Summer Undergraduate Research Fellowships

California Institute of Technology

SURF Annual Report

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Funds for the production of this SURF annual report were provided by AMETEK, Inc. The SURF class of 1985 and their faculty sponsors acknowledge with gratitude this very welcome support. Special thanks go to Dr. John H. Lux, Chairman and Chief Executive Officer; Mr. Robert L. Noland, President (and Caltech alumnus); and Mr. Alfred Schaff, Vice President, Electronics Development (also a Caltech alumnus) — and we add a sincere tribute to the memory of the late Mr. Leon S. Peters, a vice president of the company, who throughout his lifetime was deeply dedicated to inspiring the highest qualities of leadership among students.

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.

SURF Honor Roll

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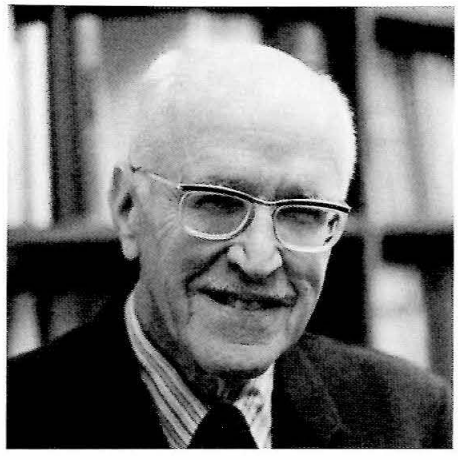


Our 1985 SURF annual report is dedicated to Ernest Swift, Professor of Analytical Chemistry, Emeritus at Caltech. Dr. Swift is regarded as a pioneer in the use of undergraduate students in scientific research, and we are indeed fortunate that he maintains a close personal interest in SURF as our mentor.

The SURF Program

The Heritage of SURF

The Summer Undergraduate Research Fellowships (SURF) program at Caltech began in 1979 with 18 students to promote interaction between undergraduates and faculty and to improve the undergraduate program. That first SURF summer was not, however, the first experience Caltech undergraduate students had with research.

Ernest Swift, Professor of Analytical Chemistry, Emeritus, wrote the following notes concerning the history of undergraduate research at Caltech:

"Undergraduate research was introduced into the curriculum at Caltech by A.A. Noyes after his arrival in 1920 as the first Chairman of the Division of Chemistry. This was probably the first extended use of undergraduates in scientific research anywhere."

"'Noyes believed that students of chemistry should be introduced to research as early as possible,'" wrote Linus Pauling in "Arthur Amos Noyes, A Biographical Memoir" in the Biographical Memoirs of the National Academy of Sciences of the United States. In 1925 he arranged that 12 freshman students in the California Institute of Technology spend the time that would otherwise be devoted to the general chemistry course in carrying out small investigations, which were directed by me, under Noyes' general supervision.

One of these investigations led to a publication: Edwin McMillan and Linus Pauling: "An X-ray Study of the Alloys of Lead and Thallium", *J. Am. Chem. Soc.*, Vol. 49, p. 666, 1927.

(In 1951, Edwin McMillan and Glenn Seaborg shared the Nobel Prize in Chemistry for discovering plutonium and other elements.)

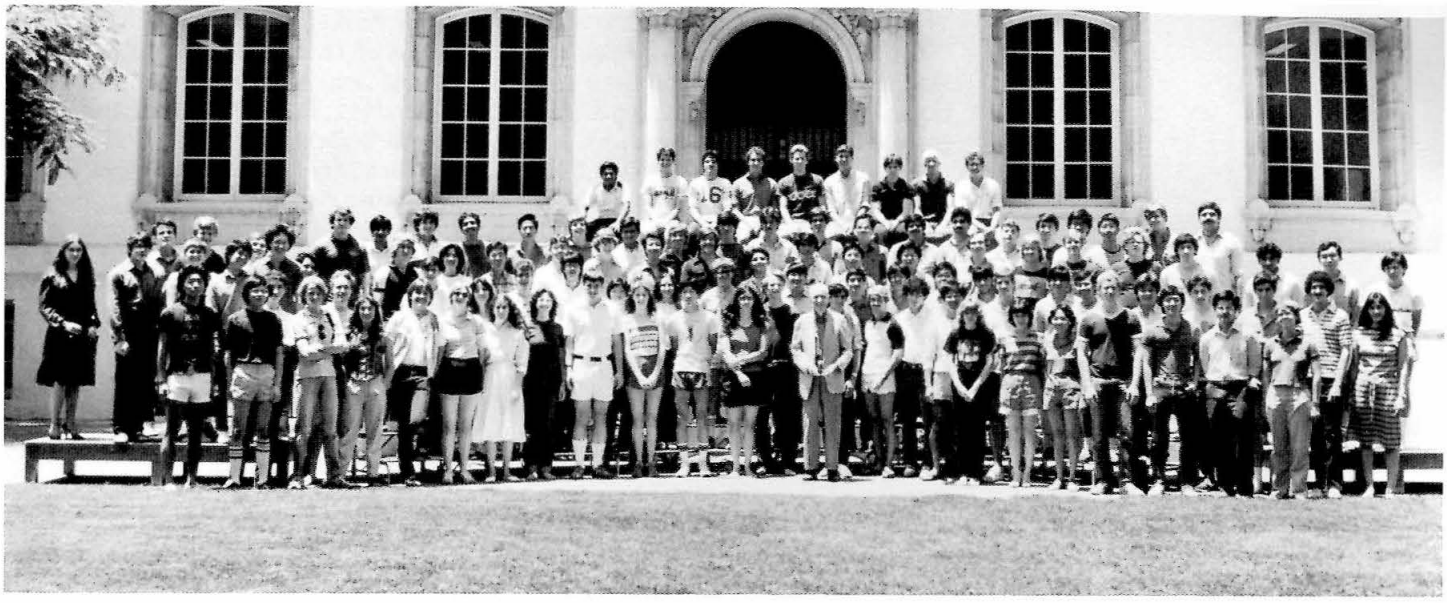
"In 1920 the sophomore course in Analytical Chemistry was assigned to me and, with the approval of Noyes, I began the practice of allowing selected students to substitute research for the routine work of the third term, which at that time was qualitative analysis. Students participating in this research would frequently continue during the summer and then in their upper years. This they would do without pay, since no funds were available for such work at the time. I believe that at least 80% of the research involved in my publications was initiated by undergraduate students."

What is SURF?

The purpose of SURF is to extend the undergraduate experience by complementing the traditional academic program.

The essence of SURF is the voluntary tutorial interaction between a student and a faculty member on a research problem of mutual interest. This interaction starts with the student and a faculty member formulating a research project and developing a research proposal, continues through the performance of that research, and ends with oral and written communications of research results. Sometimes the results are published (see the Publications List). The student then has the experience of dealing with the comments of independent reviewers, and has the satisfaction of seeing his or her work become a part of the scientific literature.

SURF provides a new dimension to the process of undergraduate education, allowing faculty to share their research interests with enthusiastic students. Students are attracted to SURF because it presents a unique challenge to do original work at the



The 1985 SURFers

leading edge of a field, and to improve their technical skills. In short, SURF offers the opportunity for an integrated professional experience within an informal setting. The judgment and experience obtained from planning, executing, and reporting an orginal piece of research is of great value regardless of what career a student chooses. Also, such an experience can aid in choosing a career.

The faculty provide and administer funds to cover the cost of laboratory supplies, computing, travel, etc. This also serves to place the student closer to the mainstream of faculty interest, and it streamlines the administration of SURF.

Although the initial planning takes place during the academic year and projects may continue beyond the end of the summer, the bulk of the activity takes place over a 10-week period during the summer. SURFers are expected to work full time during these 10 weeks on their projects.

The students have the opportunity to attend a series of seminars presented at noon on Mondays and Fridays. The purpose of these seminars is to introduce the students to an overview of a variety of research. Caltech faculty members, JPL technical staff members, and industrial researchers—these are some of the speakers. Others focus on career development, writing technical papers, and the delivery of technical seminars.

Eight SURF Leadership Roundtables, sponsored by AMETEK, Inc. were conducted; the series was very successful and enthusiastically attended by 75 SURFers.

The first Roundtable was held on June 26 under the leadership of Dr. Richard Folsom, Caltech alumnus and President Emeritus of Rensselaer Polytechnic Institute. Dr. Folsom discussed characteristics necessary in leadership in the academic world. The students who attended were Vineer Bhansali, Peter Cho, Bill Craven, Diana Foss, Santosh Krishnan, Brian Lund, Joel Seely, George Stecher, Andrew Swanson, Thomas Tysinger, and Robin Wilson.

Arthur Amos Noyes

Ms. Linda Sanford, Manager of Color Printer Work Stations, IBM Corporation, met with students on July 8. She discussed various aspects of managing within a technical organization. Students attending were Michael Yamada, Matt Compton, Nathan Hurvitz, Billy Ip, Sung Kim, Ashok Krishnamoorthy, Victor Leyva, Kim Pao, and Mike Pravica.

July 15 Dr. Betsy Ancker-Johnson, Vice President for Environmental Activities, General Motors, met with Sandra Blumhorst, Mike Bronikowski, Janet Boley, Douglas Gray, Salman Mitha, James Okamoto, George Stecher, and Isaac Wong. The discussion centered on how governmental regulations affect the automotive industry.

Mr. Robert Noland, President of AMETEK, Inc., and Caltech alumnus, and Dr. John Lux, Chairman and Chief Executive Officer of AMETEK,

Inc., were the Roundtable leaders on July 17. They discussed the various leadership qualities they look for in managers in their company. Mike Bronikowski, Karl Clauser, William Cutrell, Lynne Hannah, Michael Pravica, Jean Tang, Chris Umminger, and Kevin Wilson attended the Roundtable.

The fifth SURF Roundtable was led by Caltech alumnus Victor Veysey on July 24. Mr. Veysey has been the Director of the Caltech Industrial Relations Center; Assistant Secretary of the Army; Congressman from the 38th and 43rd Districts of California in the U.S. House of Representatives; and Assemblyman, California Legislature. He talked about leadership in the public sector and discussion centered on opportunities, problems, and the importance of technical people serving in government. SURF students attending the Roundtable were Karl Clauser, Harold Felton, Nancy Jo Fico, Kwanghak Huh, Ara Kassabian, Ashok Krishnamoorthy, Brian Lund, Massoud Pedram, William Woody, and Min Yun.

Dr. Lew Allen, Director of JPL, led the Roundtable on August 14. He discussed space exploration with the students, many of whom were working on space-related projects. Those in attendance were Peter Cho, Allen Gee, Thomas Gould, Scott Grossman, Stephen Hsu, Ara Kassabian, Sung Kim, Thomas Luke, Charles Neugebauer, Stephan Pietrusiak, Dana Pillsbury, Gino Thomas, and Stephen Winters.

On Friday, August 16, Dr. Norman Gjostein, Director of the Systems Research Laboratory at Ford Motor Company, met with Kwanghak Huh, Thomas Tysinger, George Stecher, Craig Keller, Glory Ann Yango, Minh Tran, and Supriya Ghosh to review the technological developments and problems in the automotive industry.

The final SURF Roundtable on August 19 was led by Dr. Duncan Taylor, Research Fellow in Preclinical CNS Research at Bristol-Myers

Company. Dr. Taylor discussed the personal and technical attributes that research engineers and scientists should develop when working within a technical corporation. Those who attended were David Bruning, Hideki Garren, Santosh Krishnan, John Luo, Felice Borisy, Ali Lashgari, Yvette Madrid, Katrin Rodriguez, and Janice Sakai.

