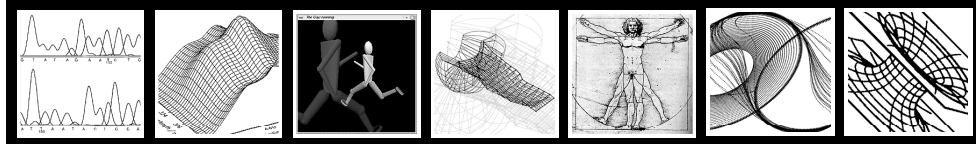


# Presentation Days 2004



A Celebration of Student Projects

May 3, 4 & 5



Harvey Mudd College  
Claremont, California

## Presentation Days 2004 A Celebration of Student Projects

Research is an integral part of the education of all students at Harvey Mudd College. The ability to conduct original investigations, to plan an approach to a problem, and to see it through are essential to success in any scholarly endeavor. We set time aside during the spring semester to celebrate the work of Harvey Mudd College students as they present their original projects in design or research. Whether this work is done in the context of the Clinic Program, as an individual research project with a faculty advisor, or as part of a class project, the emphasis is on the students' own achievements. Some of this work has already been published; much more of it will be published in the future.

This year 298 students are participating in Presentation Days, including more than 141 research talks from students in each of the majors. Students in the Department of Humanities and Social Sciences are displaying their black and white photographs and screening computer animations set to music, while students in an Integrative Experience course co-taught by a mathematician and a musician are exploring the harmony between mathematics and music. The results of the Introduction to Engineering Design projects, involving 21 teams of first year and sophomore students, will also be presented.

The keynote speaker for Presentation Days 2004 is Tyrone B. Hayes from the University of California, Berkeley. Dr. Hayes will speak on "Common Groundsel, Hermaphroditic Frogs and Premature Babies: Today's Solution, Tomorrow's Problem," Monday, May 3, at 4:00 P.M. in Galileo Hall.

For more information, please contact the Office of the Dean of Faculty, Harvey Mudd College, at (909) 621-8122.

The Presentation Days Committee consists of Sally Rich Arroyo, Alfonso Castro, Marianne de Laet, Eric Ditwiler, Ann Esin, Adam Johnson, Elizabeth Orwin '95 and Christopher Stone, and is chaired by Catherine McFadden.



**Presentation Days 2004 Schedule**

**Monday, May 3**

■ 9:00 A.M. Research Presentations Begin

All A.M.    **Chemistry Poster Session**—Galileo Foyer

On-Going    **Chemistry 110: Diversity of Individuals in Chemistry**—Galileo Foyer

	<b>Chemistry</b> <i>Galileo-Pryne</i>	<b>Engineering</b> <i>Galileo-McAlister</i>	<b>Mathematics</b> <i>Beckman B126</i>	<b>Physics</b> <i>Galileo-Edwards</i>	<b>Biology</b>	<b>Computer Science</b>
9:00 A.M.	J. Petersen	E164/Bio168:	M. Banister	A. Tamboli		
9:15 A.M.	K. Orosz	Introduction to		Z. Boekelheide		
9:30 A.M.	S. Hickman	Biomedical Engineering	W. Chang	J. Checkelsky		
9:45 A.M.	S. Price	↓		D. Snowden		
10:00 A.M.	Reception, Chemistry and Physics Departments—Galileo Foyer					
10:15 A.M.		↓				
10:30 A.M.	J. Hoover		D. Gaebler	N. Schommer		
10:45 A.M.	D. Bodzin			A. Mugler		
11:00 A.M.	R. Gabor		E. Clifford	A. Grier		
11:15 A.M.	J. Boye					
11:30 A.M.			R. Gaebler	L. Fisher		
11:45 A.M.				C. Thomas		
12:00 noon	<b>Lunch Break</b>					

■ 1:00 P.M. Research Presentations Begin

All P.M.    **CS121: Software Development Poster Session**—Galileo Foyer

All P.M.    **Math164: Scientific Computing Poster Session**—Galileo Foyer

	<b>Biology</b> <i>Galileo-Pryne</i>	<b>Computer Science</b> <i>Galileo-McAlister</i>	<b>Engineering</b> <i>Galileo-McAlister</i>	<b>Engineering</b> <i>Galileo-Edwards</i>	<b>Mathematics</b> <i>Beckman B126</i>	<b>Physics</b> <i>Galileo-Edwards</i>
1:00 P.M.		CS157: Computer			E. Harley	
1:15 P.M.		Animation		T. Icenogle		
1:30 P.M.		↓		N. Gheewala	J. Nelson	
1:45 P.M.				D. Greisen		
2:00 P.M.						
2:15 P.M.	B. Nahir		K. Miyake, S. Lin, J. Castelaz		K. Todd-Brown	M. Seetin
2:30 P.M.	P. Rettig		E. Lee-Su			S. Skelly
2:45 P.M.	T. Martin		D. Lipke			E. Henage
3:00 P.M.	V. Lake					T. Henage
3:15 P.M.						A. Laurich

All Campus Reception—Galileo Foyer

**Presentation Days Address—Galileo-McAlister**

***“Common Groundsel, Hermaphroditic Frogs, and Premature Babies: Today’s Solution, Tomorrow’s Problem”***  
Tyrone B. Hayes, Associate Professor of Biology, University of California, Berkeley

**Humanities and Social Sciences—Galileo-McAlister**

7:00 P.M. MS 127s: Screening of Final Projects—The Harmony of Sound and Light

8:00 P.M. MS 182s: Introduction to Video Production—Short Videos on the Topics of Time, Appropriation and Documentary

**Tuesday, May 4**    Projects Day 10:30 A.M.–5:00 P.M. Please See Projects Day Program for further details.

**Presentation Days 2004 Schedule**

**Wednesday, May 5**

■ 9:00 A.M. Research Presentations Begin

All Day     **Art 50: Beginning Black and White Photography**—Galileo Foyer

All Day     **E172: Structural Mechanics Poster Session**—Galileo Foyer

All Day     **HSS190: Senior Experience**—Galileo Foyer

On-Going    **Chemistry 110: Diversity of Individuals in Chemistry**—Galileo Foyer

	<b>Chemistry</b> <i>Galileo-Pryne</i>	<b>Biology</b> <i>Galileo-Pryne</i>	<b>Engineering</b> <i>Galileo-McAlister</i>	<b>Physics</b> <i>Galileo-Edwards</i>	<b>Mathematics</b> <i>Beckman B126</i>	<b>Computer Science</b>
9:00 A.M.	T. McQueen		E158: Introduction to CMOS VLSI Design	E. Main		
9:15 A.M.	C. Rotstan			S. Kolthammer		
9:30 A.M.	E. Walsh		↓	K. Rodolfa		
9:45 A.M.	A. Jacobs			D. Loh		
10:00 A.M.						
10:15 A.M.						
10:30 A.M.		M. Lee		C. Church	ICM Presentation	
10:45 A.M.		C. Raub	↓	T. Reimer		
11:00 A.M.		E. Cohick		R. Law	MCM Presentation	
11:15 A.M.		M. Hortter	↓	M. Peter		
11:30 A.M.	<b>Lunch Break</b>					

■ 1:15 P.M. Research Presentations Begin

	<b>Physics</b> <i>Beckman B134</i>	<b>Chemistry</b> <i>Galileo-Pryne</i>	<b>Humanities and Social Sciences</b> <i>Galileo-Pryne</i>	<b>Engineering</b> <i>Galileo-Edwards</i>	<b>Engineering</b> <i>Galileo-McAlister</i>	<b>Computer Science</b> <i>Beckman B126</i>
1:15 P.M.	Physics 170: Computational Physics	Chemistry 112: Inquest		E4 Design Presentations	E4 Design Presentations	
1:30 P.M.						
1:45 P.M.						
2:00 P.M.	↓	↓		↓	↓	A. Hammerly
2:15 P.M.						M. Nelson
2:30 P.M.						B. Erickson
2:45 P.M.						M. Coupland
3:00 P.M.						
3:15 P.M.		K. Esvelt				M. Vrable
3:30 P.M.		A. Kaushansky				G. Kuan
3:45 P.M.		R. Mashiyama				
4:00 P.M.		K. Rodolfa				
4:15 P.M.			IPS; L. Karp			
4:30 P.M.			T. Martin			

**Humanities and Social Sciences—Platt Campus Center, Green Room**

7:00 P.M. IE 84: Mathematics and Music—The Cosmic Harmony

8:30 P.M. Music 84: Jazz Improvisation

**Monday , May 3, 2004**

**9:00 A.M.–12:00 P.M.**

■ **Research Presentations**

9:00 A.M. **Chemistry Presentations please see page 7**

9:00 A.M. **Engineering164/Biology168: Introduction to Biomedical Engineering Presentations please see page 9**

9:00 A.M. **Mathematics Presentations please see page 9**

9:00 A.M. **Physics Presentations please see page 10**

**Chemistry Poster Session—Galileo Foyer**

All Morning **Chemistry Research Posters Presented at the American Chemical Society Meeting**

**Dena Bodzin: Surface-Enhanced Infrared Absorption Spectroscopy of 4-Mercaptopyridine and Metalloporphyrin Monolayers on Thin Gold Films**

(please see abstract Monday, May 3 at 10:45 A.M. on page 8)

**Whitney C. Duim: Determination of Biologically Relevant Lyotropic Liquid Crystalline Phases in Mixtures of Water and n-Alkyl-Glucosides or n-Alkyl-Thioglucosides**

Temperature modulated differential scanning calorimetry (TMDSC) and spectroscopy using the fluorescent probe Prodan are used to determine the phase diagrams of the lyotropic liquid crystals *n*-octyl- $\beta$ -D-glucoside and 1-S-octyl- $\beta$ -thioglucoside in water. TMDSC provides greater resolution of phase transitions than DSC. The literature phase diagram of *n*-octyl- $\beta$ -D-glucoside is studied using TMDSC. The Prodan's spectra shapes and peak wavelengths (range: 350–650 nm) are used to differentiate phases. Changes are seen after phase transitions and deconvolution of spectra into Gaussian curves yields information about the partitioning of Prodan within samples.

Faculty Advisor: *Gerald R. Van Hecke, Chemistry*

**Kevin Esvelt: Identification of Proteases Responsible for Epididymal Processing of the Sperm Surface Protein Fertilin b**

(please see abstract Wednesday, May 5 at 3:15 P.M. on page 24)

**Rachel Gabor: Experimental Measurements of Electronic Coupling in Ruthenium Porphyrin Dimers**

(please see abstract Monday, May 3 at 11:00 A.M. on page 8)

**Eric W. Hall: Mapping the Unilamellar Vesicle Regions in the Ternary DTAB-SDS-Water System**

We have investigated the formation behavior of vesicle aggregates in the aqueous system of cationic dodecyltrimethylammonium bromide (DTAB) and anionic sodium dodecyl sulfate (SDS) utilizing a combination of novel fluorescence spectrophotometric techniques and laser light-scattering. In particular, we have used the fluorescence probe Prodan which exhibits an extreme sensitivity of its maximum emission wavelength to the polarity of its environment. The overall probe fluorescence emission spectra reflect the distribution of the probe within the surfactant aggregates and thus reveal the aggregate structure.

