Summer Undergraduate Research Fellowships

California Institute of Technology

SURF Annual Report

Again this year, as in 1985, funds for production of the SURF Annual Report were provided by AMETEK, Inc. The Students of the SURF Class of 1986, their faculty sponsors, the SURF administrative committee, the SURF Board—all combine to acknowledge with gratitude such generous and continuing support from this company. A particularly warm expression of thanks goes once again to the following officers of AMETEK: Dr. John H. Lux, chairman of the board and chief executive officer; Mr. Robert L. Noland, president; and Mr. Alfred Schaff, vice president—electronics development. Mr. Noland and Mr. Schaff are both 1941 Caltech alumni.

AMETEK is a diversified manufacturer producing both capital goods and components used in consumer products. This balance permits the company to benefit from growth in both the capital equipment and consumer goods markets. AMETEK serves these markets through four operating groups: electro-mechanical, precision instruments, process equipment, and industrial materials, which represent the products of its 33 manufacturing plants in the United States.

1986 SURF Honor Roll

Corporate and Foundation Sponsors

The Alumni Association of Caltech; American Honda Motor Co., Inc.; AMETEK, Inc.; Bristol-Myers Company; Calreco, Inc.; the Flintridge Foundation; Ford Motor Company; General Motors Corporation; IBM Corporation; Greater Los Angeles Zoo Association; Los Angeles Times; Pacific Telesis Group; TRW Space and Technology Group.

Individual Sponsors

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Special Acknowledgement

To the Caltech Prize Fund for its support of the first SURF class and for its continuing financial assistance.

Dedication

Lee A. DuBridge, president emeritus of Caltech, has devoted his professional life to the development of science, particularly through the education of scientists. With appreciation for his example and gratitude for his achievements, we dedicate the 1986 SURF program to him.

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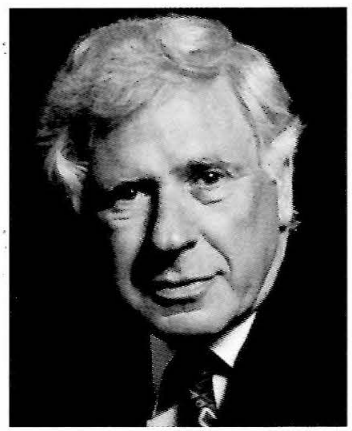


The summer of 1979 was SURF's first at Caltech; it was also my first as president of the Institute. With a great deal of help and support from wise and generous friends, we have all contributed a lot to the maturing of the program in those seven intervening years. Watching the growth and development of SURF, I have learned about the special qualities of Caltech students and faculty and the work they do together. I am impressed with the creativity of the research and the caliber of the results and proud of the willingness of everyone concerned to contribute so unselfishly to the program. My best wishes for continued success.

Marvin L. Goldberger

Marvin L. Goldberger
President
California Institute of Technology

Chairmen's Message

This year, 1986, was another banner year for SURF. A record 133 Caltech students, for example, received SURF awards as against 125 in 1985; participation of the Institute's faculty and JPL advisers remained strong and enthusiastic; two teams of students worked on projects, compared to one last year; cash contributions to operating costs and to the SURF endowment from individuals, corporations, and private foundations, plus earnings from the SURF endowment totaled $479,400 during 1986, versus $419,400 for 1985.

In late spring, Fredrick H. Shair, professor of chemical engineering, and chairman of the SURF administrative committee, appointed a subcommittee to review how the SURF program should fit into the administrative structure of the Institute. The subcommittee recommended that the SURF program continue to report to the vice president for student affairs and that SURF be a part of the student affairs budget. The Caltech administration has acted favorably on these recommendations.

SURF was able to meet its financial obligations for the year. Institute support, private contributions, volunteer help, and cost-reduction practices have all combined to meet both indirect and direct program operating expenditures; as SURF continues to grow and become increasingly effective, however, the program will be confronted by increased costs associated with expanding staff, space, and equipment needs. Plans for the future, therefore, of necessity include a greater emphasis on obtaining larger contributions from the private sector to bolster operating income and to add to the SURF endowment.

President Goldberger appointed Professor Richard M. Wilson to the SURF administrative committee to replace Professor Richard A. Dean who will retire in January 1987.

As SURF 1986 ended, it was our privilege to name Dr. Lee A. DuBridge, Mr. Samuel P. Krown, and Dr. Ernest Swift as life members of the SURF Board for their loyal commitments and services to the program. We also sincerely thank the many other people who have contributed time, resources, and encouragement to SURF. In particular, we express our warmest appreciation to our generous donors, the faculty and JPL sponsors, the seminar speakers, the roundtable leaders, the communications workshop coordinators, the administrative staff, and to a truly magnificent SURF-1986 class.

Special thanks go to Caltech's provost, Dr. Rochus E. Vogt, for his foresight in appointing the SURF administrative committee to assist in the management of the program, and to the Institute's vice president for student affairs, Dr. James J. Morgan, for his strong advocacy.

Elizabeth G. Nickerson
Chairman, SURF Board

Fredrick H. Shair
Professor of Chemical Engineering
Chairman, SURF Administrative Committee

The SURF Program

SURF Beginnings

Every successful academic project starts with an idea that draws to it people devoted to putting it into operation. The Summer Undergraduate Research Fellowships (SURF) program at Caltech has become an outstanding example of those two requirements in action. It grew out of the realization that undergraduates at Caltech needed greater interaction with the faculty, that they deserved increased hands-on experience with research, and that one way to achieve both of those ends was to combine them.

SURF began with funding from the Caltech Prize Fund in 1979 with 18 students and 17 faculty sponsors, experimenting with a program that was designed to contain all the elements of a professional research project. Each applicant found a faculty member who was willing to collaborate with the student in defining a project that the student could work on independently over ten weeks in the summer. The faculty member had to be willing to provide laboratory space, computer time, supplies, and logistical support. Each student would write and submit a proposal to be reviewed for funding. Those who were accepted would receive a stipend during the ten weeks of the summer. At the end of that time, each was expected to describe his or her results at a scientific meeting. In some cases, it was expected that research would result in published papers.

SURF-86 drew 133 students with 92 sponsors—a dramatic change in numbers and a testimony to the wisdom of both the original concept and the original guidelines, which are still in operation. Another proof of success is in the number of papers published over student by-lines in professional journals, 56 at the last count. One paper, in fact, received the Apker Award of the American Physical Society for the most promising physics research by an undergraduate in the entire country.

Over the years, other changes have taken place in the program. Noontime seminars, leadership roundtables, and communications workshops led by industrial and academic personnel have been added. The stipend has been increased, and funding for the program has become more diversified. Industrial and foundation support is increasing as the reciprocity of the benefits of the program becomes apparent.

None of this could have been accomplished without the time of many devoted volunteers, including an administrative committee, the SURF Board, speakers, faculty members, Caltech administrative staff—plus the enthusiastic and hardworking undergraduates who are the reason for its existence and the reward for the effort. SURF provides a new dimension to the process of undergraduate education. Graduates of SURF, with their sophisticated and practical knowledge of how to conduct research, have a marked advantage as they embark on their career paths, apply to graduate schools, or look for jobs in industry.

1986 in Review

Kickoff Dinner

The annual SURF Kickoff Dinner on January 21, was attended by over 140 friends of SURF. Professor Shair opened the program by welcoming guests to the dinner and dedicating SURF-86 to Caltech President Emeritus Lee A. DuBridge. Theodore P. Hurwitz, vice president for Institute Relations, also extended a welcome to the guests; Dr. DuBridge recalled his experiences as an undergraduate student and his early introduction to scientific research; Eugene R. (Gino) Thomas, 1985 SURF student, described his research as a member of the JPL Interstellar SURF team; and Harry B. Gray, Arnold O. Beckman Professor of Chemistry, endorsed the interdisciplinary values of undergraduate research and presented his outlook on the dawn of the age of synthetic materials.

Summary of the applicant and recipient pool

One hundred fifty-eight students applied for SURFs in 1986. Thirty-five of the applicants had a grade point average (GPA) of 3.8 or higher out of a possible 4.0. The median GPA among the *applicant* pool was 3.5, compared to 3.3 in 1984, and 3.4 in 1985. The median GPA among the *recipient* pool was 3.5; this has remained constant since 1984.

This year 29 percent of all faculty in science and engineering became sponsors for the 1986 program. About 26 percent of all sophomores and juniors participated in the 1986 program.

Because members of the faculty work with the students on a one-to-one basis during the proposal preparation, the quality of the applications sent to the SURF office is usually very high. After reviewing the biology applications, Professor David Van Essen commented: "They are an impressive lot—easily the best group overall in all the time I've been reviewing. There's not a one that doesn't deserve funding."

Financial arrangements for 1986 included payent of $3,000 to each student to cover room, board, and personal expenses during the summer. In addition, students receiving financial aid from Caltech are required to save a large portion of their summer earnings

Division	*No. of Faculty sponsoring applicants*	*No. of Faculty sponsoring recipients*	*Percent of Faculty sponsoring 1986 SURFs*	*No. of students applying*	*No. of students receiving 1986 SURFs*	*Percent of applicants receiving SURFs*
Biology	16	14	88	20	17	85
Chemistry & Chemical Engineering	13	10	77	19	16	84
Engineering & Applied Science	17	15	88	21	17	81
Geological & Planetary Sciences	6	5	83	15	12	80
Humanities & Social Sciences	3	3	100	3	3	100
Physics, Mathematics & Astronomy	28	26	93	40	34	85
JPL	14	12	86	28	27	96
Off-Campus	12	7	58	12	7	58
TOTALS	**109**	**92**	**84**	**158**	**133**	**84**

toward their next year's tuition. Research expenses such as supplies, equipment, computing, and travel are paid by the student's sponsor. This action on the part of the Caltech faculty and JPL technical staff is another indication of their commitment to the training and development of young scientists and engineers.

Students speak

During the year several SURFers made on- and off-campus presentations about their projects and the program. Among them were Eugene (Gino) Thomas, a member of the 1985 JPL Interstellar SURF team who presented his SURF report to a group of 15 division heads at TRW Inc., Redondo Beach, on January 10.

On January 17 four SURF 1985 students—Janet Boley, Ara Kassabian, Taylor Lawrence, and Tracy Petersen—visited General Motors Research Laboratories (GMRL) in Warren, Michigan. They reported on their summer projects to a group of GMRL technical staff.

On February 21, Janice Sakai, Umar Mahmood, and Robin Wilson, 1985 Carnation-Calreco SURFers, visited Calreco, Inc., in Van Nuys, California, to report the results of their research.

The president of the Glendale High School science club invited Gino Thomas to speak to a meeting of the club on March 12. Gino described his SURF project and the opportunity SURF affords to Caltech undergraduates.

On May 10, Janet Boley, Gino Thomas, and Dana Pillsbury represented Caltech at a poster session sponsored by the southern California chapters of Sigma Xi at the Los Angeles Museum of Natural History. Undergraduates from the various colleges and universities in southern California prepared displays of their research and were present to explain their work to museum visitors.

Diana Foss, Ara Kassabian, and Tracy Petersen reported on their SURF projects to a standing-room-only audience at Caltech's Alumni Seminar Day on May 17.

Awards and honors

Peter Cho, SURF '84, '85, and '86, received TIME magazine's College Achievement Award as announced in the April 7 campus edition of TIME. The award was presented for academic excellence, and for achievement in the student's field of interest. Peter was one of 20 selected from 775 entries from 269 colleges.

