



**Presentation Days 2001**  
*Program and Abstracts*

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Monday, April 23

9:00 A.M.-12:00 P.M.

**Research Presentations**

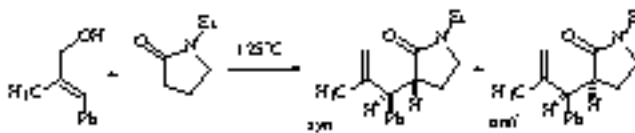
**Chemistry - Galileo-Pryne**

9:30 A.M. **Stacey C. Thonstad:** *Spectroscopic Characterization of Microdomains within Dendrimer-surfactant Supramolecular Assemblies - Single and Dou*

We have created supramolecular structures combining Starburst (polyamidoamine) dendrimers with surfactants of different chain lengths and volur positively charged dendrimer arms and anionic surfactants. We performed fluorescence spectroscopy on the neutral probe Prodan to characterize th combinations in order to encapsulate Prodan.

9:45 A.M. **Blaine Hackman:** *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 been examined for amide acetals of cyclic N-methyl, membered rings. The chair/boat topology of the transition state can be determined from the syn/anti selectivity of the reaction. The substitution patt For Claisen rearrangements that occurred at 125\_C, syn/anti selectivity ranged from 2.2 to 11.4, with yields from 60\_80%.



10:00 **Mathematics and Physics Departments Reception - Galileo Foyer**

A.M.

10:30 **Eric Vinson:** *Creation of Diblock Copolymer Nanoporous Templates*

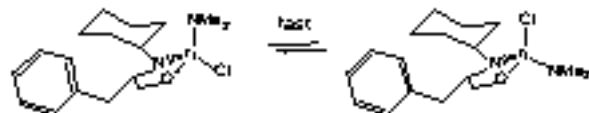
A.M.

Immiscible blocks of diblock copolymers such as poly(styrene)-b-poly(methylmethacrylate) (PS:PMMA) in a ratio of 70:30 will microphase segreg were spun-cast on silicon wafers. The film's thickness was measured by elipsometry and surface orientation characterized by AFM. UV exposure de nanoporous template. The orientation of the cylinders was studied as a function of film thickness in order to determine the limits of applicability of

10:45 **Aaron Schuler:** *Effects of Ligand Sterics and Electronics on Epimerization of Chiral Titanium Complexes*

A.M.

Our laboratory is studying the optical stability of chiral titanium complexes with bidentate N- and O-p donor ligands derived from phenylalanine, n OCH<sub>2</sub> CH(CH<sub>2</sub>Ph)N(C<sub>6</sub>H<sub>11</sub>)] epimerizes rapidly even at low temperature. Substitution of the dimethylamide group with the 2,6-diisopropylpheno high temperature. The other chiral titanium complexes based on amino acid ligands will be discussed.

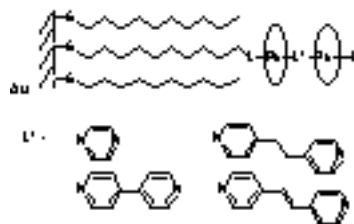


11:00 A.M. **Jennifer Godwin:** *Piezo-optic Coefficients Measured by a Michelson Interferometric Method and Excess Gibbs Energy Measured by Laser Light Scattering in Miscible Alcohols*

Isobaric piezo-optic coefficients,  $(dn/dP)$ , the changes in refractive index  $n$  with pressure  $P$ , were determined for binary mixtures of methanol, ethanol, and either water or anisole for a range of compositions using a Michelson interferometer. Little temperature dependence was found for  $(dn/dP)$  values. In general,  $(dn/dP)$  values exhibited negative behavior that varied with components and temperatures. Excess  $n$  values exhibited positive maxima that shifted with composition and mol

11:15 A.M. **Neel Joshi:** *Mixed-valence Properties of Stacked Metalloporphyrin Oligomers*

Surface-confined, stacked oligomers of meso-tetraphenylporphyrinatoruthenium(II) joined axially by linker ligands were synthesized using a modular approach. The oligomers, with linker ligand, were deposited on pyridine-terminated alkanethiolate monolayers on gold substrates. These systems were studied using cyclic voltammetry and quantified by the conproportionation constant. Linker ligands were varied to study their effect on the electronic coupling between metal centers.



#### Mathematics - Beckman 126

9:00 A.M. **Teri Krebs:** *Dictyostelium and Excitable Media*

For most of their life cycle Dictyostelium amoebae live as single-celled individuals, but upon starvation they aggregate together to form a migrating multicellular organism. The chemical signal cAMP, which forms intriguing spiral patterns. We will explore mathematical models and biological explanations of this simple class of general properties of excitable media.

9:30 A.M. **A.T. van Cort:** *Computational Evolutionary Linguistics Tree-Based Models of Language Change*

My senior research is on the application of mathematical tree-generating methods from evolutionary biology to problems in language change. Most phylogenetic trees fall into two categories: character-based and distance-based methods. The character-based method of perfect phylogeny has been applied to the history of the Indo-European languages. I have been adapting distance-based models for application to several modern Germanic languages.

10:00 A.M. **Mathematics and Physics Departments Reception - Galileo Foyer**

10:30 A.M. **Karl Mahlburg:** *Structured Attacks on Cryptographic Protocols*

Cryptographic protocols are sequences of encrypted messages sent between parties on a potentially insecure computer network, such as the Internet, even in the presence of a malicious penetrator. However, the effectiveness of protocols is in general difficult to analyze. It becomes much simpler if the tradeoff that security in realistic situations is no longer guaranteed. Protocols are analyzed by constructing a set of "unsafe" messages as an upper bound. If a penetrator never transmits one of these messages, the penetrator can never learn secret information. My work is one of the first attempts to mimic these results. Specifically, I have successfully proved security results for protocols in which the binary XOR operation is used on keys and messages.

