P1-1
Presenter: Jennifer Zelenty, University of Chicago
Title: In-Situ Removal of Beryllium and Carbon Deposits from ITER Diagnostic Mirrors and Windows Utilizing Nd:YAG Laser
Advisor: Charles Gentile, Princeton Plasma Physics Laboratory, Princeton, NJ

Data collection for ITER will rely heavily on diagnostic mirrors and windows located within the confines of the vacuum vessel. When operation of ITER commences, many repairs and alterations will need to be conducted via remote handling due to the resident radiation fields associated with operating the machine in D-D and D-T regimes. Studies from the Joint European Torus (JET) indicate that plasma deposits such as beryllium and carbon will collect on ITER diagnostic mirrors and windows. The presence of such deposits will cause a decrease in reflectivity and light transmission on diagnostic related surfaces. In order to effectively collect diagnostic data, the mirrors and windows must be cleaned via remote handling in a non-destructive fashion. This investigation will determine the effectiveness of removing plasma deposits from diagnostic mirrors and windows using a 325W continuous wave (cw) Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG) Laser. In this study, laser cleaning will be tested on single crystal molybdenum mirror substrates, the material proposed for ITER first mirrors. The mirrors will be coated with either beryllium or carbon deposits. The Nd:YAG laser, directed by a computer controlled laser scanner, will raster the mirror substrates, ablating the deposits on the surfaces. The reflectivity and polarization properties will be tested before and after to determine the efficacy of this laser cleaning technique. The results will be presented and discussed.

P1-2
Presenter: Kayton Parekh, Macalester College
Title: Computer Vision for Mobile Robots
Advisor: Susan Fox, Department of Computer Science, Macalester College

This research focused on Real Time Color Tracking and 3D Pose Estimation for use in Robot Localization. The overall project aims to develop robots that navigate through Macalester College's Olin-Rice building autonomously. The robot system uses sonar data and compares it to calculated values for sample points. This way it can narrow down probable sample points until it has a dense group centered around the actual position of the robot. However, the sonar data taken from the robot sensors is simply unreliable. The sonar rays reflect of the Olin rice walls giving much large range values. In order to improve the accuracy of this localizer we developed an application using OpenCV to find objects in images from a video stream based on their color using the CAM-Shift algorithm. CAM-Shift is a probabilistic method to tracking an object based a predefined histogram of object colors. The application also estimates a vector from the camera to the object based on points on a known model of the object and estimated image coordinates of these points. For this we use an algorithm for 3D pose estimation called POSIT, which relies solely on orthographic projections and linear algebra. This information allows the robot to localize itself based on known object locations in the map. By combining the vision and sonar sensor data we are improving the accuracy of the overall system.

P1-3
Presenter: Nathaniel Berry, The University of Chicago
Title: Transient Photoresponse of Sulfur Hyperdoped SoI
Advisor: Dr. Peter Persans, Physics Department, Rensselaer Polytechnic Institute
Coauthors: Anthony DiFranzo[1], J. Warrender[2], D. Recht[3], A. Pan[3]
1. Rensselaer Polytechnic Institute

2. US Army – ARDEC, Benet Laboratories, Watervliet, NY
3. Harvard University, Cambridge, MA

Transient photocarrier response predicts device response time and response magnitude. Analysis of photoresponse decay can also elucidate carrier transport and recombination mechanisms. In photoconducting materials with traps the effective drift mobility in carrier transit devices is reduced from the free carrier mobility by the fraction of time that excited charges spend in the traps. (The decay time for photoconductivity is likewise increased so that the drift mobility-decay lifetime product is the same as the free carrier mobility-free carrier lifetime product measured in steady state experiments.) In materials with traps distributed in energy the drift mobility for carriers generated in a pulse will be time dependent. Time dependence of the carrier density and mobility can be analyzed to deduce trap state distributions.

Coplanar devices were fabricated by implanting sulfur in 250 nm thick silicon-on-insulator layers, laser melting, and thermal annealing. This approach produces heavily-doped, optically smooth, electrically isolated layers that are ideal for photoconductivity measurements. Transient photoresponse was measured both using coplanar contacts and using a contactless microwave reflectivity technique. In order to isolate the optically induced microwave impedance change in the thin SOI layer, the silicon substrate was etched from the center of some SOI samples.