Faculty Advisor: *Kerry K. Karukstis, Chemistry*

Chemistry Poster Session Continued

**Elaine Hart: Polarized Spectroscopy of Metallomesogens—Comparison of Experiment with Theory for a Copper (II) Carboxylate Dimer and Cobalt (II) Stearate**

The geometries, electronic states, and excitation energies of cobalt (II) stearate and dimeric copper (II) stearate have been studied by experimental and computational methods. Polarized spectroscopy was used to determine the excitation energies. Cobalt (II) stearate had two z- and three xy- polarized absorbances. Copper (II) stearate had three z- and several low- and high-energy xy-absorbances. The complexes were also studied using Gaussian98 (DFT, TDDFT). Geometry optimizations were performed using the B3LYP functional and 6-311g(d,p) basis sets. The geometry of cobalt (II) acetate resembled skewed tetrahedral. The geometry of the dimeric copper (II) formate was nearly square planar about each copper ion. While the calculated excitation energies deviate from experiment, the number of spectral transitions agree with experiment.

Faculty Advisors: *Gerald R. Van Hecke and Robert J. Cave, Chemistry***Steven A. Hickman: Preparation of Diblock Copolymer Nanoporous Templates on Alkylsilane Self-assembled Monolayers.***(please see abstract Monday, May 3 at 9:30 A.M. on page 8)***Jessica Hoover: Chiral Titanium and Zirconium Amino-alcohol Complexes as Catalysts for the Intramolecular Hydroamination of Aminoallenes***(please see abstract Monday, May 3 at 10:30 A.M. on page 8)***Christine Kalcic: Excess Thermodynamic Functions of Anisole + Alcohol Mixtures using Rayleigh Light Scattering**

Mixtures of anisole with methanol, ethanol, 1-propanol, and 2-methyl-1-propanol were studied to determine excess volume, excess Gibbs potential  $G^E$ , and excess refractive index. The Rayleigh ratios, densities, and refractive indices allowed  $G^E$  curves to be fit as functions of composition at 288, 298, 308 and 318K. The mixtures exhibited positive  $G^E$  across the entire composition range. The shape of each  $G^E$  curve was not the Lattice Model parabola but had a marked asymmetry that shifts toward the alcohol-rich region as the alcohol becomes larger and branched. The temperature dependence of  $G^E$  was found to be insignificant which means there is no excess entropy of mixing.

Faculty Advisor: *Gerald R. Van Hecke, Chemistry***George K. Korir: Azo Dye Aggregation on Catanionic Vesicle Surfaces**

Binary mixtures of the cationic surfactant didodecyldimethylammonium bromide (DDAB) and the anionic surfactant sodium dioctylsulfosuccinate (AOT) form unilamellar Catanionic vesicles in aqueous solution at certain compositions. These vesicles exhibit a variable net surface charge that arises from the distribution of surfactants within the bilayer shell. We have used azo dyes with either anionic or cationic substituents to electrostatically bind the dye to the vesicle surface. UV/visible absorption spectra reveal the formation of spectrally-distinct dye aggregates. The nature of the dye aggregation was observed to be dependent on the size of the aromatic rings in the dye and the net charge on the vesicle surface.

Faculty Advisor: *Kerry K. Karukstis, Chemistry***David Liao: Explaining the Orbital Approximation by Heuristically Constructing Correlated and Orbital Wavefunctions**

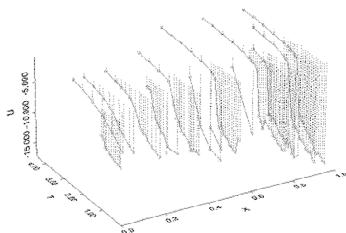
Researchers investigated the theoretical validity of the orbital approximation as early as 1928. Even so, present literature focuses on the success of the Hartree approximation as an accident. In response we construct heuristically two analytic wavefunctions. A correlated approximation of the ground state of Helium illustrates the mathematical origin of the  $r_{1,2}$  cusp condition and suggests a relationship between screening and correlation. By considering geometry, we also construct a many-electron screened wavefunction that qualitatively reproduces the ionization energies of elements 1-18 and nearly reproduces Slater's Rules.

Faculty Advisor: *Robert J. Cave, Chemistry*

Chemistry Poster Session Continued

**David Liao: Computer Simulations of Liquid-crystalline Phases in an NPT Monte-Carlo Ensemble of Lennard-Jones Spheres and Gay-Berne (3,5,1,3) Ellipsoids**

Previous workers found that the Gay-Berne (3,5,1,3) mesogen exhibited liquid-crystalline phases in NPT Monte-Carlo simulations. Previous studies in our laboratories identified isotropic, smectic, and crystal phases in 85 ensembles of spheres and ellipsoids. The resulting binary  $T$ - $X$  phase diagram explored ellipsoid mole fractions from  $X = 1.0$  to  $X = 0.6$ . We performed 117 additional equilibrations to extend the diagram to  $X = 0.0$ . Surprisingly, liquid-crystal phases persisted at mole-fractions as low as  $X_c = 0.3 \pm 0.1$ . Visualizations of packing-arrangements proved indispensable since thermodynamic variables varied smoothly in this neighborhood (shown below).

Faculty Advisor: *Gerald R. Van Hecke, Chemistry***Shelley McCormack: Use of Laser Light Scattering and Fluorescence Spectroscopy to Map a DDAB/DTAC/Water Ternary Phase Diagram**

This project uses primarily fluorescence spectroscopy to map aggregate formation in a DDAB (didodecyl-dimethylammonium bromide), DTAC (dodecyltrimethylammonium chloride), and water ternary phase diagram. The diagram contains a large asymmetric vesicle region, a micelle region, and a mixed region. The fluorophore prodan was added to the samples; its emission wavelength shows the polarity of its location within the aggregate. Prodan exhibited the longest emission wavelength when distributed within micelles and the shortest when within vesicles; mixed samples had intermediate emission wavelengths, reflecting the relative amounts of the two aggregates.

Faculty Advisor: *Kerry K. Karukstis, Chemistry***Tyrel M. McQueen: A Novel Approach to the Study of Equilibrium Phase Behavior in Multi-Aggregate Systems: Theory and Practice***(please see abstract Wednesday, May 5 at 9:00 A.M. on page 19)***Laura E. Moyer: Aggregation of Azo Dyes on DDAB/AOT Vesicles over Time**

We have generated "catanionic" vesicles composed of two double-tailed surfactants, cationic didodecyl-dimethylammonium bromide (DDAB) and anionic sodium dioctylsulfosuccinate (AOT) to provide enhanced opportunities for the ordered assembly of azo dyes. The net charge and surfactant spacing on the outer vesicle surface dictate the proximity of attached azo dyes and the formation of either H- or J-aggregates. Using UV/visible absorption spectroscopy, we observed the nature of the dye aggregation to be dependent on the size of the aromatic rings in the dye and the hydrophobicity of the substituents on these aromatic rings.

Faculty Advisor: *Kerry K. Karukstis, Chemistry***Kristina Orosz: Rate of Axial Ligand Exchange in Bisacetoneitriletetraphenylporphyrinatoruthenium(II)***(please see abstract Monday, May 3 at 9:15 A.M. on page 7)***Juliette Petersen: Asymmetric Catalytic Hydroamination of Aminoallenes with Chiral Titanium Complexes***(please see abstract Monday, May 3 at 9:00 A.M. on page 7)*

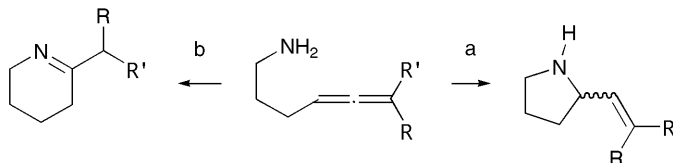
Chemistry Poster Session Continued

**Courtney Rotstan: Characterization of Synthetic Antimicrobial Peptides using Catanionic DDAB-AOT***(please see abstract Wednesday, May 5 at 9:15 AM on page 19)***Elizabeth Walsh: Experimental and Density Functional Theory Examinations of the Regioselectivity of the ketal Claisen rearrangement***(please see abstract Wednesday, May 5 at 9:30 AM on page 19)***On Going Chemistry 110: Diversity of Individuals in Chemistry**

Each student in Chemistry 110 has selected a single individual in the field of chemistry and has written a short pamphlet focusing on his or her individual contributions. Each person's most important contribution to chemistry is described at a level appropriate for a non-specialist. Included is a discussion of the social, political, cultural, economic and/or historical context of the individual's work, how those factors shaped (helped or hurt) their work, and how the individual overcame any barriers they faced. Feel free to take a pamphlet if you are interested in learning more about the diversity of individuals in chemistry.

Faculty Advisor: *Adam R. Johnson, Chemistry***Chemistry—Galileo-Pryne****9:00 A.M. Juliette Petersen: Asymmetric Catalytic Hydroamination of Aminoallenes with Chiral Titanium Complexes**

The hydroamination of aminoallenes can proceed through two pathways. One pathway yields a six-membered ring, while the other gives a five-membered ring with a chiral center. A chiral titanium complex has been synthesized that selectively catalyzes the ring closure to the five-membered product. The amino alcohol ligands are based on three amino acids, phenylalanine, phenylglycine, and valine, which were modified and the final ligands were combined with titanium tetrakisdimethylamide,  $Ti(NMe_2)_4$ , *in situ* to give the chiral catalyst. Asymmetric catalytic hydroamination has been performed on 1,3-disubstituted and 1,1,3-trisubstituted aminoallenes.

Faculty Advisor: *Adam R. Johnson, Chemistry***9:15 A.M. Kristina Orosz: Rate of Axial Ligand Exchange in Bisacetonitriletetraphenylporphyrinatoruthenium(II)**

The NMR saturation transfer technique was used to study the dissociation rate of axially-bound acetonitrile in bisacetonitriletetraphenylporphyrinatoruthenium(II). The free acetonitrile peak was presaturated and diminution of the coordinated acetonitrile peak was observed as a function of temperature. The effective  $T_1$  of free acetonitrile was determined through inversion-recovery during saturation of the free peak at each temperature. Analysis using an Eyring's plot of the data shows  $\Delta S^\ddagger$  to be  $140 \pm 30$  J/molK. The large positive  $\Delta S^\ddagger$  indicates that the mechanism of ligand exchange is most likely dissociative formation of the five-coordinate metalloporphyrin intermediate.

Faculty Advisor: *Hal Van Ryswyk, Chemistry*

## Chemistry Presentations Continued

9:30 A.M. **Steven A. Hickman: *Preparation of Diblock Copolymer Nanoporous Templates on Alkylsilane Self-assembled Monolayers.***

Nanoporous templates (NTs) constructed from diblock copolymer thin films are of interest for biological and information storage applications. Currently, a specialized type of random copolymer is necessary to prepare the surface on which the NTs are formed. This research focuses on expanding the work of Smith et. al<sup>1</sup>, in which an oxidized alkylsilane self-assembled monolayer replaces the random copolymer in the surface preparation.

Faculty Advisor: *Shenda M. Baker, Chemistry*

<sup>1</sup>Smith AP et. al. *Macromol. Rapid Comm.* 24 (1): 131-135 JAN. 24, 2003

9:45 A.M. **Sarah Price: *Synthesis of C-Aryl Glycosides using Environmentally Benign Organoindium Reagents***

The glycosidic carbon-carbon bond present in naturally occurring C-Aryl Glycosides was synthesized using organoindium chemistry. C-Aryl Glycosides have anti-tumor and antibiotic properties and a useful synthesis of them could lift the strain on natural resources. Organoindium compounds are environmentally benign, relatively stable and efficient at transferring all three of their ligands in a coupling reaction. A series of triaryliindiums were prepared and allowed to react with 3,4-Di-O-acetyl-6-deoxy-L-glucal, Tri-O-acetyl-D-galactal, and Tri-O-acetyl-D-glucal. The products, predominantly  $\alpha$ -C-aryl-D<sup>2,3</sup>-glycopyranosides, were purified and characterized.