11:00 A.M. **Ian Weiner:** *Volume-Minimizing 3-Cycles in  $R^7$*

We investigate the homologically volume-minimizing 3-cycles in the  $G_2$  holonomy manifold  $R^7$ . Specifically, we look for 3-cycles that are graphs of

quaternions, which are invariant under symmetry groups diffeomorphic to  $S^1$ . Several such cycles are identified and described geometrically. Such cycles may represent so-called BPS states of fundamental particles in String Theory.

11:30 A.M. **Marco Latini:** *Mixing in Curved Pipes*

We consider the problem of tracer dispersion in curved pipes. It has been known since Dean's work in 1928 that flows in curved pipes present more curvature of the pipe induces a transverse recirculation in the form of outward spinning vortices. In our work we consider tracer release both in a to an initial uniform release over the cross-section and the case of a point discharge at the center of the recirculation vortices. We show numerically that where the longitudinal spreading is faster than what is expected from the action of diffusion alone. This is an instance of anomalous diffusion.

#### Physics - Galileo-Edwards

9:15 A.M. **David Abraham Mann:** *Giant Magneto-Resistance in IrMn/CoFe/NiFe Multi-layer Structures*

Giant Magneto-Resistance (GMR) was discovered in 1989 and is currently implemented in sensor systems and hard drive read/write heads. We are sandwiches of IrMn/CoFe/Cu/NiFe sputtered in a magnetic field. The exchange anisotropy appears to depend on the temperature, the speed of the ferromagnetic pinning layer.

9:30 A.M. **Seth Foreman and Jeremy Liu:** *Macroscopic Detection of the Angular Momentum of Light*

Quantum theory dictates that photons must carry angular momentum equal to  $h/2\pi$ . We design and implement an experiment incorporating a very small optical angular momentum to a half-wave plate. A circularly polarized laser beam exerts torque on the half-wave plate in a resonant fashion, increased measure using sensitive position-sensing photodiodes.

10:00 A.M. **Mathematics and Physics Departments Reception - Galileo Foyer**

10:30 A.M. **Guillaume Mauger:** *Building a Wide Band Force-Feedback Seismometer*

Seismometers are typically designed by using a simple spring and mass system to measure motion of Earth in an inertial frame. The frequency dependent frequency range and makes quantitative information difficult to extract. Force-feedback seismometers use negative feedback to keep the mass approximately to do so. This method removes the mechanical frequency considerations of the system. The presentation describes my progress in the design and final horizontal component seismometer in the HMC Edwards Geophysics Laboratory.

10:45 A.M. **Ryan F. Quadri:** *Elemental Abundances of HII Regions in Nearby Galaxies*

Regions of ionized hydrogen, known as 'HII regions,' are particularly useful for making determinations of elemental abundances in the interstellar medium. Relative emission line intensities, and can then be plotted as a function of galactic radius. Other characteristics, such as electron densities and star formation narrow-band images of several nearby galaxies have been taken at the Las Campanas Observatories in Chile.

Faculty Advisor: I

11:00A.M. **John "Zach" Sanborn:** *Light-Matter Interaction in the Non-SVAA Regime*

By numerically solving the nonlinear field equations, we simulate second harmonic generation by laser pulses within a nonlinear medium without the approximation, an approximation that fails when laser pulses of moderate intensity and/or ultrashort duration are used to drive a nonlinear process. perturbatively that a backward traveling second harmonic wave is created. Conditions necessary for experimental detection of this wave are discussed.

11:15A.M. **Paul SanGiorgio:** *Modeling Electron Thermalization in Metals*

At equilibrium, electrons in a metal are characterized by a Fermi-Dirac energy distribution with a well-defined temperature. Yet, if we impulsively

distribution is no longer described by a well-defined temperature. The process by which the nonthermal distribution evolves through time is called thermalization, electron-electron and electron-phonon collisions, and use this to predict the amount of second-harmonic light generated in the pulses.

12:00 NOON    **Lunch Break**

1:15 P.M.-5:00 P.M.

**Research Presentations**

**Biology - Beckman 126**

1:15 P.M.    **Cecilia Giddings:** *Relationship Between Temperature and Food Intake in Sceloporus Lizards*

The effects of temperature on feeding and digestion have been studied in many ectotherms. It is important to determine how body temperature affects temperature is regulated after feeding. In this study, the relationship between temperature and meal size was assessed in the desert spiny lizard, *Sceloporus* species of phrynosomatid lizards were measured to test whether individuals preferentially choose different temperatures while digesting food.

1:30 P.M.    **Jesse Abrams:** *Slope and Substrate Effects on Sprint Speed in Sceloporus Lizards*

Allometric models predict that an increase in body mass will be accompanied by an increase in the cost of terrestrial locomotion, particularly for vertical habitat (and therefore vertical movement) among four species of *Sceloporus* lizards does not follow this prediction. Using a racetrack equipped with and climbing abilities of these four species were quantified, compared, and related to their natural habitat choices.

1:45 P.M.    **Bob Fuentes:** *Metabolism of Sceloporus Lizards - The Effect of Temperature on Specific Dynamic Action*

In these studies, I examined how temperature affects the Specific Dynamic Action (SDA) of metabolism in *Sceloporus occidentalis* lizards. Specific Dynamic Action occurs immediately after meal consumption. I measured metabolic rates of lizards after eating at various temperatures, ranging from 20-35C, and compared meal consumption. I used closed system respirometry to measure carbon dioxide production over two days. I will compare SDA of *S. occidentalis* to

2:00 P.M.    **Vanessa Szostak:** *Study of Behavioral Plasticity in Response to Tactile Stimulation in the Medicinal Leech, Hirudo medicinalis*

I tested the hypothesis that hungry leeches, which exhibit feeding behaviors that are not observed in satiated leeches, would also be more responsive to hungry and satiated leeches to touch using behavioral studies of intact leeches and electro-physiological studies of leech mechanosensory neurons. I will account for feeding-related behavioral plasticity.