Communications Workshops led by Jean Cass were created to assist SURF students in developing skills which will enable them to make effective presentations of highly technical material to both technical and non-technical audiences. Whereas the students are required to make a presentation of their research on SURF Seminar Day, their attendance at these workshops is entirely voluntary. Small groups of SURFers participate in discussions of effective public speaking techniques, appropriate attire, and in-depth analyses of various audio and visual aids which can be utilized to enhance their specific presentations. About 75 SURF students participated in the Workshops this summer.

At the conclusion of the summer, the students present oral reports of their projects at SURF Seminar Day. Seminar Day is attended by faculty sponsors, members of the JPL Technical Staff, other members of the faculty, parents of SURF students, representatives of corporate sponsors, and individuals who are particularly interested in the SURF program. A buffet luncheon is served at noon, followed by the presentations commencing at 1:30. Each student is given fifteen minutes to speak and five minutes to respond to questions. Students have audio/visual aids available to them to enhance their talks. During the three-hour period nine students speak in each of 14 sessions running concurrently, for a total of 126 SURF presentations.

The Year in Review

In 1985, a SURF project involving seven students, Allen Gee, Ara Kassabian, Charles Neugebauer, Stephan Pietrusiak, Dana Pillsbury, Eugene Thomas, and Stephen Winters, was set up to study the possibility of unmanned scientific missions to explore the nearest stars and, in particular, to look for and investigate planets around the stars. The sponsors were Dr. Edward C. Posner, Visiting Professor of Electrical Engineering, and Dr. Joel G. Smith, Manager, Telecommunications and Data Acquisition, Technolology Development, JPL.

While exploration techniques using large earth-based observatories were not ruled out, the main effort was directed to small spacecraft that would actually enter the stellar system. Prior work by the British Interplanetary Society and others has emphasized manned interstellar missions instead. The key area of work was in propulsion, which turns out to be the major limiting factor if mission flight times of less than 100 years are desired. The students evaluated some old and new propulsion concepts, including particle beams transmitted from earth as an alternative to antimatter stored on the spacecraft. Communication is also a potential limiting factor, but the recently demonstrated coded photon-counting system of JPL was found to provide low but adequate bit rates. Other aspects studied included evaluation of novel imaging sensor arrays of extremely light weight, compatible with

Fred Shair, *Professor of Chemical Engineering and Chairman, SURF Administrative Committee*

"Participating on the team that helped to develop SURF has been one of the most satisfying experiences of my professional life. Truly inspiring to me have been the warm and productive relationships I have been privileged to share with the SURF students, their faculty sponsors, and with the many individuals, corporations, and foundations who have contributed so generously to the success of this unique educational experience."

the severe propulsion constraint.

As is a SURF requirement, each student wrote his or her own SURF project report. However, there was a great deal of team discussion and interaction with a JPL advisory board chaired by Dr. Smith.

The overall conclusion of the students is best expressed by saying that interstellar missions may well be feasible and affordable in 50 to 100 years. But, due to difficulties, even in 50 years, in accelerating sensible masses to 1/10 the speed of light, mission lifetimes on the order of 100 years will have to be confronted.

Three years ago the first student worked at JPL. In 1984, ten students SURFed at JPL, and in 1985, 19 students. This growth represents an opportunity to build further relationships between JPL and campus and at the same time affords growth for SURF.

Three 1984 SURFers were invited to speak at the reunion of the Caltech Class of 1975 on April 13. The students were Peter L. Cho, John Houde, and Robin Wilson.

Peter L. Cho, George G. Gibbs, and Minami Yoda, also 1984 SURF students, were asked to give presentations on their SURF projects at Caltech's annual Alumni Seminar Day on May 18. This is the first time that non-faculty speakers have been invited to participate at this event. The talks were well attended and enthusiastically received. We hope to make this an annual event.

On May 23, three 1984 SURF students gave presentations based on their summer projects at The Associates' Monthly Luncheon. The students were Peter L. Cho, Margaret C. Carter, and James Dunn.

Tak Leuk Kwok received the Apker Award of the American Physical Society at the Society's annual meeting in Toronto on January 22, 1985. The Apker Award is the only national prize given by the APS for the most promising physics research by an undergraduate. Mr. Kwok presented a seminar at the annual meeting on his 1983 SURF project for which he won the award. He worked with Professor Harvey Newman on the MARK J Detector at PETRA in Hamburg, West Germany.

James Dunn, another SURF student, was selected by the Undergraduate Academic Standards and Honors Committee to receive the Sigma Xi Award. This award is given to the graduating student who has done the most outstanding piece of research. During the summer of 1983, James SURFed with Professor Jean-Paul Revel; they have published the results of their research, "Association of Gap Juncions with Endoplasmic Reticulum in Rat Parotid Glands," *Cell and Tissue Research*, (1984) 238: 589-594. During his junior year, with the help of Professor Shair, James developed some contacts at MIT and Harvard University; this led to his SURFing with Professor Clark Colton at MIT. James is publishing the results of his work with Dr. Colton and has been accepted into the Harvard-MIT Ph.D.-M.D. program for fall, 1985.

Summary of the 1985 SURF Applicant and Recipient Pools

One hundred thirty-four students applied for SURFs in 1985. Twenty-one of the applicants had GPAs of 3.8 or higher out of a possible 4.0. The median GPA among the applicant pool was 3.4. The median GPA among the recipient pool was 3.5. The Master of Student Houses, Professor Christopher Brennen, commented that this year's applicant pool was the best that SURF has had to date. This comment was corroborated by the faculty committee reviewing the proposals. 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.

Year	No. of students	Amount of Stipend	No. of Sponsors	Total Budget
1979	18	$2000	17	$ 36,000
1980	43	2200	33	97,000
1981	46	2300	41	198,000
1982	73	2400	63	191,000
1983	77	2400	61	227,000
1984	106	2800	89	308,938
1985	125	2800	97	419,400

In 1985, each student was paid $2800. Room, board, and personal expenses are supported by this. In addition, students receiving financial aid from Caltech are required to save a portion of their summer earnings toward their next year's tuition. Expenses of supplies, equipment, computing, travel, etc., are paid by the faculty sponsor. This action on the part of the Caltech faculty is another indication of their commitment to the training and development of young scientists and engineers.

A substantial portion of SURF operating funds is derived from philanthropic contributions from individuals, corporations, and foundations. These funds are applied currently to offset costs associated with stipends and administrative expenses.

Contributions are also applied to the Caltech SURF endowment fund, the earnings from which are used to support the program. During 1985 the SURF endowment increased as a result of additional gifts from individuals and a leadership endowment gift from a corporation.

The program is directed by the SURF Administrative Committee which is appointed by President Goldberger. The Committee (1) plans and administers the SURF program; and (2) advises the Caltech Administration on the long-term planning and development of the SURF program and possible related programs which may evolve.

The SURF Board is a voluntary support organization consisting of individuals who are dedicated to the educational values of undergraduate research at Caltech and who, through their advice, encouragement, and financial support, contribute to the vitality, continuity, and effectiveness of the SURF program. The members of the SURF Board, under the leadership of a Chairman and the Chairman of the SURF Administrative Committee, participate in activities of SURF such as the Noon Seminars and Seminar Day. The Board conducts promotional and fund raising activities in cooperation with the Institute's Development Office.

In March, 1985, Mr. Samuel P. Krown became Chairman Emeritus of the SURF Board. Succeeding Mr. Krown is Mrs. Elizabeth (Betty) Nickerson. Betty and her husband, Doug, have been enthusiastic members of the SURF Board since its formation.

Acknowledgements

As you can see from the above, 1985 has been a great year for SURF. We recognize that without support of a large number of people SURF could not have been so successful. These friends of SURF include individuals, corporations, and foundations who contributed money to the program; the SURF Board and the SURF Administrative Committee; and the division chairmen. We deeply appreciate the special efforts of the following members of the Caltech staff for their help in various aspects of the program: Susan Pearce and the Development staff, Thomas Branigan and the publications staff; Janet Davis and the Alumni Association and staff; our many very helpful friends in the Athenaeum, Disbursement Audit and Student Accounts, Graphic Arts, Payroll, Personnel, and Student Affairs. We especially thank Edward Baum for his continuing valuable involvement with SURF; Jean Cass for conducting the Communications Workshops; Deborah Shair for assistance on all aspects of the program; and Chris Meisl and Behzad Sadeghi for their herculean efforts in typesetting this report.

Betty Nickerson, *Chairman, SURF Board*

"Caltech's SURF program has come a long way over the years, and it seems to get better as time goes by. I am so very proud to be associated with SURF and with the students and the many people on the faculty and in the community who make it work so well."

Biology

A Possible Enhancer on the Thymidine Kinase Promoter

Felice F. Borisy
Sponsor: E. Rothenberg

Previous work in this lab with two plasmids pTK(l)-Neo^r and pTK(s)-CAT, containing a longer and shorter version respectively of the thymidine kinase (TK) promoter followed by a gene easily assayable for transcriptional activity has shown that pTK(l)-Neo^r expresses significantly better than pTK(s)-CAT. I am attempting to construct the reciprocal plasmids pTK(s)- Neo^r and pTK(l)-CAT to determine whether this difference is due to the genes involved or the promoters regions. Since both promoters contain an enhancer core at -400 but pTK(s) lacks the 300bp upstream sequence, greater expression of pTK(l)-CAT will suggest the presence of a heretofore unknown enhancer.

The Effect of 3′ Deletion on RNA Processing

David J. Bruning
Sponsor: B.J. Wold

The main purpose of this investigation is to determine if the 3′ end of the RNA transcript has an effect on the processing of the RNA. By deleting the 3′ end of a gene and placing this gene into animal cells, it might be possible to determine the function of the 3′ end.

Monoclonal Antibody Staining of Areas MT and V2 in Macaque Visual Cortex

Hideki Garren
Sponsor: D.C. Van Essen

Macaque brain sections stained with a monoclonal antibody (CAT-301) were analyzed and striking staining patterns were observed. The staining in area MT was more dense and more profound than in other areas of the visual cortex. The staining pattern in area V2 consisted of discrete stripes, which correspond to thick cytochrome oxidase rich stripes that project to area MT.

The Isolation of Jumpless Mutants in *Drosphila melanogaster*

Susannah J. Hannaford
Sponsor: M.A. Tanouye

Drosphila melanogaster were mutagenized and tested in a screen designed to enrich for mutants of the giant fiber system. Four behavioral mutants were isolated.

The Production of Soluble H-2 Molecules

Ali R. Lashgari
Sponsor: L.E. Hood

We have made an expression vector containing the H-2 L gene, the Metallothionein promoter in front of the gene, and the poly A addition sequences after it. Using gene transfer and enzyme-linked immunoassay techniques, we determined that the expression of the H-2 L gene is doubled using the new vector. However, we have been unable to actually produce the H-2 soluble molecules.

Chemistry and Chemical Engineering

Determination of Qa Gene's Interferon Regulation Region

John Luo
Sponsor: L.E. Hood

A series of subclones were generated to link the coding sequence of the chloramphenicol acetyltransferase (CAT) gene to transcriptional control regions of 4 Qa genes. This gene recombinant should elicit expression of CAT activity when it is introduced into L cells if the Qa gene promoter exerts transcriptional control over the CAT gene.

