely beneficial, as is some knowledge of condensed matter physics. Students will be required to take the lab safety course. Freshman (and even high school students) have successfully carried out research on this instrument.	Due to the nature of these experiments, students will need to commit 3-4 hours in the lab each day they take measurements. Ideally students will commit to two days in the lab each week, but fluctuations in this number are normal and expected. Although no commitment is required, it is hoped that students will be interested in working in the group for a year or more, potentially culminating in an independent study project for credit.	

AMO Henry Everitt	The rotational motion of gas phase molecules is quantized, just like its electronic and vibrational motions are. Because rotational energy levels depend sensitively on molecular shape, isotopic composition, and excitation state, rotational spectroscopy is a powerful tool for unambiguously identifying the composition of a gas. My lab has rather unique rotational spectrometers with an extensive library of molecular spectra.	This is an experimental project, and day-to-day work involves operating the spectrometer, introducing gases into the absorption chamber, measuring spectra, and identifying species.	One project would perform spectroscopy on gases not in the library, including vibrationally excited and isotopic variants. Another project would revive a second rotational spectrometer specially constructed for measuring the unknown products of chemical reactions. A third project would explore measuring forbidden transitions made possible by nanostructures filling in the absorption cell.	Having freshman physics, including optics and electromagnetism, and basic atomic quantum mechanics is essential. Some programming experience (MatLab, Mathematica, Python, C++, etc.) is extremely beneficial. If a project involves lasers, the student will be required to take lab and laser safety courses.	Due to the nature of these experiments, students will need to commit 3-4 hours in the lab each day they take measurements. Ideally students will commit to two days in the lab each week, but fluctuations in this number are normal and expected. Although no commitment is required, it is hoped that students will be interested in working in the group for a year or more, potentially culminating in an independent study project for credit.	

AMO Henry Everitt	Most microscopes are composed of lenses, but these lenses only operate over a limited spectral range, badly distort laser pulses, and often require immersing the sample in oil to achieve high resolution. My lab has a one-of-a-kind all reflective microscope that overcomes each of these challenges. Ultimately, this microscope can measure “hyperspectral images”, where the third dimension is the reflection, emission, or scattering (Raman) spectrum from the sample.	This is an experimental project, and day-to-day work involves aligning and operating the microscope, placing samples in the microscope for measurement, analyzing the imagery, and potentially measuring the scattering or emission spectra of samples.	One project would be to perfect the image acquisition techniques, both in hardware and in software, to achieve highest-resolution, diffraction limited images, for various illumination sources. A second project would perform spectroscopy on single particles with high spectral sensitivity and resolution. A third project would combine these capabilities to generate hyperspectral images. A fourth project would perform Raman spectroscopy on samples.	It is essential that the student will have completed freshman physics, including optics and electromagnetism, and have programming experience (esp. MatLab and/or LabView) is essential. The student will be required to take lab and laser safety courses.	Due to the nature of these experiments, students will need to commit 3-4 hours in the lab each day they take measurements. Ideally students will commit to two days in the lab each week, but fluctuations in this number are normal and expected. Although no commitment is required, it is hoped that students will be interested in working in the group for a year or more, potentially culminating in an independent study project for credit.	

Condensed Matter or AMO Henry Everitt	Photoluminescence spectroscopy measured the light emitted by samples when excited by lasers or tunable light sources. We use “PL” for analyzing the optical and optoelectronic properties of a wide variety of materials, including semiconductors, nanostructures, and 2D materials. My lab has a variety of light sources exciting samples, spectrometers and detectors for measuring their spectra, and cryostats for measuring how these spectra change with temperature.	This is an experimental project, and day-to-day work involves aligning and operating the spectrometer, placing samples in the spectrometer for measurement, and analyzing the spectra.	The principal project would be to measure absorption or emission spectra from a variety of semiconductors, nanostructures, and 2D materials provided by collaborators as a function of excitation wavelength and possibly temperature. Another project would be to measure the Raman scattering spectra from these same samples to ascertain their lattice structure and strain.	Having freshman physics, including optics and electromagnetism, is essential. Some programming experience (MatLab, Mathematica, Python, C++, etc.) is extremely beneficial, as is some knowledge of condensed matter physics. The student will be required to take lab and laser safety courses.	Due to the nature of these experiments, students will need to commit 3-4 hours in the lab each day they take measurements. Ideally students will commit to two days in the lab each week, but fluctuations in this number are normal and expected. Although no commitment is required, it is hoped that students will be interested in working in the group for a year or more, potentially culminating in an independent study project for credit.	