Faculty Advisors: *Thomas G. Mineham and G. William Daub, Chemistry*

10:00 A.M. **Reception, Chemistry and Physics Departments—Galileo Foyer**10:30 A.M. **Jessica Hoover: *Chiral Titanium and Zirconium Amino-alcohol Complexes as Catalysts for the Intramolecular Hydroamination of Aminoallenes***

The intramolecular hydroamination of a 1,3-disubstituted aminoallene can proceed through two possible pathways. One pathway provides a six-membered imine, while the other gives a five membered allylamine with a chiral center. My research focused on the synthesis of chiral titanium and zirconium catalysts with amino-alcohol ligands for the hydroamination reaction. We have observed selective formation of the amine product with enantiomeric excesses reaching 16 percent.

Faculty Advisor: *Adam R. Johnson, Chemistry*

10:45 A.M. **Dena Bodzin: *Surface-Enhanced Infrared Absorption Spectroscopy of 4-Mercaptopyridine and Metalloporphyrin Monolayers on Thin Gold Films***

Surface-enhanced infrared absorption spectroscopy (SEIRAS) was utilized to study the distal ligand of surface-confined metalloporphyrins. In SEIRAS, some vibrational modes of surface-confined molecules are enhanced when bound to rough gold. To demonstrate this, a thin, rough layer of gold was evaporated onto microscope slides. A 4-mercaptopyridine monolayer was then chemisorbed to the gold, followed by a monolayer of *meso*-tetraphenylporphyrinatoruthenium (II) carbonyl. SEIRAS was run on the samples after each step, and enhanced signals were observed for the mercaptopyridine, the porphyrin, and the carbonyl in the distal ligand position.

Faculty Advisor: *Hal Van Ryswyk, Chemistry*

11:00 A.M. **Rachel Gabor: *Experimental Measurements of Electronic Coupling in Ruthenium Porphyrin Dimers***

The electronic coupling in metalloporphyrin dimers was studied in an effort to understand electron transport within metalloporphyrin-oligomer molecular wires. Previous theoretical calculations predicted electronic coupling within several dimers. The shish-kabob dimer  $\{(\text{CO})\text{Ru}(\text{POR})\}_2(\text{pz})$  and the cofacial dimers  $\{(\text{CO})\text{Ru}[(2\text{-py})(\text{POR})]_2\}$  and  $\{(\text{pz})\text{Ru}[(2\text{-py})(\text{POR})]_2\}$  were synthesized and oxidized via redox titration. The intervalence charge transfer was then studied using near-infrared spectroscopy. The charge transfer bands for the various valence states were used to determine the degree of coupling in the dimer. Experimental and theoretical results were compared.

Faculty Advisors: *Hal Van Ryswyk and Robert J. Cave, Chemistry*

## Chemistry Presentations Continued

11:15 A.M. **Jordan Boye: *Theoretical Studies of the Hydroamination of Aminoallenes Using Chiral Titanium Complexes***

In this project, the titanium-complex catalyzed hydroamination reactions carried out by the Johnson research group were modeled theoretically using Gaussian98 software. These intramolecular cyclization reactions were shown experimentally to result in both six-membered imine and five-membered pyrrolidine rings. The purpose of the theoretical studies was to attempt to explain the observed selectivity. Density functional theory with the B3LYP functional and standard basis sets was used in order to examine the relative energies of reactants, products and transition states.

Faculty Advisor: *Robert J. Cave, Chemistry*

**Engineering—Galileo-McAlister****Engineering 164/Biology 168: *Introduction to Biomedical Engineering***9:00 A.M. **Jason Komadina, Sean Skelly: *Considerations for use of Electroactive Polymers as Artificial Muscles***11:30 A.M. **Nikhil Gheewala, Rachel Lovec, Erika Strandberg: *Treating Parkinson's Disease Using Gene Therapy***

**J.L. Espinosa, Christopher Wottawa: *The Use of BioMEMS in Drug Delivery***

**Franck Luu, Madineh Sarvestani: *Mesial Temporal Lobe Epilepsy—An Overview of the Medical, Technical and Social Aspects of the Disorder***

**Kyle Kondo, Alexis Utvich, Stephanie Wong: *Vagal Nerve Stimulation Using Implantable Devices Toward the Prevention and Control of Epileptic Seizures***

**Tonya Icenogle, Anne Lyons: *Tissue Engineering and the ACL***

**Jay Chow, Don Lee: *Stem Cells and Their Applications in Neural Tissue Engineering***

**Valerie Lake, Esther Lee, Adele Tamboli: *Hearing For the Future***

**Chris Moore, Alex Utter: *Skeletal and Cardiac Muscle Engineering***

**Brian Maples: *Designing a Gene Therapy for HIV-1 by In Vitro Selection of Aptamers***

**Ko Ihara, Jeffrey Lin: *Brain Cancer and Engineering Developments in Laser Treatments***

Course Instructor: *Elizabeth J. Orwin, Engineering and Biology*

**Mathematics—Beckman B126**9:00 A.M. **Melissa Banister: *Separating Sets for Finite Groups***

A module over a group ring has a canonical decomposition into invariant subspaces. We can extract information about a vector by projecting it onto these invariant subspaces, and this can be done efficiently with separating sets. Useful separating sets for the symmetric group are known and analogous methods for other groups are desired. The representation theory of the alternating group is closely connected to that of the symmetric group, and thus it is natural to examine ways to extend results for the symmetric group to the alternating group.

Faculty Advisor: *Michael Orrison Jr., Mathematics*

9:30 A.M. **Will Chang: *Image Processing with Wreath Products***

I will present a technique to decompose digital images using generalizations of the Discrete Fourier Transform (DFT). This method arises from the representation theory of iterated wreath product groups, which describe symmetries of the quad tree decomposition of an image. In addition, I will describe applications to edge detection, de-noising and compression, as well as experimental results to evaluate the performance of these operations.

Faculty Advisor: *Michael Orrison Jr., Mathematics*

10:00 A.M. **Reception, Chemistry and Physics Departments—Galileo Foyer**

## Mathematics Presentations Continued

10:30 A.M. **David Gaebler: *Toeplitz Operators on Locally Compact Abelian Groups***

Given a measure on a locally compact Abelian group  $G$ , the Toeplitz operator generated by the measure is an integral transform on the dual group  $\Gamma$ , whose kernel is the Fourier transform of the measure. If  $G$  is non-discrete, so that  $\Gamma$  is non-compact, we approximate the transform by integrating over compact subsets of  $\Gamma$ . We study how the spectra of these finite Toeplitz operators relate to the measure that generates them. Under certain conditions, the singular part of the measure will be shown to have no effect on the asymptotic eigenvalue distribution. We study the specific cases of the circle, the torus, and the real line in order to find ideas for the general problem.

Faculty Advisor: *Henry A. Krieger, Mathematics*

11:00 A.M. **Edward G. Clifford: *A Decomposition of Voting Profile Spaces***

Voting theory has been in existence in mathematical form since the 1780s. Many people have tackled parts of it using various tools, and now we shall look at it through the eyes of a representation theorist. Each vote can be thought of as a permutation of the symmetric group, and a poll is similar to a linear combination of these elements. Specifically, we will focus on translating and generalizing the works of Donald Saari into more algebraic terms to discover not just one space, but a whole isotypic component essential to positional voting schemes.

Faculty Advisor: *Jon Jacobsen, Mathematics*

11:30 A.M. **Rob Gaebler: *Alexander Polynomials of Two-Bridge Knots and Links***

Every two-bridge knot or link, which can be characterized by a rational number  $p/q$ , has a fundamental group which has a simple presentation with only two generators and one relator. The relator has a particular form that gives rise to a formula for the Alexander polynomial of the knot or link in terms of only  $p$  and  $q$ . Each two-bridge knot or link has a corresponding “up-down graph” in terms of  $p$  and  $q$ , which is analyzed combinatorially to prove properties of the Alexander polynomial, including the “trapezoidal” property proved by Hartley. The two-bridge knots and links of a given crossing number are also counted.

Faculty Advisor: *James Hoste (Pitzer College, Mathematics)*

## Physics—Galileo-Edwards

9:00 A.M. **Adele Tamboli: *Temperature Dependence of the Spin-Dependent Mean Free Path in CoFe and Cu***

The spin-dependent mean free path is an important parameter in the development of spintronics. Giant Magnetoresistance (GMR) measurements on back spin valves, with an additional layer, have been used to determine the majority carrier spin-dependent mean free path in that back layer. The structures used in our work were  $\text{Si}/30\text{\AA}$   $\text{Ru}/25\text{\AA}$   $\text{Cu}/80\text{\AA}$   $\text{IrMn}/50\text{\AA}$   $\text{NiFe}/30\text{\AA}$   $\text{Cu}/20\text{\AA}$   $\text{NiFe}/t_{\text{Back}}$ . Both magnetic and non-magnetic backing layers were investigated where the material used was either CoFe ( $10\text{\AA} < t_{\text{CoFe}} < 150\text{\AA}$ ) or Cu ( $10\text{\AA} < t_{\text{Cu}} < 175\text{\AA}$ ). We have determined the spin-dependent mean free path over the temperature range of 5K to 300K.

Faculty Advisors: *James C. Eckert and Patricia D. Sparks, Physics*

9:15 A.M. **Zoe Boekelheide: *Resistance of Ta/PtMn/Ta Thin Films***

Anomalous electrical resistance as a function of temperature has been observed for IrMn exchange-biased spin valves and Ti/IrMn/Ti trilayers. We compare these results with a study of thin films having the structures Ta/PtMn/Ta and Ta/IrMn/Ta. PtMn is reported to undergo a structural phase transition upon annealing and we have measured samples of both the annealed and unannealed trilayers in an attempt to determine the effect of annealing on the temperature dependent resistance. Our results indicate that the thickness of the PtMn or IrMn plays a significant role in determining the  $R$  vs.  $T$  behavior but the PtMn samples appear to be unstable and do not yield reproducible results.

Faculty Advisors: *James C. Eckert and Patricia D. Sparks, Physics*

## Physics Presentations Continued

9:30 A.M. **Joseph Checkelsky: *Anisotropic Magnetoresistance of Fe<sub>x</sub>Co<sub>1-x</sub>S<sub>2</sub>***

The magnetotransport properties of the spin polarized ferromagnetic alloy, Fe<sub>x</sub>Co<sub>1-x</sub>S<sub>2</sub>,  $0 \leq x \leq 0.3$  have been investigated focusing on Anisotropic Magnetoresistance (AMR). Varying the alloy concentration is predicted to change the level of spin polarization and produce a half-metallic ferromagnet. Measurements were made as a function of the temperature (300 K to 2 K), applied magnetic field magnitude (up to 8 T), and the angle of the applied field with respect to the current. Results are discussed in terms of current theories of the carrier polarization's influence on AMR, and an extension to a half-metallic characterization through this technique is proposed.

Faculty Advisors: *James C. Eckert and Patricia D. Sparks, Physics*

9:45 A.M. **Darci Snowden: *Magnetoresistance in Thermally Deposited Nickel Films with Striped Magnetic Domains***

Magnetoresistance measurements were made on thermally deposited Ni films with two different stripe domain orientations. Measurements were taken on Ni films with thickness ranging from 35 to 120 nm for both current parallel and perpendicular to the domain walls. Magnetoresistance measurements were made with the field applied out of the film plane and in the film plane. The resulting magnetoresistance curves give insight into domain wall resistance and anisotropic magnetoresistance in Nickel films exhibiting striped magnetic domains.