2:15 P.M.    **Bret Hutchinson:** *Possible Hybrid Origin of Soft Coral Species*

Preliminary research on the ITS-1 DNA sequence of one individual of the soft coral species *Bellonella bocagei* has shown that this sequence appears to be a hybrid of *B. coralloides* and *A. hibernicum*/M2. This suggests that *B. bocagei* might have arisen from a hybridization between the latter two species. I evaluated the analysis to screen multiple ITS-1 copies from multiple individuals of these three species for the presence of this possible recombinant sequence.

**Computer Science - Galileo Pryne**

1:15 P.M.    **Jeffrey Hartline:** *The Computational Complexity of Games*

In this talk we discuss recent research on the computational complexity of various one- and two-person strategy games. In particular, we show that a

1:45 P.M. **Matthew Schnaider:** *Optical Routing*

In this talk we discuss some recent research on routing problems for optical networks employing wavelength-division multiplexing (WDM).

2:30 P.M. **Tim Morgan, Ben Feinstein, Shantanu Bhattacharyya:** *Experience with Honey Pots*

Two Linux machines were made available to a group of students who acted as intruders. One of the machines ran a "honeypot" an environment that actual intrusion. This talk will discuss experience with the honeypot, in particular, its invisibility.

3:00 P.M. **Gillian Allen:** *Improving Formatted I/O in C++*

Currently, the C++ I/O package makes it very difficult to format output and to perform many important input tasks. Our goals are to create package program input and conveniently format program output using a simple and intuitive notation.

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

On-Going **Art 198: Independent Study in Black and White Photography Exhibit**

This is a study group of students interested in learning black and white photography as a fine art. They have studied all phases from camera work th demonstrates their progress after one (very dark and rainy) semester. Students presenting are Bradley Akitake, Brooke Basinger, David Clarke, Jose Pe\_a Mattozzi, Wendy Thomas.

Faculty /

1:45 P.M. **Natan Bershtel:** *Exploring Teaching Strategies for Mixed-Ability Classrooms*

How does a high school math teacher deal with a classroom composed of students with widely varying abilities? By conducting interviews, observi I attempt to discover what teaching strategies are used in mixed-ability groups at Pomona High School. After introducing background on this schoo which seem to be most effective.

2:00 P.M. **John "Zach" Sanborn:** *A Heavy Metal Senior Experience*

Have you ever wondered how a metal sculpture is developed? In my talk, I will use slides to describe the process of building a welded, steel sculptu will explain my motivations for taking a different approach to the final humanities experience.

Faculty Advise

2:30 P.M. **Humanities 2f, "The Book in Western Culture,"** examines the history of books as aesthetic objects, symbols of political and economic status, an of the semester, students working in groups were assigned an artifact (an illuminated manuscript, an early printed book, a nineteenth-century serial prospectus), which they subsequently researched, wrote about, and described in a series of web pages. Their presentations today will detail their res separate, ten-minute presentation. Questions about the presentations will be taken at the end of the session. Students presenting are: Christian Bruur Clifford, Andrew Cole, Kathryn Douma, Thomas Duncan, Brandt Erickson, Robert Gaebler, David Gleich, Andrew Grier, Aja Hammerly, Conrad Michael Terkowitz, Elizabeth Walsh.

### **Physics - Galileo-Edwards**

#### **Project Presentations of Computational Physics**

1:30 P.M. **Matt Gay:** *Simulated Annealing and the Traveling Salesman Problem*

1:45 P.M. **Jeremy Liu:** *Time Evolution of QM Wavepackets in 1D Potentials*

2:00 P.M. **Tyson Macdonald:** *Slider Block Model for Earthquakes*

2:30 P.M. **Jimmy Corno:** *Light Coordinates Around a Black Hole with Angular Momentum*

2:45 P.M. **David Clarke:** *Tracking Light Beams Emitted from a Black Hole*

3:00 P.M. **David Cooke:** *Simulation of Chaotic Behavior of a Linked Pendulum System*

3:30 **Presentation Days Reception - Galileo Foyer**  
P.M.

4:00P.M.

### **Presentation Days Address**

**Galileo-McAlister**

#### **Welcome and Introduction:**

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

#### **Keynote Speaker:**

Dr. Steve M. Potter, Senior Research Fellow, Division of Biology, California Institute of Technology "*Connecting neurons to computers - What it is like to be a*

Dr. Potter and his group at Caltech are growing cultures of rat cortical neurons in dishes with arrays of embedded electrodes that allow two-way communications between neural signals are used to control the behavior of a simulated animal, the Neurally-Controlled Animat, and the Animat's sensory inputs are fed back to the culture as learning system in which every cell that participates in the learning can be imaged in great detail by applying multi-unit electrophysiology, 2-photon time-lapse microscopy dyes to study the networks at long and short time scales. This work represents a convergence of many fields from science and engineering, including neurobiology, science, optical physics, chemistry, biochemistry, and information theory. To quote Dr. Potter, "Straddling these fields is sometimes frustrating but always very rewarding for the future of Science that Makes a Difference."

Dr. Potter received his B.A. in chemistry/biochemistry from the University of California, San Diego in 1987. The University of California, Irvine awarded him a Ph.D. in aging in the mammalian brain. He has been at the California Institute of Technology since 1994, where he is presently a Senior Research Fellow, and the Principal Investigator of his research group studying "Multi-electrode and Imaging Analysis of Cultured Networks."

In his copious spare time Dr. Potter dabbles in a variety of activities, including bicycling, hang gliding, racquetball, hiking, reading, thinking about thinking, collecting, sailplane flying, photography, fixing and building things, creating unusual art, and body-surfing. He is also the inventor of the "ToothCam," a time-lapse photograph of a tooth. The Angeles Times describes the resulting movie as "Kinda like those gorgeous, speeded-up scenes of daffodils and snowdrops sprouting forth from the rich, loamy earth rather snaggly chompers being torqued around by little bits of metal until they miraculously straighten up, just in time for the closing credits."

Tuesday, April 24

### **Projects Day**

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

Please see Projects Day Program for further details.

10:30 A.M.

#### **Registration and Poster Sessions:**

**Ronald and Maxine Linde Activities Center**

1:15 P.M.