The Role of the Cerebral Commissures in Midline Stereopsis

Katrin Rodriguez
Sponsor: C.R. Hamilton

For many perceptual tasks, the cerebral commissures are needed to integrate information presented separately to the two cerebral hemispheres. There is some evidence that stereopsis is one of these functions. In tests run on three split brain and three normal subjects, it was found that the split brain subjects had a greater deficit in midline stereopsis than the normal subjects.

The Introduction of the *Arabidopsis thaliana* ADH Gene into *Saccharomyces cerevisiae*

Robin K. Wilson
Sponsor: E.M. Meyerowitz

With these experiments, I attempted to explore a possible means of isolating particular *A. thaliana* genes by complementation of yeast mutations, and I participated in the initial phase of a project to transform alcohol dehydrogenase null *A. thaliana* plants with the *A. thaliana Adh* gene.

Laser Picosecond Time Resolution of Chemical Processes

Michael J. Bronikowski
Sponsor: A.H. Zewail

In an ongoing effort to obtain picosecond time resolution of chemical reactions and short lived intermediates, synthesis methods were devised for synthesizing molecules used in picosecond resolution studies. Synthetic routes were devised for the compounds $I\text{-}(CF_2)_3\text{-}I$, $I\text{-}(CF_2)_4\text{-}I$, and $I\text{-}CF_2\text{-}ICF\text{-}CF_3$; these molecules are used in photofragmentation studies, wherein the dissociation of the iodine atoms can be monitored on a very short time scale. $I\text{-}(CF_2)_3\text{-}I$ was synthesized in gram quantity for use in such a study.

Insertion Reactions of Organoaluminum Zirconocene Ketone Complexes

Karl R. Clauser
Sponsor: R.H. Grubbs

It was hypothesized that zirconocene ketone complexes (I) would undergo insertion reactions with alkenes, alkynes, ketones, and aldehydes. Subsequent investigation has shown that the ketone complexes will insert ethylene. However, reaction with aldehydes leads to an as yet uncharacterized cleavage of the organic ligands.

FORTRAN Computer Program to Manipulate Matrices

Mark Dubinsky
Sponsor: M. Morari

I wrote a new program, TMANI, for the CONSYD package to manipulate matrices that contain state space representations of control systems. In addition, I modified a different program, FMANI, that manipulates complex matrices.

The Development of a System for Measuring Temperatures

Thientu T. Lam
Sponsor: F.H. Shair

A modified Hartley oscillator was constructed, calibrated, and tested for its thermal sensitivity. It was found that this device was an accurate device for measuring temperature which can be used in sterilization of food.

The Stereochemistry of the Polymerization of 1-methyl Norbornene

Sandra L. Lee
Sponsor: R.H. Grubbs

Polymerization of 1-methyl norbornene-1 was achieved using the bis(η^5-cyclopentadienyl)titanacyclobutane catalyst 2 in a ring-opening metathesis reaction. Polymerization proceeds with a strong trans versus cis bias and with a lesser head-tail, tail-head versus head-head, tail-tail bias.

Electron Density Modification at the Metal Center by Stereoisomeric Metal Complexes of a Flexible PAC Ligand

Sonny C. Lee
Sponsor: T.J. Collins

Amide-bearing, polyanionic chelating (PAC) ligands have been shown to vary in electron-donating ability depending on the planarity of the amide moieties; the influence of a more flexible PAC ligand on amide planarity and electron-donating ability is discussed. The increased flexibility has been observed to allow amide planarity in all possible coordination geometries, and thus lessen the changes in donating ability.

Phosphorous-31 Nuclear Magnetic Resonance Studies on the Glucose and Galactose Metabolisms in Yeast

M. Yvette Madrid
Sponsor: J.E. Bailey

Saccharomyces cerevisiae yeast cells of strain 18790 (wildtype) and strain D603 (a mutant which inhibits glucose catabolic repression) were grown on two different media; one, galactose-based; the other, glucose-based. Cells were harvested in the mid-exponential growth phase for study under anaerobic conditions with ^{31}p nuclear magnetic resonance allowing for the determination of intracellular pH and of the concentrations of the phosphorylated metabolites.

The rate of growth using galactose as a carbon source was found to be less than that using glucose for both the wildtype (.36/hr vs. .51/hr) and the mutant (.16/hr vs. .30/hr) strains. The wildtype strain grew faster than the mutant regardless of the carbon source. The intracellular pH values for the wildtype strain were found to be between 6.53 and 7.18. The same strain grown on galactose exhibited an intracellular pH range between 6.29 and 6.65.

The Relation Between Structure and Function in Enzymes: Studies of Beta–Lactamase

Umar Mahmood
Sponsor: J.H. Richards

A mutated form of Beta-lactamase containing the amino acid substitution threonine 71 → cysteine was purified from *E. Coli* strain LS1. Kinetic data show that this mutant is thermally less stable than wild type, reaffirming the current belief that residue 71 plays a major role in the structural integrity of the enzyme.

The Synthesis of Poly-2,5,-DimethylCyclopentadiene

Alan K. Marumoto
Sponsor: R.H. Grubbs

This summer I have been attempting to synthesize 2,4-Dimethyl-Bicyclo [3,2,0] Hepta-1,4,6-Triene. In the presence of the proper organo-metallic catalyst, this monomer should polymerize into the desired poly 2,5-DimethylCyclopentadiene. When synthesized, this polymer should have excellent conductive, semi-conductive, and insulator properties in its various states. However, the synthesis as presently performed is not viable. Since the synthesis has multiple steps and the product is needed in rather large quantities, it is necessary to have a reasonably high (>10%) overall yield. In the present synthetic route, the 5th step, the methylenation of the 3,4-Dimethyl-1,5-Diyne-3-Hexene appears to be the stumbling block as no reasonable methylenation process has been found yet.

X-ray Structure Determination of Bis Cp* Scandium Ethyl

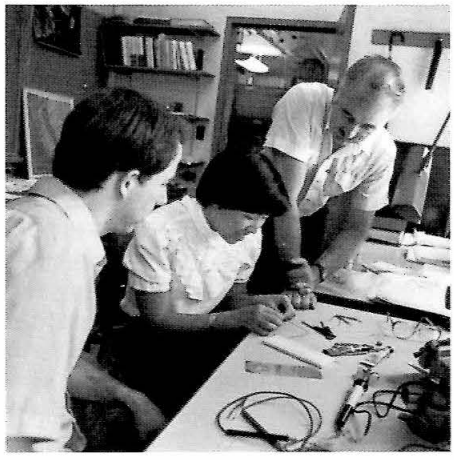
James K. Okamoto
Sponsor: W.P. Schaefer

Bis cp* scandium ethyl crystallizes in orthorhombic space group Aba2 with unit cell dimensions a = 30.5510 Å, b = 9.4412 Å, c = 14.3975 Å. The refined structure has R = 0.0853 and GOF = 1.82. The disorder of the crystal, however, precluded any clear conclusions about the bonding of the ethyl group to the scandium.

Theoretical Calculations of Si(100) Surface Reconstruction Models

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

We compare the P(2x1) and C(2x2) models of Si(100) surface construction. In agreement with experiment, we find the P(2x1) to be energetically favorable. Given an analysis of the energies, we conclude that the stability of P(2x1) occurs from a more favorable bond angle of each surface atoms to its pair of subsurface atoms.



Single Stranded DNA Binding Proteins in Yeast

Janice F. Sakai
Sponsor: J.L. Campbell

Single stranded DNA binding proteins have been shown to be essential for DNA replication in many prokaryotic and viral systems. Work to clone the gene and characterize the gene product for a single strand binding protein (SSB) in the eucaryotic organism, Sacchromyces cervisiae, has shown that one SSB, called SSB-1, can stimulate yeast DNA polymerase and that antibodies raised against SSB-1 can inhibit *in vitro* DNA replication. Yet this protein, present in high copy number, is not essential for viability and its absence does not affect DNA replication rates *in vitro*. Our work this summer has been to verify previous data and to locate the protein that may be compensating for the absence of SSB-1.

The Structure of Fahnium Tuck-in Benzyl

Michael S. Serfas
Sponsor: W.P. Schaefer

Hafnium tuck-in benzyl crystallizes in space group P1 with a = 9.084(2), b = 10.492(2), c = 12.328(1) α = 95.81(1), β = 96.60(1), γ = 91.15(2). The refined structure has R = .048 and GOF = 4.37 for all reflections with $F_0 > 0$ out of a total of 4529 independent data. This study suggests that the 4—coordinate n^5,n^2 tuck-in model predominates in this compound.

Synthesis and Investigation of Os(IV)(η^4-CHBA-DCB)(PPh_3) Complexes, Where L is a Hindered N-donor

Milton R. Smith, III
Sponsor: T.J. Collins

The reaction of Os(IV)(η^4-CHBA-DCB)(PPh_3) with 2, 2′, 2″-terpyridine (trpy) afforded a compound whose proton Nuclear Magnetic Resonance spectrum (H-NMR) is consistent with the formulation [Os(IV)(η^4-CHBA-DCB)(PPh_3)]$_2$trpy. Hindered rotation caused by pendant methyl groups for 2-substituted N-donor ligands in the Os(IV)(η^4-CHBA-DCB)LL′ systems (L = PPh, L′ = 2-methylimidazole, 2-picoline) was studied using Variable Temperature (VT) ^{1}H-NMR. At low temperatures the resonance assigned to the methyl group in the 2-methylimidazole (2-meim) compound broadened into the baseline, indicating possible hindered rotation of the imidazole group about the Os-N bond. The study of the 2-methylimidazole and the 2-picoline (2-pic) systems was intended to probe the steric environment in the N-donor complexes, particularly the steric environment near the cleft between the phenoxide arms of the η^4-CHBA-DCB chelate ligand.

On the Simulation of Particle Motion in an Electrodynamic Quadrupole

Andrew C. Swanson
Sponsor: J.H. Seinfeld

The equations of motion of a charged particle in an electrodynamic quadrupole are solved both analytically and numerically. The solutions are compared for accuracy.

The Isolation of Subunits of Cytochrome c Oxidase Using High Performance Liquid Chromatography

Darin K. Takemoto
Sponsor: S.I. Chan

Current methods for isolating subunits of cytochrome c oxidase are slow and have low yields. The task of the project is to use high performance liquid chromatography (HPLC) to isolate subunits of cytochrome c oxidase for later use in experiments involving a model of the proton pump property of the enzyme. Using reversed-phase chromatography the small hydrophilic subunits (subunits V-VII) were isolated; however, the techniques that were used to isolate subunits V-VII were less successful in isolating the larger hydrophobic subunits, so new techniques will have to be developed to isolate these subunits.

Metathesis Polymerization of 3-Methylcyclopropene

Scott C. Virgil
Sponsor: R.H. Grubbs

3-Methylcyclopropene is polymerized using a metathesis catalyst and the polymer is characterized. The major decomposition products of 3-methylcyclopropene are identified in order to rationally design a procedure for polymerization which minimizes decomposition. The catalytic intermediate 3-methylcyclopropene titanacycle is prepared and possesses surprising stability.

Engineering and Applied Science

Generalized Kolmogorov Complexity and Time Bounded Computations

Mihir Bellare
Sponsor: Y.S. Abu-Mostafa

The proportion of halting programs for the universal Turning machine that can be captured in a recursive time bound is considered. A class of strings which generalizes Kolmogorov complexity by specifying compression and decoding time is investigated.