Faculty Advisors: *Patricia D. Sparks and James C. Eckert, Physics*

10:00 A.M. **Reception, Chemistry and Physics Departments—Galileo Foyer**10:30 A.M. **Natalie Schommer: *The Droplet Source Project***

In recent years atomic clusters of deuterium have been used as targets in laser-fusion studies, specifically inertial confinement fusion. The cluster targets have shown an impressive yield of neutrons, even when irradiated by pulses generated by relatively small-scale lasers. Both models and experiments indicate that clusters between .01 and 1 micron diameter in range may more efficiently yield neutrons; however producing clusters on this size scale is not possible at this time. In an attempt to meet this need, we have been developing a droplet source that uses ultrasonic atomization of a liquid to produce droplets of a well-characterized and controllable size. In addition we have been developing and testing a sizing technique for such particles using Mie scattering theory.

Faculty Advisor: *Thomas D. Donnelly, Physics*

10:45 A.M. **Andrew Mugler: *The Droplet Source Project***

We have been developing a device that produces micron-scale droplets via the ultrasonic atomization of a liquid. In addition to applications as targets for laser-driven fusion, sizing these droplets provides a test in a novel phase space of the fluid theories that describe harmonically-driven droplet ejection. For inviscid fluids our data agree very well with the predicted scaling between droplet diameter and driving frequency. A different scaling is predicted for viscous fluids, one which has yet to be tested experimentally. We discuss our results within this viscous regime.

Faculty Advisor: *Thomas D. Donnelly, Physics*

11:00 A.M. **Andrew T. Grier: *An Experimental and Numeric Investigation of the Surface Electron States in Thin Gold Films Using Second Harmonic Generation***

The surface electronic states of thin (400-1300 nm) gold films are experimentally probed on the time scale of electron-electron scattering dynamics through measuring changes in second harmonic generation. We probe with a 50 fs pulse width, 1 kHz repetition rate, Ti:Sapphire laser system in a pump-probe geometry. The experimental data are compared with second harmonic generation predictions of a numeric model which follows the time evolution of surface electronic states. Refinements to the model include the addition of a temperature-dependent dielectric function.

Faculty Advisor: *Thomas D. Donnelly, Physics*

Physics Presentations Continued

11:30 A.M. **Laura K. Fisher: *Investigating Electron Thermalization in Gold Films through Second Harmonic Generation***

Normally, electrons in a metal are described by a Fermi-Dirac distribution with a well-defined temperature. When excited by an ultrafast laser pulse, the electrons occupy a non-thermal distribution, and subsequently thermalize through elastic scattering on the scale of a few hundred femtoseconds. Using a 50 fs, Ti:Sapphire laser in a pump-probe geometry, electron thermalization in thin gold films was investigated through second harmonic generation as a function of probe-arm delay. This was compared to a numerical simulation, which simulated electron-electron scattering, energy loss to the lattice, and temperature dependence of the reflectivity.

Faculty Advisor: *Thomas D. Donnelly, Physics*

11:45 A.M. **Creighton Thomas: *The Effects of Second Harmonic Generation in Gold***

We use a femtosecond pulse laser to study scattering rates in gold by looking at the generation of second harmonic light from a gold surface. Most notably, the spectral profile and coherence properties of the second harmonic light should be affected by scattering at the surface. A numerical model has been developed that can take basic information about the beam profile and give modifications to reproduce the effects seen for second harmonic generation in gold. The output of this program can then be compared with experimental data to see if the modifications are accurate.

Faculty Advisor: *Thomas D. Donnelly, Physics*

12:00 Noon

■ Lunch Break

1:00 P.M.–5:00 P.M.

■ Research Presentations

1:00 P.M. **Computer Science 157: *Computer Animation* please see page 13**

1:00 P.M. **Mathematics Presentations please see page 13**

1:15 P.M. **Engineering Presentations please see page 13**

2:15 P.M. **Biology Presentations please see page 15**

2:15 P.M. **Physics Presentations please see page 15**

7:00 P.M. **Humanities and Social Sciences Presentations please see page 17**

**Computer Science Poster Session—Galileo Foyer**

All Afternoon **Computer Science 121: *Software Development***

**Forrest Briggs, Dave Buchfuhrer, Adam Carasso, Janna DeVries, Jon Dodge, John Hicks, Adam Kangas, Andrew Kim, Edward Kim, Evan Parry, Ben Pellow, Cal Pierog, Ryan Riegel, Jon Samples, Paul Scott, Dominik Susarczyk, Brad Tennis, Joe Walker.**

The students will present computer games they designed and built as course projects.

Course Instructor: *Elizabeth A. Sweedyk, Computer Science*

**Mathematics Poster Session—Galileo Foyer**

All Afternoon **Math164: *Scientific Computing Poster Session***

Students in the Scientific Computing course will be presenting posters on individual research projects covering a range of topics, including the modeling of traffic flow, N-body problems, computer worms, plant growth patterns and the spread of AIDS.

Course Instructor: *Lisette de Pillis, Mathematics*

**Computer Science—Galileo-McAlister**

1:00 PM. **Computer Science 157: *Computer Animation***

1:45 PM. **Zak Andree, Will Chang, Katie Compton, Michael Coupland, James Darpinian, Drew d'Avis, Ed Heaney, Ed Kim, Michael Terkowitz, Jeff Scherpelz, Keith Stevens and Jenny Xu**

The students will show their short animated films.

Course Instructor: *Elizabeth A. Sweedyk, Computer Science*

**Mathematics—Beckman B126**

1:00 PM **Eric Harley: *Mathematically Modeling Spatial Tumor Growth in Parallel***

This work focuses on creating a model of cancer growth that incorporates both spatial tumor heterogeneity and a simple immune response to tumor invasion. We are developing a parallel computer implementation of a hybrid-lattice-gas cellular automaton model which explicitly takes into account tumor cell mitosis, apoptosis and necrosis as well as nutrient consumption and an active immune system. The parallelization of the code allows us to run larger spatial problems than have previously been considered feasible. The model is capable of evidencing qualitatively accurate biological outcomes, such as the development of a necrotic tumor core.

Faculty Advisor: *Lisette de Pillis, Mathematics*

1:30 PM **Jessica L. Nelson: *On the Erdos Problem of Empty Convex Hexagons***

One of the most elusive answers in the intersection of Ramsey Theory and Combinatorial Geometry corresponds to the question, "Does there exist a number  $H(6)$  such that any set of points of size  $H(6)$  or more with no three points on a line is certain to contain six points which are the vertices of an empty convex hexagon?" This talk will review the other solved related problems and propose a response to Erdos's question.

Faculty Advisor: *Lisette de Pillis, Mathematics*

2:00 PM. **Break**

2:15 PM **Katherine Todd-Brown: *Local Morphological Modeling of Early Stage Tumor Growth***

In this presentation we address the basic formulation and results of an early stage tumor model. This model implements a combination of a discrete probabilistic cellular automata model to simulate cellular behavior and a continuous diffusion partial differential equations model to simulate the diffusion of nutrient and chemotherapy medicines through the cellular tissues. There is a clear correlation between the morphologies simulated by the model and clinical data. We use this model to compare various chemotherapy regimens and speculate about the effects of the immune system on tumor growth and morphology.

Faculty Advisor: *Lisette de Pillis, Mathematics*

**Engineering—Galileo-Edwards**

1:15 PM. **Tonya Icenogle: *Mechanical Properties of Type I Collagen Sponges with Viscoelastic Behavior***

In order to mimic the human cornea, any tissue-engineered corneal construct needs to have similar mechanical properties. The purpose of this study was first to test and refine the procedure for examining the material properties of the type I collagen sponges in the MTS machine. Then, we ran an experiment to assess the changes in mechanical strength due to the added crosslinking created by seeding the sponges with corneal fibroblasts for 21 days. Since the sponges are porous and viscoelastic, different methods of determining the modulus of elasticity were applied to the data sets to find the best way to compare our sponges to one another and to the human cornea.

Faculty Advisor: *Elizabeth J. Orwin, Engineering and Biology*

## Engineering Presentations Continued

1:30 P.M. **Nikhil Gheewala: *A Biocompatible Intraocular Pressure Bioreactor for Corneal Tissue Engineering***

An intraocular pressure chamber has been designed for use in culturing tissue-engineered corneas. A suitable material has been tested for biocompatibility and deformation following a series of autoclave cycles. The temperatures involved in autoclaving may affect the material properties after one or several cycles. The material may deform affect the ability of nearby cells to grow. Also, a system has been devised to regulate the chamber pressure so that it remains within a standard range of intraocular pressure. This process will culminate in the production of a pressure chamber ready for use in the summer.

Faculty Advisor: *Elizabeth J. Orwin, Engineering and Biology*

1:45 P.M. **David Greisen: *A Novel Blood Chemistry Analysis Instrument***

There is a need for small, low volume, inexpensive blood chemistry analysis instruments for remote villages, outpatient clinics and immunodeficient patients. An instrument was conceived to fulfill this need that uses mature inkjet technology to place very small precisely measured amounts of blood onto chemically impregnated paper, contained in an easily replaceable cassette. Color change or fluorescence, reflecting the degree to which various chemical components of blood were present, would be detected by a spectrophotometer. The idea has been refined and the feasibility tested over the past three semesters.

Faculty Advisor: *Elizabeth J. Orwin, Engineering and Biology*

2:00 P.M. **Break****Engineering—Galileo-McAlister**2:15 P.M. **Keith Miyake, Steve Lin, Jim Castelaz: *Development of a Power Monitoring System for Photovoltaic Power Generators at The Claremont Colleges***

Motivated by the recent power shortages throughout Southern California, three of The Claremont Colleges have recently installed photovoltaic power generators on their campuses to supplement the existing electrical grid power in hopes of reducing electricity costs. To determine the cost-effectiveness of these generators, it is necessary to measure and record the power generated. The purpose of this project is to develop a power monitoring system to allow the colleges to monitor the cumulative power output and cost savings for each of the solar arrays through a web-based graphical display.

Faculty Advisors: *B. Samuel Tanenbaum and Carl J. Baumgaertner, Engineering*

2:30 P.M. **Elizabeth Lee-Su: *Satellite Drop Production and Control***

Laminar liquid jets can be broken into a sequence of uniform size drops by the application of a sinusoidal disturbance. Smaller satellite drops are usually formed in between the main drops. This research aims to use harmonic sums of sinusoidal disturbances to control the size and production rate of these satellite drops. Experimental measurements of drop sizes as a function of jet flowrate and applied disturbance frequency have been carried out on 100 micron jets of isopropanol. Linear and nonlinear theories of capillary wave growth on the surface of a cylindrical liquid jet are used to guide the experimental program.

Faculty Advisor: *Anthony Bright, Engineering*

2:45 P.M. **David Lipke: *Dielectric Elastomer Actuators—Effects of Initial Thickness and Prestrain on 3M Acrylic-based Tapes***

Dielectric Elastomer Actuators (DEA) are flexible structures which store energy from an applied electric field and convert this energy to mechanical work through the Maxwell stress. A recent study on DEAs found that an inverse proportionality exists between actuator thickness and electric breakdown strength. An implication of the study is that prestrain of the elastomer increases the maximum voltage that can be applied before breakdown occurs. The purpose of this semester's research is to determine how initial thickness and prestrain affect the performance of DEAs made from 3M VHB acrylic tapes.

Faculty Advisor: *Joseph A. King, Engineering*

**Biology—Galileo-Pryne**

- 2:15 PM. **Ben Nahir: *Sequencing and Characterization of the Mitochondrial Genome of the Opisthobranch Sea Slug, *Aplysia californica****

I sequenced and characterized the complete mitochondrial genome (14,117 bp) of the opisthobranch sea slug, *Aplysia californica*. The genome's make up is identical to that of *Pupa strigosa*, one of only two other published opisthobranch mitochondrial genomes. The sequence also closely resembles the genomes of other pulmonate snails but shows more divergence when compared to prosobranch genomes. Phylogenetic analyses were performed using a concatenated alignment of all the genes in the genome in an effort to help resolve questions concerning the monophyly of the opisthobranch group and the overall makeup of the gastropod species.