#### **General Session:**

**Galileo-McAlister**

*Welcome:* **President Jon C. Strauss**

*Remarks:* **J. Richard Phillips, Acting Director Engineering Clinic**

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

*Program: Fernando Mattos '00/01*

2:00 P.M.-5:30 P.M.

**Clinic Presentations:**

**Classrooms, Galileo Halls and Labs**

Wednesday, April 25

9:00 A.M.-12:00 P.M.

**Research Presentations**

9:00 A.M. **Chemistry Poster Session**

9:00 A.M. **Mathematics Presentations**

9:15 A.M. **Physics Presentations**

10:00 **Biology and Chemistry Departments Reception - Galileo Foyer**  
A.M.

**Biology-Chemistry - Galileo-Pryne**

10:30 **Linley Erin Hall: *Synthesis of Unnatural BPTI Variants to Study the Cation- $\pi$  Interaction***  
A.M.

The cation- $\pi$  interaction occurs between a positively charged species and the face of an aromatic ring. The crystal structure of BPTI reveals two possible orientations of the cationic amino acid side chain. Solid phase peptide synthesis can be used to synthesize a BPTI fragment containing an unnatural amino acid; these fragments can be ligated to the BPTI active site. Strategies for the synthesis, purification and ligation of these fragments will be presented.

10:45 **Loren A. Perelman: *Dendrimers as Templates in Azo Dye Aggregation***  
A.M.

We have studied the interactions between anionic azo dyes while electrostatically bound to the cationic surface of Starburst (PAMAM) dendrimers. The dendrimer generation and dictates the proximity of attached azo dyes and the ability of intermolecular forces between dyes to operate. Absorption spectra of spectrally-distinct dye aggregates. Spectra are attributed to both H-aggregation (face-to face arrangements of aromatic rings attached to the azo function) and J-aggregation (side-by-side orientations of aromatic rings inducing red-shifted spectra). In particular, hydrophilic, hydrogen-bonding substituents on the azo dye 1 and bulky hydrophobic substituents on the azo dye linking ring most effectively promote H-aggregation. The interaction of azo dyes with cationic micelles and the ability of the dendrimer surface to act as a template for dye aggregation.

11:00 **Andrew Schile: *Using Optical Coherence Microscopy to Document Frog Development***  
A.M.

I have used a non-invasive, non-destructive imaging technique (optical coherence microscopy) to document morphological changes that occur in a key event in early embryonic development. I will present two-dimensional and three dimensional time-lapse movies that illustrate events that occur in early development. I will also summarize our efforts to characterize the optical scattering properties of the different tissue layers in *Xenopus* embryos.

11:15 **Ian Tullis: *Molecular Phylogenetics of Alcyoniid Soft Corals***  
A.M.

Soft corals of the family Alcyoniidae are ecologically and commercially important members of marine communities around the world. However, the relationships within the group are unknown. I have amplified (via PCR) and sequenced three previously unstudied regions of the mitochondrial genome. I will present phylogenetic trees based on intergeneric and interspecific differences in these sequences.

**Chemistry Poster Session - Galileo Foyer**

9:00 A.M. **Chemistry Research Posters Presented at the American Chemical Society Meeting**

**Sarah Daniels** *Correlation Effects on the Electronic Coupling Element for Electron Transfer Reactions*

Results are presented from calculations that address the sensitivity of the electronic coupling element for electron transfer ( $H_{da}$ ) to the inclusion of electronic correlation effects on  $H_{da}$  for through-solvent electron transfer. For most donors and solvent orientations it was found that the inclusion of electronic correlation addition, the decay of the coupling with distance was still found to be exponential. Results of exploratory calculations relevant to electron transfer t

**Caitlin A. Devereaux:** *Profiling Catanionic Vesicles Using Fluorescence Spectroscopy*

Unilamellar vesicles are of interest for potential applications as drug-delivery vehicles. We have used fluorescence spectroscopy to characterize cationic sodium dodecyl sulfate (SDS) and the cationic surfactant didodecylammonium bromide (DDAB). The cationic and anionic fluorescent probes daun 6-sulfonate (TNS), respectively, were used to assess the overall surface charge on cationic-rich vesicles. The fluorescence data support a rapid insert the vesicle surface retains a net positive surface charge.

**Jennifer L. Godwin:** *Piezo-optic Coefficients Measured by a Michelson Interferometric Method and Excess Gibbs Energy Measured by Laser Light in Miscible Alcohols*

(please see abstract Monday, April 23 at 11:00 a.m.)

**David A. Goldsheft:** *Hydrophilic Metalloporphyrins Tethered to Alkanethiolate Monolayers*

A neutral, hydrophilic metalloporphyrin suitable for use in electron transfer studies across alkanethiolate monolayers has been synthesized. Such a independent, solvated redox centers with low solvent reorganization energy tethered to a surface. Meso-tetrakis(2,6-dihydroxyphenyl)porphyrinator ligation onto a pyridine-terminated alkanethiolate monolayer supported on a gold surface. Cyclic voltammetry was used to determine the extent of r aqueous and non-aqueous solvents.

**Blaine M. Hackman:** *Transition State Topologies of the Amide-acetal Claisen Rearrangement for Acetals of Cyclic Amides* (please see abstract Monday, April 23 at 11:00 a.m.)

**Linley Erin Hall:** *Synthesis of Unnatural BPTI Variants to Study the Cation- $\pi$  Interaction*

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**Stacey C. Thonstad:** *Spectroscopic Characterization of Microdomains Within Dendrimer-Surfactant Supramolecular Assemblies Single and Double* (please see abstract Monday, April 23 at 9:30 a.m.)

**Christine B. Yoo** *Synthesis and Characterization of Chiral Tetrahedral Titanium Complexes With Amino Acid Derived Ligands*

We are interested in preparing chiral titanium complexes with  $\pi$ -donor ligands derived from naturally occurring amino acids. The amino acids phenylalanine and proline chelate via a few short, high-yielding steps. The protonated ligand reacts with  $\text{TiCl}(\text{NMe}_2)_3$  to form the diastereomeric titanium complex characterized by  $^1\text{H}$  and  $^{13}\text{C}$  NMR spectroscopy. Initial reaction chemistry of the complexes with phenols was examined.