The photoconductance decay for commercial SOI materials is multi-exponential with an initial decay time constant of about 1 microsecond and a later decay time constant of about 10 microseconds. These times are much shorter than bulk lifetimes, indicating the importance of surface recombination in thin SOI films. Heavily sulfur doped and selenium doped SOI films exhibit longer decay times, indicating the presence of shallow traps.

P1-4
Presenter: Wiktoria Pecak, Augustana College
Title: A Ligand is Born: Synthesis of Novel Bis(N-heterocyclic carbine) Diphenolate Ligand
Advisor: Dr. Greg Domski, Department of Chemistry, Augustana College

The goal of this research project was to prepare a ligand, which serves as a Lewis base, binding to and supporting reactive metal centers. Our specific target was a new class of bis(N-heterocyclic carbene) diphenolate ligands, which are structurally related to the salen family of ligands. Salen ligands are considered a privileged ligand in that they have been shown to stabilize numerous metal oxidation states of +2 or higher. Salen complexes have exhibited impressive scope and catalytic activity, and there is every reason to hope that these new bis(N-heterocyclic carbene) diphenolate complexes will exhibit catalytic activity as well.

P1-5
Presenters: Mathew Deram and Christopher Bouxsein, St. Olaf College
Title: Custom indenter probes for studies of frictional mechanisms in micromachines.
Advisor: Brian Borovsky, Department of Physics, St. Olaf College
Coauthors: Mathew Deram

Challenges encountered in the development of microelectromechanical systems (MEMS) technology have revealed the need for a better understanding of the underlying mechanisms of friction. Currently, friction, wear and other surface phenomena impede the development of micromachines with sliding parts.

This is the first phase of a NSF-funded collaboration between St. Olaf College, Luther College, and Auburn University, with the intent to gather qualitative and quantitative data on frictional interactions on MEMS-type interfaces coated with alkane phosphonate monolayers. It is hoped that alkane phosphonates will prove to be an effective lubricant system for micromachines fabricated from metal oxides, an alternative to silicon in MEMS fabrication. Two devices will be used to measure sliding friction at different sliding speeds; researchers at Luther College will measure friction in the low-speed range using an atomic force microscope (AFM). We will gather information on high-speed interactions using a nanoindenter-quartz crystal microbalance (NI-QCM) developed by Prof. Borovsky and collaborators. Our colleagues at Auburn will play a large role in the preparation and characterization of the probes and substrates to be studied.

Our focus during this phase of research was development of the custom-made probe tips to be used in the NI-QCM. Through a process of prototyping and testing, we have developed a probe design that uses a single metal oxide microsphere as the tip. These probes are constructed to be as rigid as possible, and to withstand the pressures in our apparatus as well as the chemical treatments used in forming the lubricant layers.

P1-6
Presenter: Steve Groskreutz, Gustavus Adolphus College
Title: Multi-Dimensional High Performance Liquid Chromatography for Trace Analysis in Complex Matrices
Advisor: Dwight Stoll, Department of Chemistry, Gustavus Adolphus College
Coauthor: Bedard, Jeremy

Complicated sample matrices such as surface waters pose a challenging separation problem when the analysis of multiple target analytes is desired. This difficulty comes when multiple closely related compounds within the matrix have similar retention times on a single column used in traditional one-dimensional high performance liquid chromatography (HPLC). A possible solution to this problem is the addition of multiple separation dimensions to the HPLC system. The addition of added dimensions increases complexity of the system, but allows for the use of multiple widely varied column chemistries to separate the target analyte from the sample matrix. This process is executed by a variation on the traditional heartcutting method by taking a fraction coming off the first dimension column and using a technique we refer to as hybrid slicing. This hybrid approach has the first dimension peak sliced into multiple pieces, each of which is then individually sent to the second dimension column for further separation. The real benefit to this slicing method is when chemometric methods are applied in the data analysis step.
As a means of guiding the development of this approach, we have chosen triclosan and phenytoin as target analytes. Triclosan is a common antibacterial found in hand soaps, detergents and plastics, and has been shown to degrade into carcinogenic dioxins in the presence of chlorine used in many wastewater treatment facilities. Phenytoin is an anticonvulsive pharmaceutical used for the treatment of epilepsy. The use of hybrid multi-dimension-HPLC with chemometrics gives the ability to quantitatively separate triclosan and phenytion form surface waters at much lower levels than traditional one-dimensional HPLC with UV detection.