Faculty Advisor: *Catherine S. McFadden, Biology*

- 2:30 PM. **Pamela Rettig: *Using ITS to Detect Hybridization in Soft Coral Species***

Initial study of allozymes and PCR-RAPD analyses of *Alcyonium digitatum*, *A. monense* and a morphologically-intermediate variant found sympatric to these two soft coral species suggest that the variant is a hybrid. Using restriction digestion analysis of the multicopy *ITS-1* sequence, I have attempted to confirm that the variant is an F1 hybrid. *ITS-1* sequences characteristic of each parental species should be found in equal proportions in an F1 hybrid. My preliminary results support the hybrid origin of the variant, but not necessarily that it is an F1.

Faculty Advisor: *Catherine S. McFadden, Biology*

- 2:45 PM. **Tara Martin: *Using Amplified Fragment Length Polymorphisms (AFLP) to Identify Species-Specific Genetic Markers in the Soft Coral Genus Alcyonium***

Species boundaries in many marine organisms can be difficult to determine due to morphological plasticity. Molecular techniques have often proven more useful. Amplified Fragment Length Polymorphism (AFLP) is a technique that produces a DNA fingerprint of an entire genome, and has been used particularly in plant studies. We adapted the AFLP technique for use with soft corals, and examined the reliability and effectiveness of this technique for finding species boundaries and diagnostic markers. The technique was tested on a group of soft corals in the genus *Alcyonium*, for which boundaries had been previously established.

Faculty Advisor: *Catherine S. McFadden, Biology*

- 3:00 PM. **Valerie Lake: *Characterization of Tetrahymena thermophila Gene, RBN1***

RBN1 is a highly conserved gene seen in prokaryotes and single and multiple celled eukaryotes. This study characterized the function of RBN1 in the single-celled eukaryote *T. thermophila* by observation and quantification of the phenotypes of cells in which RBN1 was disrupted. The characteristics examined were cell shape, nuclei shape and number, cell division, growth rate, and phagocytosis. The gene appears to affect functions related to the cytoskeleton. Its disruption produced strangely shaped cells that grew slowly and divided incorrectly or not at all. RBN1 appears to be essential because its disruption inhibited successful cell division.

Faculty Advisor: *David Asai, Biology*

**Physics—Galileo-Edwards**

- 2:15 PM. **Matthew Seetin: *Using Motion-Sensitive Optical Coherence Microscopy to Study Frog Gastrulation***

We have added motion-sensitivity to our optical coherence microscope by measuring the phase of the fringe signal. The precision of our phase determination is approximately 0.1 radians. This technique, as well as recent noise reductions in the instrument, allow for deeper imaging into the developing frog embryo. We have observed scatterers with a low average phase change and a high variance, indicative of sub-cellular particles undergoing Brownian motion. We think this motion information gives us a greater understanding of the gastrulation process.

Faculty Advisors: *Richard C. Haskell and Barbara Hoeling, Physics*

## Physics Presentations Continued

2:30 P.M. **Sean Skelly: *Building and Testing a 1300 nm Optical Coherence Microscope***

An optical coherence microscope (OCM) operating at 1300 nm has been constructed to improve depth penetration and resolution over those of our existing OCM instrument operating at 850 nm. We discuss the design of the new instrument and the successful observation of output fringes. A faster CPU in the new instrument allows us to assess the signal-to-noise ratio of the fringe signal, which enhances our motion-sensitive images. Depth and lateral resolution have been measured for the new instrument and are compared with theoretical predictions.

Faculty Advisor: *Richard C. Haskell, Physics*

2:45 P.M. **Emily A. Henage: *Who Ate Our Radishes?***

Let me “plant” some ideas in your head! I helped teach science in a 4th/5th grade combination class this year at Vista del Valle Elementary School in Claremont. Our major unit this semester focused on the class garden, necessities for plant life, and physical plant characteristics. Come see the “harvest” of working with elementary school students.

Faculty Advisors: *Peter N. Saeta and Robert P. Wolf, Physics*

3:00 P.M. **Thomas Henage: *The Magneto-Optical Kerr Effect***

When polarized light reflects off of a magnetic surface, the Magneto-Optical Kerr Effect (MOKE) causes a rotation in the polarization in proportion to the magnitude of the magnetic field. This allows us to use a polarized laser beam to map the domain structure of magnetic samples. The penetration of the laser beam provides information about multilayered samples. We are constructing a MOKE microscope designed to map magnetic structures with a resolution on the order of 30 microns.

Faculty Advisor: *Peter N. Saeta, Physics*

3:15 P.M. **Alex Laurich**3:30 P.M. **All Campus Reception —Galileo Foyer**

## 4:00 P.M.

■ **Presentation Days Address****Galileo-McAlister**

**Welcome:** F. Sheldon Wettack, Vice President and Dean of Faculty, and Professor of Chemistry

**Introduction:** Anna Ahn, Visiting Assistant Professor of Biology,

**Keynote Speaker:** Tyrone B. Hayes, Associate Professor of Biology, University of California, Berkeley

*“Common Groundsel, Hermaphroditic Frogs and Premature Babies: Today’s Solution, Tomorrow’s Problem”*

Tyrone B. Hayes, associate professor of integrative biology, University of California, Berkeley, a distinguished researcher, an award-winning tenured professor, and devoted husband and father, whose two children are often topics of his engaging lectures.

After majoring in organismic and evolutionary biology at Harvard, Dr. Hayes attended Berkeley for his Ph.D. He did postdoctorate work at the National Institutes of Health before returning to Berkeley, where he has been teaching and conducting research for eight years. His research focuses on the role of steroid hormones in amphibian development, and he conducts both laboratory and field studies in the U.S. and Africa. Metamorphosis and sex differentiation are two main areas of interest, but he is also interested in growth (larval and adult) and hormonal regulation of aggressive behavior. Amphibians are good research subjects because of their vulnerability to the environment, says Hayes. Frogs are considered a “sentinel” species, one whose sensitivity can alert researchers to problems in the environment. His 2002 research on how frogs are affected by atrazine, the world’s most widely used weedkiller, received widespread attention and called into question the safety of the insecticide. Dr. Hayes is currently examining the effects of exogenous steroids on gonadal differentiation and the potential role of endogenous steroids.

Presentation Days Address Continued

Dr. Hayes, who begins and ends each of his courses with the definition, "biology is the study of life," received Berkeley's 2002 Distinguished Teaching Award at the age of 35. "My goal is to ensure that students see each lecture as an explanation of a process relative to their lives and not as an esoteric lesson from a textbook." The award recognized his innovative course on human endocrinology and his dedication to undergraduate researchers, whom he makes it a point to include in his grant applications to the National Geographic Society, which has funded all of his fieldwork trips since 1992.

**Humanities and Social Sciences—Galileo-McAlister**

7:00 P.M.    **MS 127s: *The Harmony of Sound and Light***  
**Vignesh Arasu, Tim Carnes, Katie Compton, Brandt Erickson, Brad Greer, Daniel Kagan, Laura Kanofsky, Valerie Lake, Katie Lewis, Duane Loh, Andrew Mugler, John Silny, Erika Strandberg, Gabe Takacs, Selene Tan**

In this course, students study the arts of form and color in motion, especially in connection to music. For their final projects, students create abstract computer animations with music that will be screened for the first time at this show.

Course Instructor: *William Alves, Humanities and Social Sciences*

8:00 P.M.    **MS 182s: *Introduction to Video Production***  
**Dena Bodzin, Nat Bourne, Pilun Chen, Andrew Cole, Mike Cruz, Brandt Erickson, Rose Hakim, Ed Heaney, Michelle Hortter, Tonya Icenogle, Jason Komadina, Alice Liu, Jer McCoy, Stuart Mershon, Ben Nahir, Hubert Nguyen, Evan Porter, Josh Smallman, Jenny Xu**

We will present a sampling of short videos from the course's three assignments. The first assignment was to investigate how video distorts time. The second project was to create new meanings by editing "found footage." The last project topic was to create a documentary on a local subculture.

Course Instructor: *Rachel Mayeri, Humanities and Social Sciences*

**Tuesday , May 4, 2004**

**PROJECTS DAY**

**HMC Computer Science, Engineering, Mathematics and Physics Clinics**

Please see Projects Day Program for further details or visit <http://www.hmc.edu/acad/clinic/>

**10:30 A.M.**

- **Registration and Poster Sessions:**  
**Ronald and Maxine Linde Activities Center**

**1:00 P.M.**

- **General Session:**  
**Galileo-McAlister**  
*Welcome:* President Jon C. Strauss  
*Remarks:* Robert Wolf, Director, Physics Clinic  
*Milestone Awards:* F. Sheldon Wettack, Vice President and Dean of Faculty, and Professor of Chemistry  
*Program:* Robert Wolf, Director, Physics Clinic

**1:30 P.M.-5:00 P.M.**

- **Clinic Presentations:**  
**Classrooms, Galileo Halls and Labs**

**Wednesday , May 5, 2004**

**9:00 A.M.–11:30 A.M.**

■ **Research Presentations**

Ongoing **Chemistry 110: Diversity of Individuals in Chemistry** please see page 7

9:00 A.M. **Chemistry Presentations** please see page 19

9:00 A.M. **Engineering Presentations** please see page 19

9:00 A.M. **Physics Presentations** please see page 20

10:30 A.M. **Biology Presentations** please see page 22

10:30 A.M. **Mathematics and Interdisciplinary Comparisons in Modeling Presentations** please see page 23

**Humanities and Social Sciences Poster Session—Galileo Foyer**

All Day **HSS 190 Senior Experience: *Art Project***

**Lindsay Crowl: *Final Photo Show***

This has been a project in advanced digital photography, stressing both advanced techniques in Adobe Photoshop and camera work. The theme of my work has been organized around visual representations of Paul Simon songs.

Faculty Advisor: *Tad A. Beckman, Humanities and Social Sciences*

**Matt Livianu: *Final Photo Show***

This has been a project in advanced photography, stressing primarily documentary techniques. The theme of my work has been organized around homeless people in the Los Angeles area.

Course Instructor: *Phil Marquez, Humanities and Social Sciences*

All Day **Art 50: *Beginning Black & White Photography—Spring Photo Show***

**Allison Auld, Esther Lee, Gene Lee, Daphne Park, Cal Pierog, Sarah Price, Tamara Reimer, Alexis Utvich, Alexis Clements**

This is our end-of-semester presentation of black & white photography.

Course Instructor: *Phil Marquez, Humanities and Social Sciences*

**Engineering 172 Poster Session—Galileo Foyer**

All Day **E172 Structural Mechanics: *E172 Final Project Display***

**Brian Brenhaug, Alyssa Caridis, Sharon Jeun, David Lipke, Kenneth Maples, Chuck Matlack, Daphne Park, Daniel Roche, Michelle Sakai, Stephanie Svetlik, Diana Warden, Stephanie Wong**

Tensegrity structures are trusses designed with a careful arrangement of elements in tension and compression. Compression elements are fabricated from solid bars, while tensile elements are wires, strings or cables. Because tensegrity structures are designed with no two compression elements touching each other, the solid elements appear to be floating in the structure. Students selected materials, designed and built these structures, and analyzed the forces in them with a computational method that is a focus of the course. Their structural art will be on display.