10:00  
A.M.

**Biology and Chemistry Departments Reception - Galileo Foyer**

## Engineering - Galileo-McAlister

10:30 A.M. **Engineering 189: "Power Consumption on the HMC Campus"**

Faculty Advisor: *B. Samuel Tanenbaum, Engineering*

In response to the power crisis, this group of students examined the power consumption on the HMC Campus, looking for ways to effectively save they came up with on an institutional level, such as general policies for building and lighting maintenance, or seeking ways to make the facilities on

**Group 1:** Nils Napp, Colin Choi, Jason Norman, Peter Chung, Alfredo Villanueva, Morgan Cross

**Group 2:** Ryan Ellis, Trevor Gile, Andy Mattheisen, Jonathan Faul, Gautam Thatte

11:15 A.M. **Engineering E158: Intro. CMOS VLSI Design**

Faculty Advisor: *David Harris, Engineering*

**Brett Bissinger and David Groulx:** *CIF/GDS Import Tool for Electric VLSI Design System*

Due to the high cost of VLSI design software there is a need for a freely available solution for the academic environment. Currently the Electric sys components. One such component is a complete import filter for several common file types. Our project is to design and implement this component

11:30 A.M. **Aaron Stratton and Steve Yan:** *Improvements to GrandSun of MacTester Functional Chip Tester*

Last year's Sun Microsystems clinic team developed a chip tester to work with up to 256 pin packages, operating between 1 and 7 volts. The tester vectors transmitted from a PC to the device under test. Further work on the tester involves improving PCB layout, adding PDC auto detection, and c by last year's freshman chip seminar.

11:45 A.M. **Christine Paulson and Martin Weiner:** *Clothing Color Identification Device for the Blind*

Currently, the blind depend on various memorization techniques and help from others to match their clothing. For the purpose of alleviating these d device that identifies the color of a piece of material placed in front of it. This project involves the development and calibration of a sensor to obtain of a microprocessor and a speech playback chip that will announce the color returned by the sensor.

## Mathematics - Beckman 126

9:00 A.M. **David Uminsky:** *Iteration of an Even-Odd Splitting Map Can Make Integration Easier*

We study the dynamics of the map  $F(R(x)) =$  on the space of rational functions, in the context of a new method of integration. We begin with two n closed under the action of F; we give recursive formulas for the members of both families. We give a class of rational functions which are mapped t polynomials are eventually mapped to even functions by F, and we determine the number of iterations required for a given polynomial. We use pow functions are eventually mapped to even functions by F.

9:30 A.M. **Timothy Prescott:** *Convergence of a Random Walk on a Torus*

For an irrational number,  $a$ , rotate a point on the unit circle clockwise or counterclockwise by  $2\pi a$  with equal probabilities. How many steps does or "random?" F. Su has shown that if  $a$  is a "badly approximable" number, then after  $k$  steps the resulting distribution of points has distance order  $1/k$  to obtain analogous bounds for random walks on the  $n$ -dimensional torus with several generators.

10:00 A.M. **Biology and Chemistry Departments Reception - Galileo Foyer**

10:30 A.M. **Christopher Hanusa:** *Fibonacci Generalizations*

The Fibonacci Numbers are one of the most intriguing sequences in mathematics. I present generalizations of this well-known sequence. Using con these generalizations. Then using Markov Chains, I derive a second closed form expression for these numbers which is a generalization of Binet's f understandable, informative, and entertaining for anyone who likes integers.

11:00 **Jane Pratt:** *Magnetohydrodynamics With the Eddy-Damped Quasi-Normal Markovian Closure*  
A.M.

When a magnet is heated, it loses its magnetism. Each planet and star has a magnetic field, yet at the same time their centers are very hot. Therefore look at the movement of electric charges within the molten metal of the core that can generate magnetic field. The turbulent flow sustains the magn the turbulent dynamo effect. The equations of magnetohydrodynamics (MHD) are nonlinear and highly analogous to the Navier-Stokes equations.  $\uparrow$  Markovian) closure, a statistical model designed for Navier-Stokes dynamics, has potential applications to MHD. We have proved in an earlier wor EDQNM closure can be applied successfully, and satisfies the appropriate realizability conditions in the case of MHD without mean fields (Turner needed to make the MHD equations physically realizable. We explore the area of mean field development. Finally, we discuss direct numerical sim with simulation results.

11:30 **Greg Preston:** *A Combinatorial Investigation of Harmonic Numbers*  
A.M.

We seek to discover combinatorial explanations of known identities involving harmonic numbers. Harmonic numbers do not readily lend themselves fractions, and combinatorial arguments involve counting whole objects. It turns out that we can transform these harmonic identities into new identities open to combinatorial interpretation. We have proved three of these identities, the first two being special cases of the third.

#### Physics - Galileo-Edwards

9:15 A.M. **Valerie Arndt:** *Quantum Electromagnetic Waves in Cosmic String Spacetimes*

General relativity is a classical theory, however, the real world is quantum mechanical in nature. Cosmic string spacetimes have a classical singularity with quantum test particles. A criterion for electromagnetic quantum singularity is applied to a screw-dislocated cosmic string spacetime.

9:30 A.M. **James Corno:** *Inertial Frame Dragging near Rotating Black Holes*

My research explores the rotation of the inertial frame near rotating black holes. Using the Kerr geometry, I show that circular orbits with identical direction and magnitude of the black hole's rotation. I also show that objects with equal but opposite hyperbolic trajectories near the black hole travel

9:45 A.M. **Thomas Driscoll:** *Improvements to an Optical Coherence Microscope through Digital Signal Processing*

Our current optical coherence microscope has been designed for imaging biological samples. We want to improve the speed, dynamic range, and sensitivity. We achieve these goals by replacing the existing analog signal processing circuitry with a digital signal processing (DSP) system. We describe the design bonus, our solution offers flexibility in the tradeoff between acquisition time and signal-to-noise ratio.

