Summer Undergraduate Research Fellowships

California Institute of Technology

SURF Annual Report

87

Again this year we are pleased to acknowledge with gratitude a generous gift from AMETEK, Inc., a portion of which was used to offset production costs associated with this annual report.

Dedication

The 1987 SURF program is dedicated to Robert P. Sharp, the Robert P. Sharp Professor of Geology, Emeritus. We do so with deep appreciation not only for his contributions to the science of geology, but also for his 40 years of service to Caltech as a whole and for his commitment to education and the well-being of students in particular.

Contents

The Virtues of Undergraduate Research

By Robert P. Sharp

In some quarters teaching and research are regarded as incompatible, but at Caltech we feel that a program of undergraduate research can be a highly effective pedagogical procedure. At its best, research demands resourcefulness and imagination, builds character, is challenging, and can also be fun and exhilarating. It can foster many characteristics and habits that educators regard as desirable products of a college experience.

What Is Research?

In its basic and purest form, research is a seeking for truth and understanding of something that was formerly unknown. No matter how esoteric its results may appear at the time, they are a valid goal of basic research. Students need to understand this and to be guided by that principle in defining their goals. Research does not necessarily have to be directed toward producing a better toaster or toothbrush, desirable and welcome as these would be.

Like music or art, basic research is worth pursuing for its own sake. Even negative results can be useful, for we learn from our own failures and those of others. Unsuccessful research can still blaze a trail to be followed and extended.

Exploration

Exploration is one of humankind's more noble endeavors when pursued at its best primarily for the joy and satisfaction of venturing into the unknown. Explorations come in many forms. Successful geographical exploration in the long run tends to reduce the frontiers left to be explored, even in the vast expanse of outer space. On the other hand, intellectual exploration continuously expands the frontiers because one research discovery usually identifies subjects to be explored. In the process of answering one question, a dozen others worthy of investigation are revealed. The intellectual frontier appears to be constantly expanding and never ending. There is room on that frontier for all, including ambitious undergraduates.

The Real Game

Doing research is somewhat like engaging in a competitive sport. Actual playing of the game is preceded by periods of calisthenics and practice, which develop muscles and skills. For a research-oriented student, the calisthenics consist of course work in various pertinent disciplines. Research is the real game, played against a clever, versatile competitor—the unknown—and that competitor is not easily overcome. Doing research puts student skills to work in new, demanding, and wholly unanticipated ways, strengthening and expanding them in the process.

Athletic calisthenics and practice may become boring, however, and goals can fade. Playing the real game of research is seldom boring, and the goal is clear—discovery. Discovery can produce a euphoric feeling of accomplishment that becomes an intangible, unique, and permanent possession of the investigator.

Personal Identification

One of the strong driving forces of research is the powerful personal identification with the endeavor that investigators develop; the feeling that it belongs to them. For better or worse, win or lose, the research project is in their hands. They may mess it up, have to start over, or fail, but those experiences are balanced by knowing that the ultimate solution is their responsibility.

Most of us like to accomplish something that we and others recognize as a contribution of value and significance. The resulting sense of success and accomplishment is not something we store away in a box or assign to a file. It becomes part of our intangible psyche, our soul.

The culmination of a successful research effort produces the feeling of having created understanding that did not exist before. George Leigh Mallory, who attempted to scale Mount Everest in the 1920's, may not have given the best answer when someone asked why he wanted to make the effort. He said, "Because it is there," but a better answer might have been, "Because I expect it to be a totally unique world-apart experience for me." The same is true of research; successfully accomplished, it produces a special feeling that is yours, all yours. It is an act of creation.

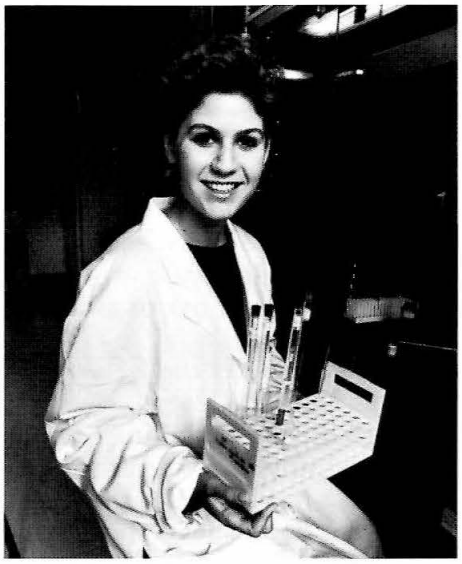
Self-Education

A major objective of college education should be to provide students with a means and motivation to educate themselves. For many professions, the factual material taught in classrooms will be out of date within a few years. To attain success in professional careers, college graduates simply must continue to grow intellectually, largely through the mechanisms of self-education. Research is good training for teaching the necessary techniques and establishing such discipline, because doing research is a learning process that requires individuals to perform on their own. Students doing research are on an isolated frontier, dependent upon their own resources of thought, analysis, and judgment.

Character Building

Research can also be a great character builder, helping to create self- reliance, independence, and a sense of self-worth. Its difficulties foster perseverance; the need to hang in there. Keeping the goal in sight and enthusiastic devotion help. The satisfactions of responding to a challenge are a strong motivating factor. Research also teaches one how to cope with frustration and failure. It demands original thinking, imagination, innovation, judgment, devotion, adaptability, industry, sustained effort, a sense of mission, and the ability to rise above disappointments. In short, it can be a hard, unrelenting task master.

Most student research emphasizes individual effort, but in some situations it is conducted within a group. As in competitive sports, this teaches teamwork. Like a blocking back or an offensive lineman in football, an individual learns to perform for the good of the group rather than his or her own exclusive benefit. They learn to find their satisfaction in the accomplishments of the team rather than depending on personal recognition.



Sharing

One of the pleasures of a successfully accomplished basic research project is the sharing of results with the whole world as widely and freely as possible. A beneficial aspect of such sharing is that it enhances the investigator's reservoir of good feeling. The more you share, the greater your feeling of accomplishment and your sense of value in what you have done.

Communication

To share, you have to be able to communicate, verbally and in writing. If research is worth doing, the results are worth communicating in a logical, clear, concise form. Indeed, it is a responsibility to do so. For some investigators the most difficult and irksome aspect of doing research is writing up the results. Learning to enjoy writing properly can be one of the more significant facets of training to be gained from undergraduate research. Unfortunately, only a few people are naturally endowed with such facility, but it is a skill that can be attained through practice and discipline. You learn by doing, over and over again, and the sooner you start, the better.

Oral presentation is equally important, both informally to colleagues and associates and formally in seminars and at meetings of professional societies or similar groups. Again, practice is necessary to develop the poise, confidence, and ability to distill the work of months or years into a concise, clear, understandable presentation that does justice to the research. Research beautifully done can be degraded by poor presentation, oral or written.

Rewards

The rewards of successful research are both tangible and intangible. Among the tangibles are prizes, awards, money, promotion, and patents or royalties. For many investigators, including students, the intangible rewards are the more prized, and the principal one is the feeling of having accomplished something that has not been done before, of having created something new, or of understanding something previously not understood. The feeling is highly satisfying because it belongs uniquely to the investigator.

Finally, one of the greatest rewards of undertaking basic research is just the pure joy and fun of doing it.

SURF Beginnings

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

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

SURF has grown beyond almost anyone's expectations. A total of 148 students, including 17 from other campuses, undertook projects this year—supervised, encouraged, and counseled by 108 faculty, JPL, and off-campus sponsors. In addition to growing numbers, the geographical spread of the research also expanded as several of the students worked in such diverse places as Italy, England, China, Boston, and San Diego. Three 1986 SURFers presented papers at the First Annual National Conference on Undergraduate Research. Two of them received certificates for the best presentation in their sessions, and one received an award for the best paper submitted in the conference.

Over the years, other changes have taken place in the program. Noontime seminars, leadership roundtables, and communications workshops led by industrial and academic personnel have been added. The stipend has been increased, and funding for the program has become more diversified. Individuals, foundations, and corporations have enthusiastically supported SURF and the needs for quality research training at the undergraduate level. In addition, many find that such support can result in reciprocal benefits to both the donor and the student.

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

1987 in Review

Summary of the applicant pool
Total number of SURF applications: 194
Number of Caltech applicants: 162
Number of non-Caltech applicants: 32

Summary of the recipient pool
Total number of SURF awards: 148
Number of Caltech students receiving SURFs: 131
Percentage of Caltech applicants receiving SURFs: 91%
Median GPA: 3.5
Percentage of Caltech student body participating in SURF-87: 19%

Number of non-Caltech NSF-SURFers: 17
Percentage of non-Caltech applicants receiving SURFs: 53%

Number of faculty participating in SURF-87: 81
Number of JPL technical staff participating in SURF-87: 25
Number of off-campus sponsors: 2

During the application process, students work closely with their faculty sponsors to define and develop the project. Because of this interaction, the quality of proposals received in the SURF office is very high, and it is, therefore, not surprising that a high percentage of students merit SURFs.

Each student received a stipend of $3000. This amount covers the costs of living on campus and personal expenses. In addition, students receiving financial aid from Caltech are required to save a large portion of their summer earnings toward their next year's tuition. The faculty sponsor provides all research costs, including supplies, equipment, computing, xeroxing, and travel. The Caltech faculty and JPL technical staff are committed to the training and development of these young scientists and engineers, as evidenced by their enthusiastic willingness to supervise these early research experiences and to assume the research costs.

Financial Notes

The financial status of SURF was strong in 1987. Contributions to operating costs and to the endowment from individuals, corporations, public and private foundations, and the earnings from the endowment totaled $475,448. A large portion of this amount was awarded to Caltech from the National Science Foundation.

National Science Foundation Grants

In March the SURF staff submitted a proposal to each of seven directorates at the National Science Foundation (NSF) under the provisions of the Research Experiences for Undergraduates (REU) program. This was the first year such an NSF program was available. Caltech was awarded grants in Chemistry, Physics, Computing, and Engineering. Under REU guidelines, eight SURF students were supported by each grant, with half of the positions filled by students from outside institutions. Students from Amherst, East LA City College, Jackson State, MIT, Pasadena City College, Pitzer College, Texas A & M, UC Berkeley, UC Irvine, UC Santa Cruz, Vassar, and Wellesley participated in SURF at Caltech.

Because the NSF students had to leave Pasadena to return to their home institutions and were unable to return for SURF Seminar Day, a special NSF-SURF Seminar Day was held on August 6. Each of these students presented an oral progress report of his or her work to an audience of their peers, sponsors, other faculty, and staff. Following the presentations, the students and their faculty supervisors met at the Athenaeum for dinner. Professor Shair gave a brief presentation on "Predicting the Future."

Kickoff Dinner

The 1987 SURF program was officially launched on January 20 with the Kickoff Dinner, attended by over 150 friends of SURF—including donors, faculty, staff, and students. Rachael Clark talked about the "Ups and Downs of SURFing"; Ravi Subramanian reported on the team project that studied orbiting antenna under the supervision of Professor Posner.

SURF-87 was dedicated to Robert Sharp, the Robert P. Sharp Professor of Geology, Emeritus. Bob Sharp reminisced about the early days of his research, about the thrill of being the first person to study a rock, or a problem, or a molecule.

The SURF-Caltech Y Program

The Caltech Y, under a grant from AMETEK, Inc., provided a number of social activities for the students during the summer. All students had an opportunity to meet with each other as they participated in some group recreation. The off-campus students SURFing at Caltech particularly enjoyed the benefits of this program.

Trips to Disneyland and Magic Mountain were available as well as a picnic at the beach, an evening of chamber music, hiking in the mountains, and the first annual SURF picnic to close the summer. The activities were selected and organized by SURFers. Students taking these leadership roles was an important aspect of the success of the activities.

SURF particularly thanks Y Director Ken McGuire, and his assistants, Julie Bolster and Gloria Brewster, for their enthusiastic and steady support in coordinating this activity.

Speakers' Bureau

As a result of the growing number of students who were invited to speak to various groups both on and off campus, the SURF Speakers' Bureau was formed last fall. Twenty-eight students volunteered to participate in the Bureau. They worked with Ms. Jean Cass to develop presentations about SURF in general, about their projects in particular, and about Caltech. They were prepared to give their talks "on a moment's notice."

In December 1986, Eric Gaidos and Rachael Clark spoke to the Alhambra Kiwanis Club. The Program Chairman of the Pasadena club, who attended that luncheon meeting, invited them to speak to the Pasadena Kiwanis Club in April.

In January 1987, Janet Boley, Thu Le, and Alex Wei presented their SURF reports to a group of technical staff at Calreco, Inc., in Van Nuys. Bassem Mora spoke to the Science Club at Fairfax High School in Los Angeles about Caltech and about his biology SURF.

Alex Wei and Janet Boley gave an overview of their 1986 projects at a reception for Caltech Alumni in San Diego in February. Prospective Caltech freshmen were also invited to the reception to meet these SURFers.

Keith Rosema, who worked with Professor James Westphal in Geological and Planetary Sciences, described the Space Telescope to a group of elementary school teachers at the Museum of Science and Industry.

During April JoBeth Schlottman and Ravi Subramanian met with incoming freshmen women to talk about Caltech and about SURF.

Alumni Seminar Day was held May 17, and three students, Kyuson Yun, Salim Khan, and Alex Becker, reported on their projects to a packed house.

Former SURFers conducted the Orientation Meeting on June 15. Alex Wei talked to the new class about SURF funding; Mike Pravica described SURF Seminar Day; JoBeth Schlottman encouraged students to take advantage of such opportunities as the Commmunications Workshops and the Speakers' Bureau; Kyuson Yun presented a student's view of SURF, and Tony Skjellum, a 1983 SURFer and currently a graduate student in Chemical Engineering, told how his SURF experience has affected his career.

Keith Rosema presented the first seminar in the Noon Seminar Series this summer, speaking on "The Space Telescope."

The August annual meeting of The Associates in Santa Barbara featured SURF. Professor Bruce Cain described the SURF projects he is sponsoring this summer and introduced the students who are working on them: Barry Lind, Kin Ha, and David Lipin. Rachael Clark presented a student's view of the program.

First Annual National Conference on Undergraduate Research

Janet Boley, Kyuson Yun, and Keith Rosema represented Caltech at the First Annual National Conference on Undergraduate Research at the University of North Carolina at Asheville in April. Two hundred eighty students from 130 colleges and universities particpated in this event. Kyuson and Keith received awards for the best presentations in their sessions. Keith also received a prize for the best student paper submitted in the conference.