P1-7
Presenter: Li Shen, Beloit College
Title: Colloidal Gold Nanoparticles: Dependence of Surface Plasmon Band Energy on Size via Citrate Reduction
Advisor: George Lisensky, Department of Chemistry, Beloit College
Coauthors: Arianna Biesso, and Jay Knutson

Nanoparticles have properties that depend on size. Gold nanoparticles have a strong absorption band in the visible region caused by in-phase oscillations of free electrons within the conduction band. This study used Turkevich's method (Turkevich, J.; Stevenson, P. C.; Hillier, J. *Discuss. Faraday Soc.*1951, **11**, 55.) where citrate reduces gold ions and provides a spacer to prevent aggregation. When a large volume of sodium citrate is added, gold nanoparticles will be small and monodispersed (particle size was measured by TEM between 25 and 30 nm.) When the volume of sodium citrate is decreased, smaller number of nuclei will be formed and a larger size distribution is observed (particle size was measured by TEM between 60 and 100 nm.) We also find that with 50 mL of 0.00025 M $HAuCl_4$, the absorption energy is linearly dependent on the amount of 0.10 M sodium citrate added in the range from 300-600 µL.

P1-8
Presenter: Bradley M. Boelkins, Hope College
Title: Synthesis of a thermally stable ladder polymer
Advisor: William S. Mungall, Department of Chemistry, Hope College

The goal of this project was to synthesize a ladder polymer, using Diels-Alder chemistry. The diene component of the monomer is disguised as a cyclobutane ring formed using Flash Vacuum Pyrolysis (FVP). The work thus far has focused on synthesis of the key benzocyclobutane intermediate.
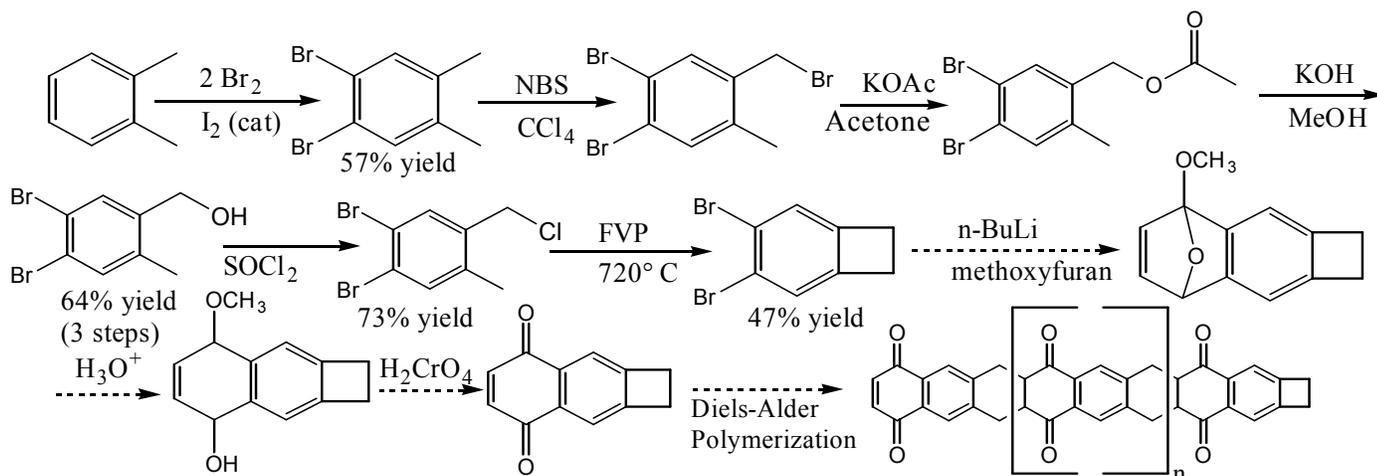
P1-9
Presenter: Munadir Ahmed , Macalester College
Title: Characterizing Graphene using Time Domain Terahertz Spectroscopy
Advisor: James Heyman, Department of Physics, Macalester College