10:00 **Biology and Chemistry Departments Reception - Galileo Foyer**  
A.M.

10:30 **Nathan A. Miller:** *Third-Harmonic Generation from Thin Silicon Layers*  
A.M.

Unlike second-harmonic generation, which can be enhanced at surfaces, third-harmonic generation is expected to be dominated by bulk effects. Recent enhancement. We report studies of third-harmonic generation from thin silicon layers of gradually varying thickness and a comparison to a model of third-harmonic-generation process.

10:45 **Martin Javier Smith-Martinez:** *Time-Dependent Second-Harmonic Generation of Silicon*  
A.M.

In second-harmonic studies of silicon surfaces an intensity-dependent rise time has been observed and attributed to photoinduced charge transfer the dependent second-harmonic generation from thin silicon layers covered by oxide layers several hundred nanometers thick is studied to investigate v and trapping in the SiO<sub>2</sub> layer.

11:00 A.M. **Andrew W. Rollins:** *Surface-Specific Second-Harmonic Generation in Silicon*

The second-harmonic intensity generated from a thin layer of nonlinear dielectric of thickness  $d$  is proportional to  $d^2$  for small  $d$ . If the front and back however, we predict a nonzero second-harmonic intensity in the limit of vanishing layer thickness. We report thickness-dependent measurements of normal electric field, which breaks the interfacial symmetry.

11:15 A.M. **Michael J. Rust:** *Estimating the Error in Coupled-Cluster Calculations of Molecular Ground States*

The coupled-cluster approximation in quantum chemistry is one of the most powerful methods currently available for obtaining accurate description coupled cluster approximation and show that it can be usefully regarded as performing a physically meaningful similarity transform on the Hamiltonian exploiting the structure of the coupled-cluster operator, it is possible to obtain an upperbound on the error committed in making the coupled-cluster with sample calculations illustrating performance of the coupled-cluster approximation and the utility of this upperbound.

12:00 NOON **Lunch Break**

1:15 P.M.

#### **Research Presentations**

##### **Computer Science - Galileo-McAlister**

1:15 P.M. **Computer Science 155: "Computer Graphics"**

We present a variety of projects produced in the computer graphics course.

2:45 P.M. Computer Science and Engineering Departments Reception

3:15 P.M. **The Harvey Mudd College Robotics Team**

**Presenting:** Chuck Schied, Ross Luengen, Ben Martin

**Participating:** Jason Hogan, David Hopkins, Ross Luengen, Vipul Lugade, Nils Napp, Jason Norman, Kevin Ota, Seema Patel, Christine Paulson,

The robotics team has developed a software framework for specifying robotic tasks behaviorally and implemented it on several platforms. One such vision and manipulation capabilities. A second platform is a homemade, wheeled base built from scratch by HMC students. Example tasks include and visually guided grasping and delivery. This talk will demonstrate these tasks, explain the unifying software and hardware framework underlying,

3:45 P.M. **Nathaniel Dirksen and Star Roth:** *Cartoonification of 3D Heads*

While much of computer graphics research is aimed at producing photorealistic images, there is also a relatively new interest in non-photorealistic models of human heads and produce simple "cartoonified" models.

4:00 P.M. **Ethan Drucker and Ross Richardson:** *Approximating the Shortest Superstring*

In the shortest superstring problem we are given a set of strings  $S$ . We are asked to find a shortest string that contains each string in  $S$  as a contiguous effort has been made to classify its approximability. We discuss new results on some long-standing conjectures about variants of a greedy algorithm

## Engineering Design Presentations - Galileo Hall

Faculty Advisors: *Lori Bassman, Patrick Little and Donald S. Remer, Engineering*

1:15 P.M.

Edwards *Device to Assist a Child with Arthrogyriposis*

**Client:** The Halstead Family

**Liaison:** Mari Halstead

**Initial Problem Statement:** A 10-year-old boy with arthrogyriposis has asked for development of devices that will be of use to him in the coming y limited functionality in his hands and arms, but has developed remarkable facility with his toes. He is looking for devices that will increase his inde without special assistance or intervention.

**Team 1:** Laura Kanofsky, Nick Reddy, Lydia Son, Anand Vemuri

**Team 2:** JL Espinosa, David Greisen, David Groulx, Esther Lee, Matt Livianu

1:15 P.M.

Pryne *Packaging for Sensors for Battlefield Medical Device*

**Client:** Center for Innovative Minimally Invasive Therapies (CIMIT)

**Liaison:** Daniel Chin

**Initial Problem Statement:** CIMIT is sponsoring a project to develop a medical diagnostic device for use by battlefield medics when performing t packaging system for a set of relatively small sensors (pulse oximeter, acoustic sensor, EKG, and ultrasound transducer). The packaging will be inc element of a larger Engineering Clinic project.

**Team 1:** Andy DelCampo, Aileen Ng, Matt Seetin, Katherine Todd-Brown

**Team 2:** Jeremiah McCoy, Brian Putnam, Damian Small, Alfredo Villanueva, Andrew Yip

**Team 3:** Ryan Carpenter, Calvin Curtis, Brandt Erickson, Michael Vrable

1:45 P.M.

Edwards *Development of a System for Visually Impaired Musicians*

**Client:** The Critchell Family

**Liaison:** Carl Baumgaertner

**Initial Problem Statement:** A member of the Critchell family is a musician whose eyesight has been deteriorating over the past few years. It has b the violin. Develop a device to assist him in reading music while playing.

**Team 1:** Elizabeth Lee-Su, Rachel Lovec, Elizabeth Main, Deborah Meduna

**Team 2:** Henry Allen-Tilford, Andrew Lim, Keith Miyake, Philip Vegdahl

**Team 3:** Candace Church, Conrad Harter, Zamir Lalji, Stephen MacVicar

2:00 P.M.

Pryne *Development of a Device to Remove Invasive Weeds from Autos*

**Client:** Bureau of Land Management

**Liaison:** Karen Smith

**Initial Problem Statement:** Each year, various federal agencies spend very large sums of money to eradicate non-native plants from federal lands : these invasive plants are carried to the parks and forests on the undersides of cars and other transportation vehicles. Design a device to wash the unc the plant seeds.