Professor Shair, Chairman of the SURF Administrative Committee and faculty coordinator of Caltech's program, was appointed to a steering committee to develop guidelines, plans, and funding for the continuation of the national conferences on undergraduate research.

Awards and Honors

1986 SURFer Eric Gaidos was one of 20 winners of TIME magazine's annual College Achievement Awards. The winners were chosen by a panel of judges from the business, academic, and public sectors on the basis of academic excellence and exceptional achievement outside the classroom. Each winner received $2500, and they were featured in the April 6 campus edition of the magazine.

Vineer Bhansali, SURF 85 and 86, was a runner-up in the TIME competition and received a $250 prize. Eric and Vineer attended an awards dinner in New York in March.

Scott Virgil, who worked with Professor Robert Grubbs in 1985 and 1986, was presented the Sigma Xi award. This award is given to a senior selected for an outstanding piece of original scientific research. The student is selected by the division chairmen, the deans, and the Undergraduate Academic Standards and Honors Committee.

Sixteen of the 22 recipients of the Caltech Prize Scholarships and Carnation Scholarships awarded this year were former SURFers. Caltech awards these prizes for academic excellence. They are based solely on merit (selection is made on the basis of grades, faculty recommendations, and demonstrated research productivity) with no consideration given to need or any other non-academic criteria.

In Memoriam

Dr. Ernest H. Swift, professor of analytical chemistry, emeritus, died in April. Dr. Swift, who was associated with Caltech longer than anyone else, came to the Institute as a graduate student in 1919 and, after receiving his PhD, remained as a member of the faculty. As early as 1925 he was involving undergraduates in his research. The 1985 SURF program was dedicated to Professor Swift in recognition of his many contributions to undergraduate research.

Lester Lees, professor of environmental engineering and aeronautics, was a most inspiring and inspired teacher and researcher. During his years on the Caltech faculty, Professor Lees was an oustanding mentor for some 40 students who came from all over the world and count among their group the Apollo Project Manager, the Chief Engineer of the Lear Jet, the Woman Engineer of the Year for 1985, the Chief Scientist at Xerox, five corporate presidents, and ten full professors. This group remains very close, bonded by the esteem and affection in which they hold their teacher.

To honor Professor Lees on his retirement, these former students created the Lester Lees SURF Endowment. Each year this endowment will support one student who will be known as the Lester Lees SURFer.

Charles D. Babcock, professor of aeronautics, had been associated with Caltech since he came here as a graduate student in 1957. His research concentrated on understanding the failure of structures, and his conclusions have been applied in the aeronautics, nuclear, marine, and civil engineering fields. He was an enthusiastic supporter of SURF and one of the original members of the SURF Administrative Committee.

Communications Workshops

Ms. Jean Cass again held a series of workshops to aid students in preparing their final presentations. In addition to the sessions on visual aids and presenting the oral report, she included workshops in technical writing. Approximately 57 students participated in the workshops. During the first two weeks of October, Ms. Cass also helped students rehearse for their oral reports to be given on Seminar Day. Student attendance at the workshops and rehearsals is voluntary.

Roundtables

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

The 1987 Roundtable leaders were:

Mr. Hugh A. Baird, Retired Chief Executive Officer, C F Braun and Caltech alumnus (BS '42)

Mr. Theodore P. Hurwitz, Vice President for Institute Relations, Caltech

Mr. David Morse, Staff Manager, Recruitment/Placement, Pacific Bell

Mr. Robert L. Shafer, Certified Management Consultant

Mr. Gaylord E. (Nick) Nichols, Director of Programs, Industrial Relations Center, Caltech

Noon Seminar Series

Each Wednesday at noon during the 10-week period, Caltech faculty and JPL technical staff members presented seminars for the students and other members of the Caltech Community. The speakers gave an overview of their particular areas of research.

The 1987 seminar speakers were:

Harry B. Gray, Arnold O. Beckman Professor of Chemistry, "Solar Fuel for the Late 80's"

Paul C. Jennings, Professor of Civil Engineering and Applied Mechanics, Chairman, Division of Engineering and Applied Science, "Earthquake Engineering"

William Kaiser, Member of the Technical Staff, JPL, "Scanning Tunneling Microscopy: Investigation of Semiconductors and Superconductors"

Masakazu Konishi, Bing Professor of Behavioral Biology, "The Gender Gap in the Brain"

James Z. Lee, Assistant Professor of History, "Chinese Population History, 1750-1950"

Allan J. Lindstrom, Director, Sponsored Research, "Sponsored Research"

James J. Morgan, Marvin L. Goldberger Professor of Environmental Engineering Science, Vice President for Student Affairs, "Tiny Particles in Water: Why Do They Persist?"

Keith Rosema, Sophomore, Applied Physics, 1986 SURF Student, "The Space Telescope"

Maarten Schmidt, Francis L. Moseley Professor of Astronomy, "Quest for Quasars: Search for the Limit"

Yuk L. Yung, Professor of Planetary Science, "Antarctic Ozone Hole: Observation and Theory"

Sponsored Research

Allan J. Lindstrom, director of sponsored research at Caltech, offered the following comments to the SURFers at his noon seminar. Al earned his Bachelor's degree in economics from UC Berkeley in 1940. During World War II he was a USNR Naval Aviator—a dive bomber pilot. He came to Caltech in 1969 after many years in private industry and as a business officer at UCLA's Brain Research Institute. Al will retire from the Institute at the end of this year.

Caltech SURFers are among the most promising members of the next generation of scientists—in a nation that is no longer driven by seemingly inexhaustible resources, but rather by ideas—ideas that grow exponentially while resources are limited and dwindling. As a result all ideas must compete for support, and the winners are determined not only on the basis of scientific merit, but also on political, social, economic, and even moral criteria.

One can express the relationship of these factors in a symbolic manner by borrowing Einstein's equation on the nature of energy and its relationship to matter $E = mc^2$ and redefining the terms as follows:

If E = Expectations (idea, goal) of the researcher
and m = money (resources)
and c = creativity of the scientist

Then the Expectation of the scientist is directly proportional to the available money times his/her creativity^2. This graphically illustrates the dependence upon adequate resources because as m approaches 0, c is severely strained in aspiring to attain E.

There are additional variables to contend with, which, because they can be a cause for distress for the dedicated scientist who wants to be left alone to pursue the work, we shall relegate to the nethermost region of our equation, thus:

$$E = \frac{mc^2}{Po\ (p_1 + p_2 + p_3 + p_4 \ldots p_n)}$$

Where Po = Political aspects of the legislative authorization of research programs as well as the annual appropriations of funds
and p_1 = proposals, which must be submitted to meet deadlines
and p_2 = publication of the research results (publish or perish),
and p_3 = peer review for selection of the most meritorious proposals for funding,
and p_4 = procrastination—a congenital human defect that can victimize even a scientist.
(Please feel free to enhance the equation with your own favorite terms.)

Of all the above, the most critical and individualistic is "c" for creativity. Note that it is squared (c^2), which results in its awesome power, as in the constant in Einstein's original. This unique personal attribute is the factor that Caltech seeks to nurture in each SURFer—your creativity—and the enthusiasm and discipline required to achieve your (great) Expectations!

Biology

The Pattern of Gap Junctional Formation in Developing Embryonic Rat Hepatocytes

Sandip Biswal
Sponsor: J-P. Revel

To monitor the pattern of junctional formation in differentiating cells, a method of indirect immunofluorescence will be used. Monolayer primary cell cultures of embryonic (18 day) rat hepatocytes have been prepared, and antibodies that bind specifically to the 28kD rat liver gap junction molecule have been purified by means of affinity chromatography against electroeluted 28kD rat liver gap junction. We will introduce higher concentrations of epidermal growth factor, insulin, and hydrocortisone to stimulate cell division and proliferation so that we can make observations as to when gap junctions appear and disappear during the cell cycle. The results of this study can relate the importance of gap junctions during embryogenesis.

The Organization and Connections of Striate and Extrastriate Visual Cortex in the Rat

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

By correlating contralateral and ipsilateral patterns of cortico-cortical connections with each other and with the myeloarchitecture of the cortex, I investigated the organization and interconnections of striate and extrastriate visual areas in the rat. Tracer injections into callosal recipient regions of lateral area 17, primary visual cortex, revealed that callosal regions project to callosal recipient regions of several extrastriate visual areas, thus complementing previous studies that showed that noncallosal regions of area 17 connect with noncallosal regions of extrastriate cortex. These experiments also raise interesting issues about the topography of area Anteromedial (AM) as the data found here seem to extend previous physiological studies. Tracer injections in extrastriate cortical areas Anterolateral (AL) and Lateromedial (LM) demonstrated connections with the same ten areas with which area 17 connects including AL, LM, Laterointermediate (LI), Laterolateral (LL), Posterior (P), Posterolateral (PL), Anteromedial (AM), Anterior (A), Medial (M), and area 29. These extrastriate injections also suggest the existence of another visual area located immediately anterior to area 17 and related to the anterior ring of the callosal pattern. Both the striate and extrastriate projections more clearly demonstrate the lateral border of the more lateral extrastriate visual areas LL and LI.

Three-Dimensional Display of Neuron Activities

Xi-Yang Deng
Sponsor: J.M. Bower

Dr. James Bower and his research group are developing methods to detect the activities of a large number of neurons simultaneously by recording a large set of electrodes placed inside the brain.

My research project involves the development of a package of software that allows the reseachers to (1) create a three-dimensional display of the positrons of these electrodes inside the brain and (2) illustrate any detected activities of the sampled neurons in real time during the experiment. The program allows the researchers to view these data from any angle and perspective.

In addition to the display of neuron activites, the application of this package of software can be extended to other areas that involve the construction and display of three-dimensional objects.

Analysis of Neural Activity

Michael J. Freeman
Sponsor: J.M. Bower

My project consisted of developing software to analyze raw neural network data and graphically display the analysis results. The programs I completed include a three-dimensional cross-correlation analysis and real time post stimulus and auto correlation histogram analyses. The two real time analyses are fast enough to display the activity of as many as 32 neurons while the raw data from those neurons is being taken and saved to disk.

Characterization of the Leukocyte Common Antigen Gene and its Homologue

Ali Lashgari
Sponsor: H. Saito, Harvard

Leukocyte common antigens (LCAs) are believed to be involved in induction of suppressor activity. Diverse size classes of human LCA cDNAs have been found. We first constructed four plasmids that contained four different forms of the LCA cDNA; next, we cloned the appropriate portion of these plasmids into the pZip vector which will be used to transform eucaryotic cells to get expression of the various forms of the LCA proteins. This way one can produce cell lines expressing the LCA proteins. Additionally, a set of human genomic DNA, different from the LCA gene, but hybridizing to a mouse LCA cDNA fragment under relaxed conditions was characterized by subcloning, mapping, and southern hybridization. A .8Kb fragment that hybridized to the LCA cDNA was sequenced. We found that this fragment has good homology to the human LCA gene.

Bicoid Expression in *Dicephalic* Mutants

Quynh-Thu X. Le
Sponsor: H.D. Lipshitz

The mutation *dicephalic* affects follicle development and thereby alters the anterior-posterior polarity of embryonic patterns. In the aberrant egg follicles of *dicephalic (dic)* mutants, the oocyte is wedged between two clusters of nurse cells, and this condition presumably generates double-headed embryos. Previous studies have shown that a maternal gene *bicoid (bcd)* plays a major role in determining the anterior-posterior axis of the fly. In wild-type follicles, *bcd*'s activity is gradiently localized at the anterior end and somehow directs the formation of the head structures of the embryo. Combining these two facts together, this project studies the correlation between the *dicephalic* phenotype and and the expression of the *bcd* gene in the mutant oocyte by means of in situ hybridization. Parafin sections of *dic* follicles had been prepared, and the mRNA's in these sections were allowed to hybridize to *bcd* cRNA obtained from the previously cloned *bcd* gene. *Actin 5C* was used as the control since its temporal expression in the follicle coincides with that of *bicoid.* The results, when obtained, will not only confirm the important role of *bcd* in the anterior-posterior axis determination process, but also provide a workable mechanism employed by *bcd* in directing the formation of the head structures. Besides the in situ hybridization, the project contains a second part which involves mapping the *dic* locus onto a specific area on the third chromosome by deficiency mapping. So far, the deficiencies used do not seem to uncover the *dic* locus since no *dic* follicle producing female has been observed. Lohs-Schardin's lab had mapped the gene to 3 – 46.0 + 1 but further attempts to narrow down the size of the locus have not been successful due to the low penetrance of the phenotype.

Optimization In Vitro of a Viral-Specific RNA Polymerase Activity from Sindbis Virus Infected Cells

Randy Levinson
Sponsor: J.H. Strauss

We have optimized the conditions necessary to carry out the in vitro transcription of Sindbis virus (SV) RNA in extracts from infected baby hamster kidney (BHK) cells. Incorporation of labeled ribonucleotides was determined by DE81 filter-binding assays. Also, the presence of replicative intermediates (RIs), 49S genomic and 26S subgenomic RNA was verified using formaldehyde-agarose gels. We plan to use these optimized conditions to reconstitute in vitro a Sindbis-specific RNA replicase system.

The Formation of Gap Junctions

Ke-Ming Ma
Sponsor: J-P. Revel

We have tried to use fluorescent dyes to study the formation of gap junctions between Novikoff heptoma cells. 5(and 6)-carboxyfluorescein (CF), 5(and -6)-carboxy-2',7'-dichloro-fluorescein (CDCF), and Lucifer Yellow CH (LY) were the fluorescent dyes used. We loaded these dyes into cells and studied how fast they leaked out of cells. Unable to use a cell sorter, we quantified fluorescence with a microscope, a camera, and a scanning densitometer. CF and CDCF were determined to be unsuitable: cells loaded with CDCF did not fluoresce highly, and the fluorescence of CF loaded cells decreased rapidly after two hours. LY has been loaded by adding LY dissolved in dimethyl sulfoxide (DMSO) to a cell suspension and then freezing it. Cells loaded with LY fluoresce for over five hours.

In Vivo Functional Localization of the Human Visual Cortex Using Positron Emission Tomography and Magnetic Resonance Imaging

Bassem Mora
Sponsor: J.M. Allman

Positron Emission Tomography (PET) and Nuclear Magnetic Resonance Imaging (NMRI) are two recent methods used to image the human brain in vivo. PET scans measure the relative activities of brain areas being scanned, while NMRI images provide a detailed anatomical map of brain centers. Until now, there has been no method by which the two may be superimposed. In this study, such a method was developed and tested. Subtracted PET scans of a visually-stimulated brain were superimposed upon NMRI images of the same brain, resulting in a precise localization of the PET response locales upon anatomical features in human visual cortex.