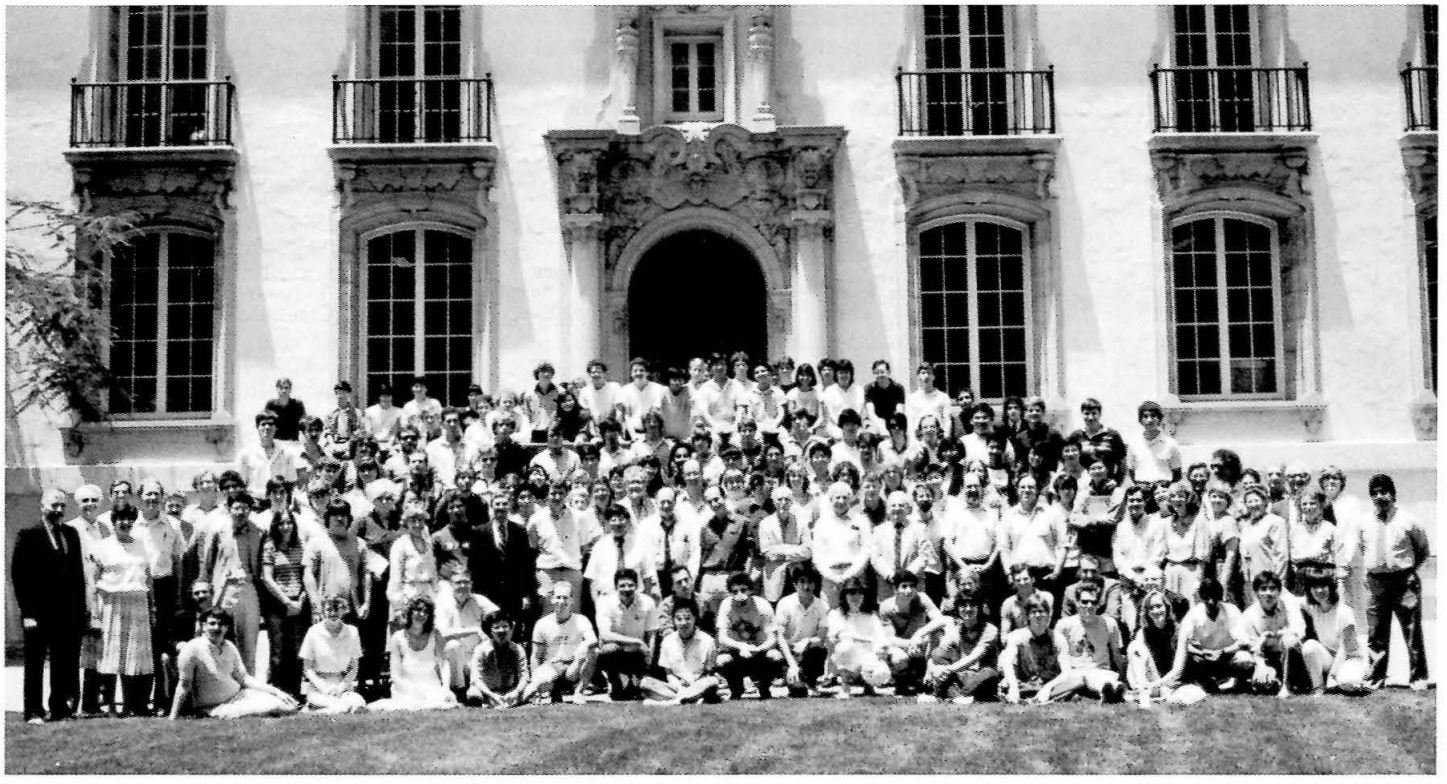
The faculty committee on Undergraduate Academic Standards and Honors selected Salman Mitha to receive the Sigma Xi Award, which is presented to a graduating senior for the most outstanding piece of research done by an undergraduate. Mitha SURFed in 1984 with Senior Research Associate Peter Haff, and in 1985 with Professor Tom Tombrello.

At its annual initiation banquet on June 3, the Caltech chapter of Sigma Xi initiated to associate membership 71 undergraduates, 70 of whom were former SURFers. This represented 9 percent of the student body and gave Caltech an all-time nationwide record in the percentage of its undergraduate student body initiated into the national honorary research society. Since a student must demonstrate an aptitude for research to qualify for Sigma Xi membership, Sigma Xi honors what SURF promotes.

SURF endowments

Six SURF endowments have been established this year: the William H. and Helen Lang SURF Endowment Fund; the Hugh F. and Audy Lou Colvin SURF Endowment Fellowship; the Bristol-Myers/Unitek SURF Endowment Fund; the Class of '36 Endowment Fund; the Lester Lees Aeronautics SURF Endowment; and the Flintridge Foundation SURF Endowment. The earnings from each of these endowments will support one SURFer per year.

We acknowledge with gratitude the personal interest and contributions of the following friends in the establishment of these SURF endowments: Mr. William Lang and Mr. Hugh Colvin for their personal endowments; Mr. Randy Wall, president of Unitek, Inc. and Mr. Hugh Colvin, former president of Unitek, for the Bristol-Myers/Unitek SURF; Mr. Hugh Colvin and the class of 1936 for memorializing the class through the SURF program; Mr. John Lewis, Mr. Tom Tyson, and the other students of Professor Lester Lees who chose to honor him through an endowment to the SURF program; Mrs. Jaylene Moseley, executive director of the Flintridge Foundation.



Roundtables

Business, community, and academic leaders met informally throughout the summer with groups of eight to ten students in the SURF roundtable series. Roundtable breakfasts and lunches provided opportunities for students to discuss with the guest such topics as leadership characteristics, career development, entrepreneurship, or academic administration. Roundtables are sponsored by AMETEK, Inc., whose special contribution made them possible this year.

The 1986 Roundtable leaders were:

Dr. Lew Allen, Jr., *Director, Jet Propulsion Laboratory,* and Dr. Terry Cole, *Chief Technologist, JPL*
Dr. Robert F. Bacher, *Professor of Physics, Emeritus, Caltech*
Colonel Dennis F. Butler, *District Engineer, Army Corps of Engineers*
Dr. Norman A. Gjostein, *Director, Systems Research Laboratory, Ford Motor Company*
Dr. George J. Gleghorn, *Vice President and Chief Engineer, Product Integrity, TRW, Inc.*
Dr. Paul Y. Hu, *Senior Engineer, IBM Corporation*
Mr. Theodore P. Hurwitz, *Vice President for Institute Relations, Caltech*
Dr. Laird E. Johnston, *Division Manager, Electronic Data Systems Corporation, General Motors*
Mr. Gaylord E. (Nick) Nichols, *Director of Programs, Industrial Relations Center, Caltech*
Mr. Robert L. Shafer, *Certified Management Consultant*
Dr. William M. Whitney, *Senior Member of the Technical Staff, Observations Systems Division, JPL*

Noon seminar series

At noon on each Monday and Friday during the ten-week period, seminars are presented for the students by faculty members, JPL technical staff, Caltech staff, and representatives from SURF's corporate sponsors. The speakers give an overview of their particular area of research.

For 1986, the faculty, staff, and JPL speakers and their topics were:

Jesse L. Beauchamp, *Professor of Chemistry,* "Chemistry in Electromagnetic Bottles"
Glen R. Cass, *Associate Professor of Environmental Engineering,* "Control of Atmospheric Carbon Particle Concentrations"
Charles Elachi, *Manager, Earth and Space Sciences Division, Senior Research Scientist, JPL,* "Earth and Planetary Observations with Remote Sensors"
William A. Goddard, *Charles and Mary Ferkel Professor of Chemistry and Applied Physics,* "Simulation of Materials, Chemical and Biological Systems"
John F. Hall, *Assistant Professor of Civil Engineering,* "Earthquake Behavior of Concrete Dams"
D. Roderick Kiewiet, *Associate Professor of Political Science,* "New Variations on an Old Theme: Budgetary Politics in the U.S. Congress in the 1980s"
Allan J. Lindstrom, *Director of Sponsored Research, Caltech,* "Sponsored Research"
Bruce C. Murray, *Professor of Planetary Science,* "Where to Land on Mars"
H. David Politzer, *Professor of Theoretical Physics,* "Large-Scale Motions as Relics of the Big Bang"
Eleanor M. Searle, *Professor of History,* "Norsemen into Normans"
Bradford Sturtevant, *Professor of Aeronautics,* "Cellular Automata"
David C. Van Essen, *Professor of Biology,* "Monkeying with Visual Cortex"

The corporate seminars included:

Dr. Robert C. Brown, *Research Nutritionist, Calreco, Inc.*, "Nutritional Parameters Affecting Drug Metabolism"

Dr. Henrick Gille, *Director of Research and Development and Quality Assurance, Unitek Corporation*, "Applications of Computers to Product Development"

Dr. Norman A. Gjostein, *Director, Systems Research Laboratory, Ford Motor Company*, "The Role of Advanced Technology in the Auto Industry"

Dr. George J. Gleghorn, *Vice President and Chief Engineer, Product Integrity, Space and Technical Groups, TRW Inc.*, "Systems Engineering and Spacecraft Design"

Dr. Paul Y. Hu, *Senior Engineer, IBM General Products Division*, "Optical Data Storage Technology"

Dr. Laird E. Johnston, *Division Manager, Electronic Data Systems Corporation*, "Computer Aided Engineering for GM"

Workshops

On July 24, Wayne Austin and Debbie A. Ardolino of TRW Inc. gave a workshop on Effective Presentation Skills to a group of students and staff members at the Industrial Relations Center at Caltech. The purpose was to develop the confidence and specific skills necessary to make effective technical presentations.

During June and July, Jean E. Cass conducted communications workshops to help students get ready for their final oral presentations. She held one series on preparing and organizing material for the talk, and another series on creating visual aids. About 60 students participated in the workshops. In addition, during the two weeks preceding SURF Seminar Day, Jean Cass and two volunteers from the JPL Toastmasters helped SURFers rehearse their presentations. Student participation in the workshops is voluntary.

SURF speakers bureau

Twenty 1986 SURF students have volunteered for the new SURF Speakers Bureau. These students will work with Jean Cass to develop a talk with visual aids about their research projects, the SURF program, and Caltech. These students will be available to speak to a wide variety of audiences including corporate, civil, and academic groups.

"The Summer Undergraduate Research Fellowships Program is a 'marketplace' for ideas and represents the dedicated efforts of many people. The academic community has joined with members from various segments of our society for the purpose of extending the student's understanding in the fields of science, economics, sociology, ethics, and other related subjects, possibly providing a more favorable basis for discerning the balance between career goals and the price of achievement.

"Students at the 'starting line' have every reason to have hope for an improved future. There can be no greater challenge to a student than the desire and will to make things better."

Robert L. Shafer
Certified Management Consultant
Member, SURF Board

Biology

Correlation Between CAT-301 Antibody, Anatomical Tracer, and Immunohistochemically Labeled Pathways in Macaque Monkey Visual Cortex

David J. Bruning
Sponsor: D.C. Van Essen

This SURF consisted of four major focal points: immunological labeling of monkey brain sections with CAT-301, high-resolution photography of CAT-301 antibody labeling, three-dimensional graphics analysis of anatomical tracing data from two monkey experiments, and beginning a set of experiments on the organization of rabbit visual cortex. The antibody experiments have provided data indicating immunologically distinct regions within the visual system and within one cortical visual area, V2, subregions labeled with CAT-301 could be correlated with subregions defined by the anatomical tracing techniques.

Development of Technique for Establishment of Dissociated Cell Cultures of Zebra Finch Neurons

Rachael A. Clark
Sponsor: M. Konishi

In vivo study of the development of sexually dimorphic regions in the zebra finch (Poephila gutatta) song system has shown that females exposed to estrogen during a sensitive period undergo masculine brain differentiation. This project is the first step toward studying this phenomenon in vitro. I have developed techniques for establishing dissociated cell cultures, including an enzymatic dissociation technique utilizing papain. Study of these cultures will provide information on physiological characteristics of these cells and clarification of the role estrogen plays in the masculinization process.

Function of a Neuronal Cell Surface Protein: SURFing on the NILE

Michael F. De Freitas
Sponsor: P.H. Patterson

Mutant PC12 cells which lack the neural cell surface glycoprotein, NILE, may be useful in determining the function of NILE. Fourteen mutant PC12 clones which show low levels of binding of a monoclonal antibody against NILE, while having normal levels of other cell surface markers, have now been isolated.

An Attempt to Isolate Alleles of *Bendless*, a Mutant Affecting Neuronal Connections in *Drosophila melanogaster*

Susannah J. Hannaford
Sponsor: M.A. Tanouye

Genetic techniques were used in an attempt to isolate new alleles of *bendless*, a mutant that affects the connection between the cervical giant fiber and the tergotrochanter motorneuron. Twenty thousand five hundred mutagenized flies were tested in a behavioral screen designed to select for non-jumping mutants. Thus far, 19 non-jumping stocks have been isolated and are currently being tested as possible *bendless* alleles using electrophysiology.

Purification of Monoclonal Antibodies Against the Lyt2, L3T4, and the IL2R Molecules

Ali R. Lashgari
Sponsor: E. Rothenberg

In order to study the various subpopulations in the thymus, one has to attain pure monoclonal antibodies (mAbs) against thymocytes' cell surface glycoproteins. I have purified 3.155 and 7D4 mAbs specific for the Lyt2 and IL2 receptor molecules using gel filtration and ion exchange chromotography techniques. Additionally, I have derived pure GK1.5 mAb (specific for the L3T4 molecule) for FACS assay. Derivation of 3.155 and 7D4 and FACS analysis of IL2 receptor expressing thymocytes is to follow.