**Team 1:** Leryn Gorlitsky, Brian Humphrey, Kim Shultz, Chuck Matlack

**Team 2:** Rose Hakim, Warren Katzenstein, Brent Rojo, Stephanie Wong

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

3:15 P.M.

Edwards *Development of a Device to Assist in Rhinoplasty*

**Client:** Beckman Laser Institute (BLI)

**Liaison:** Dr. Brian Wong

**Initial Problem Statement:** Plastic surgeons are often called upon to remove cartilage from patients undergoing rhinoplasty (or nose-related surger) adequately account for the physical properties of cartilage. Design and test a replacement device for use by plastic surgeons.

**Team 1:** Rick Bente, Ryan Mashiyama, Daphne Park, Michelle Sakai, Eric Swope

**Team 2:** Allison Auld, Janet Lui, Tamara Reimer, Kieran Smith

**Team 3:** Ian Ferrel, Nikhil Gheewala, Shane Hawke, Adele Tamboli

3:15 P.M.

Pryne *Design of a Flexible Layout for a Playground with Changing Boundaries*

**Client:** Pomona Valley Center for Community Development (PVCCD)

**Liaison:** Tomas Ursua

**Initial Problem Statement:** PVCCD has recently taken ownership of a facility that was formerly used as a nursing home. Under an innovative fina developed in the future as middle and low income housing. The Center will have the use of the land until the development proceeds, and, after deve of the land. The Center would like to develop a site plan that will allow them to fully use the land for playgrounds and athletic fields for as long as 1 during and after the transitions.

**Team 1:** Brian Brenhaug, Emily Henage, Lai Lao, Diana Warden

**Team 2:** Ethan Bodnaruk, Gene Lee, Jason Quach, Nick Villalon

**Team 3:** Jorge Escobar, Michelle Hortter, Tonya Icenogle, Jordan Taggart

**Team 4:** Brett Bissinger, Jordan Boye, Aileen Nuguid, Waley Tam

**Engineering Poster Session - Galileo Foyer**

2:45 P.M. **Engineering E168: Special Topics in EE-Robotics**

Faculty Advisor: *Sanjay Joshi, Engineering*

**Matt Burden and James Riehl:** *Design and Construction of an Autonomous Blimp*

Our proposal is to design and build an autonomous blimp. It will be constructed using a Mylar bag filled with helium for lift and the Lego Mindstor will allow us to develop a blimp that can detect when it has bumped into a wall and so turn around, and also track a beam of light. This project is di

controlled and also it is designed for indoor flight as opposed to most other autonomous blimps.

**Jason DeCamp:** *Playing Games with Robots*

Two fully autonomous mobile reactive robots will be constructed to interact with each other and with their environment. Through the use of IR emitting microprocessors these robots will be able to perform desired behaviors to simulate a game similar to Marco-Polo. The design will incorporate fewer components on a smaller budget. Ultimately these two robots will be capable of fairly complex actions through the use of reactive design and multi-agent interaction.

**Alicia Lloro:** *Insectobots*

I propose to simulate and build a colony of reactive insect robots that will mimic the behavior of ants and bees. In particular, I will focus on modeling behaviors (i.e. queen and worker). My goals for this project are to learn how insects accomplish complex tasks, apply this to robotics using reactive control, and see what behaviors can be applied to robotics.

**Ross Luengen and Seema Patel:** *The Use of Subsumption Architecture to Program a Pioneer 1 Robot to Autonomously Locate and Retrieve Soda Cans*

Rodney Brooks' subsumption based control architecture will be implemented in a fairly standard coding environment to produce an emergent behavior. The robot will use FreeBSD and communicate via serial connection with an ActivMedia Pioneer 1 robot. A USB camera will be used to gain visual stimuli for object detection. Several behaviors will simultaneously run to manage various sensors depending on the behavior's purpose. Ultimately, the robot will be able to autonomously locate and retrieve the can, and then return to a designated drop zone. The implementation will provide complete external control of the Pioneer (no pre-built software) for future applications on other hardware or emergent behavioral systems.

**Ralph McNall and Michael Tapper:** *Development of an Interactive Dancing Robot*

The project team has developed an interactive dancing robot that reacts to the beat of music and to specific human movements. The research goals include the development of devices of entertainment, and humanrobot interaction.

**Clare Schoene:** *Pet Robots: A Study of the Interactions Between Robotic Dogs and People*

A robotic dog that was built and designed to act and look like a real dog and a commercial robotic dog were used in this project. Then people were asked to interact with the robotic dog, which does not look like a real dog. After their interactions the people filled out surveys to determine what aspects of a robotic dog cause people to interact with it.

**Steve Wilson:** *Autonomous Tunneling Robot*

The primary goal of this project is to build a prototype of an autonomous tunneling robot that could have applications in space exploration. The robot will dig through soil with an onboard power supply. A treatment of navigation and the coordination of multiple robots will be explored, but not implemented.

**Mathematics - Beckman 126**

1:15 P.M. **Angela Kurle:** *Classifying Social Skill Profiles Using Imbalance Comparisons*

The Social Skills Inventory (SSI) is a self-report instrument providing a multidimensional assessment of basic social skills. Previous interpretations of the total score or to independent considerations of the skill profile provided by the six measured components. Based on recent research involving social psychopathology, it has become apparent that neither the individual scores nor the total score provide a sufficient basis for classification of the population. To address these imbalances, we propose a more informative process for interpreting SSI profiles. We expect to demonstrate that individuals with highly balanced or imbalanced profiles have different levels of communication competence.

1:45 P.M. **Anand Patil:** *Overtuning Droplets in Thin Fluid Films*

We investigate the formation of droplets in a thin liquid film on a solid substrate due to the combined action of surface tension and attractive/repulsive forces. Previous studies on droplet formation assume that droplets have a shallow profile. By removing that assumption and numerically solving for stable droplet profiles, I have found that droplets can form on a substrate on which they sit. In certain cases, the film can overturn leading to a challenging numerical problem.