Production of Monodisperse, Spherical Synthetic Coal Char

Sandra K. Blumhorst
Sponsor: R.C. Flagan

A method for producing spherical, monodisperse particles of synthetic coal char has been investigated. Spherical particles of glassy carbon, or polymerized furfuryl alcohol, have been produced. Data from the combustion of these particles suggests that controlling the size and shape of synthetic char particles would be of value in future studies of submicron aerosol formation.

Graphics for the ASK System

Matthew R. Compton
Sponsor: F.B. Thompson

The ASK system is a software system that supports access to the computer in natural language, including access to typical data bases. The project was to add a very useful feature, three dimensional computer graphics. This will make an already useful system even more useful. With the ease of English in programming combined with special features like computer graphics, ASK is indeed a computer language of the future.

Flocculation under Standing Wave Conditions

Douglas S. Gray
Sponsor: E.J. List

An experiment to investigate the effect of standing gravity waves on the coagulation rate in a flocculation process was devised. Recommendations are made for a viable study. The results may have implications on the design of water purification plants.

Shock Consolidation of Elemental Metallic Powder Mixtures

Lynne E. Hannah
Sponsor: T. Vreeland, Jr.

Shock consolidation is explored as a new technology for the formation of bulk metallic glasses free from dimensional limitations. This SURF project involves the shock consolidation of a mechanical blend of NiTi and NiZr elemental powders. TEM analysis reveals that some metallic glass is present at interparticle boundaries upon consolidation of the NiTi powder composite. Future research will investigate reactions promoting growth of the glass phase into the bulk.

Optical Measurement of Out-of-Plane Displacements at the Vicinity of a Crack Tip

Kwanghak Huh
Sponsor: A.J. Rosakis

In this paper, a new point mapping technique is introduced. This new method measures out-of-plane displacements by reflecting a laser beam from the highly polished planar specimen surface by recording the resulting angle of the reflection. In the first part of this report, the theory and development of the point mapping technique is discussed. Subsequently, the results of preliminary experiments for mapping optical mirrors as well as the near crack tip plastically deformed region of steel specimen are presented and discussed.

Study by X-ray Diffraction of Ion-implanted GaAs

Nathan N. Hurvitz
Sponsor: B.M. Paine

Ion-implanted <100> GaAs has been studied by Bragg case double-crystal x-ray diffraction. Similarities and differences between Si-implanted GaAs and Si-implanted Si and Ge have been discovered. A relationship between maximum strain and energy deposited in the GaAs single crystal has been found.

Investigation of Shear Granular Flow

Billy Chi Fung Ip
Sponsor: C.E. Brennen

The shear flows of granular materials are experimentally studied. The results are obtained by using a small rectangular chute. The experiments were performed with different chute surfaces characterized by their roughnesses. The granular materials used include IBM steel beads, 0.3mm small glass beads, and 3mm large glass beads. The flow quantities are used to calculate the wall shear using the open channel equation for a compressible material. The experimental results clearly show that the Coulomb friction law is inadequate to predict the wall shear for all flow regimes. In addition, the friction coefficient increases with increasing surface roughness.

Polynomial Based Trajectories for Robot Manipulators

Sung H. Kim
Sponsor: E.K. Antonsson

Trajectory planner is an essential component in any robot control system. It is responsible for transforming high level task descriptors into a timed sequence of arm configurations called trajectories. A trajectory planner based on a fourth order polynomial has been implemented on a simulated robot manipulator. Results indicate that this algorithm is quite efficient for generating trajectories in joint space, and requires no off-line calculations.

Information Capacity of Threshold Functions

Ashok V. Krishnamoorthy
Sponsor: Y.S. Abu-Mostafa

The purpose of my project was to find the input and output average mutual information of a threshold gate in which each of its input channels has an additive Gaussian noise factor. Each of the inputs is assumed to have normally distributed probabilities. So far I have results for threshold functions with one and two inputs and I hope to solve the general case by the method induction.

Real Time Optical Image Differentiation with a Self Pumped Phase Conjugate Mirror

Victor Leyva
Sponsor: A. Yariv

Real time optical image differentiation obtained with an interferometer using a self-pumped phase conjugate mirror is reported. Methods of extending the operation to higher order and of determining whether a function is harmonic are discussed.

Plume Entrainment at a Density Interface

Raymond Y. Mak
Sponsor: E.E. Zukoski

Experiments were conducted to measure the entrainment flux of a plume impinging on a density interface. Result shows higher flux than previous investigations.

The Feasibility of a Turbine-Driven Automotive Coolant Pump

Tracy V. Petersen
Sponsor: A.J. Acosta

The automobile coolant pump is the most widely produced centrifugal pump in the nation by almost five to one; it is also one of the most inefficient. It was the purpose of this research to demonstrate the feasibility of increasing the efficiency of this pump by 40 percent and reducing its energy consumption by a factor of three.

The Spectroscopy of Xe^{3+} Lasers

Bruce G. Tiemann
Sponsor: W.B. Bridges

A pulsed gas laser system was assembled and constructed, which will be used in ongoing research of the xenon laser transitions. Numerous delays prevented the planned spectroscopic study from being accomplished on schedule.

Geological and Planetary Sciences

Interactive Simulations on the PS300

Thomas L. Tysinger
Sponsor: F.E.C. Culick

Research was conducted on an Evans and Sutherland PS300 graphics system in an attempt to determine the practicality and feasibility of interactive flow simulations and other animations through a host computer. The outcome of this project consisted of an interactive program which maps the flow around a circle into the flow around an airfoil and a program which illustrates interactive animation on the PS300.

Studies on the Design of Sample-data Compensator

Yiu-fai Wong
Sponsor: P.M. Thompson

Given an analog compensator, a new approach to the design of the digital filter of the hybrid compensator is investigated. The resulting sampled-data feedback system resembles the analog system very closely in terms of phase margin and overshoot to a step input.

The Relationship Between Radiation Dosage and Smoky Coloration in Quartz

Gregory L. Bailey
Sponsor: G.L. Rossman

The relationship between depth of smoky coloration and amount of gamma radiation received by three samples of naturally occuring smoky quartz was developed. Using this relationship, the effective dose that each sample had experienced in its parent pegmatite was estimated. This effective dose was compared with a total dose based on the geologic age of the pegmatite and an estimate for the background radiation level within the pegmatite. In all cases the total dose was approximately three orders of magnitude greater than the effective dose.

A Numerical Model of Jovian Vortices

J. Alexander Becker
Sponsor: A.P. Ingersoll

A non-linear model of vortices in the Jovian atmosphere has been constructed and implemented on a computer. It is an extension of the model developed by Ingersoll and Cuong (1981) in which the eddy and vortex structures of interest are confined to a single, shallow upper layer on top of a much deeper lower layer. The present model splits this upper layer into two distinct, stably stratified layers, which may interact with each other and the deep lower layer to produce the motions of interest.

California's First Barbecue?

Janet L. Boley
Sponsor: J.L. Kirschvink

Several rings of cobbles were discovered amongst thousands of possible toolmaking artifacts at the putative early man site in Calico, California. Uranium-thorium assays of the surrounding caliche has shown the cobbles to be at least 200,000 years old. Paleomagnetic techniques are being used to determine if the clasts have been heated and thereby used as a firehearth by early man. In addition, similar cobbles have been used in an actual firehearth where the temperatures of the clasts were carefully monitored. Paleomagnetic techniques are also being applied to these clasts which are thus serving as a control experiment for the putative ancient firepit.

Photoclinometry of Mars

Thomas M. Gould
Sponsor: G.E. Danielson

A program which performs photoclinometry on digital images of planetary surfaces and orginally utilized data from the Voyager mission for use on Jovian satellites now utilizes Viking Orbiter data of Mars as well. The Viking data will be used to calibrate the program using previous Earth-based radar data of the same regions. The format of the Viking Orbiter 1 Supplementary Experimental Data Records was deciphered and documented. The program was run on selected regions of a Viking frame of the Ophir Chasma in the Valles Marineris, at -8 degrees latitude and 70 degrees longitude. Topographical maps of surface contours were produced along with "three dimensional" images from the derived topography of rifts, canyons, and craters in the region. An interactive program referred to as AT was developed to account for image brightness variations due to varied surface albedo. When completed, this new program is to be run in conjunction with PT to produce more accurate derived topography.

A Search for Free Magnetic Monopoles Using a SQUID Magnetometer

Joseph M. Kovalik
Sponsor: J.L. Kirschvink

The superconducting loops of a SQUID magnetometer serve as an excellent means to set up a velocity independent investigation of free moving magnetic monopole charges. In this study, a continuous monitoring of current in the coils over extended periods did not produce a suitable noise free baseline from which an event produced by a monopole could be adequately identified. The noise signals, however, do not correspond to monopole type events and seem to indicate that magnetic charges are not responsible for the instability.

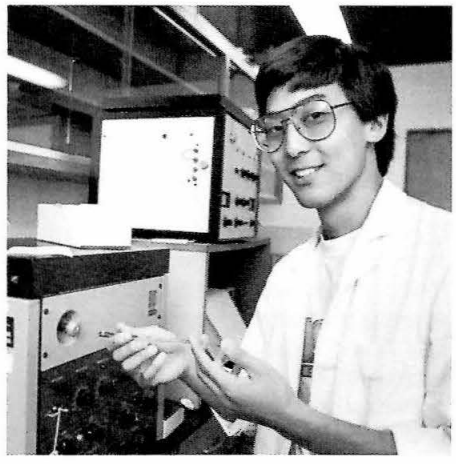
Model of Spatial Variations in the Reflectivity of Jovian Atmosphere

Tuyen T. Pham
Sponsor: Y.L. Yung

A simple atmospheric model which includes a thin haze layer of red chromophores from the pressure of 150mb to 350mb and a cloud layer consisting of both red chromophores and white ammonia particles between 350mb and 650mb is used in an attempt to explain the reflectivity spectra in 7 different observed regions, namely North and South Polar Cap (NPC), (SPC); North and South Equatorial Belts (NEB), (SEB); North and South Tropical Zones (NTRZ), (STRZ); and Equatorial Region (EQ). Results fairly well match the observed spectra except at short wavelengths around 2000 Å.

Humanities and Social Sciences

Physics, Mathematics and Astronomy



The Effect of Market Advertising

Tung Yin
Sponsor: J.A. Dubin

The main purpose of this project was to provide an economic model where advertising played a major role for both consumers and producers. The results indicate that advertising can disrupt the normal supply and demand equilibrium price and in proper amounts can aid the producer in setting his prices above that mark.

Computer Networks and Protocols

Sanjay K. Agrawal
Sponsor: G.C. Fox

Some of the protocols on the campus network are studied. The feasibility of building software gateway(s) between different network systems is investigated. Preliminary research indicates that a gateway between RCP and TCP/IP may not be possible.

Measurable Color Partition of the Planar Unit Graph

Eric K. Babson
Sponsor: R.M. Wilson

The main purpose of my SURF project was to find more information on the chromatic number K of the unit graph in the plane, previous knowledge being $3 < K < 8$. I found that K is at least five if the color-partition is into Borel sets, and at least six if it is into unions of Jordan domains with finite numbers of components in any finite disk.