We conducted research on a new and exciting material called Graphene this summer. Graphene, a single atomic layer of graphite, brings with it a promise of being able to produce smaller and faster transistors. Our summer project can be broken down into three parts: production, identification and characterization. My research was focused on the characterization of graphene and ultrathin graphite using Terahertz Time Domain Spectroscopy. These measurements enable us to study the conductivity of the material, and find how the conductivity changes after femtosecond optical excitation, as in a high-speed photoswitch. These characteristics are critical for any new high performance electronic material. We report a photocarrier lifetime of 5ps (5E-12s) in ultra thin graphite (<100 atomic layers). We hope that our findings will contribute meaningfully to the development of this product.

P1-10
Presenter: Katelyn Hartstern, Carthage College
Title: Effect of Polymer Binding on Proton Correlation Times
Advisor: Kevin Morris, Department of Chemistry, Carthage College

Chirality, the 'handedness' of a molecule, can have drastic effects in the chemical and pharmaceutical industries. For example, naproxen's trans-enantiomer causes pain-relief while the cis-enantiomer has no effect. Yet, the tablet encapsulates both enantiomers due to the difficulty in separation. Nevertheless, some separation methods focus on isolating the enantiomers. Using molecular micelles in chromatography has proved to be a successful separation technique. (Micelles are large clusters of amphipatic molecules – where one part of the molecule in polar and the other is nonpolar. As a result, all the nonpolar ends cluster together leaving only the polar edge on the micelle's surface when dissolved in a polar solvent). Therefore, by analyzing the intermolecular interactions involved in the binding of the micelles with the chiral molecules, one can better understand and improve the chiral separation process.

P1-11
Presenter: Arcelia Ortega, Harold Washington College (research at Hope College)
Title: Modeling Fluorescently Tagged RNA and RNA Oligonucleotides for Direct Comparison to Fluorescence-detected Resonance Energy Transfer (FRET) Experiments
Advisor: Brent Krueger, Department of Chemistry, Hope College
Coauthors: Amy L. Speelman, David A. Paul, Bryan A. Leland

We are developing a method for studying the structural dynamics of biological systems which brings together fluorescence spectroscopy and computational modeling, providing a more complete understanding than is possible with either technique individually. Before beginning molecular dynamics simulations, force field parameters were developed for the fluorescent probes to be used in experimental studies. This was carried out using quantum mechanical calculations to determine low-energy probe conformations and electrostatic potentials, deriving charges using the RESP charge fitting procedure, and setting force field parameters by analogy to pre-existing parameters. Several DNA– and RNA–fluorescent probe systems were created and explicitly solvated in water. These systems were then minimized and equilibrated at 298 K prior to beginning production molecular dynamics runs. In the future, these MD simulations will be used to calculate simulated fluorescence data which will be compared to experimental fluorescence data.

P1-12
Presenters: Chris Conklin and Emily Berger, St. Olaf College
Title: A Study of the Hyperfine Structure of Sodium Fluoride
Advisor: James Cederberg, Department of Physics St. Olaf College

Using St. Olaf's molecular beam electric resonance spectrometer we have spent the summer studying the hyperfine structure of $^{23}Na^{19}F$. We have almost gathered enough data to calculate certain molecular constants more accurately than ever before.

P1-13
Presenter: Kenion Blakeman, Carthage College
Title: Monitoring Chloride Conentration in the Pike River
Advisor: Christine Blaine, Department of Chemistry, Carthage College
Co-authors: Hartstern, Katelyn, Dickinson, Elizabeth, Albers, Keaton, Willis, Andrew

Harsh weather in Kenosha, WI during the winter makes road salting a necessity. While salting makes driving safer, runoff from rain and snow affects chloride concentration in the Pike River. Since October 2007 water samples at six sites in Kenosha, WI have been measured for chloride concentration with a chloride ion-selective electrode. Chloride concentrations were 67.5 ± 4.0 mg/L (ppm) through November 2008, rising to 330 ± 28 ppm in February 2009, before decreasing back to 89.0 ± 14.0 ppm by late April 2009. Preliminary snow data was collected during winter 2009 in transects leading to the river.

