This summer the Carleton Chemistry Department will offer its continuing summer research program for Carleton students. We expect to offer research positions to between eight and twelve new students. For the most part, the new student researchers will come from the sophomore and junior classes. Professors Chihade, Drew, Gross, and Kohen will offer projects that reflect their research interests. These projects are financially supported through external grant agencies and Carleton College. The research projects offered by each faculty member will be presented briefly at the Friday, January 26, Chemistry Department Seminar in Olin 04 at 3:30 p.m. and are described in the following document. We strongly encourage you to attend this seminar if you are at all interested in doing research in the department this summer.

**Dates of the Program:** Monday, June 11, through the end of August for a total of 10 weeks. Each student will arrange starting and ending dates and summer vacation with his or her professor; these dates are often flexible.

**Stipend:** $4,200 for 10 weeks.

**Expectations of Students by The Chemistry Department:**
A research position in our summer research program is a full-time position. You should not plan on taking a second job during the same period.

Each week you will be expected to attend a research conference with all of our summer researchers. Once or twice during the summer you will give an oral presentation on your project. If you would like, you may have the opportunity to give a presentation on your research at state or national research meetings in the future. Following the summer of research, you will prepare a comprehensive written report and give a poster on your research at the fall All Science/Math Student Poster Session at Carleton.

**Deadlines and How to Apply:** By Monday, February 12, submit a one-page description of your interests and background to the Chemistry Department’s Administrative Assistant, Wendy Zimmerman. List the three professors you would like to work with in order of preference. Also tell us how strong your preferences are and how flexible you are in accepting a position in all three groups. In addition to attending the January 26 seminar, you should talk to individual professors in order to explore your interest in their research project. Keep in mind that some professors will not invite a student to join their research group unless the student has taken the time to stop by, meet the professor, and discuss the research project.

On Monday, February 26, offers will go out to individual students in campus mail. We will ask for your decision on our offer by Friday, March 9 (the last day of classes).
Reasons to Participate in the Summer Research Program: Research is considered by many to be at the pinnacle of intellectual endeavors as it is the main vehicle by which new knowledge is created. Research requires a demanding combination of intellect, creativity, endurance, and curiosity. Many valuable skills are developed in the research laboratory. Some examples include the ability to work as a member of a team, to operate sophisticated instrumentation, and to use available resources to become a life-long learner. Research is also excellent preparation for graduate school, a career in the medical sciences, or a career in other scientific or quantitative fields.

Choosing to do research at Carleton offers a number of advantages. First of all, you will have the chance to get to know your professors much better. In addition, you can start preparing for your summer research experience during spring term. This additional preparation will improve the quality of the research you can perform during the short ten-week summer. Furthermore, if you wish, your research project can be continued as an independent study during the following academic year. Some students at Carleton who have had the most positive research experiences have worked on their research projects over the course of two years. Unlike the experience at a larger institution, colleges like Carleton offer research opportunities exclusively for undergraduate students. At a larger institution, you would probably work most directly with a graduate student or postdoc, which is a good, yet different kind of experience. At Carleton you are guaranteed to work closely with a professor and to have your peers as research colleagues.

Life at Carleton and in Northfield is much different during the summer than during the academic year. You will be surprised by the pace, and you will be pleased to know that you will not need your down jacket and face mask (you may want to buy a fan). Many of the facilities (such as the gym, pools, weekly movies, etc.) at Carleton are open for summer programs. We will have at least two expeditions; canoe trips, baseball games, Valley Fair, and tubing have been popular choices in the past.

INDIVIDUAL FACULTY RESEARCH PROGRAMS

Professor Joe Chihade
The major current research aim in my lab is to understand the basis of the specific interaction between human mitochondrial tRNA^{Ala} and human mitochondrial alanyl-tRNA synthetase, the enzyme that attaches the amino acid alanine to the tRNA so that the “charged” tRNA can productively participate in protein synthesis.

The aminoacyl-tRNA synthetases ensure the codon-amino acid relationship of the genetic code by matching amino acids with tRNAs that have the required anticodon. The interactions through which these enzymes discriminate among available tRNAs are complex and often involve interactions with other elements of the RNA molecule aside from the anticodon. In particular, many synthetases utilize recognition elements in the amino acid acceptor stem of their tRNA substrate. Alanyl-tRNA synthetase (AlaRS) is

![Diagram](image-url)
the most well studied enzyme in which the anticodon plays no role in tRNA recognition. Every non-mitochondrial alanine tRNA from any species that has been characterized has an identical sequence at the end of the acceptor stem that marks the tRNA for charging with alanine.