Electrophysiology of Gap Junctions

Johnny Ng
Sponsor: J-P. Revel

An electrophysiological approach to the research of gap junctions between cells has the advantage that a more localized study can be made of the individual channels. We arranged a system that enabled us to selectively test for electrical coupling between cells and to examine more closely the physical characteristics of gap junctions by altering various parameters. More quantitative results can be obtained through this approach than through en masse methods of antibody recognition or dye transfer between cell colonies.

Characterization of a Purkinje Cell Antigen

Phyllis Pugh
Sponsor: J.M. Bower

Monoclonal antibodies against rat cerebellar antigens have been raised and histologically characterized by the Bower lab. In histological sections, one of the antibodies, 6d10c7, selectively stains a membrane-bound antigen on Purkinje cells. The purpose of my investigation is to isolate the protein antigen of 6d10c7 and characterize it biochemically using Western blotting techniques. A single protein band of approximately 110,000 Daltons appears to be the antigen, and further characterization is planned.

Characterization of the Muscle (M) Actin Gene in Strongytosentrotus Purpuratus

Jeffrey Tekanic
Sponsor: E.H. Davidson

The 4.3 kilobase segment of DNA upstream of the translational start site in the M actin gene has been subcloned (pMSp4.3) and finally mapped with restriction enzymes. Using DNA gel blot techniques on BgLII-cut sea urchin sperm DNA, it has been determined that the gene does not exhibit polymorphism between individuals. Also, 72-hour messenger RNA has been isolated and run on RNA gels to find the origin of transcription, but as yet the results are inconclusive.

Chemistry and Chemical Engineering

Mitochondrial Targeting In Vitro

Kyuson Yun
Sponsor: S. Emr

Most mitochondrial proteins are synthesized in the cytoplasm and transported into mitochondria. This project focused on understanding the mechanism for targeting and localizing the mitochondrial F1-ATPase B-subunit protein. In order to achieve this goal, an oligonucleotide directed mutagenesis technique was used to introduce point-mutations in the B-subunit leader sequence. These were sequenced using the M13 dideoxy DNA sequencing method to see which amino acid residues were vital for import. The targeting ability of these mutated leaders was checked by transforming the mutant constructs into yeast and plating them on a respiration dependent carbon source. Thus far, I have successfully identified several B-subunit mutants that exhibit defects in mitochondrial delivery of this protein.

Laser Induced Isotope Separation

Mihai D. Azimioara
Sponsor: J.L. Beauchamp

A novel method of laser isotope separation is being developed. Initial experiments are focused on separation of $^{15}NH_3$, which is present in commercially available ammonia to the extent of 0.367%, the rest (99.633%) consisting mainly of $^{14}NH_3$ (together with other species such as NH_2D, NHD_2, and ND_3). The mixture is injected into a 1.5m long evacuated glass tube of 1 cm in diameter by means of a modified Bosch fuel injector. The transfer coefficient of $^{15}NH_3$ is enhanced by irradiating the mixture with infrared laser light from a CO_2 laser at 926 or 961 cm^{-1} , where this component absorbs. The other main component, $^{14}NH_3$, is relatively transparent at these wavelengths. It is anticipated that the vibrationally excited $^{15}NH_3$ molecules have lower sticking probability on the glass wall than the $^{14}NH_3$ molecules. The gas molecules will be detected by means of a specially designed Schultz-Phelps ionization detector and a quadrupole mass spectrometer. Presently, we are attempting to identify the optimum pressure and temperature conditions for separation. Also, a carrier gas (He) will be considered. The project is still in progress, and results will be available at a later date.

T_2 Dependence of Whole Blood on Hematocrit and Hemoglobin Oxygenation State at 90 MHz

Rachael Clark
Sponsor: J.D. Roberts

The use of magnetic resonance imaging for the detection of acute intracranial hemorrhage is problematic, while detection of hemorrhages in the subacute phase by this technique is highly successful. Previous research (Gomori et al, 1985) indicates that T_2 weighted images of acute hematomas

at high field (1.5 Tesla) display a shortening of the proton T_2 relaxation time. Gomori has postulated that this effect is due to diffusion of water protons across a membrane field gradient created by compartmentalized paramagnetic deoxyhemoglobin. It is further suggested that this effect will not be observed at low field due to the quadratic dependence of T_2 on the magnetic field strength. This project investigates the dependence of the T_2 relaxation time on hematocrit (red blood cell concentration) and the oxygenation state of the compartmentalized hemoglobin. The hemoglobin oxygenation state of whole blood was detected using RAMAN spectroscopy, and T_2 measurements were made on a 90 MHz Jeol NMR spectrometer. Results will indicate the degree of dependence of this effect on hematocrit and blood oxygenation state.

A Tracer Study Conducted During the 1987 South Coast Air Quality Study

Neil Crawford, UC Berkeley
Sponsor: F.H. Shair

An atmospheric tracer study was conducted in order to (1) track the high ozone levels in the Los Angeles Basin and (2) provide a set of data to test the accuracy of numerical models. The tracer data indicate that the high ozone levels observed on the test day, 15 July 1987, in cities north of Los Angeles (Reseda, Newhall, Burbank) were a result of the emissions released in downtown Los Angeles, while high ozone levels in cities east of Los Angeles resulted from emissions released elsewhere. A thermally driven boundary layer model was used to interpret some of the tracer data.

Hydrogen Atom Abstraction by Binuclear Platinum

Lisa Giaimo
Sponsor: H.B. Gray

The main purpose of this research project was to study the photochemically activated abstraction of atomic hydrogen from a substrate by binuclear platinum. When irradiated by ultra-violet light of wavelength 372nm, $(Bu_4N)_4[Pt_2(P_2O_5H_2)_4]$ (abbreviated Pt_2) phosphoresces, with the wavelength of emission 517nm. This phosphorescence is quenched by hydrogen atom abstraction from 1-phenylethanol, Ph-$CH(CH_3)OH$; the eventual products of the reaction are Pt_2H_2 and the ketone Ph-$COCH_3$. It was experimentally verified that this reaction proceeds only in the presence of light and that the dihydride produced, Pt_2H_2, is stable for several days even in the presence of excess alcohol. The rate at which Pt_2 is quenched by 1-phenylethanol, K_q, was determined to be approximately 10^6 sec^{-1}. This rate was also shown to be temperature dependent, where 10^6 $sec^{-1} \leq K_q \leq 2.5 \times 10^6$ sec^{-1} for studies run between 0°c and 60°c. Developing an effective method of conducting temperature dependent quenching studies was a time-consuming, but necessary, learning experience. Careful control experiments demonstrated the effects of numerous experimental variables on the system and helped to explain apparent inconsistencies in previous data.

Process Control Using a Block Oriented System

Glen Ivey
Sponsor: M. Morari

Classical real time control has been accomplished by writing a control program that embodies the desired control algorithm, with limited flexibility in what devices it will connect to, and no flexibility in algorithm. Our project has involved the development of a specification for an extensive flexible block-oriented controller and the implementation of a working prototype. Our system is based on an extensible set of program blocks (implementing input, output, control, data storage, and graphics) that are logically connected by the system operator. This allows any innovation in control methodology to be packaged as a block and immediately incorporated into an existing control system.

Examination of the Effect of Lead on Oxidative Sress in Red Cells and on Hemoglobin

Lisa LePome
Sponsor: H.B. Gray

The buildup of iron and protoporphyrin-IX in lead-poisoned patients is similar to that in thalassemics. This suggests that hemoglobin is the agent which facilitates the reduction of ferric iron to ferrous iron which then can be inserted into the porphyrin ring. I researched lead's influence on the electron transfer reaction by which hemoglobin and ferric iron are converted to methemoglobin and ferrous iron. This reaction was studied both in isolated hemoglobin and in intact red cells using the formation of methemoglobin as an indicator.

Mechanism of oxidation of Alcohols by 2,2,6,6-Tetramethylpiperidine Oxide in Aqueous Media

Ming F. Lee
Sponsor: F.C. Anson

The electrocatalytic alcohol oxidation by 1-oxo-2,2,6,6-tetramethylpiperidium cation (TEMPO cation) in aqueous media at glassy carbon electrodes was investigated. A mechanism is proposed wherein the catalytic cycle is initiated by the reversible electrochemical oxidation of a neutral TEMPO radical to a cation that is the active oxidizing agent. A homogeneous reaction between the cation and alcohol substrate results in a selective, two-electron oxidation of the alcohol to a corresponding carbonyl compound with the concomitant reduction of the TEMPO cation to a hydroxylamine. A conproportionation reaction between hydroxylamine and electrode-generated cation yields two molecules of TEMPO, completing the catalytic cycle. Evidence for this mechanism and for pH-dependent alcohol oxidation and conproportionation rates was obtained using voltammetric techniques at stationary and rotating ring-disk electrodes, coulometry and conventional NMR and UV-VIS spectrometry.

The Synthesis of Asymmetric Pinacols

Peter Lindstrom
Sponsor: A.G. Myers

The pinacolic couplings of hexanal and pentanal to form vicinal diols were studied with different systems of reducing metals. Analysis of the reactions by gas chromatography and proton NMR showed the presence of the six expected products: the *syn* and *anti* diastereomers of 5,6-decanediol, 5,6-undecanediol, and 6,7-dodecanediol. The structures of the products were verified by the stereoselective synthesis of each.

Bs: An Intramolecular Metallation Proof Ligand

Wayne W. Lukens
Sponsor: J.E. Bercaw

Carbon hydrogen bond activation by electron deficient early transition metal centers promises to be useful in functionalizing methane and other abundant, aliphatic hydrocarbons. Determination of metal carbon bond strengths is important in determining the thermodynamics of carbon hydrogen bond activation, but in early transition permethylmetallocenes, intramolecular metallation, "tucking in," of the pentamethylcyclopentadienyl ligands interferes with the equilibria from which relative metal carbon bond strengths are measured. To simplify the determination of metal carbon bond strengths, a "tuck in" proof ligand, Bs, was synthesized. The Bs zirconocene neopentyl iodide complex decomposes over three thousand times slower than the permethylzirconocene neopentyl iodide complex. This ligand should greatly simplify the determination of metal carbon bond strengths in early transition metal systems.

A Conformational Study of Succinic Acid

Frederick Mallon
Sponsor: J.D. Roberts

The project attempted to measure the changes in the conformation of succinic acid with pH by determining the changes in the H-H NMR coupling of *dl*-2,3-d_2 succinic acid and *meso*-2,3-d_2 succinic acid in solutions of varying pH. Measuring the H-H coupling constants was difficult because of line broadening arising from a multitude of D-H couplings and deuterium quadripolar relaxation. These measurements, if successful, could resolve ambiguities in the report of Gil et al on the changes in the ^{13}C-H satellites of ordinary succinic acid with pH. The next phase of the research is to observe the H-H couplings with deuterium decoupling.

Enhancement of NMR Signals

Michael Pravica
Sponsor: D.P. Weitekamp

The PASADENA effect has been theoretically predicted for a system of bosons (D2). However, attempts to experimentally verify the effect have been ineffective so far. Recently, I have predicted a new form of the PASADENA effect which I will call the ADIABATIC PASADENA effect and have experimentally verified that it exists. Future experiments will better understand the effect quantitatively. At this stage, I have seen even more enhancement with the ADIABATIC PASADENA effect than with the normal PASADENA effect.

An Engineered Disulfide Bond in Crambin

Eric G. Scharin
Sponsor: F.H. Arnold

With the aid of molecular graphics modeling a new disulfide bond has been designed between residues 12 and 30 of crambin, a small, highly hydrophobic protein. The DNA for this mutant protein has been constructed by cassette mutagenesis on a synthetic gene. Work is currently being done on the expression of this protein in E. Coli.

Engineering and Applied Science

Numerical Simulation of a Low Reynolds Number Suspension of Hard Spheres Between Hard Oscillating Walls

Joseph Shiang
Sponsor: J.F. Brady

Low Reynolds number suspensions of particles can model a variety of phenomena, including sewage suspensions and fluidized bed reactors. Low Reynolds number suspensions are studied using a method developed by Durlofsky, Brady and Bossis. In this method, the forces on the surface of the spheres are modeled by using a multipole expansion, and the forces on the walls are modeled by discretizing the wall into constant force patches. The method provides results that are consistent with previous studies of one and two particle suspensions. This project used this method to study suspensions of 25 particles subjected to oscillating forces. The bulk properties, such as viscosity, were calculated and related to the configuration of particles in the suspension.

Enhancing Nitrogen-15 Signals in Nuclear Magnetic Resonance Using the Nuclear Overhauser Effect

Alex Wei
Sponsor: J.D. Roberts

The Nuclear Overhauser Effect (NOE) has been known to enhance the signal of nitrogen-15 to nearly four times its normal intensity. The NOE is a function of T_1 and T_2 relaxation times, which are in turn a factor of solvent viscosity, paramagnetic substances, and the particular nucleus in question. Labelled and unlabelled heterocyclic compounds have been studied under different solvent systems and with varying concentrations of paramagnetic molecules. So far, it has been positively determined that for labelled ^{15}N-benzylphthalimide, the T_1 is significantly reduced in the presence of trace oxygen gas, allowing a faster rate of data acquisition, while some NOE signal enhancement is still preserved.

Testing the New World of Computing System

Pennington Ahlstrand, Pitzer College
Sponsor: F.B. Thompson

The New World of Computing System is a commercial prototye natural language processing system. Development completed, New World has begun a refinement phase just prior to entering the commercial market. Two important parts of this refinement stage are of an evaluative nature: assessing the system from the new-user perspective, and comparing New World to other natural language processing systems. Testing the New World of Computing System is the result of these two evaluations.

Study of Flow Effects on a Special Hydrofoil

Raza Akbar
Sponsor: A.J. Acosta

Research work was carried out in the Low Turbulence Water Tunnel facility at Keck.The foil under study was an N.A.C.A 64-304. Experimental work mainly consisted of (1) flash and time-lapse photography, (2) surface flow visualisation using a technique involving oil based paint, and (3) determining cavitation inception indices. Each test was repeated for various angles of attack and for two values of dissolved air content. In the next stage, a rounded tip made out of body filler was attached to the foil, and the tests were repeated. The last stage involved the attachment of a "ring-wing."

Development of a Document Preparation System for ASK

Jerome Banks and Stanley Chen
Sponsor: F.B. Thompson

ASK is a natural language system used for building and accessing a "knowledge base." The purpose of this project was to add document preparation capabilities to ASK, taking advantage of its natural language interface. Sophisticated text formatting would be included. The TeX text formatter and a preview program have been partially integrated with ASK, and routines which aid in letter-writing by accessing the knowledge base have been written.

