Chem 50: Topics in Physical Chemistry **Prof. Tom Varberg (OR317, 696–6468)**
Spring 2003 varberg@macalester.edu

Course Format: This course will be quite different than any course I have taught and perhaps any course you have taken. My goal is to introduce you to research techniques in the field of molecular spectroscopy. We will spend our time working in my research laboratory, OR365, working on a few different projects, which are as follows:

1. Searching for new electronic spectra of diatomic transition metal hydrides and oxides. We will be using our Nd:YAG-pumped pulsed dye laser to carry out laser excitation spectral scans for molecules containing Os, Ir, Ru, Rh and Re. We will try to generate the molecules using a hollow-cathode sputtering source.
2. Preliminary spectroscopic measurements of previously observed electronic transitions of the molecule tantalum oxide, TaO. Alex Plionis ('02) and I first observed this molecule in the summer of 2001, but the present laser system I have is not capable of adequately resolving the observed spectra. I have a new laser system on order (see below) that will easily resolve the rotational structure, as well as the nuclear hyperfine structure when measured with sub-Doppler resolution. We will want to acquire more detailed preliminary spectra of TaO with the present low-resolution laser in order to learn as much as we can about the spectrum in advance of the high-resolution work. We will spend some time looking at the previously reported studies of this molecule by reading and discussing the original literature. We will also want to optimize the production of the molecule by playing with the chemistry used to produce it (e.g., by trying different oxidant gases).
3. Reassembly of a tunable far infrared spectrometer donated to Macalester College by the National Institute of Standards and Technology. This spectrometer generates tunable light in the far infrared region by mixing on a non-linear, metal-insulator-metal (MIM) diode the output of two carbon dioxide lasers operating in the mid infrared. While I have not yet purchased all of the pieces necessary for the spectrometer to operate, we do want to get the carbon dioxide lasers operating and align the optics on the tabletop.
4. Upon delivery of my new Ti:sapphire/dye ring laser (hopefully in March, but we'll see), we will be able to begin high-resolution studies of TaO. We will probably test out the system with a well-known molecule like NiH to optimize our data collection methods. Then we can start recording spectra of TaO. Our eventual goal here is to record sub-Doppler spectra of the transitions in order to resolve the hyperfine structure, which has never been measured.

We will need to find a time that we can all meet together occasionally. We will use this time for some lecturing, some problem assignments, and discussion of literature articles and experimental results. The rest of your time in the course will be spent in the research laboratory, carrying out the work described above. We will try to agree to a schedule that works best for everyone. It is my expectation that for this 4-credit course, you will commit to at least eight hours per week of laboratory time.

Grading: A traditional grading regimen seems inappropriate to the nature of this course. There will be no examinations or regularly assigned problem sets. Your grade will be based on your keeping your commitment to working at least eight hours per week as well as your contributions to the joint class sessions we schedule.