2:15 P.M. **Ari Nieh: *In Search of the Fractional Four Color Theorem***

The Four Color Theorem states that any planar map can be colored with at most four colors, so that adjacent regions are always colored differently. equivalent to being able to three-color the edges of every planar, three-regular, two-edge-connected graph. Not surprisingly, this equivalent problem the problem of fractional colorings, which resemble ordinary colorings but allow for some degree of "cheating." Happily, in this new case, it is known that a graph is fractionally three-edge-colorable. Is there an analogue to Tait's theorem that would allow us to derive the "Fractional Four Color Theorem"?

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

**Mathematics and Interdisciplinary Competitions in Modelling Presentations - Beckman 126**

3:15 P.M. **Matthew Schnaider, Chris Hanusa, Ari Nieh: *Jammin' with Floyd: A Traffic Flow Analysis of South Carolina Hurricane Evacuations***  
**Outstanding Citation - Mathematical Competition in Modelling**

We chose to investigate the discrete problem, or so-called "Hurricane Evacuation" problem, in this year's MCM. The problem outlines various aspects of evacuation in South Carolina and requires that we develop a model for traffic flow under evacuation conditions. We analyze the 1999 Hurricane Floyd evacuation congestion on Interstate 26. Then we look at the newly formed South Carolina Hurricane Evacuation Plan, and its plan for lane reversals. We analyze the coast, showing that it will significantly benefit traffic leaving Charleston. Next, we determine that with lane reversals in place, the maximum number of cars per hour without creating stop-and-go traffic is 6,000 passenger cars per hour. We then develop two plans to accommodate the evacuation of the South Carolina coast: the first by geographic location; the second by license plate number parity. This evacuation plan is practical given the predictability of a hurricane's path and the temporary shelters. We use our model to determine that I-26, with coastal-bound lanes reversed, has sufficient capacity to accommodate oversized trucks from Georgia and Florida on the evacuation of South Carolina.

3:45 P.M. **Deborah Chun, Michael Schubmel, Marcy LaViolette: *Biceps, Quads and Other Zebra Mussels***  
**Outstanding Citation (INFORMS Prize) - Interdisciplinary Competition in Modelling**

We present an analysis of zebra mussel population growth and chemical sensitivity, developed as a solution to the 2001 Interdisciplinary Contest in Modeling. We analyze population growth, and found to be in good agreement with available data. The dependence of the equation's various constants on chemical concentration is used to predict growth rates in two additional lakes, and to make recommendations about environmental policy near the lakes.

5:00 PM **Dinner Break**

**Humanities and Social Sciences - Galileo Hall**

7:00 P.M. **Music Concert Featuring Nick Bodnaruk, Bryan Tysinger and Aaron Schuler**  
Faculty Advisor: *William Alves, Humanities and Social Sciences*

*High Velocity Music* by Aaron D. Schuler  
Daniel Gianotti and Norimasa Yoshimizu, violins  
Aaron D. Schuler, cello

*High Velocity Music* was composed between September and November 2000, as a senior composition project. The 12 church modes are treated in a serial fashion, the former acting as a harmonic basis to the melodic lines of the latter.

Cadenza from Violin Concerto No. 5 by Henri Vieuxtemps  
Nick Bodnaruk, violin

On April 28 and 29, Nick Bodnaruk will perform the virtuosic fifth violin concerto of nineteenth-century French composer Henri Vieuxtemps. Tonight he will present a section of that piece as a part of his senior project in music.

*Gamelan I* by Bryan Tysinger  
Bryan Tysinger, Masashi Ito, Sarah Olmstead, Neel Joshi and William Alves, gamelan

*Gamelan I* was composed for Harvey Mudd's new set of metallophones and gongs from the island of Java, an orchestra collectively known as the Gamelan. It adapted its scales and idioms to Western composition as a part of his composition project.

String Quartet 4 by Aaron D. Schuler  
Daniel Gianotti and Norimasa Yoshimizu, violins  
Christopher Zarzana, viola  
Aaron D. Schuler, cello

String Quartet 4 follows a hero's journey from tempered hope to utter despair. In between, he journeys through unstable happiness and travels into the inner thoughts of this fallen hero with his musical signature of A-D-Eb.

8:30 P.M. **Humanities and Social Sciences Department Reception - Galileo Foyer**

9:00 P.M. **An Evening of Improvisational Comedy**  
**Directed by Ian Schempp**

For my senior experience in Humanities and Social Sciences, I taught a half-course on improvisational comedy under the supervision of Professor J. Since my first year at HMC, I wanted to deepen my experience by teaching other students about this comic form. The courageous students who enrolled in improv and have been briefly introduced to more advanced kinds of performance. Tonight, they will bring what they've learned in front of an audience. This will not only showcase the progress of the students, but that it will also suggest how the course has helped them to realize their potential as actors and performers.

The performers are: Dustin Barnard, Brooke Basinger, Natan Bershtel, Nicholas Breznay, Adam Bush, Nathan Cappallo, Kurt Dresner, Marc Gimble, Matthew Macauley, Ari Nieh, Paul Paradise, Vikram Patel (POM), Emily Reese (PIT), John Walseth, Eric Wolfinger (POM).

Faculty Advisor

**Mathematics - Beckman 126**

7:30 P.M. **Colin Little, Cameron McLeman, Stephen Haas, Mark Dean, Benjamin Hulse** *Surfing the Web for Differential Equations - Introducing the Be*

ODEToolkit is a new online differential equations solver that is freely accessible over the Internet. The software originated three years ago as a course at the Polytechnic Institute (WPI), and continues to be developed by Harvey Mudd undergraduates supported in part by Compaq, the Andrew W. Mellon Foundation, and HMC. The Toolkit is an advanced suite of solvers, including solving algorithms for first and second order differential equations, as well as arbitrary order equations, with applicability in both the classroom and research.

Courtney S.

Technical Advisor

This presentation will be followed by a wine and cheese reception in Beckman Hall Foyer.