Software-Controlled Materials Testing System

Vivek Dave
Sponsor: B.T. Fultz

A servo-hydraulic materials testing system with software-controlled feedback was constructed. Mechanical assembly of the load frame was completed, the hydraulic hose layout was designed and assembled, a few small mechanical components were fabricated, and the connections between the computer and the load cell, displacement gauge, and servovalve were completed. This system integrates these mechanical, hydraulic, and electrical components to provide closed-loop, software-implemented feedback control. The user may choose from many possible loading patterns and set limits on stresses and displacements.

Vector Riccati Differential Equations

Charles Fu
Sponsor: P.A. Lagerstrom

Lie's theorem on systems of first-order ODE's with superposition formulas leads to interesting generalizations of the Riccati equation. Projective systems of Riccati equations, their transformations, and the significance of the cross ratio are examined using group theory and projective geometry, with the case of a system of two equations taken as an example. Conformal systems of Riccati equations and their group theoretical and geometrical properties are also discussed. The importance of understanding the connections between the Lie property and other types of integrability (the Painleve property, Liouville integrability, and completely integrable PDE's) is emphasized.

Freeway Observations and Computer Modeling of Traffic Jams

Peter Hughes and Bradley Solberg
Sponsor: G.B. Whitham

This report discusses how to model a real or projected freeway using such parameters as vehicle type, driver type, visibility, grade, number of lanes and initial distribution of the vehicles. The authors have developed a working computer model which is fully developed in the car following routines but has only a simple lane changing model due to the time constraints of this project. The model has been developed and tested for accuracy using our observations of the traffic flows on the Los Angeles freeways.

Optical Parallel Processing and Pattern Recognition

Maneesh Jain
Sponsor: D. Psaltis

A pattern ('CIT') was sequentially written onto a transmissive optical disk using an Argon laser. The image plane and the Fourier plane of the recorded pattern were examined. A Vander Lugt correlator was then constructed for pattern recognition. However, irregularities of the disk surface posed problems. Detailed examination of the disk surface using a Mach-Zehnder interferometer showed variations in the surface up to 8.5 um over a 2.8 cm diameter circular region. To reduce the irregularities, the disk was squeezed between two optically flat glass plates with index-matching liquid at the interface. This reduced the variation to 3.5 um. We concluded that if the inner surface of the disk was flat, immersing the disk in an index-matching liquid gate would enable correlation.

Dynamic Assembly and Behavioral Simulation of the Flagellar Axoneme

Jerome Lengyel
Sponsor: A.H. Barr

A new computer graphics modeling technique is applied to show structure and function of the flagellar axoneme. We start with basic proteins and use the new tools to assemble the forms of the axoneme. The resulting three-dimensional, animated sequences give the viewer an accurate, intuitive picture of the geometry of the axoneme. The new modeling tools allow us to specify a structure by its connectivity alone, so we are not forced to give fixed positions and orientations as in conventional modeling techniques. This allows for flexible and dynamic forms. We use these capabilities to show the action of dynein arms in bend formation along a section of the axoneme.

Characterization of Museum Dust Particles with Electron Microscopy

Harvey I-Heng Liu
Sponsor: G.R. Cass

Museum dust particles collected by nucleopore filters and mica deposition plates were analyzed with X-ray fluorescence and computer-driven scanning electron microscope. A software package and a chemical classification scheme were developed to enhance the capability of the current system. Attempts were also made to discriminate carbon soot particles from other organic particles and a simple method based on morphology was found. The procedures of sample preparation and electron microscopy and some results of the analyses will be discussed.

Investigation of Airflow Adjacent to Indoor Surfaces

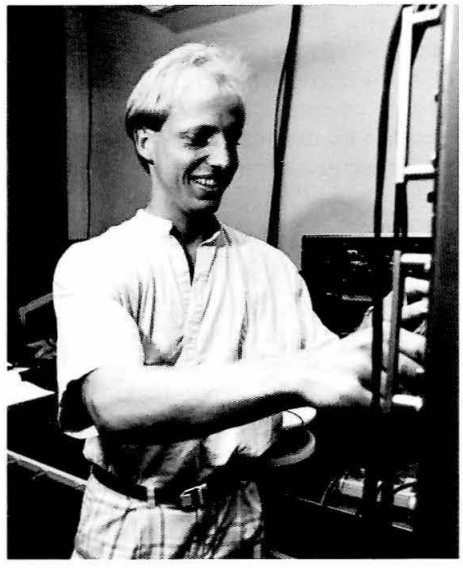
Tim Ma
Sponsor: G.R. Cass

Airflow adjacent to indoor surfaces may result from turbulent air movement in the core of the room and/or from temperature differences between the surfaces and the air. To obtain information on the relative importance of these two processes, boundary-layer temperatures and airflows were measured over 24-hour periods in eight different buildings. Data show some buildings are dominated by natural convection while others are dominated by turbulence. An understanding of indoor airflow near surfaces will benefit research on indoor air quality and energy use in buildings.

3-D Surface Geometry Measurement and Analysis

Saroj Manandhar
Sponsor: E.K. Antonsson

An automatic, high precision surface geometry measurement system using an opto-electronic technique based on lateral photo-effect diode detectors is being developed. The motivation is for acquisition of surface geometries of fabricated parts, machined surfaces, biological surfaces, and deformed parts. The SURF project concentrates on the development of the optical part of the system and designing the system setup. One initial application of this system is the study of surface deformations in the near crack-tip region of a fractured specimen; however the system will be useful in a variety of general 3-D surface geometry determinations including: engineering design, manufacturing, inspection, and robot kinematics measurement and vision.



Neural Nets and Optical Data Processing

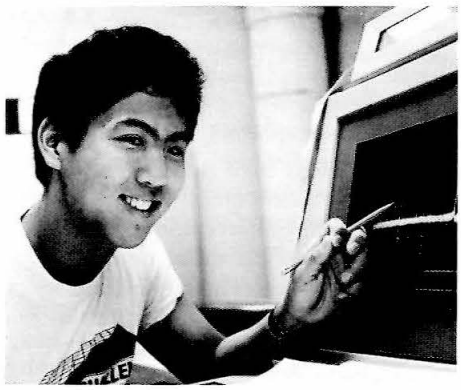
Charles Neugebauer
Sponsor: A. Yariv

The potential of large simulated neural nets is presently being explored. Most present models of the nervous system employ a large number of connections between neurons. The large communications need has hindered practical implementations of even the simplest networks. This paper describes a number of developments in the implementation of large neural nets using existing technologies. A number of processing architectures were also researched, including semi-parallel discrete time systems, fully parallel discrete time systems, and fully parallel continuous time systems. A network that learns requires that the connection strengths between neurons be variable. A large amount of information must be transmitted to a simulation chip in order to specify all the interconnections. The devices researched are meant to be optically loaded in parallel, allowing both parallel data transfer and parallel computation. A number of test chips have been built to test the designs.

Acoustical Analysis of a Two Phase Flow

Keith Owens
Sponsors: C.E. Brennen and A.J. Acosta

This project involved the design, construction and implementation of equipment to measure noise in a pipe flow of water laden with plastic particles. Amplified signals from a hydrophone were fed into a high-speed data-taking system to first identify the frequency and amplitude response of particle noise and to distinguish this from the underlying resonant vibration of the piping system and pump noise. An electronic counter was constructed to count peaks of noise of varying amplitudes representing particle collisions. This information was then linked to the overall void fraction and velocity of the flow in the vicinity of the hydrophones.



The Convergence of Neural Networks

Marios-Christos Papaefthymiou
Sponsor: Y.S. Abu-Mostafa

The number of transient steps required for the convergence of a neural network to a stable state is investigated. The length of the transient determines, in terms of time complexity, the capability of the network to solve problems efficiently. The analysis follows two directions: worst-case analysis and average-case analysis. It is shown that there are symmetric neural networks, operating in serial mode, which require an exponential number of steps to converge. A probabilistic approach is attempted for the average-case. However, it still remains an open problem.

Correlation of Cavitation in Hydraulic Equipment

Thai Pham
Sponsor: A.J. Acosta

This project involves the calibration of a new instrument called the Cavitation Susceptibility Meter (CSM). To perform the calibration, fluid is passed through a glass venturi which causes dissolved microbubbles to become susceptible to cavitation. Cavitation is the explosive growth of bubbles when the fluid is subjected to reduced pressures at constant ambient temperature. The CSM is used to measure the concentration of the cavitated bubbles. The concentration of bubbles derived from the CSM is compared against the concentration determined through a standard holographic method which involves taking a hologram of the sample fluid. The volume of the sample fluid is then reconstructed and magnified for the bubbles to be counted and the concentration computed. The CSM is then calibrated to give a corresponding bubble concentration reading to that of the holographic standard.

Geological and Planetary Sciences

The Study of Cu-Er Amorphization by X-Ray Diffraction and DSC

Edward Ratner
Sponsor: E.J. Cotts

In the 1960s, researchers found that they could form metallic glasses by rapidly cooling the molten metal. Recently, amorphization by solid state reaction in alloys has been discovered. Metallic glass formation in deformed Cu_xEr_{1-x} multilayer composites has been studied using Differential Scanning Calorimetry and X-ray Diffraction Analysis. Amorphous material was obtained by cold rolling the multilayer composites, and was studied with X-ray diffraction. It was found that a significant amount of the amorphous material forms as the individual layer thickness approaches 400 angstroms. A Free Energy diagram (40% Cu—70% Cu) has been constructed using the data from the DSC. Crystallization in amorphous Cu_xEr_{1-x} formed by solid state reactions in multilayer composites has also been studied. The Activation Energy of CuEr crystallization was found to be 1.2 ± 0.1 eV, while that of Cu_2Er was 2.0 ± 0.1 eV (the activation energy of solid state amorphization is expected to be around 1.1 eV).

The Cretaceous-Tertiary Extinction Bolide Impactor

Jason Beresford
Sponsor: T.J. Ahrens

The Cretaceous-Tretiary boundary marks the point of a major, worldwide extinction event, best known for the disappearance of the dinosaurs. Current evidence strongly suggests the earth was struck by a large, ~10 km diameter, extraterrestrial body at this time. I have been investigating what the ocean's response would be should the impactor strike there. This includes the size of tsunami expected from the impact, the effects of the tsunami on the seabed, and the expected wave run-up of the tsunami.

Numerical Advection by Conservation of Fourth-Order Moments

Yuk Lung Ha
Sponsor: Y.L. Yung

The advective process involves the transport of trace species in a medium moving at a given velocity field. Because the equation governing advection cannot be solved analytically, research workers ranging from atmospheric chemists to oceanographers have sought to model this process numerically. Pitfalls as well as benefits usually accompany each of the many schemes developed. My SURF project involves the extension of an especially accurate scheme developed by M.J. Prather which conserves the second-order moments of tracer distribution. The present scheme uses conservation of fourth-order moments and is expected to achieve greater numerical accuracy.

Humanities and Social Sciences

Automatic Feature Matching in Voyager Images of Jupiter

Michael D. Smith
Sponsor: A.P. Ingersoll

Until now, matching of cloud features to obtain wind velocities was done manually. This was both time consuming and prone to human biases. Using a standard correlation algorithm, an automated method for matching features in Voyager images was attempted. We have tried various iterative approaches using known long-time average wind velocities and known viewing angles. These enhancements have proved to be very useful and have yielded promising results.

Was the Earth a Snowball? Evidence for Late Precambrian Equatorial Glaciation

Dawn Sumner
Sponsor: J.L. Kirschvink

Although many paleomagnetic studies of late Precambrian glacial sediments suggest deposition in low latitudes, few tests have been performed to determine whether the magnetic directions in these formations are original. I have studied two of these deposits: (1) the Rapitan and (2) the Elatina. Deformation in the Rapitan was produced by a glacial drop stone which warped layers of sediments allowing a microfold test. This test conclusively showed that the high latitude component is secondary. The test has proven inconclusive for the low latitude components as of yet. In the Elatina, a single sample with small-scale folds was found. A similar fold test showed that the low latitude direction for this formation is original, and it formed in equatorial regions.

Constraints on the Surface Properties of Titan

Felicity Wong
Sponsor: D.J. Stevenson

Data of radar studies of Titan obtained using the Goldstone antenna in the past two years are conflicting. Last year's data indicated that Titan's surface was a much better reflector than previously supposed, with a radar albedo of 0.27, which would require a real dielectric constant of about 10 (or a high imaginary part). This year's data, however, showed no echo, indicating a radar albedo of less than 0.1 and a low dielectric constant.

If last year's data are correct then a possible model for Titan's surface is a planet composed of a number of landmasses coated in a lossy material such as polyacetylene, surrounded by a nonreflective ocean. If this year's data are correct then it is possible that Titan is covered in a global ocean, likely to be composed mainly of ethane.

Committee Policy Equilibria

Eric Babson
Sponsor: R.D. McKelvey

In a system with finitely many voters, each of whom has circular preferences over a two-dimensional euclidean bill space, where each voter places a single bill on the amendment style agenda, the outcome will be within six yolk radii of the center of the yolk. More generally, if the bill space is a finite dimensional euclidean manifold, over which the voters have compact convex indifference curves, but each is allowed to submit a finite sequence of proposals to the agenda then the outcome will be in the set of bills liked by each voter at least as well as some uncovered bill. Note that both of these sets are simply the core, if one exists.

The Dynamics of Interest Group Membership

Jeffrey J. Flint
Sponsor: L.S. Rothenberg

This project studies the factors that affect membership in a political interest group. Common Cause, a public interest group, was used as a case study. Data included individual-level data from the Common Cause survey of 1981 and aggregate-level data obtained from a variety of sources. Preliminary results show that membership is highly sensitive to income effects. Specifically, wealthier and more educated individuals are more likely to join the organization. In addition, contributors show a much greater interest in national rather than state-level activities of the group, despite the group's large monetary efforts towards the furthering of Common Cause goals at the state level.

The Politics behind Science Funding

Kin Ha and David Lipin
Sponsor: B.E. Cain

Traditionally, universities acquired most of their federal funds through the process known as peer review, in which university proposals are reviewed by professionals, or peers, on the basis of the merit of the projects. In the early 1980s, however, some universities and colleges began bypassing this process by directly lobbying Congress for funds, either to expedite the combersome peer-review process or to acquire funds which otherwise might not have been approved. Our project was to study this pork barrel route in science funding. We began by studying the pre-era of this pork barrel practice. In 1982 when the first case started, of the 592 academic research institutions in this country, 50 of them were receiving about 70 percent of the peer-review money, leaving the other 542 to fight for the rest. In 1986, pork barrel money accounted for about three percent of the total university funds, with only 15 percent of the pork going to the top 50 institutions mentioned above. If nothing changes, the pork barrel route will become a major mean of acquiring science funding.