Course Instructor: *Lori C. Bassman, Engineering*

**Engineering—Galileo-McAlister**

**Engineering 158: Introduction to CMOS VLSI Design: VLSI Design Projects**

Course Instructor: *David Harris, Engineering*

9:00 A.M.   **Charles Matlack, Alex Utter: *Asynchronous Hamming Decoder***

9:10 A.M.   **Josh Smallman, Keith Stevens: *Alarm Clock***

9:20 A.M.   **Ko Ihara, Shane Ouchi: *Alarm Clock with Snooze***

9:30 A.M.   **Kyle Kelley, Daniel Woo: *OCDMA Decoder***

9:40 A.M.   **Mark Locascio, Daniel Rinzler: *EKG Analyzer***

9:50 A.M.   **Kevin Alley, Nicole Kang: *Four-Function Calculator***

10:00 A.M.   **Reception, Mathematics and Biology Departments—Galileo Foyer**

10:30 A.M.   **Renee Logan, Philip Vegdahl, U. Kazancioglu, O. Pacin, M. Silay: *Floating Point Adder***

10:40 A.M.   **Brad Greer, Knut Strom-Jensen: *32-bit Floating Point Adder***

10:50 A.M.   **Shamit Grover, Andrew Cole, O. Yilidirim, S. Sutay, M. Elalmis: *A Hardware Firewall***

11:00 A.M.   **Dan Chan, Tommy Leung: *Digital-to-Analog Converter***

Engineering Presentations Continued

11:10 A.M.   **Galen Chui, Waley Tam: *Analog-to-Digital Converter***

11:20 A.M.   **Karen Lee, Kevin Chu: *3-D Tic-Tac-Toe & Connect Four***

**Chemistry—Galileo-Pryne**

9:00 A.M.   **Tyrel M. McQueen: *A Novel Approach to the Study of Equilibrium Phase Behavior in Multi-Aggregate Systems—Theory and Practice***

The Karukstis group uses fluorescence probes to study the micro-environments present in aggregates formed in aqueous surfactant mixtures. One observation is that the peak fluorescence intensity and shape of the probes changes substantially depending on the type and number of aggregates present (micelle, etc.). A well-known fitting algorithm was utilized to extend the approach, using the “fluorescent fingerprints” characteristic of particular aggregates to elucidate multi-aggregate regions. Results are presented for both the heptane/propanol/water and the cetyltrimethylammonium bromide (CTAB)/sodium octyl sulfate (SOS)/water systems.

Faculty Advisor: *Kerry K. Karukstis, Chemistry*

9:15 A.M.   **Courtney Rotstan: *Characterization of Synthetic Antimicrobial Peptides using Catanionic DDAB-AOT Unilamellar Vesicles***

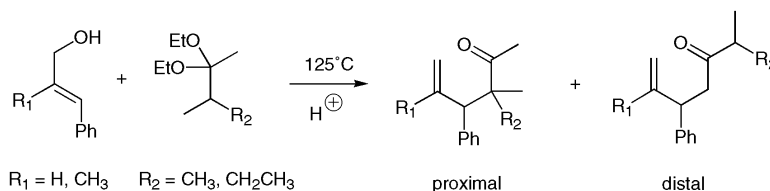
Cyclic D,L- $\alpha$ -peptides, a promising new antibacterial agent developed by the Scripps Research Institute, were investigated using tryptophan fluorescence and “catanionic” vesicles of varying surface charge. In particular, the role of electrostatics in peptide efficacy was examined using two peptides differing only in one amino acid residue – histidine versus lysine – that display large differences in *in vivo* and *in vitro* toxicity to methicillin-resistant *S. aureus*. Results are presented for both the histidine- and lysine-containing peptides at pH 5 and pH 7 for the model vesicle system of didodecyldimethylammonium bromide (DDAB) and aerosol sodium octylsulfate (AOT).

Faculty Advisor: *Kerry K. Karukstis, Chemistry*

Chemistry Presentations Continued

9:30 A.M. **Elizabeth Walsh: Experimental and Density Functional Theory Examinations of the Regioselectivity of the Ketal Claisen Rearrangement**

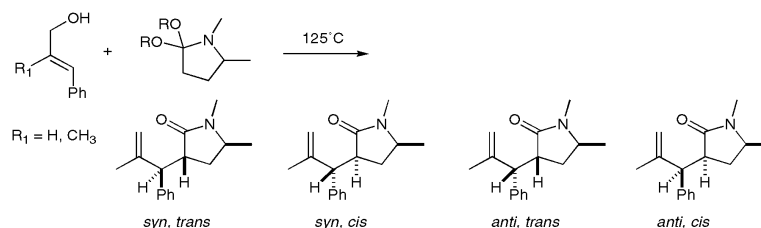
The regioselectivity of the Claisen rearrangement was examined for four systems. The ratio of distal and proximal products from Claisen rearrangements of cinnamyl and  $\alpha$ -methyl cinnamyl alcohol with (2,2)-diethoxy-3-methyl butane and (2,2)-diethoxy-3-methyl pentane were determined and the products were characterized. Both less complex model Claisen rearrangement systems and the (2,2)-diethoxy-3-methyl butane system were investigated by modeling the chair/boat transition states using density functional theory with B3LYP using the 6-31g(d) and 6-311g(d,p) basis sets. The experimental results were compared to the results from theory.



Faculty Advisors: *Robert J. Cave and G. William Daub, Chemistry*

9:45 A.M. **Aaron Jacobs: Transition State Topologies of the Amide-Acetal Claisen Rearrangement for Acetals of Cyclic Amides**

The chair/boat topology of the transition state for the amide-acetal Claisen rearrangement has previously been examined for amide-acetals of cyclic N methyl derivatives of 5, 6 and 7-membered rings. The partitioning of the reaction through chair and boat topologies can be determined directly from syn/anti selectivity of the reaction. The Claisen rearrangements of cinnamyl and methyl cinnamyl alcohols with the amide acetal of 1,5-dimethyl-2-pyrrolidinone were studied, and an attempt was made to separate and characterize the products.



Faculty Advisors: *G. William Daub, Chemistry*

Physics—Galileo-Edwards

9:00 A.M. **Elizabeth J. Main: Second-Harmonic Generation in the Surface Limit**

In the nonlinear optical process of second-harmonic generation (SHG), an atom absorbs two laser photons and emits a single photon at twice the frequency. To test a limiting case of a general phenomenological theory of harmonic generation in multilayers, we are using femtosecond laser pulses to study the intensity of SHG produced at the surface of a thin gold film as a function of film thickness. An accurate model of the results must account for surface roughness.

Faculty Advisor: *Peter N. Saeta, Physics*

## Physics Presentations Continued

9:15 A.M.   **Steve Kolthammer: *Second-Harmonic Generation from Thin Silicon Films***

Measurements of second-harmonic generation from thin silicon films are obtained to distinguish bulk and surface contributions. Second-harmonic light is generated in silicon of thickness 1-100 nm with a fundamental beam of 800-nm wavelength, 100-fs pulses at 1 kHz. These results are used to test a general phenomenological theory of harmonic generation in multilayer structures, as applied to a material of cubic symmetry and (001) orientation. The relevant nonlinear optical susceptibility elements for the surface and bulk tensors, including a previously unmeasured bulk component, are investigated.

Faculty Advisor: *Peter N. Saeta, Physics*

9:30 A.M.   **Kit Rodolfa: *Brane Surgery in the Matrix—How We Connect The Dots***

String theory is a theory of much more than strings—current formulations include fundamental objects of many dimensionalities, from point-like particles (called D0-branes) to sheet-like objects (called D2-branes) to higher dimensional “Dp-branes” living in 9 or 10 dimensional space! While such a wide spectrum of objects seems unreasonably complex for a fundamental theory, recent work suggests that all of the Dp-branes may be constructed from point-like D0s. In the present research, we have analyzed the dynamics of a membrane like configuration of D0-branes in the form of a cylindrical shell rotating about its symmetry axis.

Faculty Advisor: *Vatche V. Sahakian, Physics*

9:45 A.M.   **Duane Loh: *Radiation from Spinning Cylindrical D0 Branes***

In a certain context of string theory, D0-branes, i.e. a particular type of point-like lumps of energy, can be thought to be fundamental building blocks of the theory. In this work, we find a cylindrical configuration of spinning D0-branes which can be useful as a toy model for understanding unusual dynamics in cosmological “brane-world” scenarios. We investigate various forms of radiation emitted by this configuration, and explore some of the dynamics.

Faculty Advisor: *Vatche V. Sahakian, Physics*

10:00 A.M.   **Reception Mathematics and Biology Departments—Galileo Foyer**10:30 A.M.   **Candace Church: *Observations of the Molecular Cloud Along the Line of Sight to the Perseus Star Association***

I present new results from the STIS instrument on the Hubble Space Telescope relating to the Perseus star association and molecular cloud. These observations are used to determine precise models of the kinematics and relative abundances of ions and atoms within the cloud. The column densities, velocities, and line widths for several ionized and non-ionized species, including S I, S II, Mg II, Mn II, and Ni II were obtained by fitting Hubble STIS spectra in the wavelength region between 1150 and 1550 Å with an interactive fitting program. The resulting column densities were used in conjunction with the CLOUDY program to model conditions and constrain the density, pressure, temperature, and ionizing flux within the clouds.

Faculty Advisor: *Bryan E. Penprase (Astronomy, Pomona College)*

10:45 A.M.   **Tamara Reimer: *Determining the Distance to the Draco Molecular Cloud Using Automated Spectral Classification***

By constraining the distance to the Draco Molecular Cloud, other cloud properties can be derived that may help us to understand the origins of the cloud and possibly more about the history and dynamics of our galaxy. An IDL routine that compared the total, H lines, Ca II lines, and G band regions of sample spectra to an atlas of spectra with known types was created in order to find temperature and luminosity classes for stars in the direction of the Draco Cloud. From these temperature and luminosity classes, the distance to the Draco Molecular Cloud may be estimated.

Faculty Advisor: *Bryan E. Penprase (Astronomy, Pomona College)*

## Physics Presentations Continued

11:00 A.M. **Robert Law: *Modeling the X-ray Source X-7—Black Hole or Neutron Star?***

X-7 is an eclipsing x-ray binary system in the galaxy M33. The system consists of a “normal” star whose mass is spilling over onto a compact object. This object was originally thought to be a neutron star, but more recent observations place the system in ambiguous territory: X-7 is now considered to be a black-hole candidate. Using ellipsoidal and x-ray heating models for the optical companion star, we attempt to constrain the physical parameters of this binary system and aid in the identification of the compact object.

Faculty Advisor: *Ann Esin, Physics*

11:15 A.M. **Mary E. Peter: *Teaching High School Physics Students about Work***

I helped teach 11th and 12th grade physics students at Claremont High School in the Project Physics course. Things I've learned: (a) 31 students is too many to keep track of; (b) demonstrations don't always work out the way they're supposed to; and (c) cat defenestration helps engage students in a discussion of terminal velocity. Come see if you can solve the loop-the-loop problem.

Faculty Advisors: *Peter N. Saeta and Robert P. Wolf, Physics*

**Biology—Galileo-Pryne**10:30 A.M. **Melanie Lee: *Development of Transparency Assays for Tissue-engineered Corneal Replacements***

Characterization of the optical properties is critical in the tissue engineering of the corneal replacements. We used microscopic and molecular assays to quantify transparency of the tissue. Using HMC Physics Department's optical coherence microscope (OCM), we measured the degree of light scattering from the engineered corneal replacements relative to that of the native rabbit cornea. We also used real-time RT-PCR technique to measure the mRNA expression levels of aldehyde dehydrogenase 1 (ALDH1) and transketolase (TKT), molecular markers for transparent cell phenotype. Western blot was used to confirm the presence of the two proteins.