Concurrent Ray-Tracer for the Caltech Hypercube

Vineer Bhansali
Sponsor: G.C. Fox

Implementation of Ray Tracing on a Nearest Neighbor Concurrent Processor is described. By exploiting the parallelism of Ray-Tracing, enormous speed-ups and exceptionally realistic images are obtainable. A simple renderer has been coded that uses an efficient scattering algorithm for load distribution. Separate programs include an LFF file converter and an Adaptation Algorithm for frame buffers of dissimilar configurations. With such algorithm/implementation compatibility, conventional (sequential) methods of graphics may very well become obsolete.

Load Balancing

Daniel B. Bikle
Sponsor: G.C. Fox

Concurrent processors, CCPs, have the potential to surpass conventional computers in processing speed. In order for a CCP to work well it must be load balanced. The load balancing problem may be solved using an analogy from physics, along with an algorithm named metropolis. The key parameter, temperature, in metropolis was studied in an attempt to maximize the effects of metropolis on a given problem.

Continuum Mapping of Extended Radio Sources at 22 GHz with the OVRO 40-M Telescope

Peter L. Cho
Sponsor: K.Y. Lo

The implementation of a technique for restoring dual-beam observations of extended radio sources is described. Fundamental limitations of this method along with some unresolved problems are also discussed. Although the technique has not yet been fully perfected, several preliminary reconstructed maps evince superior resolution over others of earlier investigators.

^{10}Be(p,n) Cross Section from Threshold to 1.11 MeV

Yiu Y. Chu
Sponsor: R.W. Kavanagh

The total cross section for $^{10}Be(p,n)^{10}B$ reaction has been measured from threshold to E_p = 1.11 MeV, and inverted by detailed balance to find the $^{10}B(n,p)$ cross section from $0 < E_n < 0.79$ MeV.

APL Routines for the Math Department

Karen L. Condie
Sponsor: R.M. Wilson

This project was intended to provide the Math Department with APL routines for classwork and general use. Few such routines have been written, because of the complexities of one of the first and most important of the routines. The Todd-Coxeter routine, in fact, took up much of the project's time. The only other routine which was worked on was the EGENS differential equations plotter.

Performance Limitations of an Acousto-optical Spectrometer for Submillimeter Astronomy

William A. Craven
Sponsor: T.G. Phillips

Performance limitations of the acousto-optical spectrometer built as a prototype for future designs for use on the Kuiper Airborne Observatory and Caltech's Submillimeter Telescope are discussed. Especially important is quantification of the noise generated by the instrument relative to that of the input signal.

Rigorous Studies in Mathematical Physics: Quantum Potential Theory and Related Topics

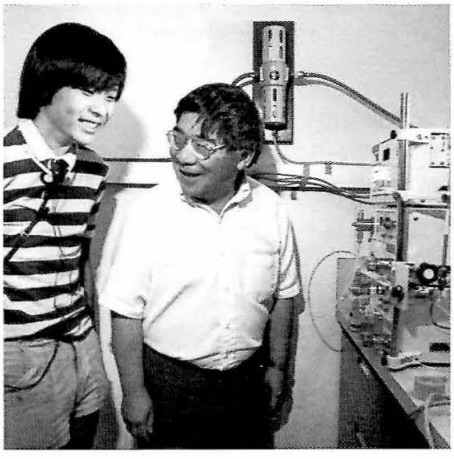
William D. Cutrell
Sponsor: B.M. Simon

An overview of rigorous mathematical methods in basic quantum mechanics is given, emphasizing proper ties of the binding energies of simple atoms and molecules. Included is the author's survey of logical foundations for quantum mechanics.

A Directed Graph Version of Strongly Regular Graphs

Arthur Duvall
Sponsors: H.J. Ryser, R.M. Wilson

We study a directed graph version of strongly regular graphs, graphs whose incidence matrices satisfy $A^2 + (\mu-\lambda)A-(t-\mu)I = \mu J$, and $AJ = JA = KJ$. We prove existence (by construction), non-existence and necessary conditions, and homomorphisms for several families of parameter sets.



A Search for Short Period Binary White Dwarfs

Diana Foss
Sponsor: J.G. Cohen

Seven white dwarf spectra were observed at wavelengths between 4200 Å and 5000 Å with the spectrograph on the 60-inch telescope on Palomar Mountain. None of the stars showed definite binary motion, although two had variable radial velocities. Computer modeling of binary white dwarf systems predicts that, of the 40% of all white dwarfs that have companions, 23% should show radial velocity variations of 200 km/sec or higher. A new detector, recently installed on the spectrograph, will vastly improve the data on the next observing run.

Distance Determination Using the Doppler Shift and Light Curves of M5-32, an RR Lyrae Star or The Hitchhiker's Guide to Galactic Distances

Gabrielle A. Gordon
Sponsor: J.G. Cohen

Since the flux of light from a star depends on its radius and distance, for most astronomical objects the measured flux cannot give a measure of the distance. The pulsating RR Lyrae stars, however, have a periodically varying temperature, flux and radius. The radius fluctuations are measurable by means of the Doppler shift. Temperature variations and brightness variations are also measurable. By combining radial velocity and spectral photometry data as a function of phase, I have managed to obtain a distance and average radius for M5-32, an RR Lyrae star in the globular cluster M5.

Determination of the $^{16}O + \alpha \rightarrow {}^{20}Ne + \gamma$ Cross Section at Low Energies

Kenneth H. Hahn
Sponsor: B.W. Filippone

^{20}Ne recoils produced in the reaction from the $O^+ + 6.72$ MeV neon resonance were counted using a technique of coincidence timing of the recoil detection spectrometer. The recoil detection system was tuned for reaction yields by using a flourine beam and elastically scattered neon nuclei. Important parameters, such as recoil and gamma-ray detector efficiencies, target thickness, and beam current calibrations were determined as a part of the CTAG experiment. Plans for non-resonant direct capture and further resonant measurements are discussed.

A V.L.A. 6CM Map of Sagittarius A West

Marc E. Herant
Sponsor: K.Y. Lo

I worked towards the creation of a six centimeter radio continuum map from the galactic center. The data which I used was gathered by the V.L.A. in its A, B, and C configurations. The resolution of the map is 0.3 arcsecond.

A New Proof of Erdös's Theorem on Monotone Multiplicative Functions

Everett W. Howe
Sponsor: T.M. Apostol

A new proof is given of a theorem of Erdös that all increasing multiplicative functions have the form $f(n) = n^{\alpha}$.

Calculation of the Static Configuration of a Single Skyrmion in Three Dimensions

Stephen D. Hsu
Sponsor: R. Seki

Calculations using the effective Langrangian of Skyrme's chiral soliton model of baryons are performed on a three-dimensional lattice. Numerical relaxation methods are used to find the static configuration of a single baryon. Prospects of time-dependent calculations involving scattering of two solitons are discussed.

Localization and Quantum Resonance of the N-dimensional Quantum Mechanical Kicked Rotor

Jung Choon Im
Steve E. Koonin

Localization and quantum resonance of the N-dimensional quantum mechanical kicked rotor, defined by

$$H = -\frac{\hbar^2}{2}\sum_{i=1}^{i=N}\frac{1}{J_i}\frac{\partial^2}{\partial\theta_i^2} + V(\Theta)\sum_{n=0}^{n=\infty}\delta(n-\frac{t}{T})$$

are examined from first principles. The analysis shows a universal localization phenomena in one and two dimensions and a resonance phenomenon that is related to the structure of V in higher dimensions. Some easily applicable criteria for deciding the asymptotic behavior of a given kicked rotor are also derived.

Study of a BGO Electromagnetic Calorimeter using Electron Beams of 180 MeV and 10 GeV

Taylor W. Lawrence
Sponsor: H.B. Newman

A calorimeter of 25 Bismuth Germanate (BGO) crystals equipped with silicon photodiode readout was tested in a 180 MeV beam of positrons at Cornell University's Wilson Synchrotron Lab. A fast effective method of off-line data analysis was used for immediate feedback as to data quality. The rms resolution at this energy was found to be approximately 4.5%. Position resolution by center of gravity reconstruction of energy deposition was found to be approximately 4 mm. A larger matrix of 100 BGO crystals was tested with 10 GeV electrons from the CERN SPS. A study of the amplifiers in the electronic data acquisition system using beam data revealed that all amplifiers had a gain of 5.00 ±.05.

Investigation of the Leakage Correction Algorithm for the Liquid Argon Module of the MARKII Detector

Edwin Y. Lee
Sponsor: F.C. Porter

Monte Carlo programs (EGS, OVREZY) were examined in anticipation of their essential role in the development of a better leakage correction algorithm for the liquid argon component of the MARKII detector. OVREZY was found to be a satisfactory substitute for EGS but an apparent disagreement between an EGS data set and a real data set was found. A simple test indicated that the disagreement may be too significant for the Monte Carlo programs to be used in the development of a new code.

Electronics System for Solid Xenon Detector

Thomas C.T. Luke
Sponsor: J.H. Thomas

The development and design of a solid/liquid Xenon detector is discussed with emphasis on the electronics and filter systems. A noise level of less than 5 microvolts unamplified is desired. With a prototype system noise levels were less than 5 mV for voltages up to 5 KV. A resolution of 4 channels (FWHM) was obtained for a 3 channel (FWHM) peak at 5 KV. Noise attenuation was measured at 8.0E-9 for 50 KHz noise and 1.25E-7 for 60 Hz. Despite breakdown and silicon potting problems, a viable prototype filter has been developed.

Production of Isotopically Pure Implanted Targets

Brian J. Lund
Sponsor: C.A. Barnes

An investigation of the feasibility of using the Fractionally Charged Particle (FCP) experiment's source at Caltech to produce an isotopically pure implanted target was made. It is believed that production of isotopically pure targets is possible, using the FCP source. Progress on target production has been hampered by equipment failure.

Internal Friction Measurements of Semiconductors

Chris Meisl
Sponsor: R.M. Housley

A bar resonance apparatus for measuring elastic properties of materials has been automated and its usefulness as a method to determine the internal friction of semiconducting materials was explored. Measurements on cadmium telluride and gallium arsenide were made and a change in internal friction due to incident light was examined.

Calculation of Depth Profiles of Strain and Damage Induced by MeV Ion Irridation in III-V Compounds

Salman Mitha
Sponsor: T.A. Tombrello

MeV ions induce damage and strain in the surface layers on III-V compounds. X-ray diffractometry techniques and a dynamical theory model of x-ray diffraction are used to calculate the depth profiles of strain and damage in the layers. As of the writing of this paper only preliminary results are available.

Noise in the Photodiode Readout

Massoud Pedram
Sponsor: R. Gomez

We report on recent study of the electronic readout system for the BGO Calorimeter in the L3 experiment. After a review of sources of the noise in the electrical devices, we derive different noise terms in the photodiode readout. Then, we compare the performance of the Rutherford preamplifier with the Princeton preamplifier for different shaping filter time constants.

The Mechanism of Graphite Production in Amorphous Carbon Films

Michael G. Pravica
Sponsor: T.A. Tombrello

When an amorphous carbon film is bombarded by ions, the electrical resistance of the foil decreases. It is theorized that graphite is produced in tiny nodules and that hydrogen impurities are essential in the mechanism. I have shown that the $\triangle$H vs. E curve looks like the $\triangle$R vs. E curve for a fluorine beam, which means that the loss of hydrogen is proportional to the amount of graphite produced.