The Italian Background to the *Cantos*

Ken Haynes
Sponsor: R.L. Bush

The *Cantos* is a didactic poem, not in the sense that a poem of quality may be thought to teach us something, but in the much more literal sense that the poem tries to force us to educate ourselves. One way of reading, then, is to go and LOOK. I have looked at the major Italian "objects" that Pound includes in the poem. I have also investigated principles of structure in *Cantos* and contributed something to the annotation.

The Voting Rights Act: How California Municipalities are Affected

Barry Lind
Sponsors: B.E. Cain and J.M. Kousser

The original Voting Rights Act (VRA), passed by the U.S. Congress in 1965, was intended to allow full participation in the political process by blacks and other minorities. The current VRA as amended in 1982 makes unconstitutional more subtle attempts at voting rights discrimination, such as vote dillusion in at-large elections. This study examines 165 California municipalities of greater than 25,000 persons to see whether, in the wake of recent litigation in Pomona, Watsonville, and Los Angeles, other cities may be vulnerable to such litigation. The potential for great gains exists for minorities, especially California Hispanics.

State Tax Amnesty Programs

Mike McDonald
Sponsor: L.L. Wilde

Recently, there has been a growing concern in the United States over a perceived growth in tax evasion. As a result, several states have held tax amnesty programs designed to reduce the amount of tax noncompliance. This paper discusses the issues concerning tax amnesties, summarizes the state's experiences with these programs, and models econometrically the decision for a state to run an amnesty program.

Physics, Mathematics and Astronomy

Geometry of Sporadic Groups

Laura Anderson
Sponsor: M. Aschbacher

We considered the result: If G is a simple finite group, $G \cong \langle M, C \rangle$, where $M \cong (S_3 \times Z_2)/(Z_4 \times Z_4)$, $C \cong S_3/Q_8^2$, $M \cap C = S \in Syl_2(G)$, and there exists z an involution in G with $C = C_G(z)$, then $G \cong M_{12}$. This result has been found using modular representations; our object was a simpler proof using combinatorial methods. We showed $|G| = |M_{12}|$ and are working towards the full result using representations of G and M_{12} on rank 3 geometries.

Liquid Phase Growth of the High T_c Superconductor, $Ba_2GdCu_3O_x$

Leila C. Astarai, UC Berkeley
Sponsors: D.L. Goodstein and R.M. Housley

Different techniques used in attempting to grow crystals of the high Tc superconductor, $Ba_2GdCu_3O_x$, are presented along with results. Methods in liquid phase epitaxy of thin films onto $SrTiO_3$ substrates are also explored. Recent successes are described, and paths for future research are suggested.

Optimization with a Distributed-Memory Parallel Processor

Fortunato Barajas, East L.A. City College
Sponsors: R. Williams and G.C. Fox

We considered the minimization of a global cost function by many independent processing elements. Each processor may independently make a potentially beneficial change, but taken together the changes may be detrimental. This phenomenon we called a parallel collision. We considered several algorithms for avoding these collisions, which are variants on the greedy algorithm and on simulated annealing. Our test-bed was a graph coloring problem derived from the design of a load-balancer for a parallel processor. We concluded that special parallel variants improve performance considerably in some cases.

Metallicity of Galactic Star Clusters in High Signal to Noise Spectroscopy

Kelly V. Beck, Vassar College
Sponsor: A.M. Boesgaard

Equivalent width measurement of Fe lines in the spectra of stars of six galactic clusters is the basis for metallicity determination. The metallicity values function in an age-metallicity relation to indicate the galactic age and evolutionary process. Selection of cluster stars for analysis is according to sharp and high resolution spectra. The widths of Fe lines in such spectra were measured and, by mathematical manipulation, expressed as the cluster metallicity, [Fe/H]. The final comparison of [Fe/H] for each cluster may be described by galactic mixing or infall.

Watching for Small Protons: A Test of Color Transparency

Munir Bhatti
Sponsor: B.W. Filippone

During electron-proton collision, the electron exites one of the proton's quarks. For the three constituent quarks to remain a proton, the excited quark must communicate with the other quarks. If the color transparency theory is correct, then as the incident electron's energy increases, the quarks must be closer together to communicate within the decreasing time limit of the interaction. This is tested by embedding the protons within heavy nuclei and looking for the percentage of protons that interact with the other nucleons. Computer simulation results were compiled with and without the color transparency theory and compared with existing data.

Comparison of HI Radio Emission with IRAS Infrared Emission in the Galactic Plane

Brian L. Biswell
Sponsor: N.Z. Scoville

I present the infrared and atomic hydrogen (HI) radio emission of the galactic plane from $l = 10°$ to $l = 250°$, and $|b| \leq 10°$. HI clouds are isolated and compared in a velocity-integrated form with distinct IR objects (both at the same resolution: blocks 30′ in l and 15′ in b). Contour maps of the velocity integrated HI emission are being created. These are being used to determine if a relationship exists between the infrared luminosity and the gas mass in the HI clouds, and the galactic infrared radiation density at the location of the clouds. Also, the dust temperature of the HI clouds is compared with that in molecular hydrogen clouds.

Cipheronic Computing Algorithm

Kay Yut Chen
Sponsor: P.K. Haff

A new numerical method of solving mathematical problems with the form $f(x) = 0$ (where f is an operator and x a vector) is investigated. Motion of one-dimensional classical particles, cipherons, is simulated inside a potential field in the form of $(f(x))^2$ with a certain frictional force. The equilibrium positions of the cipherons (at potential energy = 0) are the numerical solution of the problem. This method is tested with several problems like linear algebraic equations, the 1-D diffusion equation and 2-D hydrodynamic partial differential equations. The behavior and converging process of this method is studied.

Computer Simulations in Elementary Science Education

Diana Chu
Sponsor: J. Pine

The purpose of this project is to develop computer simulations of scientific experiments which can be used in the elementary school classroom to supplement current science education. The computer simulations act as an aid and an extension to the hands-on experiments done in the classroom.

Measurement of 5-Minute Solar Oscillation

Yong Song Chu
Sponsor: K.G. Libbrecht

The five-minute solar oscillation is due to the trapped standing acoustic waves. My SURF project is to measure the $l = 1$ mode of solar oscillation. Acoustic oscillation modes are labeled with three indices, n, l, and m, where n gives the number of nodes of the radial eigenfunction, and l and m are from the spherical harmonic $Y^l_m(\theta,\phi)$. The solar oscillations with low l's are important, for they provide the information near the core of the sun. To measure the $l = 1$ mode, the Doppler-shifted velocity signal on the solar surface were integrated on a single photodiode. A series of measurements were taken in the Helioseismology Lab at Caltech's Big Bear Solar Observatory. The velocity signal corresponding to the five-minute oscillation of the $l = 1$ mode was apporximately 1 m/s.

Analysis and Modeling of Electron-Nucleus Scattering Experiments from SLAC

William Foster
Sponsor: B.W. Filippone

By examining the cross section for scattering of electrons from nuclear matter it is possible to learn a great deal about the properties of the nucleons (protons and neutrons) in the matter. At the energies considered here, the principle components of the cross section are the quasi-elastic component (scattering from nucleons) and the deep inelastic component (scattering from the quarks in the nucleons). In this paper, we examine the deep inelastic component by smearing the structure functions of the free neutron and proton with a momentum distribution derived from quasi-elastic measurements.

Use of Computer Simulations in Teaching Elementary School Science

Claire Griffin, Pasadena City College
Sponsor: J. Pine

While many projects exist to improve elementary school science education, few if any make use of the classroom computer to further science study. It is the aim of the current project to provide useful computer simulations for the elementary school that is using one or several hands-on science projects. This simulation was designed to complement the seed-growing experiment used in the lower elementary school grades. It will allow the student to experiment with various environmental variables and measure the growth of corn plants as a function of both height and yield.

^{54}Mn: A New Clock for the Heavy Cosmic Rays?

Brian T. Hayes
Sponsors: T.L. Garrard and R.A. Mewaldt

Radioactive ^{54}Mn has been suggested as a clock for measuring the lifetime of heavy cosmic rays in the galaxy. In high energy cosmic rays, which are stripped of their orbital electrons, the standard decay mode of electron capture is not possible and only β-decay, with a poorly known halflife of 10^5 to 10^7 years can take place. Most Mn and almost all Sc, Ti, and V in cosmic rays come from the fragmentation of Fe nuclei in collisions with interstellar gas. The Mn clock problem was investigated using newly measured cross sections in a cosmic-ray propagation calculation and by comparing the results with cosmic-ray measurements covering the energy range from ~ 100 to 3×10^4 MeV/nucleon from satellite experiments including the HEAO-3. By modeling the ratio Mn/(Sc + Ti + V)as a function of energy, it was found that with Mn abundances in the cosmic-ray source material similar to solar system abundances only β-decay half-lives $\geq 10^7$ years are consistent with the data. If Mn is more abundant in the cosmic-ray source, then half-lives $\geq 10^6$ years are possible. This increased abundance could be detected with additional cosmic-ray measurements at higher energies.

Batteries and Bulbs

Nam Tong Hua, Pasadena City College
Sponsor: J. Pine

"Batteries and Bulbs" project is an interactive scientific simulation for elementary school children. With this simulation, they can design various electric circuits by connecting simulated batteries and bulbs in several ways, and use a simulated voltmeter to predict the voltages of these circuits, so they can strengthen and expand the learning achieved in their hands-on materials. This project will be an aid in understanding real science and an approach to applying science education in the elementary schools.

Continuity of Globular Cluster Formation in the Large Magellanic Cloud

Joseph Jensen
Sponsor: J.R. Mould

Preliminary observations of Large Magellanic Cloud (LMC) globular clusters suggest that globular clusters have been forming continuously since the LMC formed. In the LMC there are eight clusters which may have ages between four and ten billion years. To test the continuous formation hypothesis, direct age measurements of the eight clusters must be made photometrically. Five clusters were observed, and accurate ages were determined for three. All three clusters were found to have ages significantly less than four billion years, suggesting that a lull in cluster formation occurred between four and ten billion years ago. However, no final conclusions can be drawn until ages for the remaining clusters have been determined.

Optical Features of Solar X-Ray Bright Points

Nikhil R. Joshi
Sponsor: H. Zirin

Solar x-ray bright points have been shown to correspond strongly to very small active regions with mean diameters of approximately 15 arcseconds. These mini active regions are bipolar, isolated from other regions of activity, and do not have related sunspots. During formation they exhibit the arch filaments associated with larger active regions, developing quickly, and may exist as long as 24 hours before dissipating.

Universal Aspects of Large Hermitian Ensembles

Randall Kamien
Sponsor: M.B. Wise

The energy levels of complex nuclear systems obey the same statistics as the eigenvalues of a gaussian ensemble of Hermitian matrices. We have shown that "gaussian" is not a necessary aspect of the ensemble; that is, all ensembles will have the same short-distance behavior of its two-point function.

Better Helmholtz Coil

Yoo Chun Kim
Sponsor: R.D. McKeown

A Helmholtz coil is very useful in producing an uniform magnetic field. Different variations were investigated for better uniformity. A circular coil between the coils with a bigger separation was found to improve on the uniformity. Other designs were limited by our Helmholtz coil in the lab.

The Macintosh Hypercube

Allen Knutson
Sponsor: G.C. Fox

The purpose of the Macintosh Hypercube is to demonstrate the feasibility of a hypercube network for parallel processing on the readily available Macintosh. My segment was to write a Mandelbrot Set generator (an application ideally suited to parallel processing) using the Crystalline Operating System for communication and a COSH Set generator using Mercury for communication.

Energy Straggling Measurements Using Nuclear Resonant Reaction Analysis

Edward L. Koo
Sponsor: T.A. Tombrello

Energy straggling properties of fast protons in solids of varying thicknesses (e.g., silver and gold) are measured Using the nuclear resonance reaction $^{27}Al(p,\gamma)^{28}Si$. Assuming a Gaussian-integral curve for the experimental data, least-squares fits are performed to determine the straggling parameters. The thicknesses of the silver and gold layers range from 100 to 2000 nm, and their results are compared to theoretical predictions.

Applications Software for the Macintosh Hypercube

Sho Kuwamoto
Sponsor: G.C. Fox

Our group is involved with networking a number of Macintoshes in order to simulate a hypercube environment. My particular project is a program to solve the many body problem that will serve as a programming example. In order to illustrate how a hypercube program could merge with the Macintosh interface, a number of features have been added, such as multiple windows with different view angles and the use of the standard cut-and-paste analogy. Some of the problems that needed to be overcome included determining program structure taking into consideration the unusually long communication time in the AppleTalk network.

Distances to M5 and M92

Karen C. Lassey, Amherst College
Sponsor: J.G. Cohen

The objective for the following project is to detemine the distances to two particular globular clusters—M5 and M92. To obtain the distances, we combine a study of the photometry of some PR Lyrae variable stars in the clusters with a study of the spectroscopy.

Gravity Wave Detector Alignment System Automation

Brian E. Lemoff
Sponsor: R.W.P. Drever

The Caltech Gravity Wave Detector consists of two 40-meter Fabry-Perot optical cavities, oriented at 90 degrees to each other. Each optical cavity consists of two mirrors mounted on suspended test masses. The precise alignment of the test masses is critical to the correct operation of the detector. Three orientation servo systems have been developed to align the masses, each with different degrees of precision and different dynamic ranges. My project was to develop a computer automation system to monitor mass alignment, to switch between the three different servos, and to ensure smooth transitions.

Using Computer Simulations in Grade School Science Education

Michael Meckler
Sponsor: J. Pine

To create an effective tool for elementary science education, a new approach to computer software was developed. An interactive simulation stresses scientific method, not correct responses. Inherent advantages include student-paced sessions, remote teacher supervision, and a plethora of experimental resources extending beyond what would be possible in reality. Field testing will determine the viability of this approach.

Original Configuration and Evolution of Cosmic String

Lev Nayvelt and Jorden Woods
Sponsor: J.P. Preskill

A static, Z-3 cosmic string network was simulated on a computer-generated cubic lattice. The network was created by a combination of random assignments of strings to each cube and a Z-3 conservation law. Creation and analysis of different networks in the lattice seemed to indicate that the string number was dominated by one infinite loop. The network is currently being evolved by allowing the string-nodes to move and interact. Results from this dynamic simulation should yield information concerning the efficiency with which Z-3 strings lose their energy.