Faculty Advisor: *Elizabeth J. Orwin, Biology and Engineering*

10:45 A.M. **Christopher Raub: *Immunogold-mediated Contrast Enhancement of Corneal Stromal Cells in Tissue-engineered Corneas Using Optical Coherence Microscopy***

In order to detect corneal stromal cells and their phenotype in tissue-engineered corneas, colloidal gold was conjugated to antibodies that recognize an extracellular epitope on the alpha-5 beta-1 integrin receptor. Immunogold-labeled cells were detected using optical coherence microscopy (OCM). Spectrophotometry confirmed antibody:gold conjugation. An immunofluorescence study confirmed the integrin specificity of the antibody. OCM data shows that unconjugated colloidal gold nonspecifically enhances cell and protein contrast, whereas antibody conjugated gold enhances contrast of targeted cell phenotypes.

Faculty Advisor: *Elizabeth J. Orwin, Biology and Engineering*

11:00 A.M. **Evan Cohick: *Root-to-Shoot Cold Signaling in Arabidopsis thaliana***

The *SAC9* gene in *Arabidopsis thaliana* codes for a phosphatidylinositol phosphatase that breaks down phosphatidylinositol 4,5-bisphosphate (PIP<sub>2</sub>), a membrane-bound signal involved in cold signaling. The *sac9-1* null mutant has reduced *SAC9* mRNA transcript and elevated levels of PIP<sub>2</sub> in the roots, however the mutant expresses an abnormal shoot phenotype, and biochemical data suggest the existence of an acropetally diffusing signal. I have been micrografting wild-type shoots to *sac9-1* roots and vice-versa to investigate whether the *sac9-1* mutant does indeed produce a diffusible stress signal that travels to the shoot and causes the abnormal shoot phenotype.

Faculty Advisor: *Mary E. Williams, Biology*

## Biology Presentations Continued

11:15 A.M. **Michelle Hortter: *Phenotypic Characterization of the SAC Family of Genes in Arabidopsis***

Phosphoinositides are membrane-bound proteins that are involved in multiple functions in eukaryotes, including osmotic signaling, vesicle trafficking, and actin filament polymerization in the cytoskeleton. This study focuses on phenotyping *Arabidopsis* mutants of the SAC family of genes, which encode phosphatidylinositol phosphate phosphatases that degrade a phosphoinositide signal. Genetic crosses using plant lines with mutations in 9 individual SAC genes were used to produce double mutants, on which analysis was then done to further elucidate the mutant phenotypes, revealing possible distinct functions of the 9 SAC genes in *Arabidopsis*.

Faculty Advisor: *Mary E. Williams, Biology*

**Mathematics and Interdisciplinary Comparisons in Modeling Presentations—Beckman B126**10:30 A.M. **Steven Avery, Eric Harley and Eric Malm: *Mathematical Modeling of Fingerprints as Forensic Evidence***

In the wake of such hearings as “Daubert v. Merrill Dow Pharmaceutical”, the legitimacy of fingerprints as forensic evidence has been called into question. In order to resolve this debate, we develop a mathematical model of fingerprint structure that captures both the overall topological structure and the low-level detail present in a fingerprint and takes into account the uncertainties inherent in determining this structure. We then use parameter estimates that correspond to ideal conditions to estimate the probability that fingerprints are unique from person to person and those that correspond to more realistic conditions to compare the accuracies of fingerprint and DNA forensic evidence.

Faculty Advisor: *Jon Jacobsen, Mathematics*

10:45 A.M. **Les Fletcher, David Gleich, and Jeffrey Hellrung: *A Mathematical Modeling Evaluation of QuickPass Systems on Amusement Park Lines***

In this presentation, we consider QuickPass systems as a solution to extremely long amusement park lines. As amusement park ride lines become longer, visitor satisfaction decreases. The QuickPass system attempts to remedy this double problem by allowing an individual to access a kiosk for a particular ride, receive a stub with a wait time, and, after the wait time has passed, enter a separate QuickPass line (which, ideally, would be much shorter than the normal line). We developed three models to analyze the effect of the QuickPass system on line length. The first is a continuous model of line lengths without a QuickPass system; the second is also a continuous model with the addition of QuickPasses; and the third is a discrete time simulation of an amusement park to simulate actual lines. We used data from real amusement parks to investigate the properties of these models.

Faculty Advisor: *Jon Jacobsen, Mathematics*

11:00 A.M. **Warren Katzenstein, Tara Martin, Michael Vrable: *How to Make the CIA Work for You!***

We developed a general model for formulating network security systems with minimal costs. Our model uses the standard categories of confidentiality, integrity, and availability (CIA) to create a security profile for a company. We then numerically determine an optimal combination of security measures from a set database. We rely on estimated CIA values, and costs over a fixed length of time to compare defense measures. The result is a model that is flexible enough to initially and periodically assess a variety of company models and incorporate changes in security technology.

Faculty Advisor: *Jon Jacobsen, Mathematics*

11:15 A.M. **Eli Bogart, Cal Pierog, Lori Thomas: *It's All About the Bottom Line—Winning the ICM through Showmanship, Low Expectations and the CIA***

We will describe our development of a cost-benefit model of security configurations for an arbitrary computer network, tell you how to make it through the ICM alive, and suggest reforms of the ICM competition. Alternately, come hear how Shakespeare, the Goldbach Conjecture and guys with sticks helped our sleepless minds churn out a full model of 29 pages and in just 4 days.

Faculty Advisor: *Jon Jacobsen, Mathematics*

11:30 A.M.

■ Lunch Break

1:15 P.M.—5:15 P.M.

■ Research Presentations

1:00 P.M. **Engineering4 Presentations please see page 25**

1:15 P.M. **Physics Presentations please see page 27**

1:45 P.M. **Computer Science Presentations please see page 28**

4:15 P.M. **Independent Studies Presentation please see page 29**

4:30 P.M. **Humanities and Social Science Presentations please see page 29**

### Chemistry—Galileo-Pryne

1:15 P.M. **Chemistry 112: Mock Coroner's Inquest**

2:45 P.M.

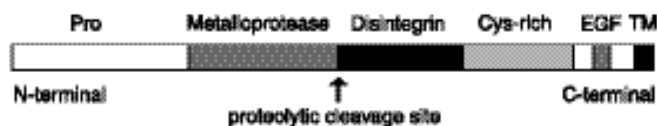
Mock Coroner's Inquest: Students in **Chemistry 112 (Instrumental Methods Laboratory)** will present their findings regarding the physical evidence gathered in a fictional death investigation. A list of the physical evidence and crime scene photos are available at <http://www4.hmc.edu/chemistry/112/CSI>. Members of the community are invited to participate as the jury in this mock coroner's inquest.

Course Instructor: *Hal Van Ryswyk, Chemistry*

2:45 P.M. **Reception, Engineering and Computer Science Departments—Galileo Foyer**

3:15 P.M. **Kevin Esvelt: Identification of Proteases Responsible for Epididymal Processing of the Sperm Surface Protein Fertilin b**

Epididymal serine proteases fractionated by phenylboronic acid affinity chromatography were tested for proteolytic activity using a recombinant GFP-fertilin b-His protein assay.



**Figure 1.** Domain structure and proteolysis site of mouse fertilin  $\beta$ .

Faculty Advisor: *Hal Van Ryswyk, Chemistry*

3:30 P.M. **Alexis Kaushansky: Filling in the Black Box between I-CreI induced DNA Ceavage and Double-Strand Break Repair**

I-CreI is a small, dimeric protein that cleaves double-stranded DNA at a 24 bp recognition site. After cleavage, the DNA undergoes homologous recombination (HR), a repair pathway that inserts the open reading frame of I-CreI at the site of the double-strand break. Unlike many endonucleases, I-CreI remains stably bound to its substrate after hydrolysis. Little is known about the steps between hydrolysis and HR. We overexpressed and purified I-CreI with a hexa-his-tagged construct. Gel-shift assays were designed to illuminate the specific protein-DNA contacts crucial for post-cleavage binding.

Faculty Advisor: *Karl Haushalter, Chemistry*

## Chemistry Presentations Continued

3:45 PM. **Ryan Mashiyama: *The Rate of DNA Repair by hSMUG1***

The enzyme hSMUG1 is a single-strand-selective uracil DNA glycosylase that excises uracil from single- and double-stranded DNA. This enzyme will be synthesized to gather information about its rate and mechanism of repair on naked and nucleosomal DNA. According to the current model for target site localization, hSMUG1 initially binds DNA non-specifically and then scans along the length of the DNA molecule using one-dimensional diffusion to locate uracil residues. This facilitated diffusion model will be tested by studying the kinetics of uracil repair with DNA substrates of varying length.

Faculty Advisor: *Karl A. Haushalter, Chemistry and Biology*

4:00 PM. **Kit Rodolfa: *hUNG up on U***

DNA faces a constant battle for the integrity of the data it encodes. Every day it is threatened by numerous mutagens. Several proteins exist in the cell solely for the purpose of identifying DNA lesions where they occur and repairing them. The present research seeks to explore the interaction of one class of proteins, the uracil DNA glycosylases, typified by human uracil DNA N-glycosylase (hUNG), with the elementary unit of chromatin, the nucleosome. Work presented will include the overexpression and purification of the uracil DNA glycosylase helper protein APE1, the development of uracil containing DNA substrates, and suggestions for future experimentation.

Faculty Advisor: *Karl A. Haushalter, Chemistry and Biology*

**Engineering—Galileo-Edwards and Galileo-McAlister****Engineering 4: Introduction to Engineering Design**1:15 PM. **Digital Wound Monitoring Device**

**Galileo-Client:** Department of Physical Therapy, Pomona Valley Hospital and Medical Center (PVHMC)

**Edwards-Liaison:** Joseph Baumgaertner

**Faculty Advisors:** *Mary Cardenas and Elizabeth J. Orwin, Engineering*

**Initial Problem Statement:** PVHMC's Department of Physical Therapy (DPT) uses a digital camera to photograph and document the size and nature of wounds. Digital cameras offer significant cost and portability advantages. However, to establish progress (or deterioration) of a wound over time, images taken during the course of care must be taken in such a way that they are comparable. The DPT would like to develop a system for a digital camera that would replicate their prior work in this area that used a Polaroid camera with a flash, fixed focus lens and an infrared "eye" that signaled when the camera was at a specific distance from the subject. Furthermore, the film had a pre-etched grid of 1 cm squares that allowed easy estimation of wound size. Thus, the goal of this project would be to figure out how to get images from a digital camera that are as comparable as those from their Polaroid while maintaining the cost saving and other advantages of digital images.

1:15 PM. **Team A:** Paul Chandler, Jacques Favreau, Carrie Meldgin, Clarence Rowland

1:30 PM. **Team B:** Stephen Brawner, Cassie Chou, Josh Hwung, Heather Schalliol

1:45 PM. **Team C:** Ryan Ellis, Nicole Esclamado, Walter Liau, Jamie Shoffeitt

2:00 PM. **Team D:** Richard Garfinkel, Emily Hogan, Eli Kwitman, John Hankinson

2:15 PM. **Team E:** Lindsay Muth, John Parker, Daniel Pivonka, Shannon Scovall  
(done by 2:30 PM.)

Engineering Presentations Continued

1:15 P.M. **Data Monitoring for Fish Aggregation Devices**  
**Galileo-** **Client:** Scripps Institution of Oceanography  
**McAlister** **Liaison:** Dr. Peter Nelson  
**Faculty Advisors:** *Mary Cardenas and Clive L. Dym, Engineering*

**Initial Problem Statement:** Most of the world's tuna catch is from Fish Aggregation Devices (FADs), which are nothing more than bamboo rafts with some nylon webbing dangling beneath it and tracked with a GPS or radio beacon. Better information about how tuna and other fishes can be found with these resources would be extremely useful. We need a device that can sample a vertical profile of the water column by taking an instrument package to a desired depth, and then return to the surface. The instrument package would collect data at several stations on the way down or up. We hope to use experimental FADs to sample the water around them for the presence, abundance and distribution of fishes.