P1-14
Presenter: Liwei Ding, Knox College
Title: Novel synthesis of mixed ligand complexes of copper (II) butanoate
Advisor: Thomas Clayton, Department of Chemistry, Knox College

A novel method has recently been developed for synthesis of mixed ligand complexes of copper (II). Previous work at Knox has shown that substituted complexes derived from copper(II) butanoate have unusual liquid crystalline properties with substantially depressed melting points and increased ranges of thermal stability. We report synthesis of a series of substituted dimeric copper(II) complexes coordinated by butanoate ligands and either one or two long chain carboxylates. The long chain carboxylates utilized include dodecanoate, tetradecanoate and hexadecanoate. FT-IR was used to monitor the progress of reactions, in particular to determine when the carboxylate ligands assume a bridging geometry. Final products will be characterized by spectroscopic, thermal and gravimetric methods: infrared spectroscopy (IR), melting point determination; differential scanning calorimetry; polarized optical microscopy and elemental analysis. The systematic variation

of chain length and degree of substitution will allow the investigation of structure function relationships in liquid crystalline complexes based on copper(II) butanoate.

P1-15
Presenter: Travis Helgren, Knox College
Title: Synthesis of a Mixed Ligand Copper(II) Carboxylate Species Containing a Dicarboxylate Ligand
Advisor: Thomas Clayton, Department of Chemistry, Knox College

Here at Knox College, we have been synthesizing mixed ligand copper(II) carboxylates for 15 years (rxn 1). However, we have been unsuccessful in synthesizing a species

$Cu_2(O_2CR)_4 + Et_3OBF_4 \rightarrow [Cu_2(O_2CR)_3(solvent)_x^{+1}] + NaO_2CR' \rightarrow Cu_2(O_2CR)_3(O_2CR')$ rxn 1
containing a single dicarboxylate ligand. All efforts have led to generation of insoluble byproducts and regeneration of starting material. Apparently, species containing various amounts of copper, terephthalate and water have been precipitating, removing necessary reactants from the reaction. Other researchers have reported such species being synthesized with the careful reaction of copper(II) and terephthalate salts (rxn 2)[1,2].
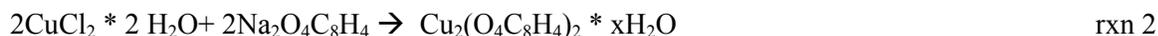
$2CuCl_2 * 2 H_2O + 2Na_2O_4C_8H_4 \rightarrow Cu_2(O_4C_8H_4)_2 * xH_2O$ rxn 2
Recently, our efforts have produced novel amber colored intermediates in THF solutions that are rich in copper(II) and chloride but poor in carboxylates (rxn 3). We believe that

$3/2CuCl_2*2H_2O + 1/4Cu_2(O_2CR)_4 \rightarrow [Cu_2(O_2CR)_1(solvent)_x^{+3}] + 3NaO_2CR' \rightarrow Cu_2(O_2CR)(O_2CR')_3$ rxn 3

this method could result in the desired product of a copper(II) carboxylate containing a single terephthalate ligand. Various solvents of increasing polarity have been tried including MeOH, THF, CH_3CN, and water. Products are characterized by infrared spectroscopy and melting point analysis.

Deakin ,Laura, Arif , Atta M., Miller , Joel S. "Observation of Ferromagnetic and Antiferromagnetic Coupling in 1-D and 2-D Extended Structures of Copper(II) Terephthalates." Inorg. Chem. 1999, *38,* 5072-5077.

Panasyuk, Azarova, Budova, Savost'yanov**. "**Copper Terephthalate and Its Thermal Decomposition Products." Inorganic Materials. 2007. Vol. 43, No. 9, 951–955.

P1-16
Presenter: Gennady Malyshev, Lawrence University
Title: Measurement of the fine structure splittings in n^2F states of ^{87}Rb
Advisor: John Brandenburger, Department of Physics, Lawrence University

Measurements of the fine structure splittings in n^2F states of ^{87}Rb by way of three-step laser excitation have been expanded to include n=12 through 15. The trend in these splittings as a function of n departs from the hydrogenic case and presents a new avenue of theoretic analysis. Supported by E. Bliss, D. Skran and NSF CCLI.