Acoustic Oscillations of the Sun and the Stars

Kwok Lun Ngan
Sponsor: K.G. Libbrecht

Acoustic oscillations are employed to study the solar interior. The aim of the project is to generate the eigenfrequencies and eigenfunctions of the oscillations based on the existing stellar structure code.

Investigating a Liquid Argon Calorimeter

Christopher Nolle
Sponsor: F.C. Porter

The ionization and electron collection processes in a liquid argon calorimeter chamber are explored. The relative roles of electron-parent ion recombination and columnar recombination in attenuating electron yields are examined for chambers with electric field strengths close to 10 kV/cm. The dependence of electron yield efficiency on the ionization loss rate and angle of incidence of the ionizing particle is thus examined. Implications for the

Lithium in the Pleiades and Alpha Persei Clusters

Mary E. Ramsay, Wellesley College
Sponsor: A.M. Boesgaard

Lithium abundances have been determined for 23 F stars in the Pleiades and Alpha Persei star clusters, clusters of age $\sim 5 \times 10^7$ years. Previous studies of clusters of age $\sim 5 \times 10^8$ years show a "lithium chasm," pronounced depletions in the lithium content of F stars of temperature 6300-6900 K by as much as two orders of magnitude. My present work indicates that no such lithium chasm exists in the two younger clusters: most of the stars studied show lithium content close to the initial abundance of $Li/H = 10^{-9}$. Thus, significant depletion of lithium from cluster F stars occurs between the ages of $\sim 5 \times 10^7$ and $\sim 5 \times 10^8$ years.

RADFET Project

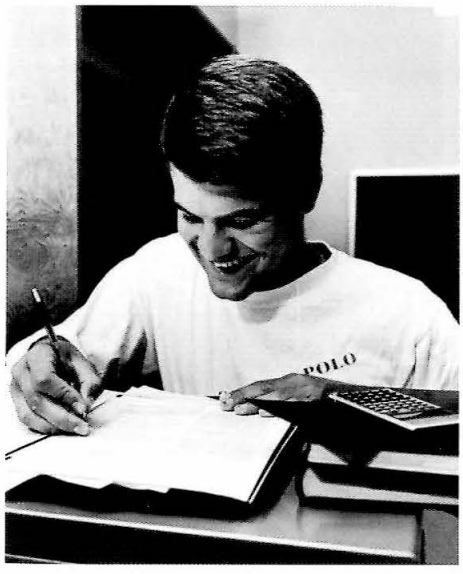
Doug Roberts
Sponsor: H.B. Newman

Radiation sensing field effect transistors (RADFETs) can act as dosimeters by storing trapped charge proportional to the recieved radiation dose. This trapped charge shows up as a shift in the gate voltage of the RADFET. A circuit was devised which would allow for the continuous tracking of the gate voltage. Using this circuit I was able to study the linearity of the response of the RADFET to radiation, and doses on the order of 1 rad were able to be measured. Also, by allowing the RADFET to be shorted after being irradiated, the trapped charge can be stored for up to a year, with a decay in gate voltage shift of only a few percent. This permits measuring a long period radiation history of an object.

Study on the Radiation Damage of BGO Crystals, and A New Design of Targets for L3 BGO Calibration Target

Fred G. Roeber
Sponsors: H.B. Newman and R.Y. Zhu

Part I: The light uniformity of tapered BGO crystals was measured by using a collimated Cs137 source shooting at different positions along the axis of the crystal. The effect of radiation damage on the light uniformity was also measured with gamma ray irradiation at the front face of BGO for doses of 1 rad to 20 rads. The results will be used as an input for corrections of BGO calibration when radiation damage occurs.
Part II: A new structure of the Boron and Lithium targets used in the calibration of the L3 EM Calorimeter was designed and constructed. With the Molybdenum as the only material seen by the proton beam, the background counting rate is minimized. A test of these targets at the Caltech Pelletron confirmed the lower background.



Development of Software for the Hypercube Simulator

Jonathan Schiff, UC Santa Cruz
Sponsor: G.C. Fox

The hypercube is a type of computer hardware that performs concurrent processing, a system of microprocessors working simultaneously on small parts of a large problem. The hypercube is so named because its component processors are connected with the topology of a n-dimensional cube. The hypercube is advantageous because concurrent processing enables complicated calculations to be done at high speeds, a convenience that was once only available on much more expensive supercomputers. My SURF project this summer was to help develop software for the hypercube; I did not work directly with the hypercube but, rather, with a software package that simulated it. I verified the results of hypercube programs written in C and then translated them into FORTRAN. These programs are the contents of a "test" library, designed to demonstrate the ability of the hypercube to handle a wide variety of algorithms and the relative ease to implement them.

The Construction of an Ionization Chamber for Observing Double Beta Decay

William C. Smith
Sponsor: J.H. Thomas

A high pressure ionization chamber was constructed in order to observe double beta decay in ^{136}Xe. It was tested with a ^{113}Sn source; the chamber was filled with both pure argon and a mixture of 90% argon and 10% methane. Energy resolutions of 13% were obtained with the argon-methane mixture at 40 atm. pressure, and an electric field in the drift region of .9 kV/cm.

Modeling of the IR Emission from Cold Dust Clouds

Eugene Thomas
Sponsor: L.G. Mundy

This project consists of two parts. In the first part, the 60 micron and 100 micron images of several cold molecular clouds obtained by Infrared Astronomical Satellite (IRAS) were processed to remove background emission, due to zodiacal light and extended galactic emission, and instrumental artifacts, mainly stripes. The results were clear pictures of the clouds at these wavelengths. In the second part, the infrared emission from an idealized dark cloud was modeled by computer. We assumed that the cloud was heated only by the general interstellar radiation field. The radiative transfer of the interstellar light into the cloud, the heating and thermal equilibrium of the dust grains, and resulting far-infrared emission spectrum of the dust were calculated numerically. Since the emission spectrum is strongly dependent on the dust content and size distribution in the models, we can attempt to derive some of the physical properties of interstellar dust by matching the models to the emission characteristics of the observed clouds.

Beta Spectrometry Performance of a Voyager Detector for Magnetospheric Electrons

Minh Q. Tran
Sponsor: J.F. Cooper

A laboratory calibration of a 3-mm detector identical to that used in the Voyager spacecraft was carried out. A Ruthenium-106 source placed inside a magnetic spectrometer provided electrons up to 3 MeV. The detector efficiency over the range 0.5 – 3 MeV was obtained at normal beam incidence. For energies < 1.8 MeV the efficiency shows a decreasing trend as the incidence angle is increased. However, for energies > 2.5 MeV, the efficiency seems to increase with increased incidence angle. The Landau most probable peak was observed at 1.1 MeV as the detector became less and less efficient with the increasing beam energy. At higher incidence angles, the Landau peak shifts up as the detector's effective thickness increased. The efficiency of a 450-micron detector in the energy range 130 – 1100 KeV was also obtained at normal beam incidence. For this detector, the Landau peak showed an almost monotonic decrease in energy as the beam energy was increased.

Measurement of MeV Ion Implantation Damage in InP and Si Single Crystals by Rutherford Backscattering (RBS) Channeling

Charles S. Tsai
Sponsor: T.A. Tombrello

High energy ion implantation defects in InP and Si crystals have been measured by using channeling RBS with He ion beams. The data from CRBS confirmed the qualitative results obtained by applying Transmission Electron Microscopy (TEM) to some samples with implantation defects. The amorphous region grows closer to the sample surface as the total implantation dosage is increased. The maximum usable depth limit of this measurement technique is about four to five micrometers from the sample surface for 3.8 MeV He ion beam.

Two Paths to Forcing

Keith Vanderveen
Sponsor: A.S. Kechris

Two approaches to the development of forcing are compared. One approach, which hammers out its arguments with painstaking and tedious logic, is contrasted with a newer approach, which uses the topological notion of category to motivate the development of forcing in a more natural way. Important theorems in forcing, such as the Definability and Truth Lemmas, the proposition $M[G] \models ZF$, and a few results of forcing such as $Con(ZF + V \neq L)$ are discussed in connection with both approaches, with more emphasis being given to the topological approach.

Design and Construction of a Nitrogen Laser for a Xenon Time Projection Chamber

Robert S. Williamson
Sponsor: M.Z. Iqbal

A nitrogen laser and associated circuitry were designed and constructed for use with a xenon time projection chamber, essentially an "electronic cloud chamber" which is used to detect $\beta\beta$ decay in ^{136}Xe. The nitrogen laser ionizes a track in the chamber which can be imaged via a computer and a 336 channel charge collection system; the straightness of this track reflects the anode grid and field uniformity. When combined with a signal from the laser circuitry, the electron drift velocity can be determined. This drift velocity is a function of field strength, pressure, and gas purity, making it a convenient monitor of the chamber's operating conditions.

JPL

Growth of Crystals in a Centrifuge

J.D. Bondy, Texas A&M
Sponsor: P.J. Shlichta

We investigated the effect of gravity on two types of crystals: mercuric iodide and the protein canavalin. With mercuric iodide, the purpose of high gravity is to grow a pure mercuric iodide crystal, since it is so much heavier than its impurities. With canavalin, we plan to plot the size of protein crystals versus the gravity field so that the effect of zero-gravity on crystal growth can be predicted.

Cosmic Ray-Related Single Event Upset Errors of Spaceborne Integrated Circuits

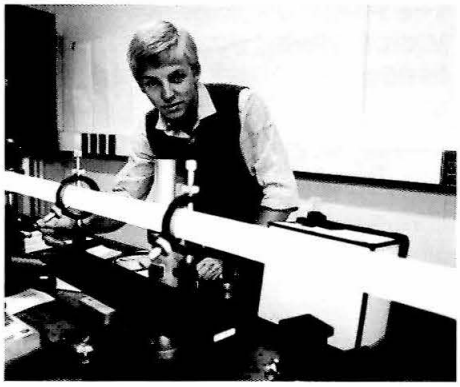
Christopher M. Chu
Sponsor: R.W. Kuberry

Protons or heavy ionizing particles often cause single event upset errors in spaceborne integrated circuits. Immunity from these single event upset errors is an essential requirement for the reliability of the circuits. In order to prevent a CMOS static RAM cell from experiencing a single event upset at the drains of the off p- and n-channel device, polycrystalline silicon resistors are placed in the feedback paths to reduce the maximum change in gate voltage during the single event. The research begins with a closer investigation of this single event resistive-hardening model. It is known that this model depends on increased resistivity to modify the threshold charge for RAM cell logic transition. An attempt will be made to test the validity of such a model, as well as to test the effects of different simulated models of galactic cosmic rays.

The Preparation of Polymeric Microspheres by Ultraviolet Irradiation

Amy Goodlow, Jackson State
Sponsor: W.K. Rhim

Magnetic monodisperse polymeric microspheres have been used to remove cancerous cells from blood. Similar microspheres can be used as filter beds for chromatography and other cell separation methods. The present studies investigate the conditions which may produce large monodisperse polymeric microspheres. In order to produce large, 0.1 mm to 0.4 mm polymeric microspheres, studies of percent conversion were done on glyceryl monomethacrylate (GMA), which forms a very biocompatible polymer. Twenty 1-ml samples of GMA were prepared with different concentations of Irgacure 184, a photoinitiator, and irradiated. These samples were irradiated with a six-inch medium pressure mercury vapor lamp with an input power of 200 watts per arcinch at a 200 mm distance for intervals ranging from 0.5 to 2.5 minutes. The GMA samples without Irgacure 184 had percent conversions ranging from approximately 1% to 53%. All GMA samples containing 1% or more of Irgacure 184 had nearly 100% conversion. These results suggest that 1% of Irgacure 184 can photoinitiate GMA for complete polymerization.



Modeling of Internal Electrostatic Discharge Phenomenon

Jung S. Gwon
Sponsor: P.L. Leung

Internal Electrostatic Discharge (IESD) is one of the phenomena by which spacecraft components can be charged. The resulting discharge could create anomalies in spacecraft operation. Tests were made to determine probable electromagnetic interference (EMI) characteristics generated by IESD. These tests consisted of exposing circuit traces to an electron beam with the entire system placed inside a vacuum chamber so as to approximately simulate space conditions. Using the results of the tests, a lump electrical circuit model was developed which represents the impedance of a discharge condition.

Noncoherent Image Processing Using Rotational Shearing Interferometry

Chris Habecker
Sponsor: J.B. Breckinridge

Through the use of an amplitude splitting rotational shearing interferometer, the two-dimensional Fourier transform of a noncoherent object (A) has been obtained. The Fourier transform (A) has been retransformed through a second interferometer to produce overlapping object pairs which interfere to produce coherent fringes. The process of matched filtering in the Fourier plane was applied, but the expected autocorrelation in the image plane did not appear. Using an image intensifier, the Fourier transform (A') is now being used as a noncoherent object from which we hope to reproduce the original object (A). When this is accompished, matched filtering will be applied again.

High Temperature Superconducting Neural Network Project

Gregory Harry and Heath Maxfield
Sponsor: J. Stephens

This project is an investigation into the possibility of building a back-propagation neural networking computer manufactured out of high T_c $YBa_2Cu_3O_{7-x}$ superconducting crystals. Hardware implementation of necessary electronic components was examined and devices possible to create it include a memory cell, a Josephson junction, and a neuron. Possible methods of building these devices by manipulation of superconducting crystals were examined. The preferred embodiment used containerless processing techniques to manufacture the crystals, low power lasers to move the crystals to the necessary positions, electrostatic methods to hold the crystals in place, and a high power laser to permanently place the crystals by creating a diffusion bond. All these ideas were placed in a patent application.

Optical Properties of Ammonia Ice Particles

Earl Hubbell
Sponsor: R.A. West

A series of numerical calculations of the infrared optical properties of ammonia tetrahedra and spheres with and without foreign inclusions were run to assess the role of shape and composition in the formation of resonance extinction peaks near 9.4 and 26 micron wavelengths. The calculations were based on the discrete dipole approximation due to Purcell and Pennypacker. Particle shape did not significantly affect the shape of the 9.4 micron resonance for homogeneous particles, but did affect the 26 micron feature, which becomes less sharply peaked, and shifts to longer wavelengths. Heterogeneous spheres and tetrahedra were compared on an equal volume basis, and the 9.4 micron resonance was suppressed in proportion to the volume of the inclusion. The shape of the feature depends on the particle orientation and the polarization of the incident light for tetrahedra, but the strength of the feature decreases more rapidly for spheres than tetrahedra.