Polarized ^{3}He Target: A Progress Report

Michael A. Rigler
Sponsor: R.D. McKeown

Development and construction of an optical pumping apparatus to polarize gaseous ^{3}He was begun. The prototype uses a ^{4}He lamp for the pumping light. The apparatus is currently at a state in which the ^{3}He absorbs the pumping light but does not maintain any significant polarization. Spectroscopic analysis indicates that the glass wall of the ^{3}He polarization chamber gives off impurities which are probably causing polarization relaxation through collisions.

A Monte Carlo Analysis of ^{3}He

Michael J. Roberts
Sponsor: S.E. Koonin

The Hubbard Hamiltonian and Gutzwiller's variational wavefunction are studied for ^{3}He, a system of fermions, using Monte Carlo techniques, I find that the Hubbard/Gutzwiller model is applicable to an unpolarized system, but that it does not produce valid results when applied to a spin-polarized preparation of ^{3}He. This analysis does not find a transition to a localized state at finite U, suggesting that other analyses of this model which find such a transition contain unreliable approximations.

A Look at Current Research in Electron-Nucleus Scattering

Joel A. Seely
Sponsor: S.E. Koonin

Measurements of the longitudinal and transverse structure functions have been made in electron-nucleus scattering at momentum transfers from .01 to 20 Gev. Different models have been used to obtain results that agree in form with the experimental results, including the Fermi gas and shell models. In this research an attempt to utilize the Fermi gas model in a numerical calculation with an IBM PC is made. Although data obtained showed some charactistics of the analytic expression for the same model, the overall form of the results differed greatly; the program was, therefore, never able to be expanded to utilize other models that do not have analytic form.

The Effects of Ion Beam Fluence on the Adhesion of Gold on Silicon

George J. Stecher
Sponsor: T.A. Tombrello

A silicon wafer with a 500 angstrom gold film was bombarded with varying fluences of 6 MeV oxygen ions. The scratch test was used to study the effect of the ion beam fluence on the adhesion of the film to the wafer. No noticeable change was detected at fluences from $5x10^{12}$ to $2x10^5$ ions/cm^2 but adhesion worsened at the dose of 10^{16} ions/cm2.

Resolution Characteristics of an Isotope Spectrometer Composed of Silicon Solid State Detectors

Ichiro Takeuchi
Sponsor: R.A. Mewaldt

A stack of silicon solid state detectors was used to resolve the isotopes of elements from Ge (Z = 32) to Kr (Z = 36). Measured resolution values were compared with predicted theoretical values in order to determine some of the major causes of the mass uncertainty.

The Production of ^{13}N and the ^{13}N(p,γ)^{14}O Reaction

Jean C. Tang
Sponsor: C.A. Barnes

Various methods for the production of ^{13}N targets, or ^{13}N beams, have been explored as necessary steps towards studying the astrophysically interesting nuclear reaction, ^{13}N(p,γ)^{14}O. A ^{13}C target chamber was also designed.

Saltation: The Jumping of Sand Grains

Minh Q. Tran
Sponsor: P.K. Haff

Previous studies have been conducted to understand sand saltation in the deserts. However, little detail is known about the saltation caused by an impact of a single sand grain. Results from this experiment show that saltation by itself cannot propagate if no energy is added to the saltating grains by the wind.

Graphics Applications in Computational Physics

Christopher B. Umminger
Sponsor: G.C. Fox

This research project studied the use of computer graphics to model certain physics problems in a clear and attractive way. Software was written on an IBM PC to demonstrate planetary motion and a bouncing ball. The graphic displays involve both animation and three dimensional viewing.

Time Variations in Emission Line Profiles of Seyfert 3C120

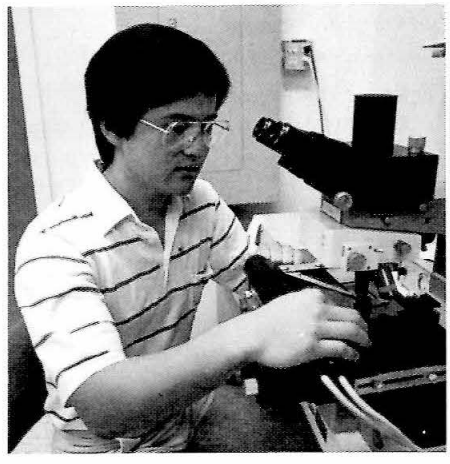
Jeffrey A. Valenti
Sponsor: J.B. Oke

Ten observations of 3C120 over a four year period are consistent with a rotating accretion disk model in which the disk is nearly face on and a jet is directed very nearly towards the earth. Two additional observations show an unexplained broadening of the blue wing of hydrogen alpha.

Experiments in Two-Dimensional Granular Flow

Kevin E. Wilson
Sponsor: P.K. Haff

Apparatus was designed and constructed that allow data to be collected on a two-dimensional granular flow. This data is collected by means of photographs that can later be digitized. Information available from the photographs include the location and identity of every particle, the amount of compaction the system experiences, and qualitative measure of the stress on each particle. Reproduction of photographs are included.



A Study in the Use of High Resolution Graphics for Transmitting the Astrophysical Concepts of Stellar Structure

Jorden E. Woods
Sponsor: G.C. Fox

Through the union of the IBM 5080 graphics package and the four equations of stellar structure, a program was designed to create an educational array of astrophysical images. Completion of the project confirmed that the blending of data and graphics produced a visual environment conducive to the understanding of stellar physics.

A Survey of Giant Molecular Clouds Associated with HII Regions

Min Su Yun
Sponsor: N.Z. Scoville

Ninety-three spatial contour maps of CO($J = 1 \rightarrow 0$) emission from $l = 8°$ to $l = 60°$ have been made at positions based on a list of 173 radio sources of hydrogen recombination-line emission (HII regions) in the Milky Way. The Galactic CO survey was done by Five College Radio Astronomy Observatory (FCRAO). Properties of CO clouds bearing HII regions have been measured and studied to test various proposed mechanics of star formation in large molecular clouds. This study reveals that there are molecular clouds ranging up to 220 parsecs in size, and the location of star formation is farther inside of the clouds than predicted by the popular "blister" model of O star formation.

Magnetic Fields in Molecular Hydrogen Clouds

Dennis F. Zaritsky
Sponsor: N.Z. Scoville

Polarization measurements of stars seen through molecular clouds were taken. The procedure to reduce the data and produce a map of the magnetic field of the cloud is outlined, and a preliminary map of the magnetic field in B335 is presented.

Photoelectric Observations of Asteroid 1627 Ivar

Leila Belkora
Sponsors: A.W. Harris, S.J. Ostro

Photoelectric observations of asteroid 1627 Ivar were made from Table Mountain Observatory (TMO) in July and August, 1985. Three monthly composite lightcurves were drawn up. From these a period of 4.800 hours ±0.004 hours was inferred. The maximum amplitude of the lightcurve we observed was 0.53 ±0.02 magnitudes.

Ulysses SEGS and Its Future

Harold J. Felton
Sponsor: R. Durstenfeld

This SURF provided the Ulysses Sequence of Events Generation Subsystem (SEGS) with help in getting the software debugged and the operator trained. Limitations of the programs were defined and investigated for use on future missions.

The Lightcurve of 1036 Ganymed

Nancy Jo Fico
Sponsor: A.W. Harris

The purpose of this project was to obtain the lightcurve for the asteroid 1036 Ganymed. Observations were made at Table Mountain Observatory and reduced at Jet Propulsion Laboratory. The light curve has a period of 10.3 hours. The amplitude is approximately 0.40 magnitudes, with two maxima per cycle. This is the first light curve obtained for Ganymed, and it will be used for statistical studies of rotation properties of asteroids, and in combination with radar data for determining the shape and pole orientation of Ganymed.

Reduction of Stainless Steel Outgassing on the Large Gravity Wave Detector

Supriya Ghosh
Sponsor: F.L. Lansing

This research paper discusses the outgassing phenomena in ultra-high vacuum systems. The Jet Propulsion Laboratory, under the management of the California Institute of Technology, is presently examining the probability of building a large L-shaped gravity wave detector with each leg being 5-kms long. The sensitivity of the detector should be higher than any other gravity-wave detector built so far. Hence, each 5-km long cavity is required to be at a vacuum pressure of 10^{-8} torr. To achieve such a high level vacuum, the chamber surfaces need to be thoroughly outgassed. This paper discusses this outgassing problem and reviews past research work performed on the subject. A suggested cleaning procedure and test-model are also included at the end.

Photometric Observations of Comets Halley and Giacobini-Zinner

Scott A. Grossman
Sponsor: J.T. Trauger

Comets Giacobini-Zinner and Halley have been observed with the 24 inch telescope at Table Mountain Observatory with a CCD photometer during late August and early September. The observation procedures are discussed, as well as a means for analyzing the data.

Particle Analysis by Mass Spectrometry

Nhi G. Hua
Sponsor: M.P. Sinha

The PAMS technique is being used to obtain the mass spectra of biological compounds such as RNA and DNA. We were able to observe the mass spectra of RNA from aerosol particles composed of RNA. However, due to experimental difficulties in generating a sustained supply of mono-disperse aerosols of the above compounds, a quantitative measurement of their mass spectra could not be made. A better method for generating aerosols of the biopolymers would be nebulization of their solutions.

A Long Term Study of Solar Wind/Magnetosphere Coupling

Gerard J. Jungman
Sponsor: J.A. Slavin

Solar wind plasma data and auroral activity indices for the periods October 1963-December 1975 and January 1978-April 1982 are analyzed for correlation. It is found that the best predictor of auroral activity is the quantity VB^s, with linear correlation coefficients of .65 vs. AE, .58 vs. AU, and .73 vs. AL. The quantity VB^2 shows poor correlation in all instances. No solar cycle variation in correlation is observed for the quantities VB^s and V2Bs.

Work Towards a Numerical Simulation of the Hydrodynamics Governing the Evolution of a Quasar Jet

Dawn M. Meekhof
Sponsor: D.L. Meier

This paper discusses the work, still in progress, towards a numerical simulation of the conditions in a quasar jet. We use a simple conservative monotonic two-step numerical scheme with harmonic mean differencing to update certain conserved quantities: density, magnetic field strength, momentum and internal energy. Eventually, we wish to understand the conditions that lead to the structure of the jets.

Single Photon Detection with Cooled Avalanche Photodiodes

Brian D. Metscher
Sponsor: J.R. Lesh

Operation of a passively-quenched avalanche photodiode in a photon counting mode has been demonstrated. The need for a faster (active) quenching circuit is evident. Time intervals between dark noise pulses of a photomultiplier tube are Poisson distributed, while those of the APD are not.

The Use of Hybrid Mascon Models to Describe Complex Gravitiational Potentials

Andrew M. Tikofsky
Sponsor: N. Jacobi

An attempt was made to develop asymptotic models of the standard spherical harmonic expansion through the use of Balmino's model of Mars' gravitational potential. These models utilized point mascons (mass-concentrations). The location and magnitude of the mascons was based on physical data as well as a least-squares computer fit to data generated by the Balmino model.

Discharge Cleaning Techniques for Ultrahigh Vacuum Systems

Glory Anne Yango
Sponsor: F.L. Lansing

Cleaning of the 5-kilometer, 4-foot diameter 304 L stainless steel tubes for the gravity wave detector vacuum system is discussed. A review of various ultrahigh vacuum system cleaning methods is presented, including descriptions of pretreatment, baking, pulse and glow discharge cleaning, and gettering processes. Laboratory research must be conducted before the final cleaning method for the gravity wave detector is determined, but the most efficient cleaning at a reasonable cost seems to be: (1) pretreating the tube with a known effective cleaning process like the standard Varian method or the Diversey DS-9 method, (2) baking the 40-foot tube sections at high temperatures of 450° C or more before installation, (3) using a low electron temperature hydrogen glow discharge *in situ* on the 5-kilometer tube.