- 1:15 P.M. **Team A:** Rick Havlak, Daniel Percival, Josh Sinanan, Stephen Yu
- 1:30 P.M. **Team B:** Chris Acon, Jennifer Shockro, Todd Taniguchi, Victor Wang
- 1:45 P.M. **Team C:** Jens Gardner, Lesley McGurk, Amanda Painter, Tyler Posten
- 2:00 P.M. **Team D:** Diego Gonzalez, Allison Hutchings, Amy Jarvis, Stephen Wyckoff
- 2:15 P.M. **Team E:** Tyler Brown, Renee Campbell, Kyle Jacobs, Lauren Lacount
- 2:30 P.M. **Team F:** Fang-Yuan Chang, Max Pflueger, Michael Pugh

2:45 P.M. **Reception, Engineering and Computer Science Departments—Galileo Foyer**

3:15 P.M. **Table Display for HMC Alumni Association**  
**Galileo-** **Client:** HMC Alumni Association  
**Edwards** **Liaison:** Gerald Van Hecke '61  
**Faculty Advisors:** *Clive L. Dym and Elizabeth J. Orwin, Engineering*

**Initial Problem Statement:** The HMC Alumni Association needs a table display for college fairs. The display should fit on a table, be easily assembled and disassembled, fit in a standard mailing tube, and be lightweight. The display needs to have at least a two-sided display of a 36"x36" poster and attract attention in a clever and neat way.

- 3:15 P.M. **Team A:** Whitney Buchanan, Laurel Fullerton, Badier Velji, Caitlin Vierra
- 3:30 P.M. **Team B:** Eddy Chavarria, Sheri Markwardt, Heather Martelle, Jason Swaim
- 3:45 P.M. **Team C:** Sarah Estrada, Peter Hillegas, Becky Kelcher, Alex Wright

Engineering Presentations Continued

**Thermal History Monitoring Device for Nasal Cartilage**

**Client:** University of California, Irvine, Medical Center

**Liaison:** Dr. Brian Wong

**Faculty Advisors:** Clive Dym and Elizabeth Orwin, Engineering

**Initial Problem Statement:** Laser cartilage reshaping involves the use of surgical lasers to heat tissue maintained in mechanical deformation. Heat accelerates stress relaxation which leads to shape change. This procedure is investigational and performed in the nose (septum) and external ear. One problem with this technology is the control of heating. Cartilage and the mucous membranes or skin that cover it are relatively thin and the combination of deep laser energy penetration and heat conduction often lead to full thickness injury to the tissue. In order to optimize and reduce the effect of uncontrolled heat generation, cooling can be applied to the surface of the tissue that is opposite the irradiated segment. So one side is heated with a laser, while the other side is cooled via some mechanism (cryogen spray, contact cooling, thermoelectric, water etc.). At present, this area has not been explored and what is needed is a simple device/jig that can monitor internal mechanical stress in cartilage while at the same time record back surface temperature. This would allow testing of numerous potential cooling mechanisms during laser heating, and accelerate the development of clinical devices to optimize laser cartilage reshaping.

4:00 PM. **Team A:** Ronn Gruer, Greg Nielsen, Ian Preston, Gordon Whyburn

4:15 PM. **Team B:** Tracy Fox, Scott Mahr, Gen Satoh, Max Smoot

4:30 PM. **Team C:** Philip Cheung, Fiela Gutierrez, Ted Jiang, Michael Saldana

3:15 PM. **Patient Input Device for Automated Stroke Diagnosis System**

**Galileo- Client:** CIMIT

**McAlister Liaison:** Patrick Little

**Faculty Advisors:** Mary Cardenas and Elizabeth J. Orwin, Engineering

**Initial Problem Statement:** The CIMIT Clinic Team is designing an automated stroke diagnosis system. Part of the system includes having elderly patients look at graphics of a key, hammock and bird. The patients are then told to point to a specific item. We want a way to automate this procedure without having an expensive touch screen. The device needs to be safe, reliable for diagnostic purposes, inexpensive, and produce output that can be read by a standard computer using Labview.

3:15 PM. **Team A:** Nick Alger, Rosalind Beckwith, Nicolas Flacco, Betsy McIver

3:30 PM. **Team B:** Nicholas Evans, Ben Lickly, Paul Yen, Kevin Zielnicki

3:45 PM. **Team C:** Mark Emanuel, James Steele, Christina Tang, Matt Totino

4:00 PM. **Team D:** Alice Clifton, Aaron DeFeyter, Mackenzie Miller, Eduardo Ruvalcaba

**Physics—Beckman B134**

1:15 PM.— **Physics 170: Computational Physics**

4:15 PM. Students in the computational physics course will present their work simulating a variety of systems.

These are likely to include the following:

- a magnetic toy consisting of two spinning three-fold symmetric rotors
- a leaking waterwheel that exhibits chaotic motion
- percolation
- the ferromagnetic transition in the Ising and Heisenberg models
- a "strange" bead-string toy somewhat akin to a double pendulum, but of varying length
- wave functions and energy levels of polyelectronic atoms
- a molecular dynamics simulation of the vapor-liquid phase transition
- the role of rough walls in producing thermal behavior in a simulation of an ideal gas

Faculty Advisor: Peter N. Saeta, Physics

**Computer Science—Beckman B126**

1:45 P.M. **Aja Hammerly: *Jazz Analysis using Logical Programming***

Prolog, a powerful paradigm for specifying relational rules, provides an ideal basis for modeling the relationships between chords, scales, and melody in music. Although there are genre-related expectations in jazz solos, such as goal note usage, the rules that govern specific solos is an open question. Our tool will allow us to explore the patterns in various solos and then to use this data to improve the computer's ability to interact with live performers.

Faculty Advisor: *Belinda Thom, Computer Science*

2:00 P.M. **Mark Nelson: *Real-Time MIDI Performance Evaluation***

MIDI is a widely-used protocol for interconnecting electronic musical components such as synthesizers. It is now commonly used for computer music applications, but testing its performance in real-time settings has been rather ad-hoc and uncommon. We have developed a set of proposed benchmarks as well as software to run these benchmarks in real time, which should allow others to easily quantify the performance of their systems. We present a sampling of results from a number of such tests we have conducted ourselves over a range of interfaces (USB, parallel port and PCI) and operating systems (Mac OS X, Linux and Windows).

Faculty Advisor: *Belinda Thom, Computer Science*

2:15 P.M. **Brandt Erickson: *Investigating SIFT Image Features***

An important challenge in computer vision is to extract meaningful, repeatable features from raw image information, most commonly encoded as red, green and blue pixel intensities. SIFT is an image processing technique introduced at UBC for finding visual features in grayscale images. Those features are determined by locating regions of high contrast over the course of several Gaussian smoothings of an image. Recent research has shown SIFT to be robust under changes in image scale and orientation. The goal of this work is first to research and understand SIFT feature extraction and recognition and second to adapt SIFT to work with color images.

Faculty Advisor: *Zachary Dodds, Computer Science*

2:30 P.M. **Michael Coupland: *Silhouette Roughening***

One of the most noticeable issues with polygon-based rendering is the prominence of straight lines and hard angles in the silhouettes of rendered objects. We investigated a method of roughening the silhouette by extruding silhouette edges to form *fins*. The fins are mapped with a mask texture to provide the illusion of roughness.

Faculty Advisor: *Elizabeth A. Sweedyk, Computer Science*

2:45 P.M. **Reception, Engineering and Computer Science Departments—Galileo Foyer**

3:15 P.M. **Michael Vrable: *A Flexible Proportional-Share Disk Scheduler***

Proportional-share disk schedulers aim to share access to a hard drive so that competing applications each receive some fixed percentage of the disk accesses. This can be important, for example, to properly stream video from a disk. We propose a design for an efficient proportional-share scheduler built on top of a traditional disk scheduler, providing a combination of service guarantees and good overall performance. The scheduler allows the interaction between short-term fairness and long-term performance to be adjusted. We present simulation results that compare the performance with traditional disk schedulers.

Faculty Advisor: *Geoffrey H. Kuenning, Computer Science*

Computer Science Presentations Continued

3:30 P.M.   **George Kuan: *Design of an Optical Network Simulator***

Optical networking is an important emerging technology. Many researchers are actively designing algorithms and protocols for message routing in such networks. Simulation tools are needed to help understand the complex interactions of message traffic in such networks. This talk will present progress on the design of a new simulation tool which allows researchers to empirically evaluate routing algorithms in optical networks employing wavelength-division multiplexing (WDM).

Faculty Advisor: *Ran Libeskind-Hadas, Computer Science*

4:00 P.M.   **Break**

**IPS—Beckman B126**

4:15 P.M.   **Leslie Karp: *Correlating Academic Enrichment Programs, Student Self-efficacy, and Academic Performance in Secondary Math and Science***

This project investigated relationships between high-school students' participation in academic enrichment programs, academic performance, and sense of self-efficacy in math and science. The data we used included student transcripts of grades and standardized test scores, a survey of attitudes toward math and science, student interviews, and a measure of their participation in Upward Bound, MESA, and Harvey Mudd's Outreach Program. Our results show that significant differences do exist between participating and non-participating students—both in their grades and their attitudes toward math and science.

Faculty Advisor: *Zachary Dodds, Computer Science*

**Humanities and Social Sciences—Beckman B126**

4:30 P.M.   **Tara Martin: *Developing Countries and International Climate Change Policy—A Case Study of the Alliance of Small Island States (AOSIS)***

Developing countries face serious disparities in size, wealth and resources that put them at a disadvantage in international relations. However, the cooperation of these countries is critical to the success of global environmental protection efforts. The Alliance of Small Island States (AOSIS) is a coalition of developing countries that has gained significant influence in climate change negotiations. We examine the methods used by AOSIS to gain expertise and influence in this arena. Specifically, what hurdles did the group face, and how did they acquire the scientific, legal and economic resources to overcome these obstacles.

Faculty Advisor: *Paul F. Steinberg, Humanities and Social Sciences*

**Humanities and Social Sciences—Platt Campus Center-Green Room**

7:00 P.M.   **IE 84: *Mathematics and Music—The Cosmic Harmony***

The Integrative Experience (IE) at HMC explores the interaction between science, technology and society. The students in this course explored the relationship between music and mathematics, and created original compositions of mixed acoustic instruments and computer-generated music. Also featured will be Chris Raub's final senior project, a composition for piano, cello and violin.

Course Instructors: *William Alves, Humanities and Social Sciences and Michael Orrison Jr., Mathematics*

8:30 P.M.   **Music 84: *Jazz Improvisation***

**Players: Kristina Bajema (piano), Colin Delaney (trumpet), Nicholas Demarest (piano), Ryan Emry (guitar), John Hankinson (trumpet), Jessica Hoover (piano), Stephen Jones (electric bass), Elizabeth Main (cello), Daniel Pederson (vocal), Alexis Piazza (drums), Michael Saldana (tenor saxophone), Mele Sato (vocal), Ansel Schmidt (drums), Wayne Tanaka (trombone), Elliott Temkin (guitar), Joseph Walker (guitar), Carl Yerger (drums)**

The Jazz Improvisation class initiates or enhances the abilities of motivated students in the art of jazz improvisation. This performance will feature several of the famous works of pianist/composer Horace Silver.

Course Instructor: *Robert M. Keller, Computer Science*



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