P1-17
Presenter: Steffen Docken, St. Olaf College
Title: Neutron Backgrounds in the Cryogenic Dark Matter Search
Advisor: Angela Reisetter, Department of Physics, St. Olaf College
Coauthor: Bunkofske, Alex

This study was done to help understand the expected background in the data of the CDMS experiment. The purpose of this study was to develop an estimate of how many neutrons from the Uranium/Thorium in the cavern walls are able to reach the detectors through the holes in the shielding that the wires go

through. If in the final analysis, the number of quality events is significantly over the expected background, it will indicate that CDMS has discovered Dark Matter.

P1-18
Presenter: Elizabeth Dickinson, Carthage College
Title: Investigating the Structures of Chiral Polymer: Drug Complexes with 2D-NMR Spectroscopy
Advisor: Kevin Morris, Department of Chemistry, Carthage College

NMR spectroscopy was used to characterize the interactions of the β-blocker drugs aprenolol, isoproterenol, atenolol, pindolol and the chiral molecule benzoin with the molecular micelle polysodium N-undecanoyl-L-leucylvalinate (poly(SULV)). Enantiomers of both the drugs and benzoin were separated using poly(SULV) in chromatography experiments performed by Shamsi et.[all] In this study it was found that Aprenolol fell into class I with high chiral resolution, benzoin fell into class II with moderate chiral resolution and isoproterenol, atenolol and pindolol fell into class III where chiral resolution was poor. The goal of our study was to use NMR spectroscopy to determine why this was the case. NOESY experiments allowed us to generate binding maps and to identify which analyte atoms were closest to the molecular micelle chiral centers and which atoms were closest to the hydrocarbon chain. We also used NOESY to determine which of the two poly(SULV) chiral centers was the primary site of chiral recognition in each mixture. Finally, NMR diffusion experiments were used to measure the analyte association constants. Our results are summarized as follows. Aprenolol interacted primarily with the poly(SULV) leucine chiral center and had a large association constant. Benzoin had a smaller association constant and also interacted with the leucine. Isoproterenol had a small association constant as well and interacted exclusively with the valine chiral center. Work is under way to characterize the atenolol and pindolol and to use the binding maps to generate proposed structures of the polymer:analyte complexes.

P1-19
Presenter: Pat Ramsey, Colorado College
Title: Design and Implementation of a Generic Matching Framework
Advisor: Jonathan Bredin, Department of Mathematics and Computer Science, Colorado College

Matching and exchange are the basis of transactions for many applications as well as autonomous agents. This implementation of a generic matching framework uses a multitude of different technologies including Java, Ruby on Rails, and MySQL to accomplish matching. The structure of the matching framework work allows human and autonomous interaction while being scalable to include thousand of agents. Examples are included in the framework that demonstrate its abilities. This generic matching framework can easily find a match while being extendible into many different applications and levels of complexity.

P1-20
Presenter: Desiderio Romero, Grinnell College
Title: Elemental Analysis of Organometallic Complexes
Advisor: Andrew Mobley, Department of Chemistry, Grinnell College

The purpose of my project was to determine the elemental composition of Tungstenocene Stannyl Complexes and their derivatives, through Atomic Absorption Spectroscopy. Because of the lack of spectral interference data between Tungsten and Tin, this percentage had to be determined. Analysis of better than 0.25 absolute error has been performed.

P1-21
Presenter: Charles Franz, Grinnell College

Title: Combining Hierarchy and Feature Sharing for Object Categorization
Advisor: Dr. Jerod Weinman, Department of Computer Science, Grinnell College

We consider two recently explored strategies for improving the performance of a visual object recognition system: 1) using a two-level category hierarchy during categorization by assigning each object both a supercategory (more broad) and a subcategory (more specific), and 2) choosing the best visual features for discriminating between object categories. While some of the work on this second strategy has involved selecting features to be shared between tasks at one level of categorization, there has been limited investigation of the potential benefits of selecting features that are optimal when shared between the hierarchical tasks of identifying supercategory and subcategory. We devise an object recognition model based on this principle and compare its performance on the Caltech-256 data set, a standard benchmark, with several other current models. We find, contrary to our hypothesis, that a non-hierarchical model performs best. However, a hierarchical model that selects features for sharing between the two levels of categorization outperforms others given a low number of features.