Selecting for Revertants of the *Bendless* Mutation

Ann J. Lewis
Sponsor: M.A. Tanouye

Ethyl metham sulfonate mutagenesis was utilized in an attempt to select for revertants of the *bendless (ben)* mutation which affects the synapse between the cervical giant fiber and the tergotrochanter motorneuron in *Drosophila melanogaster*. Of the 11,000 chromosomes screened, I have isolated 14 putative *ben* revertants. These revertants are being characterized more completely.

Postprocessing for Neural Network Modeling

Curtis C. Ling
Sponsor: J.M. Bower

To make results of neural network models more easily understood, programs which produce easily understood results rapidly from raw datastreams were written on the Mark III Hypercube. The processing performed by these programs includes putting raw datastreams into PST Histograms and performing cross-correlation on all different combinations of neurons to find 1) the pairs of neurons with the highest correlation, 2) the correlation, and 3) the time lag at which the maximum correlation was achieved. The unoptimized program performed these functions on 16 neurons each with 64 data points, in under 60 seconds on a four-node Mark III. By optimizing and running on a 32-node, 1000 neurons could be post-processed in about 3 hours.

Characterization of the *Sevenless* Mutation: a Three-Part Study

Bassem N. Mora
Sponsor: S. Benzer

Five mutageneses were performed and the progeny screened in order to isolate a temperature-sensitive allele of *sevenless*. Mold was encountered; its sources were subsequently isolated and removed. A total of 29 new *sevenless* mutants were isolated, at least seven of which are independent. Mapping and complementation tests are under way to determine whether any are temperature sensitive. In addition, progeny from mutagenized males was screened in the search for *sevenless* revertants. Although all revertants isolated did not breed true, several interesting mutants have been isolated and studies on them are being continued. Finally, the phototactic behavior of *bendless*, a jumpless mutant with structural defects in R7, was studied and it seems that *bendless* is very similar to *sevenless*, which is missing R7.

A Study of Type II CaM Kinase in *Drosophila*

Phyllis C. Pugh
Sponsor: M.B. Kennedy

Type II Ca^{++}/calmodulin dependent protein kinase has been partially purified (approximately 190-fold) from *D. melanogaster* Canton Special (wild type) and Radish (a learning mutant). In *Drosophila*, this kinase is composed of three subunits at 60 000, 58 000, and ~ 52 000 daltons, all of which autophosphorylate in the presence of calcium and calmodulin. This autophosphorylation causes the appearance of calcium-independent activity which is 40% of the normal calcium-dependent activity. No detectable difference was discovered between the wild type and learning mutant kinases.

In Vivo Footprinting of the Metallothionein Promoter

Stephen J. Salser
Sponsor: B.J. Wold

A key issue in understanding the differential expression of genes under varying conditions is to observe the direct interaction of regulatory molecules with DNA. I have developed a technique sensitive enough to detect these interactions within living mammalian cells, and plan to study the regulation of certain genes expressed in response to heavy metals.

Possible Polyprotein Precursors in Mitochondria

Ivan Tarle
Sponsor: G. Attardi

Antibodies prepared against chemically synthesized peptides predicted from the DNA sequence have been used to find evidence of a polyprotein precursor for two human mitochondrial proteins encoded by a pair of overlapping genes. In particular, antibodies directed against an amino-terminal peptide of ATPase 8 and antibodies directed against a carboxy-terminal peptide of ATPase 6 have shown some evidence of ATPase 8/ATPase 6 polyprotein existence when incubated with a mixture of mitochondrial proteins.

Conservation of Synaptic Space of Neonatal Rabbit Soleus Muscle Endplates During Synapse Elimination

Alexander Wei
Sponsor: D.C. Van Essen

By observing the morphological changes at the rabbit's neuro-muscular junction during synapse elimination, we can compare and evaluate two hypotheses for synapse competition: a) the synapses actively compete for occupation, or b) a shortage of some trophic substance causes the synapses to lose hold and retract. The end result in either case is that only one synapse remains. The results of this project are still pending.

Finding and Sequencing β-related Genes

Kenneth K. Yoshimoto
Sponsor: M.I. Simon

DNA sequences and the presence of two different-sized mRNAs show that there are at least two different types of β subunit, rather than one, as previously believed. There is a high degree of homology between the two protein sequences and homologous repeats exist within each sequence. Evidence suggests there may be a third β as well.

Protein Targeting to Mitochondria

Kyuson Yun
Sponsor: S. Emr

Most mitochondrial proteins are encoded in the nucleus and synthesized in the cytoplasm as larger precursors with amino terminal presequences that are cleaved off after their import into mitochondria. To test how much of the precursor is necessary for correct targeting, I fused two mutated presequences (one mutant with double deletion and the other mutant containing two amino acid substitutions in the presequence) of the gene that encodes the mitochondrial F1-ATPase β-subunit protein with the gene SUC2 which codes for the normally secreted enzyme invertase. The experimental results indicate that these constructions code for hybrid proteins that are imported into mitochondria, indicating that there may be redundant import information in the β-subunit presequence.

Chemistry and Chemical Engineering

Ion Cyclotron Resonance Spectroscopy of $(CO)_5MnCH_3$: Observation of Carbon Monoxide Exchange Reactions

Kathleen C. Hayashibara
Sponsor: J.L. Beauchamp

Gas phase carbon monoxide exchange reactions of $CH_3Mn(CO)_5$ were studied in the Fourier-transform ion cyclotron resonance mass spectrometer. Results indicate that the rate of CO exchange is more rapid for $CH_3Mn(CO)n^+$ and $Mn(CO)n^+$ where $n = 3$ and 5 than for ions having 1, 2, and 4 carbonyl ligands.

The Structure of $Cp_2TiC_8H_{11}N\Phi_2$

Nhi G. Hua
Sponsors: B. D. Santarsiero

The compound $Cp_2TiC_8H_{11}N\Phi_2$ ($\Phi = C_6H_5$) with solvent benzene, crystallizes in space group $P2_1/n$ with $Z=4$. The unit cell dimensions are $a=18.430(9)$Å, $b=14.335(4)$Å, $c=10.776(5)$Å; $\beta=106.41(4)°$, and $V=2731(2)$Å^3. Important bond lengths and angles are as follow: Ti-C1: 2.02(3)Å, Ti-C4: 2.34(3)Å; ∡C1-Ti-C4: 71(2)°, ∡R1-Ti-R2: 134.4(3)°.

Modification of Arginine Residues in Proteins with Phenylglyoxal

Quynh-Thu X. Le
Sponsor: S.I. Chan

Although phenylglyoxal has often been used to modify arginine residues at protein band 3 active site, the adduct formed between the two species has not been structurally established. The task of the project is to employ various chromatographic methods to isolate the complex and high-field proton nuclear magnetic resonance spectroscopy to identify its structure. Data collected indicated that phenylglyoxal molecules are unstable under basic conditions, and that they undergo more than one reaction with arginine as well as among themselves. Since the complexes dissociate rapidly in aqueous solution, more efficient separation methods will have to be developed to isolate them for further spectroscopic studies.

The Synthesis of a Possible C + G DNA-Binding Molecule

Kim Liu
Sponsor: P.B. Dervan

In an effort to obtain a C + G DNA-binding molecule, N-methylpyrrole-carboxamides were reacted with both 2,6-diamino- and 2,6-dicarboxylpyridines. While the former pyridine derivative has thus far bound only one peptide unit, the latter has successfully reacted with the peptide unit which was linked to N-dimethylaminopropyl. Synthesis of a similar molecule, with a dipeptide unit rather than the monopeptide, is currently under way. Then efforts will be made to bind these molecules to DNA.

Titanium Enolates and Synthesis of a Beta-Lactam Ring System

Wayne W. Lukens
Sponsor: R.H. Grubbs

I. The activated pentaflurorophenyl esters form enolates with titanium metallacycles like acid halides rather than doing methelene transfer like normal esters.
II. The synthesis of the beta-lactam ring system 1 was not observed due to the inability to synthesize the enol-ether 2 in the key reaction of the synthesis.

Synthesis and Characterization of Macrobicyclic Polyethers Containing Strong Anionic Nitrogen Donors

Timothy J. Parrott
Sponsor: T.J. Collins

A new synthesis of an important precursor to a class of bridged macrocyclic polyethers which complex well with alkali metals was studied. The synthesis of C.3-dihydroxydibenzo-14-crown-4 was investigated in the hopes of achieving greater synthetic flexibility and increased control over the separation and rotation of the products.

Molecular Modeling of Silicon (100) and (111) Surface Reconstructions

Janice L. Peters
Sponsor: W.A. Goddard III

Using force fields obtained from quantum mechanical (generalized valence bond) calculations, we have examined the energetics of various proposed models for the reconstruction of Si(100) and Si(111) surfaces. We find that for Si(100) the P(2 × 1) reconstruction is stable with respect to C(2 × 2) (in agreement with experiment) and have extracted the origin for this preference of P(2 × 1). For Si(111) there is currently considerable controversy about the atomic displacements involved in both the 2 × 1 and 7 × 7 reconstructions. We have examined a number of possible models of 2 × 1 including some of the massively reconstructed models (e.g., π-bonded chains) and will discuss the results.

Synthesis and Oxidation of Os(IV) (η^4-HMPA-DMP)L_2 Complexes, Where L is a Para-Substituted Pyridine

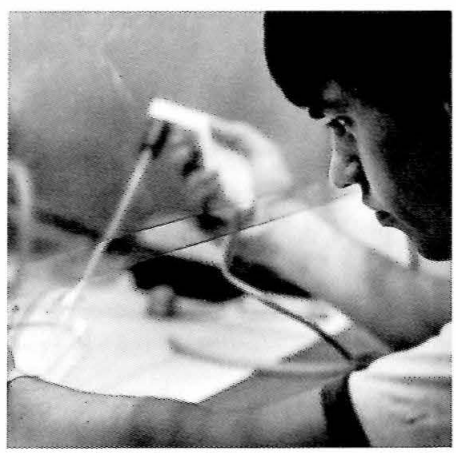
Tzejen James Shih
Sponsor: T.J. Collins

Reaction of OS(IV) (η^4-HMPA-DMP)L_2 (L = pyridine, 4-methyl pyridine, 4-t-Butyl pyridine, 4-dimethylamino pyridine) with bromine leads to the formation of the respective [Os(V) (η^4-HMPA-DMP)L_2]Br_3 compounds with varying stability corresponding to the electron donating ability of the substituent. UV-VIS, NMR, and chemical analyses suggest that the less stable OS(V) compounds air-oxidize to Os(VI) (η^4-HMPA-DMP)O via the Os(IV) intermediates, and that the dissociation of the substituents might be the first step in the Os(IV) to Os(VI) conversion.

The Omega Graphics Package

Pierce T. Wetter III
Sponsor: M. Morari

The Omega graphics package consists of three graphics packages: gr and xgr, two packages to handle the basic lower-level graphics tasks in MS-DOS and XENIX on the IBM-PC; and wplt a high-level graphics package using gr and xgr as a base to build a device-independent graphics system. This report chronicles the development of this package, presents a short tutorial on its use, and also serves as a reference for the application programmer.



Engineering and Applied Science

FRAMES: A Computer-Animated Display of Human Gait Data

James W. Busacker
Sponsor: E.K. Antonsson

An interactive, high-performance graphics rendering device has been applied to the display of human gait data produced by a three-dimensional kinematic acquisition system. The system will be used as a feedback mechanism for improving the data-filtering and dynamic analysis processes applied to the output of that system.

Photoelastic Analysis of a Gothic Cathedral Section under Load in a Centrifuge

Suman Chakrabarti
Sponsor: R.F. Scott

The purpose of this project is to analyze the stresses to which a gothic cathedral is subject. This is done by constructing and loading plastic models of a cathedral cross section using the photoelasticity of the plastic to record the stresses at each section of the model. The types of plastics under consideration for modeling are solithane and homolite. Through prolonged testing involving cantilever beam loads and pure bending moments upon these materials, it was found that homolite—with a stress-optic coefficient (C) 450—would be the optimum plastic for further experiments. Now that this preliminary work has been completed, a next logical step will be to commence testing of models under the loads in the 50-100 g environment of a centrifuge. This will provide a good approximation of the load that gravity imposes upon an actual cathedral.