Propulsion Applications of High Critical Temperature Superconductors

Robert L. Jarecki
Sponsor: D. Jan

Successful harnessing of the unusual temperature and magnetic field tolerance of recently discovered superconducting materials in practical lossless technology was presumed. An effort was made to broadly consider resulting implications to advanced propulsion. Three specific concepts (MHD Reentry, Direct Electromagnetic Propulsion, and the Pulsed Inductive Accelerator) chosen for high field requirements and potential enabling enhancements, were examined in detail to the limit of available literature. MHD Reentry was found to be the most intriguing, followed by Pulsed Inductive Accelerators, with Direct Electromagnetic just borderline in feasibility. MHDR and DEM were potentially enabled, while PIA offered more modest systemic gains.

Optical Properties of CdTe Crystals for Stratospheric Wind Measurement

James M. Layland
Sponsor: D.M. Rider

Stratospheric winds can be measured using gas correlation spectroscopy to measure the Doppler shift of radiation emitted by gases in the atmosphere. This project examined cadmium telluride crystals which will be used as electro-optic phase modulators to measure these Doppler shifts. A ray-tracing model was used to predict transmission of infrared light through the crystals at varying input angles and to show how simple images propagate through the crystal. The transmission at varying angles was also experimentally measured and correlated to a large extent with the calculated values.

Investigation of Superconductor Applications for NASA

Huan Lin
Sponsor: D.M. Strayer

Through a combination of review of appropriate literature and communications with researchers at the Jet Propulsion Laboratory, a survey of possible applications of superconductors for NASA was conducted. Possible applications in the areas of electronic sensors, propulsion, power, computing, signal processing and communications, and others were identified and investigated, with emphasis on researching the advantages and benefits offered by superconducting technology. Moreover, the impacts and possible new uses of the recently discovered class of high temperature superconductors were also examined. Finally, particular NASA spacecraft missions and ground-based applications that would benefit from the use of superconducting technology were identified.

Analysis of Radar Echo Spectra for Asteroid 3199 Nefertiti

Robert E. Lister
Sponsor: S.J. Ostro

Analysis of radar echoes obtained for asteroid 3199 Nefertiti on September 6, 1986, at the Arecibo Observatory in Puerto Rico reveals that Nefertiti is very rough at a 13 cm scale and has a nearly circular polar silhouette with a diameter of at least 3.2 km. Since optical methods give an estimate of 3.2 km for Nefertiti's diameter (Tholen 1984), the view during the radar observations was probably close to equatorial. There is also marginal evidence that Nefertiti's circular polarization ratio (a measure of 13 cm scale roughness) varies by as much as 20% from its average value of 0.5 as Nefertiti rotates.

Temperature, Chemical and Cloud Properties of Jovian Atmosphere From Ground-based Infrared Scans

Michael E. Malcom
Sponsor: G.S. Orton

The NASA Infrared Telescope Facility (IRTF) at Mauna Kea, Hawaii made several scans of the planet Jupiter during 1981 and 1982 at wavelengths 7.8, 8.7, 10.3, 12.5, 17.8, and 19.6 microns. After rectifying and calibrating the IRTF data to conform to disk-averaged 1979 Voyager 1 mapping, it is possible to construct a temperature structure for the planet as a function of optical depth, based on a model taken from Voyager radio occultation experiments. The model should be adjusted downwards 2 degrees Kelvin (2 K) at 500 millibars, upwards 3 K at 400 millibars, and upwards 2 K at 250 millibars. Images constructed from the IRTF scans show seasonal warming.

The Effect of Physical Aging on the Glass Transition Behavior in Polymer Blends

Christina Mannino, UC Irvine
Sponsor: P. Cebe

Four blends of Poly vinylidine fluoride (PVF2) and Poly methyl methacrylate (PMMA) were aged by allowing them to sit at a temperature below their glass transitions for a predetermined period of time. The samples were aged at three different temperatures and analyzed by differential scanning calorimetry (DSC) at 0, 1.67, 5.0, 16.7, 50.0, 100.0, and 450.0 hours. The results of the DSC showed an increase in enthalpy as the aging time increased and also as the aging temperature approached the glass transition of the polymer blends.

Fiber Optic Network Performance Characterization and Modeling

Stefan Marelid
Sponsor: L.A. Bergman

A high-speed fiber optic local area network (LAN), used for data and voice communications, is analysed both analytically and experimentally. The performance characteristics of the utilized 80Mbit/s token ring are compared to other standard network models. A novel in situ method of characterizing fiber optic links embedded in local area networks via LAN performance measures is described. Optical power budget, receiver sensitivity, and burst noise are estimated from packet bit error rate data.

Determination of Asteroid Spin Vectors from Light Curves and Radar Observations

Sean McNamara
Sponsors: A.W. Harris and S.J. Ostro

A method for finding the pole positions of asteroids from visual lightcurves based on Henry Russell Norris' theoretical paper (Astrophysical Journal 1906) has been developed. This method assumes that the asteroid is convex (but not necessarily ellipsoidal) and that the lightcurves are measured at zero solar phase angle. Tests of this method with synthetic data indicate that it is sensitive to the line of equinoxes of the asteroid, but less sensitive to inclination of the rotation axis.

Crystallization of Various Proteins

Sonja Y. McNeil, Jackson State
Sponsor: W.K. Rhim

The proteins—lysozyme, protease, pepsin, and canavalin—were crystallized using various techniques. Different pH buffers were selected for each protein near its isoelectric point. Most buffers were acidic but a few were close to neutral and one was basic. Different techniques such as bulk solution and vapor diffusion were used to obtain supersaturation of the protein solutions. Factors such as the protein concentration, salt concentration, and the rate of vapor diffusion were varied to obtain various size crystals from the proteins. A solution of 3% lysozyme w/v and 5% sodium chloride w/v at pH = 4.6 produced crystals as large as 0.7 mm using the bulk solution technique. Protease, pepsin, and canavalin crystals were grown using the vapor difusion technique. A 1% protease w/v solution at pH = 4.1 grew crystals the size of 60 microns. A 0.15% pepsin solution at pH = 3.8 yielded crystals that were about 70 microns, while a 1.5% canavalin w/v solution at pH = 7.2 grew crystals as large as 1.5 mm. Results of this experiment were compared with results from previous experiments.

Measurement of Lifetimes by the Electron Impact Method

Hung Nguyen
Sponsor: S.K. Srivastava

Lifetimes of excited levels of, nitrogen, oxygen, and carbon have been measured by a number of investigators. Most of these measurements have been made by the beam-foil or the electron-impact methods. The latter is used in this investigation. The fluorescence spectra and excitation functions of these gases are obtained by injecting electrons of about 160eV to a stream of gas at 10^{-7} Torr. From these excita-

Application of Neural Networks to Real-Time Spectral Pattern Analysis and Interpretation

J. Andrew O'Dea
Sponsor: J.E. Solomon

The learning speed of a simulated three layer neural network using the backward error propagation learning algorithm is studied as certain parameters of the simulation are changed. The effects of changing learning rate, number of hidden nodes, and correlation of the patterns to be learned are analyzed. The special case of a set of highly correlated spectral patterns is examined.

The Feasibility of Vapor Transport Growth of $YBa_2Cu_3O_{7-x}$ Crystals

Tab A. Stephens, Texas A&M
Sponsor: P.J. Shlichta

To determine whether (123) crystals could grow in a microgravity environment, an attempt at crystal growth was made by vapor transport. Preparation of the starting material was made by both mixing the oxides and by coprecipitation. Two systems were used for the growth. A closed tube assembly was devised for its simplicity, while a flowing gas system was created for its flexibility. The results at the end of the project were examined.

The JPL Planetary Surface Laboratory

David Taub
Sponsor: W.D. Smythe

It is well known that the surfaces of planets and planetary satellites exhibit an unusual increase in brightness as they become fully illuminated to the observer. This is referred to as the opposition effect, and is generally explained by the disappearance of mutual shadowing among the regolith particles. Models suggest that porosity and albedo are the primary factors in determining the effect's amplitude and angular dependence. A more porous surface will have a higher opposition effect because there will be more shadows to disappear. Similarly, a surface with a higher albedo will have a smaller effect due to multiple scattering of photons, which partially illuminates the shadows that are there. If we can fit our data to our models and remote sensing observations, we will be able to gain a good understanding of the surface texture of planets and satellites. To achieve small phase angle measurements, we originally had a collimated laser being split by a pellicle beam splitter, hitting the sample and then reflecting up to the detector. This worked out fine at angles above four degrees, but below this point the beam splitter caused problems with scattered light. We decided that the best way to get good small angle data would be to subtend a very small angle by placing the detector and laser far away from the sample. By attaching the detector 7mm from the laser beam and having them both 9 feet above the sample, we were able to subtend an angle as low as a tenth of a degree.

Equatorial Upwelling

Jeff Tseng
Sponsor: D. Halpern

Estimates of vertical motion in the uppermost 200m of the eastern equatorial Pacific were computed from triangular arrays of moored horizontal current measurements. Data was recorded for different durations during 1983 – 85 along the equator at 140° W, 134° W, 124.5° W, and 110° W, and near 140° W at 1.5° N and 1.5° S. Only those triangles for which data continuously exists for two months or longer were used. Vertical motion at a specific depth was computed using the continuity equation (i.e., $\partial u/\partial x + \partial v/\partial y + \partial w/\partial z = 0$) with the surface boundary condition of zero vertical motion, and trapezoidal estimates of vertical integrals of horizontal currents. The mean vertical velocity was upward at 2×10^{-5} m/s, with a maximum usually at a depth of about 80m, near the core depth of the Equatorial Undercurrent. Except at the sea surface, no zero vertical motion was found at depths greater than 160m, the greatest depth of the calculations. Monthly mean values of vertical motion were highly variable, presumably because of the prominent 20-day meridional current oscillations, which peak at the equator and therefore contribute significantly to the $\partial v/\partial y$ term in the continuity equation.

CANSAT SURFs

A Radio Scintillation Study of Coronal Transients in the Solar Wind

Sophia Wang, MIT
Sponsor: R.T. Woo

Events taking place at or near the sun often trigger interplanetary disturbances that propagate outwards from the sun. Upon arrival at earth, some of these disturbances cause geomagnetic storms which in turn adversely affect communications technology and manned spaceflight. To track and investigate the evolution of these interplanetary disturbances, correlations of near-sun radio scintillation data from the Pioneer and Voyager missions have been made with interplanetary type II radio emission, long duration X-ray, Solwind white-light coronagraph, and Helios plasma measurements. Although the most obvious correlations between the varying data types have been found, further study is required to identify the less obvious correlations.

Satellite Operations

Suman Chakrabarti
Sponsor: J. G. Smith

The KLUDGE—K/X-band Low-power Undergraduate Designed Goldstone Experiment—project was a design study whose purpose was to design an Earth-orbital satellite (CANSAT) for the following two experiments. First, it will simulate the transmissions of deep-space probes such as Voyagers 1 and 2 in order to compare the efficacy of broadcasting at the current deep-space frequency (8.45 GHz or X-band) versus using a proposed frequency (33.8 GHz or Ka-band), which should theoretically yield a higher gain. An upgraded tracking antenna capable of receiving both these frequencies is now under construction at the Goldstone facility in southern California. Second, it will enable scientists to measure the noise variation at the higher frequency. The subject of satellite operations encompasses the problems of launching the satellite, inserting it in its desired orbit, and predicting the behavior of said orbit.

Stabilization

Tim Hochberg
Sponsor: J.G. Smith

I describe several passive stabilization schemes for satellites in a 10,000 kilometer altitude (circular) orbit. I consider the effectiveness of spin, gravity gradient, and magnetic stabilization, when combined with an appropriate antenna system, in minimizing the wobble of power and frequency associated with transmissions from a tumbling satellite and assuring constant coverage of the receiving station while the satellite is overhead. Magnetic hysteris damping is also considered as a passive method of removing initial spin and/or dampening out oscillations of the stabilized satellite.

Structural and Thermal Design

Sean Wakayama
Sponsors: J.G. Smith

When a passive thermal control system is used for controlling satellite payload temperatures, the satellite's structure becomes an integral part of that system. In such cases, thermal considerations, along with the normal functional requirements for the structure, drive the structural design. In this study, several structural designs were made which incorporated various passive control methods. These designs were then analyzed for the degree of thermal control they provided. The results show that reasonable thermal control is attainable, but some tradeoffs must be made between thermal control, structural simplicity, and weight.

X/Ka-Band Antenna Design

Amish Shah
Sponsor: J.G. Smith

Our satellite is going to operate at an altitude of about 10,000 Km. It is hard to find a stabilization scheme that would completely damp out the oscillatory motions of the satellite at such a high altitude. Thus, we need an antenna which is isotropic in order to ensure the continuous coverage of the ground station at Goldstone. Also, the radiated signal is required to be circularly polarized. The microstrip patch antenna satisfies all these requirements. The particular microstrip antenna that we would be using for our satellite is called the crossed-slot microstrip array.

X-/Ka-Band Transmitter System Design

Khurram Khan Afridi
Sponsor: J.G. Smith

Until now all deep space communication has been done at frequencies below 9 GHz (X-band), mainly because atmospheric radio noise rapidly increases at higher frequencies. However there does exist an atmospheric window around 30 GHz (Ka-band) where earth-space communication is practical. To demonstrate the feasibility of telemetry and navigation at Ka-band, our satellite will transmit microwatts of signal power at both X- and Ka-band. In this report different 8.45/33.8 GHz transmitter designs are discussed and their components described. Both digital and analog phase modulation techniques are considered, and the transmitted signal is analysed. Downlink Signal to Noise Ratio (SNR) is modeled, and signal power requirements are calculated.

Receiver System

Richard Reid
Sponsor: J.G. Smith

At this time deep space communications are performed primarily at X-band frequencies. Communication at higher frequencies (e.g. Ka-band) is desirable, however, despite increased atmospheric attenuation, because of the greater efficiency due to a narrower beam width. A window in this attenuation exists around 32 GHz, and the purpose of this satellite is to transmit identical signals at 8 and 32 GHz. The signal levels on the ground can then be compared and the feasibility of Ka-band for deep space communication evaluated. The transmitter will produce 8 and 32 GHz carriers that are phase modulated with three sinusoidal signals. The primary purpose of the receiver is to enable ground stations to turn off the transmitter should it cause undesirable interference. It will also provide the ability to toggle the transmitter between a high power mode (for ease of acquisition) and a low power, 1 uW, mode (for deep space mission simulation).