The Response of a White Light Variable Rotational Shearing Interferometer when Applied to Extended Sources

Joel B. York
Sponsor: J.B. Breckinridge

The purpose of this project was to investigate the properties of a white light variable rotational shearing interferometer when applied to extended sources. The system used was designed to produce the optimum output, so that the maximum utility of the device could be evaluated. This entailed the use of an achromatizing lens system to remove the wavelength dependence of the interference pattern, and the use of CCD imaging to view the interferometer output. Thus far the system has been deployed in raw form, and it is already evident that the information contained in the output is of reasonably high quality.

Interstellar SURFs

An Overview of Selected Topics in Interstellar Studies

Eugene R. Thomas
Sponsor: E.C. Posner, J.G. Smith

This paper presents a broad-brush overview of interstellar studies, and serves as background for the papers of the Interstellar SURF team.

An Interstellar Voyage: How do we Get There?

Allen Gee
Sponsor: E.C. Posner, J.G. Smith

The possibility of an interstellar mission to one of the nearby stars has intrigued scientists for the last several decades. The purpose of this study was to examine the difficulties and the feasibility of such a mission, and to suggest areas of research that would be most beneficial in developing such a mission capability. My study focused on propulsion, probably the most difficult aspect of an interstellar voyage. I began by developing some relativistic equations for rocket kinematics in order to analyze exactly what the motion of the spacecraft would be, given a particular propulsion system. Based on the results which I obtained by applying these equations to different ideas, I have designed a propulsion system which I will describe in this paper.

Propulsion Systems for Interstellar Vehicles

Ara Kassabian
Sponsor: E.C. Posner, J.G.Smith

The propulsion problem of interstellar rockets is examined. Various propellants are examined from the points of view of energy density, cost, and efficiency of energy extraction. Fission propellants are found to be most suitable for the next generation of rockets. Antimatter is also found to hold great promise, but is deemed too prohibitively expensive for use, at least until rising production efficiencies bring the prices down.

Feasible Near Term Interstellar Probe Evaluation

Charles F. Neugebauer
Sponsor: E.C. Posner, J.G. Smith

This paper will discuss workable models of spacecraft propelled by nuclear electric propulsion systems and laser pushed light sails as potential extra-solar vehicles. Both classes of spacecraft have individual benefits and drawbacks and due to their vastly different mission profiles, each has distinct scientific value. The nuclear electric propulsion unit is designed to complete a rendezvous mission transit time in about 200 years to the Proxima Centauri system while the light sail will operate in flyby mode at one quarter the speed of light, giving mission durations one order of magnitude less than the electric system. The large payloads the electric propulsion system can accommodate make its long scientific return time less of a drawback. Within the limited scope of this paper, the systems will be described in detail. Technological requirements will be noted, and some recommendations made for research areas concerning the missions. Some critical technologies that need to be developed include the production of long lifetime and high power propulsion energy sources and the development of instrumentation that can withstand a few centuries sojourn in the interstellar region.

The Feasibility of Optical Communications over Interstellar Distances

Stephan A. Pietrusiak
Sponsors: E.C. Posner, J.G. Smith

The feasibility of an optical communication system for an interstellar probe is examined. It is found that a practical optical communications system for a distance of 4 to 5 light-years satisfying vehicular payload requirements will have a data rate typically 10 to 100 bits per second. Although the data rate is extremely slow compared to current communication systems now in use, optical communications can be used over interstellar distances.

Assessment of the Feasiblity of a Maser-driven Light Sail as an Interstellar Probe

Dana M. Pillsbury
Sponsor: E.C. Posner, J.G. Smith

Starting with the broad object of assessing the feasibility of any and all types of interstellar probe, the project quickly narrowed to the qualitative assessment of the feasibility of one particular type, the microwave-propelled "light" sail suggested by Forward. Research is by no means complete, especially in the areas of propulsion and communication, but it appears that a satisfactory material for the construction of the sail has been found in Niccalon, a very thin silicon carbide fiber; and an adequate system for detecting planets, using simple optics and a far-infrared detector array, is in the process of being conceived.

An Analysis of a Specific Payload and a Propulsion System for an Interstellar Probe

Eugene R. Thomas
Sponsor: E.C. Posner, J.G. Smith

The first half of this paper analyzes the utility of an interferometer to detect planets around a target star. The second half derives the required mass-power ratios for any propulsion system that ejects an inert working fluid, and finds that the required mass-power ratios preclude the use of such a propulsion system.

Prototype Interstellar Propulsion and Communication Systems

Stephen N. Winters
Sponsor: E.C. Posner, J.G. Smith

Propulsion systems capable of traversing interstellar distances will be discussed. The process whereby the interstellar propulsion systems are chosen will be explained. Two classes of vehicles will be covered (1) Nuclear Electric Propulsion and (2) Laser-pushed Light Sails. Accompanying each propulsion system will be its corresponding communication system and payload specifications. An explanation will be given for the general communication design. Only one method of information transfer will be discussed—laser communication. Two mission profiles will be given.

SURF Publications

This is a cumulative listing of papers published by SURF students.

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3. "Flux Pinning by Magnetic Impurities in an Amorphous Superconducting Alloy", Report to the Department of Energy, (1980) D.L. Whiting*, (worked with W. Johnson**).
4. "IUE and Visual Spectrophotometry of Markarian 9, Markarian 10, and 3C 390.3", *Astrophysical Journal*, Vol. 243, p. 445 (1981), R.W. Goodrich*, J.B. Oke**.
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12. "Experimental Study of Autorotation with Flow Visualization", Received Third Place Certificate of Merit at American Institute of Aeronautics and Astronautics Minta Martin Student Competition for presentation of a technical paper, University of California, Irvine, April, 1982. I. Sugioka* (worked with F.E.C. Culick**).
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40."On the Capacity of Certain Associative Memories", Paper delivered at IEEE International Symposium on Information Study, Brighton, England, June 23-28, 1985, Y.S. Abu-Mostafa**, J-M. St. Jacques*.

* SURF student
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Thientu T. Lam *Junior, ChE*	F.H. Shair, *Professor of Chemical Engineering*	The Development of a System for Measuring Temperatures
Ali R. Lashgari *Freshman, Bi*	L.E. Hood, *Ethel Wilson Bowles and Robert Bowles Professor of Biology*	The Production of Soluble H-2 Molecules
Taylor W. Lawrence *Junior, Ph*	H.B. Newman, *Associate Professor of Physics*	Calibration of the BGO Calorimeter in the LEP-L3 Detection System at CERN
Andy K. Lee *Sophomore, Ph*	J.L. Kirschvink, *Assistant Professor of Geobiology;* G.J. Carman, *Graduate Student, Biology*	Magentic Sensitivity in Homing Pigeons
Edwin Y. Lee *Sophomore, Ph*	F.C. Porter, *Assistant Professor of Physics*	Investigation of the Leakage Correction Algorithm for the Liquid Argon Module of the MARKII Detector
Sandra L. Lee *Junior, Ch*	R.H. Grubbs, *Professor of Chemistry*	The Stereochemistry of the Polymerization of 1-methyl Norbornene
Sonny C. Lee *Sophomore, Ch*	T.J. Collins, *Assistant Professor of Chemistry*	Electron Density Modification at the Metal Center by Stereoisomeric Metal Complexes of a Flexible PAC Ligand
Victor Leyva *Junior, Ph* *IBM-SURF*	A. Yariv, *Thomas G. Myers Professor of Electrical Engineering and Professor of Applied Physics*	Real Time Optical Image Differentiation with a Self Pumped Phase Conjugate Mirror

STUDENT	SPONSOR	TOPIC
Thomas C.T. Luke *Junior, Ph*	J.H. Thomas, *Research Fellow in Physics*	Electronics System for Solid Xenon Detector
Brian J. Lund *Junior, Ph*	C.A. Barnes, *Professor of Physics*	Production of Isotopically Pure Implanted Targets
John Luo *Freshman, Bi* *Bristol-Myers-SURF*	L.E. Hood, *Ethel Wilson Bowles and Robert Bowles Professor of Biology*, M.C. Zuniga, *Senior Research Fellow in Biology*	Determination of Qa Gene's Interferon Regulation Region
M. Yvette Madrid *Junior, ChE*	J.E. Bailey, *Professor of Chemical Engineering*	Phosphorous-31 Nuclear Magnetic Resonance Studies on the Glucose and Galactose Metabolisms in Yeast
Umar Mahmood *Sophomore, Ch* *Carnation-SURF*	J.H. Richards, *Professor of Organic Chemistry*	The Relation Between Structure and Function in Enzymes: Studies of Beta-Lactamase
Raymond Y. Mak *Junior, Eng*	E.E. Zukoski, *Professor of Jet Propulsion and Mechanical Engineering*	Plume Entrainment at a Density Interface
Alan K. Marumoto *Junior, Ch*	R.H. Grubbs, *Professor of Chemistry*	The Synthesis of Poly-2,5,-DimethylCyclopentadiene
Dawn M. Meekhof *Sophomore, Ph*	D.L. Meier, *Member of the Technical Staff, JPL*	Work Towards a Numerical Simulation of the Hydrodynamics Governing the Evolution of a Quasar Jet
S. Thomas Megeath *Junior, Ph*	T.A. Prince, *Assistant Professor of Physics*	Fourier Transform Gamma-ray Imaging
Chris Meisl *Junior, APh/Ec*	R.M. Housley, *Visiting Professor of Physics*	Internal Friction Measurements of Semiconductors
Brian D. Metscher *Junior, GePh*	J.R. Lesh, *Supervisor, Optical Communications, Telecommunications, Science, and Engineering Division, JPL*	Single Photon Detection with Cooled Avalanche Photodiodes
Salman Mitha *Junior, Ph*	T.A. Tombrello, *Professor of Physics*	Calculation of Depth Profiles of Strain and Damage Induced by MeV Ion Irridation in III-V Compounds
Charles F. Neugebauer *Freshman, EE* *Interstellar-SURF*	E.C. Posner, *Visiting Professor of Electrical Engineering;* J.G. Smith, *Manager, Telecommunications and Data Acquisition, Technology Development, JPL*	Feasible Near Term Interstellar Probe Evaluation
Bao-Uyen Nguyen *Sophomore, Ph/Ma*	T.G. Phillips, *Professor of Physics*	Investigation of the Performance of the SIS Mixer
James K. Okamoto *Freshman, Ph* *GM-SURF*	W.P. Schaefer, *Senior Research Associate in Chemistry*	X-ray Structure Determination of Bis Cp* Scandium Ethyl
Kim C. Pao *Junior, EE* *IBM-SURF*	P.M. Thompson, *Assistant Professor of Electrical Engineering*	Computer Algorithms for Control Analysis