Polarization Morphometric Detection of Mineralization During Bone Healing

Christopher M. Chu
Sponsor: H. Winet

During the process of wound healing, an injured bone goes through a specific sequence of reparative steps to initiate growth of new calcified bone in the affected region. The main purpose of the research is to seek out quantitative relationships between the rate of growth of incoming hydroxyapatite mineralization fronts and the resultant appearance of bone. By using the data collected with polarized light during the third to seventh week after the injury, it can be concluded that the rate of mineralization is gradually reduced with the introduction of actual bone. On the other hand, the regeneration of bone is significantly increased, suggesting that the two differing rates of growth are biologically linked.

Generation of *Pseudomonas* sp. 200 Mutants Defective in Iron-Reduction Capability

Stephen M. Gomez
Sponsor: M.R. Hoffmann

Pseudomonas sp. Strain 200 recently isolated from a Canadian oil pipeline, is capable of reducing iron [i.e., Fe(lll)-→Fe(ll)] under anaerobic conditions at rates higher than those previously reported for other capable bacteria. Respiratory inhibitor studies have shown that this species possesses both a constitutive iron-reductase and an inducible (low-oxygen growth) ferri-reductase. As part of a preliminary genetic investigation, two methods have been devised to screen for ferri-reductase deficient mutants. These methods will be used to identify genomic loci involved in expression of the *Pseudomonas sp. Strain 200* ferri-reductase.

Image Digitization, Acquisition, and Analysis of Biological Structures

Timothy K. Horiuchi
Sponsor: W. J. North

My project was to develop custom software for a PC-based image-analysis system to measure the effects of pollutants on vegetative growth of kelp gametophytes and to reject contaminating organism biomass. Project goals were to increase measurement accuracy and sample size, automate data analysis, and decrease data-acquisition and analysis time. The resulting system achieved most of these goals.

Microvascular Casting Around a Bone Chamber

Andy K. Lee
Sponsor: H. Winet

Microvascular casting was used to study the vasculature around a bone chamber, a surgically implanted observation device, in the upper tibia of a rabbit's leg. The casting material was a mixture of methyl methacrylate - Batson #17, and a dental plastic - Servriton. In addition to the methacrylate cast, we also had two latex casts - Microfil. These casts were embedded and sectioned into pieces of approximately 10 micron thickness. The sections were then studied as magnified video images with help of a computer. With the sections stored in the computer, we could compute the volume of the vasculature and also consider other manipulations.

Innerconnection Lines With Tungsten

Timothy J. Ma
Sponsor: M-A. Nicolet

Innerconnects run between the various components throughout the different layers of the silicon chip. They, therefore, must have good conductivity and must be well insulated. Present technology uses tungsten and molybdenum-silicides for these interconnects. Silicides are semiconductors, and thus are fair conductors. They also can be readily oxidized to form an insulating layer of silicon-dioxide. However, pure metal, such as tungsten is more efficient for innerconnects and would provide greater speed. Therefore, my SURF project was to find a process of oxidizing tungsten-silicide such that all of the silicon oxidizes into the insulating silicon-dioxide and leaves pure tungsten underneath. My results show formation of silicon-dioxide and some phase change in tungsten-silicide, but further research is being done to identify the process of transformation.

Frequency Response Measurements using Ring-Dye Laser

Khanh B. Nguyen
Sponsor: W.B. Bridges

Measurements of photodetector frequency response were made by coherently mixing a He-Ne laser with a single-frequency ring-dye laser which used DCM dye and was electronically tunable over 30 GHz. The measurements were made on three types of photodetectors.

(1) PIN avalanche photodiode - large sensitive area and large internal gain, but low-frequency response (0.0 - 2.0 GHz) because of large shunt capacitance.
(2) Schottky barrier photodiode - small sensitive area and little internal gain, high-frequency response (0.0 - 18.0 GHz) because of low capacitance.
(3) Interdigital Metal-Semiconductor-Metal photodiode - large sensitive area and moderate internal gain, good frequency response (0.0 - 12.0 GHz) and responsivity because of low capacitance and large area.

Results of the measurements agreed with manufacturer's specification (for the PIN diode), and with measurements made at Hughes Research Labs by mixing two current-tuned semiconductor lasers (for the Schottky and MSM diodes). Because of the high quality of the output beams of the He-Ne laser and the ring-dye laser, we obtained very detailed pictures of the frequency response, detailed enough that the effects of the bond wire and packaging of the detector chip could be seen.

Microstrip Fabrication for a Network Analyzer

Stephan A. Pietrusiak
Sponsor: D.B. Rutledge

My work under the SURF program entailed several projects relating to EE 153, a microwave course offered at Caltech. Specifically, the latter portion of the SURF consisted of working on the fabrication of a silicon integrated circuit needed for a network analyzer that is being built for use in EE 153.

Graphics System for a Natural Language Environment

Steven G. Roskowski
Sponsor: F. B. Thompson

This project involved design and implementation of a graphics system for the ASK natural language environment. The project included a graphics editor and an image-acquisition and storage system. It also includes a method for interrelating the above to each other as well as to the rest of the database environment.

A Mössbauer Spectroscopy Study of Short Range Order in Feco Alloys

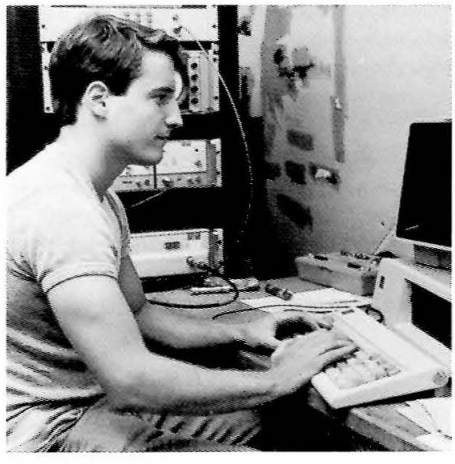
Bradley E. Solberg
Sponsor: B.T. Fultz

An Iron 57 Mössbauer Spectrometer was received, modified, installed and used to study the process of short-range ordering in rapidly quenched FeCoX alloys. Ordering kinetics were shown to be supressed by the addition of 2% solutes of vanadium and tungsten. Vanadium and tungsten atoms were shown to attract cobalt atoms into their first nearest neighbor crystal sites.

Multi-lingual Access of the ASK System

Sean E. Trabosh
Sponsor: F.B. Thompson

ASK, a Simple Knowledgeable system, is a total system for the structuring, manipulation, and communication of information. ASK uses a Natural Language interface to communicate with the user. English, French, and Italian have already been successfully implemented in the ASK system. But, until this summer, each language had its own underlying database. That is, data entered in one language could only be accessed in that language. This paper discusses the problems encountered in providing true multi-lingual access for ASK. The project was completely successful and an ASK database can now be totally accessed in any language that ASK individually supports. In this way, an international company or research team with branches or members that use different languages can utilize the same database.



Photorefractive Properties of Ce-doped Single Crystal SBN:75

Stephen N. Winters
Sponsor: A. Yariv

An experimental study of the photorefractive effect in single crystal SBN:75 is presented. Theoretical explanations are given. The two-beam coupling coefficient is given for various geometries. For each coupling coefficient the transient response is shown, including the fanning effect.

Solid-State Reactions in the Ni-Zr System

Gerard C. Wong
Sponsor: E.J. Cotts

Metallic glass formation in deformed multilayer composites of the Ni_xZr_{1-x} system has been studied with differential scanning calorimetry and X-ray diffraction analysis. The large (17.9 ± 5 kJ/mol for $Ni_{.44}Zr_{.56}$) heat release during amorphization confirms the hypothesis that solid-state glass formation is driven by a free-energy difference. A micromechanism for solid-state amorphization in Zr-rich glasses has been proposed and the Zr/amorphous Ni_xZr_{1-x} interface composition has been estimated to be approximately $Ni_{.44}Zr_{.56}$.

Geological and Planetary Sciences

Observations of Mars during the 1986 Opposition using the University of Hawaii 88-inch Telescope on Mauna Kea

James F. Bell
Sponsor: A.P. Ingersoll

Ten weeks this summer were spent conducting research at the University of Hawaii in Honolulu. Two weeks were spent performing observations of the planet Mars at the Mauna Kea Observatory on the island of Hawaii, and the remaining time back in Honolulu was spent performing the data reduction pertinent to these observations. Observing runs were made on two separate occasions: first in mid-June, and again in late July. The University of Hawaii 88-inch telescope with an f/35 secondary was used to obtain reflectance spectra in the near-infrared (0.5-2.5μm) of several geologically varying regions on Mars. This wavelength range yielded information on the presence of Martian surface water, surface and atmospheric carbon dioxide, ferric oxides, ferrosilicates, and a host of other surface carbonates and clays. Preliminary data analysis shows strong carbon dioxide absorbtions in many regions and several weaker absorbtions which may be attributed to ferric-iron mineralogy. Much of the analysis to date is only preliminary. Instrument problems and poor weather conditions throughout much of the observing time introduced further difficulty in correctly deciphering all the observed spectral features.

Where Did the Calico Artifacts Come From?

Janet L. Boley
Sponsor: G.R. Rossman

Approximately 11,000 putative lithic tools have been unearthed at the Calico Early Man Site near Barstow, California. The artifacts have been dated at 150,000 to 200,000 years, making this locality possibly the oldest archaeological site in North America. The lithological source areas of the tools remains unknown. In the area surrounding the site there are several possible rock outcrops with lithologies similar to the lithologies of the artifacts. Thermoluminescence, infrared spectroscopy, and, in particular, x-ray fluorescence are being used to try to "fingerprint" these outcrops in terms of their differing chemical impurities. If the various outcrops indeed show a characteristic "fingerprint" then the artifacts could be correlated to their source areas.

Mars Exploration SURFs

Shock Experiments on Ferrous Oxide

Andrew J. Campbell
Sponsor: T.J. Ahrens

It is understood that ferrous oxide may have had an important role in the evolution of planetary cores. To study its behavior at high pressures and temperatures, FeO samples having porosities of 34.5 - 36.6% were shocked to pressures up to 20 GPa and recovered for examination. Melting was observed in samples which were shocked to ~11 GPa and above. The resulting temperature estimates are significantly higher than those predicted from equation of state (Hugoniot) calculations.

Booming Sands

Nadeem Ghani
Sponsor: G.R. Rossman

Apparatus to reproduce the booming phenomenon in the laboratory was designed and built. The sound produced in this apparatus was digitized and used to investigate the effect of grain morphology and the physical characteristics of the sand on sound production.

Mars Balloon Payload

Jason R. Beresford
Sponsor: B.C. Murray

Consideration of the capabilities of the Mars balloons led to the development of representative payloads of 15 and 30 kg. The two payloads accommodate similar scientific instrumentation; the difference lies in their power systems. Smaller payloads are restricted to "one-shot" batteries, limiting the mission lifetime to the battery life, while payload systems of 30 kg or more can accommodate solar cells and rechargeable batteries, making mission lifetimes limited only by failure of a critical system. The payload in both cases will consist of two vertically separated instrument packages; an aerial package, containing the delicate optics and electronics, is designed never to touch down, while the ground package is designed to touch down and perform surface science measurements.

Balloons as an Option for Exploring Mars

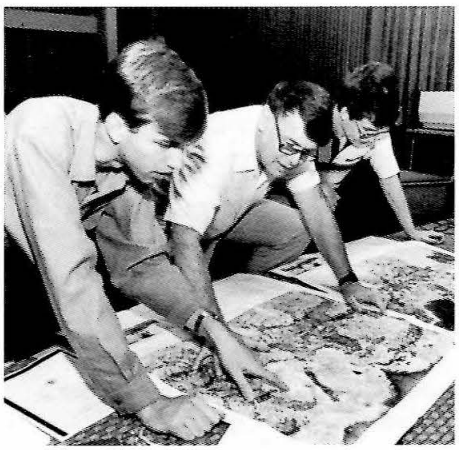
Eric Gaidos
Sponsor: B.C. Murray

Possible options for exploring the Martian surface were judged in terms of their suitability to an automated precursor phase to a manned Mars mission. The need for site-specific information from widely separated regions required a highly mobile system, and the decision to consider only innovative concepts ruled out the many methods currently being studied. It was concluded that lighter-than-air vehicles are a feasible and efficient option for the near-term exploration of Mars, and that this research effort would specifically examine free-floating balloons.