Eukaryotic cells contain two systems for translation of genetic information, one in the cytoplasm and another in the mitochondria. (Plants have yet another in chloroplasts.) In most cases, the rules for tRNA recognition that apply in the cytoplasm also apply in mitochondria, but animal mitochondria are markedly different. In animals, mitochondria contain tRNAs that are “bizarre”. These tRNAs differ both in shape and in sequence from those found in all other forms of life.

The particular case we’re focusing on involves alanine tRNAs from animal mitochondria, which all lack the conserved sequence described above, raising the question of how these tRNAs are identified as carriers of alanine. Surprisingly, the animal mitochondrial AlaRSs that recognize and specifically aminoacylate these unusual mitochondrial tRNAs are extremely similar in amino acid sequence to their non-mitochondrial counterparts. In other words, relatively minor changes in the enzymes’ sequence and structure lead to large changes in the specificity of RNA recognition. At the moment we have two major aims in the lab: (1) Find out what part or parts of human mitochondrial tRNA\textsuperscript{Ala} are markers of identity, and (2) find out what part of parts of human mitochondrial AlaRS interact with the tRNA specifically.

Our major approach to Aim #1 is to test various tRNAs that differ from human mitochondrial tRNA\textsuperscript{Ala} in significant ways to find out what differences block alanylation. By comparing the tRNAs that work with those that don’t, we’ll be able to identify the pieces of tRNA that are most important for identity. Our approach to Aim #2 is to continue work started by Andy Nieuwkoop and Thayne Dickey in which we delete portions of the AlaRS protein sequence. These enzyme fragments will then be tested for their ability to alanylate tRNA. Essentially, if an enzyme fragment doesn’t function, we’ve removed something important.

Work in my lab will include protein purification, in vitro transcription of mutant and wildtype tRNAs, creation of new RNA and protein mutants using site-directed mutagenesis, enzymatic assays to measure charging ability, and probing of tRNA structures to determine regions of protein-RNA interactions. I plan to take 4-6 new students in my lab this summer.

**Professor Steve Drew**
Recently, research in my group has turned towards materials chemistry, specifically, the synthesis and characterization of platinum(II) extended linear chain (ELC) materials and...
their potential application as gas transducers. Generally, these materials are composed of many platinum(II) square planar complexes linked through weak platinum-platinum bonds. Examples of these types of structures are shown in Figure 1. The ligands on the platinum(II) square planar complexes are either cyanide anions (CN\(^-\)) or neutral isonitriles (CNR). Both types of ligands give stable, microcrystalline materials that can be studied in the solid-state. These materials have some very interesting solid-state properties including being highly colored, luminescent, and “vapochromatic.” The term vapochromic means that these crystalline materials change color in the presence of various gases, in particular solvent vapors. As reversible vapochromes, platinum(II) ELC materials have potential applications as vapor sensors. By monitoring changes in the luminescence intensity of the material in the presence of various solvent vapors, important analytical characteristics of the materials, such as selectivity, sensitivity, reversibility, and reproducibility, can be determined.

![Figure 1. Platinum(II) extended linear chain materials. A. double salt structure; B. neutral structure.](image)

Our research goals for this summer will be to synthesize and characterize platinum(II) ELC materials composed of chiral isonitrile ligands then determine their viability as enantiomerically selective sensors. We hope to show that an enantiomerically pure platinum(II) ELC material gives different luminescence spectra when exposed to the R- and S- enantiomers of a organic vapor. Students in my group will learn how to synthesize isonitrile ligands, platinum(II) coordination compounds, and platinum(II) ELC materials. Characterization methods will include attenuated total reflectance infrared
spectroscopy (ATR-IR), nuclear magnetic resonance (NMR) spectroscopy, solid-state luminescence spectroscopy, and spectrofluorometry. I have external funding for this project and expect to support a total of two students for the summer of 2007.

**Professor Deborah Gross**

“**So Many Particles, So Little Time!**”

The air around us is full of aerosol particles (small droplets or chunks of solids), which impact our lives in many ways. These particles come from natural as well as anthropogenic (human) sources. They nucleate cloud droplets, they decrease visibility by scattering sunlight, and they impact our health when we inhale them. Our research group works with an Aerosol Time-of-Flight Mass Spectrometer (ATOFMS), code-named “Gromit,” to obtain size and chemical composition of the aerosol population in real time. With this data, we hope to try to increase our understanding of some of the complex issues in the atmosphere. I am recruiting students for two types of projects this summer:

1. I hope to recruit two to three new students this summer to work at Carleton. Students working in my lab will get an opportunity to work on analysis of ATOFMS data sets obtained in collaboration with groups at the University of Minnesota, University of Wisconsin, and the Paul Scherrer Institute in Switzerland. We have long-standing collaborations with these groups, and have a number of complex data sets to work with. Our analysis is done using software under development by Dave Musicant’s group in the CS Department at Carleton. Our work in Summer 2007 will involve analysis of data from a variety of studies. In addition to working with existing data sets, we will obtain data here at Carleton to search for macromolecules in the ambient air.