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Massoud Pedram *Junior, EE*	R. Gomez, *Professor of Physics*	Noise in the Photodiode Readout
Janice L. Peters *Freshman*	W.A. Goddard, *Charles and Mary Ferkel Professor of Chemistry and Applied Physics*	Theoretical Calculations of Si(100) Surface Reconstruction Models
Tracy V. Petersen *Junior, Eng*	A.J. Acosta, *Professor of Mechanical Engineering*	The Feasibility of a Turbine-Driven Automotive Coolant Pump
Tuyen T. Pham *Sophomore, EE*	Y.L. Yung, *Associate Professor of Planetary Science*	Model of Spatial Variations in the Reflectivity of Jovian Atmosphere
Stephan A. Pietrusiak *Sophomore, EE* *Interstellar-SURF*	E.C. Posner, *Visiting Professor of Electrical Engineering;* J.G. Smith, *Manager, Telecommunications and Data Acquisition, Technology Development, JPL*	The Feasibility of Optical Communications over Interstellar Distances
Dana M. Pillsbury *Freshman* *Interstellar-SURF*	E.C. Posner, *Visiting Professor of Electrical Engineering;* J.G. Smith, *Manager, Telecommunications and Data Acquisition, Technology Development, JPL*	Assessment of the Feasibility of a Maser-driven Light Sail as an Interstellar Probe
Michael G. Pravica *Freshman, Ph/AMa* *IBM-SURF*	T.A. Tombrello, *Professor of Physics*	The Mechanism of Graphite Production in Amorphous Carbon Films
Michael A. Rigler *Junior, Ph*	R.D. McKeown, *Assistant Professor of Physics*	Polarized ^{3}He Target: A Progress Report
Michael J. Roberts *Junior, Ph*	S.E. Koonin, *Professor of Theoretical Physics*	A Monte Carlo Analysis of ^{3}He
Katrin Rodriguez *Junior, Bi*	C.R. Hamilton, *Senior Research Associate in Biology*	The Role of the Cerebral Commissures in Midline Stereopsis
Matthew O. Rowe *Sophomore, Lit/Ma*	M.G. Berg, *Lecturer in Literature*	An Introduction to Contemporary Latin-American Literature
Janice F. Sakai *Junior, Bi* *Carnation-SURF*	J.L. Campbell, *Associate Professor of Chemistry and Biology*	Single Stranded DNA Binding Proteins in Yeast
Joel A. Seely *Junior, Ph*	S.E. Koonin, *Professor of Theoretical Physics*	A Look at Current Research in Electron-Nucleus Scattering
Michael S. Serfas *Freshman, Ch/Bi* *GM-SURF*	W.P. Schaefer, *Senior Research Associate in Chemistry*	The Structure of Hafnium Tuck-in Benzyl
Sarvjit D. Shastri *Freshman, APh*	R. Gomez, *Professor of Physics*	Development of Educational Software in Physics
Milton R. Smith, III *Junior, Ch*	T.J. Collins, *Assistant Professor of Chemistry*	Synthesis and Investigation of Os(IV)(η^4 - γ CHBA-DCB)(PPH_3)L Complexes, Where L is a Hindered N-donor

STUDENT	SPONSOR	TOPIC
George J. Stecher *Sophomore, Ph* *Ford-SURF*	T.A. Tombrello, *Professor of Physics*	The Effects of Ion Beam Fluence on the Adhesion of Gold on Silicon
Andrew C. Swanson *Junior, APh*	J.H. Seinfeld, *Louis E. Nohl Professor and Professor of Chemical Engineering*	On the Simulation of Particle Motion in an Electrodynamic Quadrupole
Darin K. Takemoto *Sophomore, Bi*	S.I. Chan, *Professor of Chemical Physics and Biophysical Chemistry*	The Isolation of Subunits of Cytochrome c Oxidase Using High Performance Liquid Chromatography
Ichiro Takeuchi *Sophomore, Ph*	R.A. Mewaldt, *Senior Research Associate in Physics*	Resolution Characteristics of an Isotope Spectrometer Composed of Silicon Solid State Detectors
Jean C. Tang *Sophomore, Ph*	C.A. Barnes, *Professor of Physics*	The Production of ^{13}N and the $^{13}N(p,\ )^{14}O$ Reaction
Eugene R. Thomas *Freshman, Ph* *Interstellar-SURF*	E.C. Posner, *Visiting Professor of Electrical Engineering;* J.G. Smith, *Manager, Telecommunications and Data Acquisition, Technology Development, JPL*	An Overview of Selected Topics in Interstellar Studies
Eugene R. Thomas *Freshman, Ph* *Interstellar-SURF*	E.C. Posner, *Visiting Professor of Electrical Engineering;* J.G. Smith, *Manager, Telecommunications and Data Acquisition, Technology Development, JPL*	An Analysis of a Specific Payload and a Propulsion System for an Interstallar Probe
Bruce G. Tiemann *Junior, Ch*	W.B. Bridges, *Carl F Braun Professor of Engineering*	The Spectroscopy of Xe^{3+} Lasers
Andrew M. Tikofsky *Sophomore, Ph/AMa*	N. Jacobi, *Member of the Technical Staff, JPL*	The Use of Hybrid Mascon Models to Describe Complex Gravitiational Potentials
Minh Q. Tran *Freshman, Ph*	P.K. Haff, *Senior Research Associate in Physics*	Saltation: The Jumping of Sand Grains
Thomas L. Tysinger *Junior, Eng* *Ford-SURF*	F.E.C. Culick, *Professor of Applied Physics and Jet Propulsion*	Interactive Simulations on the PS300
Christopher B. Umminger *Freshman, EE*	G.C. Fox, *Professor of Theoretical Physics*	Graphics Applications in Computational Physics
Jeffrey A. Valenti *Sophomore, Ay*	J.B. Oke, *Professor of Astronomy*	Time Variations in Emission Line Profiles of Seyfert 3C120
Scott C. Virgil *Sophomore, Ch*	R.H. Grubbs, *Professor of Chemistry*	Metathesis Polymerization of 3-Methylcyclopropene
Robin D. Whitt *Junior, APh*	E.S. Munger, *Professor of Geography;* R. Van der Ross, *Vice Chancellor, University of the Western Cape, South Africa*	Cadmium Telluride Thick Films
Kevin E. Wilson *Junior, Ph*	P.K. Haff, *Senior Research Associate in Physics*	Experiments in Two-Dimensional Granular Flow

STUDENT	SPONSOR	TOPIC
Robin K. Wilson *Junior, Bi* *Carnation-SURF*	E.M. Meyerowitz, *Assistant Professor of Biology*	The Introduction of the *Arabidopsis thaliana* ADH Gene into *Saccharomyces cerevisiae*
Stephen N. Winters *Freshman, Ph/EE* *Interstellar-SURF*	E.C. Posner, *Visiting Professor of Electrical Engineering;* J.G. Smith, *Manager, Telecommunications and Data Acquisition, Technology Development, JPL*	Prototype Interstellar Propulsion and Communication Systems
Kenneth Wong *Sophomore, Eng*	K.G. Libbrecht, *Assistant Professor of Astrophysics*	Research in Solar Oscillations
Yiu-fai Wong *Sophomore, EE* *Ford-SURF*	P.M. Thompson, *Assistant Professor of Electrical Engineering*	Studies on the Design of Sample-data Compensator
Jorden Woods *Freshman, Ph/CS*	G.C. Fox, *Professor of Theoretical Physics*	A Study in the Use of High Resolution Graphics for Transmitting the Astrophysical Concepts of Stellar Structure
William Woody *Sophomore, Ma*	R.D. McKelvey, *Professor of Political Science*	Computer Modeling of Game Theory Solutions
Michael Yamada *Junior, Ch* *IBM-SURF*	J.L. Beauchamp, *Professor of Chemistry*	FT-ICR Studies of Gas-Phase Organometallic Photochemistry
Glory Anne Yango *Freshman*	F.L. Lansing, *Supervisor, Advanced Antenna and Faculty Technology, JPL*	Discharge Cleaning Techniques for Ultrahigh Vacuum Systems
Tung Yin *Freshman, APh/EE*	J.A. Dubin, *Assistant Professor of Economics*	The Effect of Market Advertising
Joel B. York *Sophomore, Ph*	J.B. Breckinridge, *Technical Group Supervisor, Optical Sciences Group, Observational Systems Division, JPL*	The Response of a White Light Variable Rotational Shearing Interferometer when Applied to Extended Sources
Min Su Yun *Junior, Ph*	N.Z. Scoville, *Professor of Astronomy*	A Survey of Giant Molecular Clouds Associated with HII Regions
Dennis F. Zaritsky *Junior, Ph*	N.Z. Scoville, *Professor of Astronomy*	Magnetic Fields in Molecular Hydrogen Clouds
Miriam S. Zucker *Junior, Bi*	J.M. Allman, *Professor of Biology*	A Method of Identifying Specific Proteins in the Macaque Brain Using Monolonal Antibody Labeling

Legend of Options

AMa	Applied Math
APh	Applied Physics
Ay	Astronomy
Bi	Biology
Ch	Chemistry
ChE	Chemical Engineering
CS	Computer Science
EE	Electrical Engineering
Ec	Economics
Eng	Engineering
GePh	Geophysics
H	History
Lit	Literature
Ma	Mathematics
ME	Mechanical Engineering

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John Lux, *Chairman and Chief Executive Officer, AMETEK, Inc.*
Robert Noland, *President, AMETEK, Inc.*
Linda Sanford, *Manager, Color Work Station Printers, IBM Corporation*
Duncan Taylor, *Research Fellow, Preclinical CNS Research, Bristol-Myers Company*
Victor Veysey, *Director, Emeritus, Caltech Industrial Relations Center*

SURF Noon Seminar Speakers

Allan J. Acosta, *Professor of Mechanical Engineering* "Cavitation and Fluid Flow"
Betsy Ancker-Johnson, *Vice President, Environmental Activities Staff, General Motors Corporation* "Effect of Government Regulations on the Automotive Industry"
Sally J. Asmundson, *Director, Career Development Center* "Assessment of Personal Goals and Values, Information on Career and Educational Choices"
James M. Bower, *Assistant Professor of Biology* "Cerebellar Cortex: One of the Best Known, but Least Understood Structures in the Mammalian Brain"
Colonel Fred Butler, *District Engineer, Los Angeles District, Army Corps of Engineers* "The History, Infrastructure, and Mission of the Army Corps of Engineers"
Norman Gjostein, *Director, Systems Research Laboratory, Ford Motor Company* "Advanced Technology at Ford Motor Company"
Peter M. Goldreich, *Lee A. DuBridge Professor of Astrophysics and Planetary Physics* "Planetary Rings"
Robert H. Grubbs, *Professor of Chemistry* "Polymers: Catalysts, Structure, and Properties"
Allan J. Lindstrom, *Director, Sponsored Research at Caltech* "Government Sponsored Research"
Thomas R. McDonough, *Lecturer in Engineering* "How to Give a Seminar"
Wheeler J. North, *Professor of Environmental Science* "Marine Ecology at Caltech"
Donna Pivirotto, *Manager, Automation and Robotics Program, JPL* "Space Station"
Linda Sanford, *Manager of Work Station Printers, IBM Corporation* "Color Jet Printer"
Thayer Scudder, *Professor of Anthropology* "Development Anthropology: Relevance, Achievements and Ethnical Dilemmas"
Duncan Taylor, *Research Fellow, Preclinical CNS Research, Bristol-Myers Company* "Receptor Binding — The Central Nervous System and Drug Discovery"
Shirley Thomas, *Technical Writer and Consultant* "The Written Report"
Steven Witherly, *Research Scientist, Carnation Research Laboratory* "Taste, Aroma, and Product Development"
Peter J. Wyllie, *Professor of Geology, Chairman of the Division of Geological and Planetary Sciences* "An Old-Style Geological Expedition"

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