Mars Balloon Design

Brian T. Hayes
Sponsor: B. C. Murray

In order to satisfy the mission requirement of acquiring site-specific information from widely separated sites, it was decided that any balloon design must allow the payload to repeatedly touch down on the surface. In this paper, two types of Mars balloon designs, both of which satisfy this criterion, are discussed. The first type, recently proposed by French scientists, is a double Montgolfiere balloon incorporating a sealed inner balloon and an open hot air outer balloon. A computer balloon design generator was used to compare balloon sizes for given payloads and cruise altitudes and important conclusions are reached concerning both Mars balloon designs.



Mars Balloon Performance

Erik P. Krumrey
Sponsor: B.C. Murray

My responsibility was to evaluate the performance of the two balloon types under consideration. They were evaluated in several areas, including ascent/descent rates, landing velocities, tilt angles due to nighttime winds, altitude as a function of time for a typical day. In addition, a likely travel path was developed for a two-week period. The conclusions were that a balloon could travel up to 500 km a day, covering a wide variety of latitudes, and that while there are some performance differences between the two balloon types, the differences do not seem to give the double balloon sufficient advantage to offset its mass disadvantage. The conclusion reached was that the single balloon was preferable from a performance standpoint.

Delivery and Deployment of a Mars Balloon

Leo Merken
Sponsor: B.C. Murray

Various options for deployment of a balloon on Mars were studied, with the objective being promising methods for near-term missions. Specifically, air and surface launch options were investigated and compared. The surface launch option presented itself as a well-tested method; the air launch option had the advantage of simplicity and low mass, but it is a relatively new technique. Comparison of the two launching methods led to the conclusion that both options are feasible, and more study is needed before a choice is made.

Thermal Evolution of the Uranian Satellites

William C. Smith
Sponsor: D.J. Stevenson

It has been determined that for resurfacing of Miranda to occur because of radiogenic heating, the thermal conductivity of non-crystalline ice at temperatures of 60 to 150 Kelvin would have to be less than 5.57×10^4 erg/cm/sec/K. Also, a smaller proportion of the NH_3-H_2O ice would have melted in Miranda than in the larger satellites, allowing another heat source to cause resurfacing at a later date.

Humanities and Social Sciences

A Research of the Double Oral Auction Theory

Catherine T. Chen
Sponsor: C.R. Plott

The Easely-Ledyard theory provides an explanation for the convergence behavior observed in experimental markets. By separating the predictions of their theory from the predictions of the competitive equilibrium model, the theory can be tested against the currently accepted model. The design also provides tests of Holt's market power theory and Smith's convergence theory. The data support the Easely-Ledyard theory over the other three.

California Voting Trends Analysis

David R. Ely
Sponsor: B.E. Cain

This is a study, sponsored by the L.A. *Times*, of voting trends in California. A database of the vote returns from counties for statewide offices and selected propositions in general elections from 1960 to 1984 was built as a basis for the study. Among the questions addressed were trends in voter registration by party, trends in loyalty of registered voters, counties share of total vote, and average votes for winning candidates. Several important trends in registration were discovered. Democratic gains in the Bay area counties and losses in the central valley counties and the Southern California counties other than L.A. were balanced by Republican losses in the Bay area and smaller gains in the central valley and the south. Throughout the period Republican loyalty was considerably higher than Democratic loyalty as measured by the vote for a party's candidates divided by party registration. Those counties with falling Democratic registration also showed decreased Democratic loyalty. The most significant trend in counties voting strength was the drop in Los Angeles' share of the vote from 40% in 1960 to 27% in 1984, with gains in the rest of Southern California.

Physics, Mathematics and Astronomy

Applied Rainbows

Eric K. Babson
Sponsor: M. Aschbacher

We associate to each Hopfield model T a geometry A(T) and investigate the model from the point of view of this geometry. In particular we produce an algorithm for determining when, for any given geometry A and state Y, there exists a model T with A(T) = A and Y stable with respect to T. We also determine all geometries A with two nontrivial colors and with a group of automorphisms transitive on the states of energy e for each e.

Quark Model Predictions for the Electron Energy Spectrum in Semileptonic B-meson Decays

Vineer Bhansali
Sponsor: M. B. Wise

The constituent quark model is used to predict the electron energy spectrum in semileptonic B-meson decays. Convergence of decay rates with respect to the free quark spectrum with increasing n is studied by explicit calculations up to the states π''' and ϱ'''.

Delta (3,3) Resonance in a Nuclear Medium

Kay-Yut Chen
Sponsor: R.D. McKeown

Electron—proton scattering experiment was done at SLAC to study delta (3,3) resonance in a nuclear medium. Electrons with energy ranged from 0.65 GeV to 4 GeV are scattered off carbon, iron, and liquid hydrogen targets. Data are analyzed on a VAX computer and calculation of cross section of the elastic scattering data shows that results coincide with theoretical models and the experiment is successful. In the future, a Rosenbluth separation will be done for data obtained at different angles, and the longitudinal and the transverse response function will be studied.

An IBM PC-AT Raster Graphics Display Station

David A. Gates
Sponsor: G.C. Fox

Programs for displaying and creating Lucasfilm-format picture files are described. 24 bit/pixel encoded or dumped, single or multiple tile pictures with or without offsets are supported. Programs for the video presentation of these files are described. Zooming and scrolling are implemented. Geometric drawing programs are included in the software base.

Track Recognition in a Time-Projection Chamber

John C. Gehring
Sponsor: J.H. Thomas

The time-projection chamber will be used for the detection of double beta decay in Xenon gas. Software has been written to analyze the output of the chamber and discard background events. This can be done at a rate of 1.7 events per second and 90% efficiency.

MM Observations of Pre-Main Sequence Stars: A Peek into the Cradle

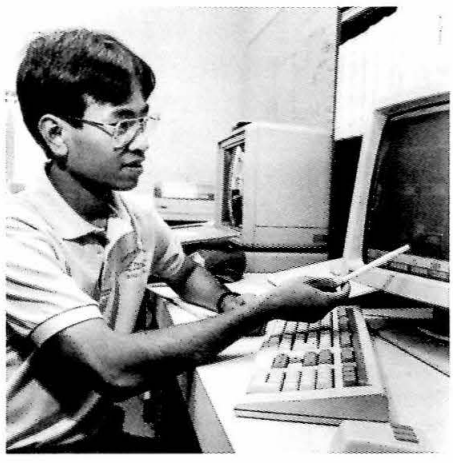
Gabrielle A. Gordon
Sponsors: L.G. Mundy & N.Z. Scoville

Observations at 2.7 mm have yielded evidence for circumstellar dust in about 21% of CO-outflow sources surveyed. We have derived physical parameters for the dust, which show masses and densities of dust that fit well with current theories about star formation and with specific models for the detected sources. Such a survey as ours could easily be expanded to detect dust that has the mass necessary to form planetary systems.

Pawn Endgames for the Concurrent Chess Program

Francis Ho
Sponsor: G.C. Fox

Two pawn endgame evaluation functions were written. One pawn () scored kings and one pawn positions and pawneval () scored multi-pawn positions. A third evaluation function, locked (), was left in the debugging stage. It was designed to play locked pawn positions.



The Development of Filaments Between Adjacent Active Regions

Sandra J. Horton
Sponsor: H. Zirin

Filaments that develop between adjacent bipolar active regions were studied to determine the origin and nature of the magnetic fields supporting the neutral line. Spreading of the magnetic field toward an adjacent active region and the build-up of a neutral line is observed with subsequent filament development. Measurements were taken of the distances between magnetic polarity elements during the developing stage.

The Study of Neural Networks using Silicon Devices

Andrew C. Hsu
Sponsor: J. Pine

Studies were completed on the use of a silicon multicellular culture substrate for electrophysiology. A suitable environment was discovered for growing neurons and glial cells on the silicon substrate. There, cells were maintained in this environment for up to three weeks with no difference in viability compared to sister culture controls. Also, a technique for micromanipulating neurons into individual silicon wells was developed. Data for the viability of cells after manipulation have been inconclusive. Finally, the use of a fluorescence-activated cell sorter for isolating subpopulations of neurons was investigated. The isolated subpopulations would later be manipulated onto the silicon device for electro-physiological experiments.

Cosmological Mass Density Fluctuations in 1 and 3 Dimensions

Randall D. Kamien
Sponsor: M.B. Wise

Perturbation theory for the cosmological mass density fluctuation $\delta\varrho/\varrho$ does not converge for small wavenumber at the present epoch in three dimensions. This does not happen in one dimension where perturbation theory gives the Zel'dovich approximation, which is exact in one dimension.

Solar Radio Bursts

Lushalan B. Liao
Sponsor: G. Hurford

Solar flares are spectacular events that occur in the sun. In the past there was a scarcity of good spatial data in the decimetric range; therefore, the relationship between decimetric bursts and flares was less well understood. Now, with the frequency-agile interferometer at Owens Valley, good spatial data are no longer scarce. A survey of high-resolution interferometric data in the frequency range 1.0 GHz to 2.4 GHz was made. The burst on February 13, 1986, was then selected for further study. It was found that though the time profile of the burst appears to be simple, it is actually made up of three sources at distinctly different positions, turning on and off at different times. Furthermore, it was found that two of the precursor spikes that occurred within one hour before the main burst and the different sources of the main bursts were all in the same active region.

Critical Study of Riccati Equations

Paresh S. Murthy
Sponsor: P. A. Lagerstrom

We study Lie's theorm about first order ODE's with superposition principles and give proof and examples. We reproduce basic computational facts: simplification of RE (Riccati equation) when one, two, or three solutions are known; superposition principle; cross-product formula; RE and second order linear equations. Next, we study the Moebius transformation as a structure group of Riemann spheres; its Lie Algebra and sub-groups (sub-algebras) with geometric interpretation. Finally, the relations of RE and Moebius group: behavior under coordinate change with group-theoretical and geometrical discussion of basic computational facts. We also show the uniqueness of RE's.

Development of a Polarized ^{3}He Target

Kwok L. Ngan
Sponsor: R.D. McKeown

A model for high-energy ionizing beam which gives rise to depolarization effects in the polarized helium-3 target is studied by using the Caltech room temperature polarized helium-3 target and a 1 MeV proton beam from the Caltech Pelletron. The depolarization effects will also be studied as a function of the target pressure.

BGO Calibration of the LEP/L3 Detector

Michael G. Pravica
Sponsor: H.B. Newman

This summer, after studying various materials by using the Tandem Van de Graaf accelerator, I altered the previous target design with great success. I built 6 targets (3 Li targets, one Li_2S, one Boron, and one B_4C target). Then the targets were tested using the same accelerator (produced a beam of 2 MeV protons, 1 μA current incident on targets) and found them to be quite durable. Then, 24 BGO crystals were tested for light uniformity and radiation damage. The major contribution to the LEP/L3 group that I made was the discovery of an interesting reaction with boron which now may be used instead of the Li reaction for obtaining the calibration x-ray.

A Photometric CCD System for the 14-inch Celestron

Susan E. Ridgway
Sponsor: K.G. Libbrecht

The purpose of this project was to design a useful, reasonably precise photometric system for the Robinson 14-inch Celestron telescope, using an RCA video CCD camera, an image-processing card, and a Compaq personal computer. Software was written to perform tasks appropriate to photometry. An observation program was written using these routines to maximize speed of measurement and ease of use. The video camera's fixed rate of 30 frames per second limited the stars visible to about 7th magnitude, while disrepair of the telescope drive greatly limited the utility of the software integration. The performance level of the system will be greatly raised by the repair of the telescope, but even in the system's current state, careful observations produce recognizable characteristic light curves of variable stars.

Correlation Functions for Large-Scale Structure

D. Eric Smith
Sponsor: H.D. Politzer

Recent large-scale observations indicate that there may be some simple large-scale structure to the bright matter in the universe. One theory (Ostriker and Cowie 1981) proposes that the large-scale structure may have the form of a foam, in which the matter is accreted on the surfaces of the bubbles, with voids inside. Measurements have been made of the two-and three-point correlation functions for some samples of bright galaxies. We have constructed simple models of the proposed large-scale structure and calculated the correlation functions for them. These can be compared with experiment, to test the agreement of the models with the observed structure, and the degree to which the simple model accounts for the behavior of the statistically derived correlation functions. It turns out that the two-point function for the models we constrtucted is not in good agreement with that observed. For small radii, it depends on a different power of the radius, and for large radii, the fluctuations introduce large error into any approximation of the envelope.