2. I would like to recruit one student for a unique opportunity: to spend the Spring Term being trained with the ATOFMS instrument here at Carleton, and then to spend the summer working with collaborators at the Eidgenössische Technische Hochschule (ETH) in Zürich, Switzerland (in the ). The group there has an ATOFMS instrument (code-named “Bun-Vac 6000”) which they plan to take to the Abisko Research Station in Sweden (www.ans.kiruna.se) – located about 200 km north of the arctic circle – for measurements of clean background aerosol. The student on this project would spend ~3 weeks in Zurich working with a Ph. D. student and staff scientist to prepare for the mission (and gaining experience with the project), 3-4 weeks in Sweden, followed with about 3 weeks in Zürich to help do the initial data reduction. There is a chance to continue the data analysis when back at Carleton, through independent studies. The trip will be paid for, as will housing while in Switzerland and Sweden, and the student will receive a 10-week summer stipend.

**IF YOU ARE INTERESTED IN JOINING EITHER OF THESE PROJECTS, YOU SHOULD DO ALL OF THE FOLLOWING THINGS:**

- Come talk to me as soon as possible, to discuss the details of the research and to see the ATOFMS instrument. I won’t accept anyone into the group unless we’ve talked about your interests, the projects, etc.
• Be prepared to spend part of the summer away from Carleton. While we are not sure yet of our specific plans, fieldwork might well be part of them! Your expenses for fieldwork would be paid.

• Be prepared to work very hard for long hours! I don’t mean to scare anyone, but fieldwork has a different set of constraints than lab work – we are in a non-laboratory setting, away from our usual infrastructure and away from home, we have a predetermined end date by which our experiment must be done successfully, and we are working with collaborators. I don’t want anyone to be surprised by what this entails. The success (or lack thereof) of the experiment determines our daily schedule.

• Plan to enroll in independent studies (Chem 394) in Spring, 2007 as well as throughout the 2007-2008 academic year (except terms when you might be off campus) to work on this project.

**Professor Dani Kohen**

I am a theoretical and computational physical chemist. I am interested in the general area of dynamics in condensed phase (how atoms and molecules move and interact when they're not by themselves). Currently, I am using atomistic simulations to understand and characterize at the molecular level how small gas molecules interact with pure CO$_2$ on molecular sieve's pores, and how this interaction changes in the presence of other gases that are present in our atmosphere. The goal of these studies is to provide a basic understanding of the use of molecular sieves as filters to remove CO$_2$ from the atmosphere. In recent years the power of computational research has been shown to provide scientific insight that might not result from experimental research alone. That sort of insight is described in a paper entitled “Atomistic Simulations of CO$_2$ and N$_2$ Adsorption in Silica Zeolites”. [J. Phys. Chem. B, 106, 8367 (2002). A. Goj, D. S. Sholl, E. D. Akten and D. Kohen].

This research will introduce students to the study of chemistry through the lens of molecular simulations, which provide a powerful tool in giving new meaning to familiar concepts. It will also serve as a reference point to understand not only the computational chemistry literature but also why the importance of this field as a tool for studying many problems keeps growing.

The way my research group works is that I mostly write the programs (software), my student collaborators use and modify these to investigate chemical systems; and then, together, we use the results to learn about the chemical processed that occur in the systems we study. This is exactly what my group, David Selassie’09, Felix Amankona-Diwuo ’08 and I did this past summer. We set ambitious goals for everyone as each one of my students had a complex problem to tackle. In doing this kind of research the learning curve is steep, but the results are very satisfying and my students collaborators made significant progress in their own projects.
while enjoying doing research. Felix investigated how to best simulate the Coulombic interactions in our system and is now changing gears and beginning to prepare to spend the summer working with Mark Gordon at Iowa State where he will begin to apply quantum chemistry techniques to our simulations. David did look at diffusion within zeolites, and will continue to do so next summer. I anticipate that I might be able to invite one student to join my group. If you are interested in joining us, please e-mail me so we can set an appointment to talk and even better, ask a member of my group about their experience as their thoughts will be the best introduction to our work.