Calculations of the Cross Section for Electron-Positron Pair Production Near Threshold Energies

Samuel N. Southard, Jr.
Sponsor: P. Vogel

The purpose of this SURF project was to attempt to solve the existing discrepancy between theory and experimental results in electron-positron pair production near threshold energies by investigating the methods used and performing the calculations using our own numerical methods and potentials.

On the Integral Roots of $x^n + Px + Q = 0$ and the Vanishing of $\sum_{a+b+c=n} x^a y^b z^c$

Theron W. Stanford
Sponsor: T.M. Apostol

The vanishing of the above homogeneous sum for nonzero integers x, y, z, is known to be equivalent to the existence of three integral roots of the given polynomial equation for some integers P, Q, (P,Q) = 1. We discuss the restrictions under which this may happen for n + 2, a nonprime integer greater than 3, and in particular n = 7, since it is known there are no solutions for any other choice of n.

Hydrogen Content of Irradiated Carbon Foils

George J. Stecher
Sponsor: T.A. Tombrello

The reaction $^1H(^{15}N,\alpha\gamma)^{12}C$ was used to measure the hydrogen content of a thin carbon foil under increasing ^{15}N fluence. The foil was periodically depth profiled to observe any depth-dependent changes in hydrogen content. The entire experiment was conducted under high vacuum, near hydrocarbon-free conditions. The hydrogen:carbon atomic ratio was observed to drop exponentially with ion fluence until 8×10^{15} particles/cm^2, where it remained constant at $\sim .01$. Two or more hydrogen-to-carbon bonding mechanisms with different MeV ion cross sections are probably responsible for this behavior.

Massive Star Formation

Eugene R. Thomas
Sponsor: N.Z. Scoville

The majority of massive star formation in the Galaxy is known to occur in giant molecular clouds (GMC's) in the galactic disk. Using the Massachusetts-Stony Brook CO survey to study the structure of the GMC's, and Infrared data from IRAS to study the formation of young massive stars, still enshrouded in dust, we derive and analyze the mass and luminosity distributions of the clouds. This investigation included 74 clouds with mass in the range 5×10^4 to 10^6 solar masses, containing 155 HII regions. This constitutes a complete sample of all high-mass star-formation regions in the first galactic quadrant with luminosity greater than two times that of the Orion Nebula. We find no correlation of the star-formation efficiency with cloud mass and size, suggesting that most massive star formation is triggered from outside of the cloud.

Explaining an Observed Resonance by Alternate Decay Schemes

Andrew M. Tikofsky
Sponsor: S.E. Koonin

In the attempt to explain an observed pair-production resonance in heavy ion collisions, various pair-production schemes were analyzed. Based on the states involved, a $0+ \rightarrow 1- \rightarrow 0+$ scheme seems promising.

Apples in Space

Minh Q. Tran
Sponsor: P.K. Haff

A system of 20 two-dimensional circular elastic particles of diameter of 4 cm confined in a two-dimensional box was simulated and was found to behave like an ideal gas. When the system was allowed to lose energy through interparticle collisions and to simultaneously gain energy by the vibration of one of the box's walls, it reached a steady state in which a) the particles tended to keep a distance from the vibrating wall and b) those that were near the wall tended to have a velocity higher than those far from the wall.

Granular Flow Property of Asymmetric and Photoelastic Particles

Charles S. Tsai
Sponsor: P.K. Haff

Data were collected on a two-dimensional granular flow system by digitization. The average of displacement along the flow channel shows that the flow is similar to uniform shear flow with the exception of slipping on the boundary. Observations of the channel flow showed some formations of rigid pseudo-particles made of several particles.

JPL

Numerical Experiments to Determine the Collision Cross Section of a Binary Star System

Michael S. Warren
Sponsor: T.A. Prince

This paper discusses the development and use of software suitable for studying the collision cross section for comets in a binary star system. The project determines the number of comet-star collisions expected for two solar-mass stars as a function of their radius. This result is then applied to the comet-impact scenario for γ-ray bursts. Results of over 200,000 integrations performed on a hypercube are presented.

The Importance of Fe II Emission in Moderate Redshift Quasars

Jorden E. Woods
Sponsor: J.B. Oke

The intensities of both ultra-violet, λλ 2500-2700 and λλ 2913-3060, and visible, λλ 4470-4725 and λλ 5130-5540, Fe II regions were measured in twenty-two radio-loud, moderate redshift quasars, z in the range 0.5 to 0.7. Preliminary investigation has shown that there is evidence for a linear-type correlation between these two regions. Such a correlation has not been noted by other investigators and is presently undergoing further evaluation.

Superlattice Fabrication

Michael B. Allweiss
Sponsor: F. J. Grunthaner

This project was an attempt to fabricate a monolayer superlattice composed of alternating layers of GaAs and InAs on a GaAs substrate. Spin-etching was explored as a method for producing smoother substrate surfaces, but without success. Preparation of substrate including cleaning, etching, and mounting was completed, but equipment malfunction precluded project completion.

PPM Modulation of a Frequency-Doubled Nd:YAG Laser Via Cavity Dumping

Laura M. Anderson
Sponsor: J.R. Lesh

PPM modulation was modeled on the computer to find the range of possible modulation rates and power outputs as a function of pumping rate, initial population inversion, and optical field strength. With a laser pumped at a constant rate, only a small range of buildup times was possible. For a laser pumped at 1.1 times the threshold rate, buildup times of 127 ± 25 μs gave pulses stronger than the threshold pulse strength. Two ways to expand the range of buildup times are to shut the pump off between pulses or to vary the pumping rate for each buildup time. The first alternative could not be accurately modeled with our program. The second met the OPTRANSPAC specs, with buildup times between 3.5μs and 210.9μs possible for pumping rates between 1.1 and 3 times the threshold rate. We were unable to carry out experiments due to problems with equipment.

Shapes of Asteroids from Radar: Studies of 1627 Ivar and 1862 Apollo

Leila A. Belkora
Sponsor: A.W. Harris

A new method for obtaining information about the shape of an asteroid from its radar echo was applied to asteroids 1627 Ivar and 1862 Apollo. The silhouette obtained for Ivar was compared with a model in another error analysis project.

An Investigation of an Electrooptic Phase Modulator

Daniel B. Bikle
Sponsor: D. M. Rider

The performance of an electrooptic phase modulator (EOPM) was studied. Computer software was written to model the circuit that drove the EOPM and determine the EOPM's frequency response. This research was an important step toward using a similar EOPM in a wind sensor based on the electrooptic phase-modulation gas correlation spectroscopy concept.

Optogalvanic Spectroscopy in a Ytterbium Discharge

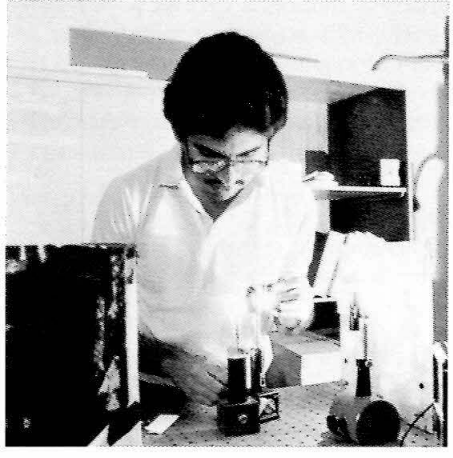
Terry Fu
Sponsor: L. Maleki

An experimental investigation of the optogalvanic effect in a ytterbium hollow cathode discharge cell is described. The effect, over the range 530nm to 565nm, is an increase in discharge current due to laser-induced resonant ionization of the cell. A complete characterization of the discharge cell under varying conditions and wavelength measurements corresponding to atomic energy level transitions are reported.

Planet-Crossing Asteroid Survey

Susan M. Gerhart
Sponsor: E.F. Helin

The Planet-Crossing Asteroid Survey is a search for asteroids (minor planets) which are composed of useful elements and which have orbits that bring them into a configuration which makes them easily accessible from the earth. These can make excellent, inexpensive spacecraft-recovery mission candidates. With my help and the help of Karen Sangster, another SURF student, Eleanor Helin's group at JPL used plates taken from Palomar's 48-inch and 18-inch Schmidt telescopes for the search, and made many more discoveries this summer, including some planet-crossers.



Piezopolymer Characterization: Development of PVDF Transducers for Mechanical Pointing Applications

Andrew J. Huntington
Sponsor: C.E. Bell

Poly(vinylidene fluoride) (PVDF), a piezoelectric polymer, was tested in this project to support analytical models of PVDF electrical-to-mechanical transducers. PVDF actuator fabrication techniques and deflection performance were established. Multilayered actuators verified theoretical models, and a model mirror pointing platform demonstrated that PVDF actuators are well suited to optical pointing mechanisms.

Parameterization of Electron Impact Ionization Cross Sections for CO, CO_2, CH_4, NH_3, and SO_2

Hung P. Nguyen
Sponsor: S.K. Srivastava

The electron impact ionization and dissociative ionization cross section data of CO, CO_2, CH_4, NH_3, and SO_2, measured in our laboratory, have been parameterized utilizing an empirical formula based on the Born approximation. For this purpose on χ^2 minimization technique was employed which provided an excellent fit to the experimental data.

SPICE Model and Numerical Computation Verification

James K. Okamoto
Sponsor: M.G. Buehler

This project develops a series of 5 software experiments to systematically benchmark the models and the numerical computations used in the VLSI circuit simulator SPICE Version 3A6. The results seem to indicate an error in the junction capacitance model and also show some problems with nonconvergence and noise in the simulator.

Near-Earth Asteroid Search

Karin A. Sangster
Sponsor: E.F. Helin

The search for near-earth asteroids is important because these asteroids may provide clues to the formation of the solar system. The search is also important because it may identify possible candidates for spacecraft missions. This summer's search yielded at least two new asteroids with orbits crossing that of Mars. Orbits have been calculated for these two and will be used to make follow-up observations of these asteroids.

Ho:YLF Laser for Deep Space Communications

Karen M. Siegrist
Sponsor: J.R. Lesh

Optical frequencies have several advantages over RF for deep space communication. Radio signals are highly divergent, require reorientation of the spacecraft for redirection, and are incapable of high bit rates. Laser output signals are highly directional, eliminating the need for very large receiving antennae. They are easily redirected with mirrors and are capable of much higher bit rates due to their higher frequency. Development of a high energy laser is therefore of much interest. Ho:YLF, because of its extremely long fluorescence time, is a promising laser material for this purpose. At present, however, liquid nitrogen cooling is necessary. We have developed a lasing system to utilize a Ho:YLF crystal and are now set up to investigate and optimize the temperature vs. output properties of the crystal.

Photometric Observations of the Outer Planets

Felicity M. Wong
Sponsor: B. Buratti

The purpose of this project was to implement a data analysis system on a VAX 750 for reducing astronomical observations of outer planets' satellites obtained at the Mt. Palomar 60" telescope. The program was successfully implemented and measurements of one Pluto/Charon eclipse event and the Uranian satellites and Triton were reduced. Additional data was obtained during two clear nights at Mt. Palomar.

Space Station Polar Platform/Earth Observing Systems

Moon-Tai Yeung
Sponsor: C.E. Bell

A set of operational weather instruments is to be sent into orbit aboard the EOS (Earth Observing System) space platform. In order to solve the pointing control problem posed by the varied articulation activities on the flexible platform, a detailed frequency-response analysis was performed on the platform. Findings show that special attention must be paid to activities at six model frequencies at which pointing requirements are either violated or only barely satisfied.

Orbiting Antenna SURFs

Communications Systems for Global Lunar Coverage

Paul J. Brewer
Sponsors: E.C. Posner & R.V. Powell

Communications systems capable of providing many voice and data channels to the entire moon are discussed. Link power and dish requirements are calculated for a 24 GHZ - 10 mhz bandwidth earth-moon relay involving the collinear and triangular lagrange points. This system is compared with single or multiple low-lunar orbit satellite relay systems and conventional ground-based relay systems. A recommendation is given based on the need for some type of high reliability link for the safety of future lunar operations, including possible radio astronomical facilities on the backside of the moon discussed elsewhere in this report.

Elements of Extra-Solar Planetary Search: Theory and Procedure

Paul J. Brewer and Glenn A. Smith
Sponsors: E.C. Posner & R.V. Powell

Theoretical factors limiting the location of a Jupiter-like planet about a star of arbitrary magnitude are discussed. Probabilities of detection and false detection are defined in terms of the radial probability density of planet formation about a star, with consideration given to the design of the detection system previously defined. Nearby stars likely to be candidates for observation are listed, and possible lunar locations are discussed in terms of star visibility.

Power and Cooling

Allen Gee
Sponsors: E.C. Posner & R.V. Powell

We examine the cooling and power requirements. The refrigeration system consists of individual refrigerators placed at each mixer. These refrigerators are used to cool the detection components of the receiver to 4K. A 'sorption' type refrigerator is recommended because of its long life and relatively light weight. The refrigeration system consists of three stages. The first and second stages utilize the expansion of hydrogen gas to produce temperatures of 65K and 14K, respectively. The third stage then brings the temperature down to 4K using helium gas. For a moon-based system, the refrigerator load will vary over the 28-day cycle of the moon. Approximately 1000 W is required during the lunar day, and 150 W during the lunar night, per antenna dish. Up to two-thirds of the required power can be obtained as solar heat. Other components are cooled to room temperature by passive radiators. The electrical power required is approximately 800 W per dish. At 160 dishes, this comes to 128 kW. The best power system seems to be a combination of nuclear and solar energy.

Antenna Performance as a Function of Structure

Salim Khan
Sponsors: E.C. Posner & R.V. Powell

The choice of location of a system that detects Jupiter-like planets in extra-solar systems is discussed. In addition, the effects of rms surface errors on the main and side lobes are finally calculated using Dr. John Ruze's antenna tolerance theory. Finally, a hypothetical comparison is made between the Leighton and the EFRM type dishes with particular regard to the number of actuators required for a given rms surface accuracy.

Off-Campus SURFs

Receiver System Design

Glenn A. Smith and Ravi Subramanian
Sponsors: E.C. Posner & R.V. Powell

The problems associated with the design of a receiver system operating at 600 GHz are discussed. The various possible receiver types that can be used are briefly described, and the reasons for opting for heterodyne detection are put forth. Preliminary sensitivity calculations for heterodyne detection are carried out, examining background noise, receiver noise, and quantum-limited performance. A complete dual-polarization receiver system is described, consisting of quasi-optical polarization-sensitive diplexers, SIS mixers, and GaAsFET IF amplifers. Two possible system options are considered: (1) combination of signals before detection after appropriate phasing through beam 'waveguides' and a mobile central phasing control and (2) combination of signals at IF level, with phasing control done at IF. The merits and technological problems associated with the development of both systems are briefly discussed, and recommendations are made on the feasibility of actually building such a receiver.

Elements of Extra-Solar Planetary Search: Theory and Procedure

Glenn A. Smith
Sponsors: E.C. Posner & R.V. Powell

Theoretical factors limiting the location of a Jupiter-like planet about a star of arbitrary magnitude are discussed. Probabilities of detection and false detection are defined in terms of the radial probability density of planet formation about a star, with consideration given to the design of the detection system previously defined. Nearby stars likely to be candidates for observation are listed, and possible lunar locations are discussed in terms of star visibility.

Antenna-Array Design and Pattern Synthesis

Atul Srinivasan
Sponsors: E.C. Posner & R.V. Powell

The large collecting area that an extra solar planetary detection system would require for operation at 0.5 mm necessitates the use of a large number of collecting antennas. It is shown how phased-array principles can be very powerful in shaping beam patterns to meet system requirements. Two such antenna-array designs are presented. Each possesses desirable features, but each also introduces case-specific problems. The clustered circular is determined to be the more suitable of the two for a space-based orbiting system, though mechanical rotation of the array is required. For a lunar-based system, the uniform circular array is preferential, providing an electronic means of planet signal modulation, higher gain and signal-to-noise ratio. Each system is found to need a pointing accuracy of 0.01 arcsec, and a method of distinguishing multiple modulated signals. The versatility afforded by the uniform circular array in meeting these requirements, together with the results of the phase-in and baseline-error analyses, suggest it as a more promising option. Should expansion or modification of the system be deemed desirable, the location and size of the uniform circular cluster give it additional appeal.

Antenna Array/Pattern Synthesis/Signal Analysis

Atul Srinivasan and Ravi Subramanian
Sponsors: R.V. Powell & E.C. Posner

The problem of designing an antenna-array configuration and synthesizing a power pattern to satisfy the system requirements is a challenging one. This section introduces the basic design principles that govern the antenna design, the problems encountered in meeting system requirements, and puts forth two possible design and synthesis options.

Cosmological N-body Simulations

J. Alexander Becker
Sponsor: W.H. Press

A numerical N-body code is developed based on the Friedman cosmology. The code is capable of calculating the time evolution of up to 20,000 particles under their mutual gravitational interactions in an expanding, triply periodic universe. It is used to investigate the behavior of distributions of mass which model various aspects of recently discovered large-scale voids in the universe.

Ionization of the Interstellar Medium by Hot White Dwarfs

Peter L. Cho
Sponsors: J. Raymond and A. Dupree

Hot white dwarfs ionize large volumes of interstellar gas and leave elongated trails of ionized matter as they move throughout the galaxy. The probability function for observing specific column densities of C IV, N V and Si IV along a random line of sight passing through an average number of these ionization trails is presented.

Oedipus: Guilt, Innocence and Tragedy

Kenneth D. Haynes
Sponsor: D.S. Carne-Ross

This SURF project was based on close reading of the text *Oedipus Rex*. In addition to reading, I did background work in Greek religious beliefs of pollution and myth. In interpreting the text, I was drawn to two German thinkers, Hölderlin and Nietzche, for I found most contemporary criticism inadequate.

Gabor Expansion Analysis of Radar Signals

Benson C. Lam
Sponsor: W.K. Bohannon

This SURF project implements Gabor Expansion using the Fourier Series method. The implementation was done on the VAX system using the IMSL library for performing numerical integration. Some simple signals such as the harmonic functions have been tested on the program with satisfactory results. However, for more complicated functions such as modulated harmonic functions, the convergence became poor.

Development of an Experimental Instrument to Measure Shear Stress in a Dusty Gas Boundary Layer Behind a Normal Shock Wave

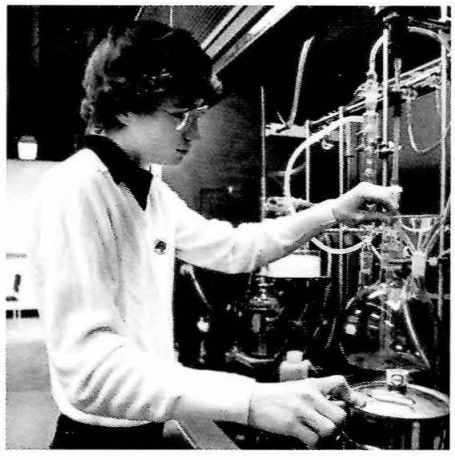
Dana M. Pillsbury
Sponsor: H. W. Behrens

The mechanism with which dust particles are lofted by a normal shock wave passing over a dusty surface is not well understood. An accurate measurement of surface shear within the first few microseconds of lofting would greatly enhance understanding. However, it can be shown that instrumentation which indirectly measures shear in clean flows does not give meaningful results for dusty flows; and instrumentation which directly measures shear cannot easily be adapted to the very short test time required in this application. There are indications that a direct measurement device employing piezoelectric crystals in place of the usual bonded wire strain gages may be satisfactory. Research is still in progress in this area.

Feature Extractions from 2D Images

Kenneth L. Wong
Sponsor: F.H. Kishi

What does a picture mean to a computer? An image on a screen is only a two-dimensional object to a computer. A computer can do calculations on an object. A computer can figure an object's area, an object's moments, and do a Fourier transformation of the object. By taking quantities such as these, a computer may be able to differentiate between objects. During this research, we have developed algorithms in Fortran to calculate the area of an image. Other algorithms developed computed the centroid of the image and moments of different order. A Fourier transform of the horizontal and vertical components of an image was also implemented. These algorithms were tested on a VAX 8650, and a RAMTEK screen was used to display images.



SURF Publications

This is a cumulative listing of papers published by SURF students

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* SURF student
** Faculty Sponsor

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Laura M. Anderson *Sophomore, Ph/Ma* *Pacific Telesis-SURF*	PPM Modulation of a Frequency-Doubled Nd:YAG Laser Via Cavity Dumping	J. R. Lesh *Supervisor of Optical Communications, JPL*
Eric K. Babson *Sophomore, Ma/Ph*	Applied Rainbows	M. Aschbacher *Professor of Mathematics*
Gregory L. Bailey *Junior, APh*	A UV Laser System for Time Projection Chamber Calibration	M. Z. Iqbal *Research Fellow in Physics*
J. Alexander Becker *Junior, Ph*	Cosmological N-body Simulations	W. H. Press *Harvard University*
Leila A. Belkora *Junior, Ph* *Cornell University*	Shapes of Asteroids from Radar: Studies of 1627 Ivar and 1862 Apollo	A. W. Harris *Supervisor of Geology and Planetary Physics, JPL*
James F. Bell *Junior, Ge*	Observations of Mars during the 1986 Opposition using the University of Hawaii 88-inch Telescope on Mauna Kea	A. P. Ingersoll *Professor of Planetary Science*
Jason R. Beresford *Sophomore, Ae*	Mars Balloon Payload	B. C. Murray *Professor of Planetary Science*
Vineer Bhansali *Sophomore, Ph/CS*	Quark Model Predictions for the Electron Energy Spectrum in Semileptonic B-meson Decays	M. B. Wise *Professor of Theoretical Physics*
Daniel B. Bikle *Junior, EE*	An Investigation of an Electrooptic Phase Modulator	D. M. Rider *Member of the Technical Staff, JPL*
Janet L. Boley *Senior, GePh*	Where Did the Calico Artifacts Come From?	G. R. Rossman *Professor of Mineralogy*
Matt A. Breaden *Freshman, CS* *IBM-SURF*	SURF Cube	G. C. Fox *Professor of Theoretical Physics*
William L. Breazeal *Junior, APh* *Calreco-SURF*	Propagation Studies in a Single Mode Optical Fiber	K. J. Vahala *Assistant Professor of Applied Physics*
Paul J. Brewer *Freshman, Ph/AMa*	1. Elements of Extra-Solar Planetary Search: Theory and Procedure 2. Communications Systems for Global Lunar Coverage	E. C. Posner *Visiting Professor of Electrical Engineering* R. V. Powell *Member of the Technical Staff, JPL*
David J. Bruning *Sophomore, Bi*	Correlation Between CAT-301 Antibody, Anatomical Tracer, and Immunohistochemically Labeled Pathways in Macaque Monkey Visual Cortex	D. C. Van Essen *Professor of Biology*

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Suman Chakrabarti *Sophomore, Eng*	Photoelastic Analysis of a Gothic Cathedral Section Under Load in a Centrifuge	R. F. Scott *Professor of Civil Engineering*
Kayee Chan *Sophomore, Ma*	Computer Simulations of Phase Transformations in Solids	B. T. Fultz *Assistant Professor of Materials Science*
Carole S. Chang *Freshman, Ch*	Crystal Structure Investigations	B.D. Santarsiero *Scientist*
Douglas Chang *Sophomore, Eng* *AMETEK-SURF*	SURF Cube	G. C. Fox *Professor of Theoretical Physics*
Catherine T. Chen *Sophomore, Eng* *GM-SURF*	A Research of the Double Oral Auction Theory	C. R. Plott *Professor of Economics*
Kay-Yut Chen *Freshman, Ph*	Delta (3,3) Resonance in a Nuclear Medium	R. D. McKeown *Assistant Professor of Physics*
Stanley Chen *Freshman, EE* *IBM-SURF*	SURF Cube	G. C. Fox *Professor of Theoretical Physics*
Peter L. Cho *Junior, Ph*	Ionization of the Interstellar Medium by Hot White Dwarfs	A. K. Dupree *Associate Director, Harvard-Smithsonian Center for Astrophysics* J. Raymond *Physicist, Smithsonian Astrophysical Observatory*
Christopher M. Chu *Freshman, EE*	Polarization Morphometric Detection of Mineralization During Bone Healing	H. Winet *Visiting Associate in Engineering Science*
Yiu Y. Chu *Junior, Ph*	Internal Rotation Rate of the Sun	E. S. Phinney *Assistant Professor of Theoretical Astrophysics*
Rachael A. Clark *Freshman, Bi* *Colvin-SURF*	Development of Technique for Establishment of Dissociated Cell Cultures of Zebra Finch Neurons	M. Konishi *Bing Professor of Behavioral Biology*
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Terry Fu *Sophomore, Ph/AMa*	Optogalvanic Spectroscopy in a Ytterbium Discharge	L. Maleki *Group Supervisor of Geology and Planetary Physics, JPL*
Eric J. Gaidos *Sophomore, APh*	Balloons as an Option for Exploring Mars	B. C. Murray *Professor of Planetary Science*
David A. Gates *Sophomore, EE*	An IBM PC-AT Raster Graphics Display Station	G. C. Fox *Professor of Theoretical Physics*
Allen Gee *Junior, Ph*	Power and Cooling	E. C. Posner *Visiting Professor of Electrical Engineering* R. V. Powell *Member of the Technical Staff, JPL*
John C. Gehring *Sophomore, Ph*	Track Recognition in a Time-Projection Chamber	J. H. Thomas *Research Fellow in Physics*
Susan M. Gerhart *Sophomore, Eng*	Planet-Crossing Asteroid Survey	E. F. Helin *Member of the Technical Staff, JPL*
Nadeem Ghani *Junior, Ph*	Booming Sands	G. R. Rossman *Professor of Mineralogy*
Stephen M. Gomez *Junior, Bi*	Generation of *Pseudomonas* sp. 200 Mutants Defective in Iron-Reduction Capability	M. R. Hoffmann *Associate Professor of Environmental Engineering Science*
Gabrielle A. Gordon *Junior, Ay*	MM Observations of Pre-Main Sequence Stars: A Peek into the Cradle	N. Z. Scoville *Professor of Astronomy* L. G. Mundy *Research Fellow in Astronomy*
Susannah J. Hannaford *Junior, Bi*	An Attempt to Isolate Alleles of *Bendless*, a Mutant Affecting Neuronal Connections in *Drosophila melanogaster*	M. A. Tanouye *Assistant Professor of Biology*
Kathleen C. Hayashibara *Junior, Ch* *GM-SURF*	Ion Cyclotron Resonance Spectroscopy of $(CO)_5MnCH_3$: Observation of Carbon Monoxide Exchange Reactions	J. L. Beauchamp *Professor of Chemistry*
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Rudolf J. Hofmeister *Junior, Ph*	Color and Monochromatic Image Subtraction and Processing using Wollaston Prisms and Van der Lugt Filters	H.-K. Liu *Senior Scientist, JPL*
Timothy K. Horiuchi *Sophomore, EE* *IBM-SURF*	Image Digitization, Acquisition, and Analysis of Biological Structures	W. J. North *Professor of Environmental Science*
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Andrew C. Hsu *Freshman*	The Study of Neural Networks Using Silicon Devices	J. Pine *Professor of Physics*
Nhi G. Hua *Junior, Ch*	The Structure of $Cp_2TiC_8H_{11}N\Phi_2$ Compounds	B. D. Santarsiero *Scientist*
Andrew J. Huntington *Junior, EE* *GM-SURF*	Piezopolymer Characterization: Development of PVDF Transducers for Mechanical Pointing Applications	C. E. Bell *Technical Manager of Attitude and Articulation Control Subsystem for the Comet Rendevous Asteroid Flyby Project (AACS-CRAFT), JPL*
Gerard J. Jungman *Junior, Ph/Ma*	Instabilities of a Self-gravitating Fluid and Cosmological Mass Clustering	M. B. Wise *Professor of Theoretical Physics*
Randall D. Kamien *Sophomore, Ph*	Cosmological Mass Density Fluctuations in 1 and 3 Dimensions	M. B. Wise *Professor of Theoretical Physics*
Salim Khan *Junior, ME*	Antenna Performance as a Function of Structure	E. C. Posner *Visiting Professor of Electrical Engineering* R. V. Powell *Member of the Technical Staff, JPL*
Erik P. Krumrey *Freshman, Ge*	Mars Balloon Performance	B. C. Murray *Professor of Planetary Science*
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Kim Liu *Junior, Ch*	The Synthesis of a Possible C + G DNA-Binding Molecule	P. B. Dervan *Professor of Chemistry*
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Kwok L. Ngan *Sophomore, Ph*	Development of a Polarized ^{3}He Target	R. D. McKeown *Assistant Professor of Physics*
Hung P. Nguyen *Freshman, Ph/Ma*	Parameterization of Electron Impact Ionization Cross Sections for CO, CO_2, CH_4, NH_3, and SO_2	S. K. Srivastava *Member of the Technical Staff, JPL*
Khanh B. Nguyen *Junior, EE* *IBM-SURF*	Frequency Response Measurements using Ring-Dye Laser	W. B. Bridges *Carl F Braun Professor of Engineering*
J. Andrew O'Dea *Sophomore, EE* *AMETEK-SURF*	SURF Cube	G. C. Fox *Professor of Theoretical Physics*
James K. Okamoto *Sophomore, Ph*	SPICE Model and Numerical Computation Verification	M. G. Buehler *Member of the Technical Staff, JPL*
Timothy J. Parrott *Junior, Ch*	Synthesis and Characterization of Macrobicyclic Polyethers Containing Strong Anionic Nitrogen Donors	T. J. Collins *Assistant Professor of Chemistry*
Janice L. Peters *Sophomore, Ch* *Ford-SURF*	Molecular Modeling of Silicon (100) and (111) Surface Reconstructions	W. A. Goddard *Charles and Mary Ferkel Professor of Chemistry and Applied Physics*
Stephan A. Pietrusiak *Junior, EE* *IBM-SURF*	Microstrip Fabrication for a Network Analyzer	D. B. Rutledge *Associate Professor of Electrical Engineering*
Dana M. Pillsbury *Sophomore, Eng* *Lester Lees- SURF*	Development of an Experimental Instrument to Measure Shear Stress in a Dusty Gas Boundary Layer Behind a Normal Shock Wave	H. W. Behrens *Department Manager, TRW*
Michael G. Pravica *Sophomore, Ph/AMa*	BGO Calibration of the LEP/L3 Detector	H. B. Newman *Associate Professor of Physics*
Phyllis C. Pugh *Sophomore, Bi*	A Study of Type II CaM Kinase in *Drosophila*	M. B. Kennedy *Associate Professor of Biology*
Susan E. Ridgway *Sophomore, Ph*	A Photometric CCD System for the 14-inch Celestron	K. G. Libbrecht *Assistant Professor of Astrophysics*
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Karin A. Sangster *Junior, Ph*	Near-Earth Asteroid Search	E. F. Helin *Member of the Technical Staff, JPL*
Jo Beth Schlottman *Junior, Bi* *Krown-SURF*	Cerebellar Tactile Maps	J. M. Bower *Assistant Professor of Biology*
Tzejen J. Shih *Freshman, Ch/Lit*	Synthesis and Oxidation of Os(IV) (η^4HMPA-DMP)L_2 Complexes, Where L is a Para-Substituted Pyridine	T. J. Collins *Assistant Professor of Chemistry*
Karen M. Siegrist *Sophomore, APh* *GM-SURF*	Ho:YLF Laser for Deep Space Communications	J. R. Lesh *Supervisor of Optical Communications, JPL*
D. Eric Smith *Junior, Ph/Ma*	Correlation Functions for Large-Scale Structure	H. D. Politzer *Professor of Theoretical Physics*
Glenn A. Smith *Freshman, Ph*	1. Receiver System Design 2. Elements of Extra Solar Planetary Search: Theory and Procedure	E. C. Posner *Visiting Professor of Electrical Engineering* R. V. Powell *Member of the Technical Staff, JPL*
William C. Smith *Sophomore, Ph*	Thermal Evolution of the Uranian Satellites	D. J. Stevenson *Professor of Planetary Science*
Bradley E. Solberg *Sophomore, Eng*	A Mössbauer Spectroscopy Study of Short-Range Order in Feco Alloys	B. T. Fultz *Assistant Professor of Materials Science*
Hisaho Sonoda *Junior, Bi*	Behavioral Research on Endangered Species	C. R. Cox *Director of Research, Los Angeles Zoo*
Samuel N. Southard, Jr. *Freshman, Ph*	Calculations of the Cross Section for Electron-Positron Pair Production Near Threshold Energies	P. Vogel *Senior Research Associate in Physics*
Atul Srinivasan *Sophomore, EE*	Antenna-Array Design and Pattern Synthesis	E. C. Posner *Visiting Professor of Electrical Engineering* R. V. Powell *Member of the Technical Staff, JPL*
Theron W. Stanford *Sophomore, Ma*	On the Integral Roots of $x^n + Px + Q = O$ and the Vanishing of $\sum_{a+b+c=n} x^a y^b z^c$	T. M. Apostol *Professor of Mathematics*
George J. Stecher *Junior, Ph/Hist*	Hydrogen Content of Irradiated Carbon Foils	T. A. Tombrello *Professor of Physics*

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Darin K. Takemoto *Junior, Bi/Ch*	Characterization of the Cysteinal Ligands of the Cu_A Center of Cytochrome *c* Oxidase	S. I. Chan *Professor of Chemical Physics and Biophysical Chemistry*
Ichiro Takeuchi *Junior, Ph*	Neutralization of H-Ion Beams using Lasers	H. B. Newman *Associate Professor of Physics*
Ivan Tarle *Sophomore, Bi/Ch*	Possible Polyprotein Precursors in Mitochondria	G. Attardi *Grace C. Steele Professor of Molecular Biology*
Joan M. Tetrault *Junior, Bi*	Antisense Transformation in *Drosophila*	E. M. Meyerowitz *Assistant Professor of Biology*
Eugene R. Thomas *Sophomore, Ph*	Massive Star Formation	N. Z. Scoville *Professor of Astronomy*
Andrew M. Tikofsky *Junior, Ph/AMa*	Explaining an Observed Resonance by Alternate Decay Schemes	S. E. Koonin *Professor of Theoretical Physics*
Sean E. Trabosh *Junior, Eng/CS*	Multi-Lingual Access of the ASK System	F. B. Thompson *Professor of Applied Philosophy and Computer Science*
Minh Q. Tran *Sophomore, Ph* *Lang-SURF*	Apples in Space	P. K. Haff *Senior Research Associate in Physics*
Thao N. Tran *Sophomore, Ph*	Uncertainties in Solar Neurtrino Flux	B. W. Filippone *Assistant Professor of Physics*
Charles S. Tsai *Freshman, Ph/EE*	Granular Flow Property of Asymmetric and Photoelastic Particles	P. K. Haff *Senior Research Associate in Physics*
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Michael S. Warren *Sophomore, Ph*	Numerical Experiments to Determine the Collision Cross Section of a Binary Star System	T. A. Prince *Assistant Professor Physics*
Alexander Wei *Sophomore, Bi* *Krown-SURF*	Conservation of Synaptic Space of Neonatal Rabbit Soleus Muscle Endplates During Synapse Elimination	D. C. Van Essen *Professor of Biology*
Pierce T. Wetter III *Freshman, EE*	The Omega Graphics Package	M. Morari *Professor of Chemical Engineering*

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Felicity M. Wong *Sophomore/Ph*	Photometric Observations of the Outer Planets	B. Buratti *Member of the Technical Staff, JPL*
Gerard C. Wong *Junior, Ph* *Ford-SURF*	Solid-State Reactions in the Ni-Zr Systems	E. J. Cotts *Research Fellow in Applied Physics*
Kenneth L. Wong *Junior, Eng* *TRW-SURF*	Feature Extractions from 2D Images	F. Kishi *Senior Staff Engineer, TRW*
Jorden E. Woods *Sophomore, Ph/Eng*	The Importance of Fe II Emission in Moderate Redshift Quasars	J. B. Oke *Professor of Astronomy*
Moon-Tai Yeung *Junior, Ae*	Space Station Polar Platform/Earth Observing Systems	C. E. Bell *Technical Manager of Attitude and Articulation Control System for the Comet Rendevous Astroid Flyby Project (AACS-CRAFT), JPL*
Kenneth K. Yoshimoto *Junior, Bi*	Finding and Sequencing β-related Genes	M. I. Simon *Professor of Biology*
Kyuson Yun *Freshman, Bi*	Protein Targeting to Mitochondria	S. Emr *Assistant Professor of Biology*

Legend of Options

Ae	Aeronautics	Eng	Engineering
AMa	Applied Math	Ge	Geology
APh	Applied Physics	GePh	Geophysics
Ay	Astronomy	Hist	History
Bi	Biology	Lit	Literature
Ch	Chemistry	Ma	Mathematics
ChE	Chemical Engineering	ME	Mechanical Engineering
CS	Computer Science	Ph	Physics
EE	Electrical Engineering	SS	Social Sciences
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