SURF Publications

1. "Crustal Structure Near the Eastern Transverse Ranges," *Am. Geophys. Union Trans. Eos,* 60 p. 876 (Abstract), N.W. Clayton*, J.B. Minster**.
2. "Coulomb Distortion of Pion Spectra from Heavy-Ion Collisions," *Phys. Rev. Letters,* Vol. 43, p. 1581 (1979), K.G. Libbrecht*, S.E. Koonin**.
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**.
5. "Structure and Transcription of Normal and Abnormal Globin Genes," *J. Supermolecular Structure of Cellular Biochem.,* supp. 5, 381 (1981), N. Proudfoot, M. Shander, S. VandeWoude*, T. Maniatis**.
6. "Repetitive Sequences of the Sea Urchin Genome II. Subfamily Structure and Evolutionary Conservation," *Journal of Molecular Biology* (1981) 149, 15 – 39, R.H. Scheller, D.M. Anderson, J.W. Posakony, L.B. McAllister*, R.J. Britten, E.H. Davidson**.
7. "Repetitive Sequences of the Sea Urchin Genome, Distribution of Members of Specific Repetitive Families," *Journal of Molecular Biology* (1981) 145, 5 – 28, D.M. Anderson, R.H. Scheller, J.W. Posakony, L.B. McAllister*, S.G. Trabert, C. Beall, R.J. Britten, E.H. Davidson**.
8. "Molecular Basis of Genetic Defects in Human Globin Genes," *J. Supermolecular Structure of Cellular Biochem.,* Supp. 5, 229 (1981), M. Shander, S. VandeWoude*, N. Proudfoot, T. Maniatis**.
9. "Organization and Expression of Multiple Actin Genes in the Sea Urchin," *Molecular and Cellular Biology,* July 1981, pp. 609 – 628, R.H. Scheller, L.B. McAllister*, W.R. Crain, Jr., D.S. Durica, J.W. Posakony, T.L. Thomas, R.J. Britten, E.H. Davidson**.
10. "Infrared Photometric Observation of BL Lac Object BL Lacertae (2200 – 42)," *Annual Report of the Mount Wilson and Las Companas Observatories,* 1981 – 1982, R. Pogge*, (Worked with G. Neugebauer**).
11. "Absolute Spectrophotometry of Very Large Redshift Quasars," *Astrophysical Journal,* Vol. 255, p. 11 (1982), D. Korycansky*, J.B. Oke**.
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**).
13. "Electrical Characteristics of Thin Ni_2Si, NiSi, and $NiSi_2$ Layers Grown on Silicon," Paper presented at the Electronic Materials Conference 1982, June 23 – 25, Colorado State University, Ft. Collins, CO, and a manuscript to be published in the *Journal of Electronic Materials.* E. Colgan* (worked with M-A. Nicolet**).
14. "Erosion of Frozen Sulfur Dioxide by Ion Bombardment: Applications to IO," *Geophysical Research Letters,* Vol. 9, No. 10, Oct. 1982, pp. 1151 – 54, C.L. Melcher, D.J. LePoire*, B.H. Cooper, T.A. Tombrello**.
15. "Shock Compaction of Ferrous Alloy Powders," Proceedings of the Third Conference on Rapid Solidification Processing at the National Bureau of Standards, Gaithersburg, MD, December 6 – 8, 1982, ed. R. Mehrabian, p. 672, T.J. Ahrens, D. Kostka*, P. Kasiraj, T. Vreeland**.
16. "Interspersed Sequence Organization and Developmental Representation of Cloned Poly(A) RNAs from Sea Urchin Eggs," *Journal of Molecular Biology,* In Press. J.W. Posakony, C.N. Flytzanis, R.J. Britten, E.J. Davidson** (Gary Mockli* helped with this work though not an author on the paper).

17. "Sputtering of SO_2 by High Energy Ions," *Radiation Effects,* Vol. 71, pp. 245 – 259, 1983, D.J. LePoire*, B.H. Cooper, C.L. Melcher, T.A. Tombrello**.
18. "Two-Phase Gravitational Instabilities in Thin Disks with Application to the Origin of the Moon," *Lunar & Planetary Science Abstracts,* XIV (1983), A.C. Thompson*, D.J. Stevenson**.
19. "Study of Ni-Nb System by Ion Mixing," Submitted to *physica status solidi (a).* K.T. Kung*, B.X. Liu, M-A. Nicolet**.
20. "Electrical Characteristics of Amorphous Iron-Tungsten Contacts on Silicon," *Applied Physics Letters 42* (11). M. Finetti, E. T-S. Pan*, I. Suni, M-A. Nicolet**.
21. "Rapid Grain Flow in a Vertical Chamber," in preparation, K. Hui*, P. Haff**.
22. "A Possible Phase Transition in $(Zr_2Ni)_{1-x}B_x$ Metallic Glasses," To be submitted to *J. Non-Cryst Solids,* A.Y.L. Mak*, W.L. Johnson**.
23. "Shock Wave Consolidation of an Amorphous Alloy," *J. Non-Cryst. Sol.,* 61 & 62, 967 – 972 (1983), P. Kasiraj, D. Kostka*, T. Vreeland, Jr.**, and T.J. Ahrens.
24. "Isolation of New Yeast DNA Replication Mutants Using Permeabilized Cells," *Proc. Natl. Acad. Sci., 80,* in press, C-L Kuo, N-H Huang*, J.L. Campbell**.
25. "Suppressors of a Temperature-Sensitive Copy-Number Mutation in Plasmid NTP1," *Molec. Gen. Genet.,* in press, D.R. Moser, C.D. Moser, E. Sinn*, J.L. Campbell**.
26. "X-Ray, Radio, and Infrared Observations of the 'Rapid Burster' (MSB 1730 – 335) During 1979 and 1980," *The Astrophysical Journal,* 267:301 – 309, April 1, 1983, R. Pogge*, (worked with G. Neugebauer**).
27. "Formation of the Galilean Satellites in a Gaseous Nebula," *Icarus,* 52, 14 – 39 (1982), J. Lunine*.
28. "The Relative Timing of Microwaves and Hard X-Rays in Solar Flares," *The Astrophysical Journal,* 279, 875 – 81, April 15, 1984, M.E. Cornell* (worked with H. Zirin**), G.J. Hurford, A.L. Kiplinger, B.R. Dennis.
29. "Assessing Constituency Involvement: The Hemel Hempstead Experience," *Parliamentary Affairs,* Vol 35, No. 1, Winter, 1982, D.B. Ritchie*, B.E. Cain**.
30. "Atomic Level Populations in the Hollow Cathode Discharge," *J. Quant. Spectrosc. Radiat. Transfer,* Vol. 31, No. 1, pp. 1 – 5, 1984, J.N. Humphrey*, D.L. Adams, W. Whaling**.
31. "Hemispheric Differences in Split-Brain Monkeys Viewing and Responding to Videotape Recordings," *Behavioral and Neural Biology,* 41 (1984) 231 – 235, C.K. Ifune*, B.A. Vermeire, C.R.Hamilton**.
32. "Beta-Decay Phenomenology of Nuclear Fission Products," *Nuclear Physics,* A411 (1983) 199 – 208, J.A. Behr* and P. Vogel**.
33. "Study of Charge Asymmetry in the Reaction $e^+ + e^- \rightarrow \mu^+ + \mu^-$ with the Forward Counters of the Mark J. Detector at Petra," *The Journal of Undergraduate Research in Physics,* Vol. III, No. 1, T.L. Kwok* (H. Newman**).
34. "Experimental and theoretical studies of monoclonal anti-BSA-BSA immune complexes," D.M. Yarmush, J. Dunn, C.K. Colton, and M.L. Yarmush.
35. "Determination of the Proximity Potential from Sub-Barrier Fusion Data," *Physical Review,* C30, 175 (1984), M. Inui* and S.E. Koonon**.
36. "Magnetosonic Waves and Streaming Energetic Ions in the Distant Plasma Sheet Boundary Layer," EOS, also submitted to *Journal of Geophysical Research,* B.T. Tsurutani**, I.B. Richardson, W. Butler*, E.J. Smith, S.W. Cowley.
37. "Evidence for Two Distinct Amorphous Phases in $(Zr_{0.667}Ni_{0.333})_1$-x^B Alloys," *Physics Letters,* Vol. 98A, No. 7, 31 October 1983, A. Mak*, K. Samwer, W.L. Johnson**.

38. "Computations and Etes of Rate Coefficients for Hydrocarbon Reactions of Interest to the Atmospheres of the Outer Solar System," *Icarus,* 56, 560 – 567 (1983), A.H. Laufer, E.P. Gardner, T.L. Kwok*, Y.L. Yung**.

39. "Studies of Extreme-Ultraviolet Emission from Rydberg Series of H_2 by Electron Impact," *Physical Review* A, Vol. 29, No. 2, February 1984, J.M. Ajello, D. Shemansky, T.L. Kwok*, Y.L. Yung**.

40. "Isolation of New Yeast DNA Replication Mutants Using Permeabilized Cells," *Proc. Nat. Acad. Sci. USA 80,* 6465 – 6469. Chia-lam Kuo, Nak-hui Huang*, Judith Campbell**, (1983).

41. "Suppressors of a Temperature-Sensitive Copy-Number Mutation in Plasmid NTP1," *Mol. Gen. Genet.* 192, 95 – 100, David R. Moser, Catherine D. Moser, Eric Sinn*, Judith Campbell**, (1983).

42. "Association of Gap Junctions with Endoplasmic Reticulum in Rat Parotid Glands," *Cell Tissue Res* (1984) 238:589 – 594. James Dunn* and J.-P. Revel**.

43. "Proliferation of Thymic Stem Cells With and Without Receptors for Interleukin 2: Implications for Intrathymic Antigen Recognition," *J. Exp. Med.* The Rockerfeller University Press, Vol. 161, May, 1985, 1048 – 1069. J.P. Lugo, S.N. Krishnan*, R.D. Sailor, P. Koen, T. Malek, E. Rothenberg**.

44. "Experimental Studies of Phase Conjugation with Depleted Pumps in Photorefractive Media," *Optics Letters,* Vol. 10, p. 359, July 1985. S-K Kwong, Y-H Chung*, M. Cronin-Golomb, A. Yariv**.

45. "Instrument to Collect Fogwater for Chemical Analysis," *Rev. Sci. Instrum.* 56(6), June 1985, D.J. Jacob, J.M. Waldman, M. Haghi*, M.R. Hoffmann, R.C. Flagan**.

46. "California's First Barbecue?: A Paleomagnetic Study of the Hearth Feature at the Calico Archeological Site," *Anthroquest,* No. 34, Spring, 1986, J.L. Boley* (worked with J. Kirschvink**).

47. "Comparison of Theory with Experiment in Convectionless Growth of Crystals from Solution," *Journal of Crystal Growth,* 71 (1985), 791 – 794, D.G. Schlom*, P.J. Shlichta**.

48. "Pair-Induced Spectral Changes and Variability in Compact X-ray Sources," *Monthly Notices of the Royal Astronomical Society,* Vol. 221, p. 931, 1986, A.C. Fabian, R.D. Blandford**, P.W. Guilbert, E.S. Phinney, L. Cuellar*.

49. "Motions in the Interiors and Atmospheres of Jupiter and Saturn," *Icarus* 65, 370 – 382 (1986), A.P. Ingersoll*, R.L. Miller**.

50. "A Reassessment of a Hearth-like Feature at the Calico Site Using Thermoluminescence, Electron Spin Resonance, Paleomagnetic, and 40 – 39 Argon Techniques," *Current Research in the Pleistocene,* Vol. 3, 1986, edited by Jim I. Mead, Center for the Study of Early Man, University of Maine, Orono. F.E. Budinger, Jr., J.L. Boley*, (worked with J.L. Kirschvink**), A.R. Gillespie.

51. "Evidence for Non-Axisymmetric Nuclear Bulges in Spiral Galaxies," *Astrophysical Journal,* 303, p. 66 (1986), D. Zaritsky*, K.Y. Lo**.

52. "A New Proof of Erdös's Theorem on Monotone Multiplicative Functions," 1985, Everett Howe*, T.M. Apostol**.

53. "New Superconducting-quantum-interference-device-based Constraints on the Abundance of Magnetic Monopoles Trapped in Matter: An Investigation of Deeply Buried Rocks," *Physical Review A,* Vol. 33, No. 2, February 1986, J.M. Kovalik*, J.L. Kirschvink**.

54. "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*.

55. "Hexanuclear Tungsten Cluster Structures: $W_6Cl_{14}^{2-}$, $W_6Br_{14}^{2-}$, $W_6I_{14}^{2-}$. Relevance to Unusual Emissive Behavior," *Inorganic Chemistry,* (1986), 25, 2195, Thomas Zietlow, William P. Schaefer**, Behzad Sadeghi*, Nhi Hua, Harry B. Gray**.

56. "Preparation and Properties $[((C_6H_5)_3P)_2N]W_6Br_{14}$," *Inorganic Chemistry,* (1986), 25, 2198, Thomas C. Zietlow, William P. Schaefer**, Behzad Sadeghi*, Daniel G. Nocera, Harry B. Gray.

57. "Fe II Level Populations in a Hollow Cathode Discharge," submitted to *Journal of Quantitative Spectroscopy and Radiative Transfer,* R.S. Hudson*, L.L. Skrumeda, W. Whaling**.

58. "Fiber Optic Link Characterization Via Local Network Performance Measures," submitted to *Optical Society of America,* (1987), L. A. Bergman, R. Hartmayer, F. Halloran, S. Marelid*.

59. "Lithium in the Pleiades and Alpha Persei Clusters," submitted to *The Astrophysical Journal,* (1987), Ann Merchant Boesgaard**, Kent G. Budge, Mary Elizabeth Ramsay*.

60. "The Distance to M5 From Its RR Lyrae Variables," *The Astrophysical Journal,* 318,215, (1987), J. G. Cohen**, G. A. Gordon*.

61. "Type II Ca^{2+}/Calmodulin-Dependent Protein Kinase in Drosophila," *Soc. for Neurosci.,* vol. 13, 1987, D.S. Leonard, J.B. Wall, P.C. Pugh*, and M.B. Kennedy**.

*—SURF Student
**—Faculty Sponsor

Index of Students and Sponsors

STUDENT	TOPIC	SPONSOR
Jinane Abounadi *Junior, EE* *GM-SURF*	Bounds on the Free Distance of Finite-State Codes	McEliece, R. J. *Professor of Electrical Engineering*
Khurram Khan Afridi *Sophomore, EE*	CANSAT SURF—X-/Ka-Band Transmitter Systems Design	Smith, J. G. *Manager, Telecommunications and Data Aquisition, Technology Development, JPL*
Pennington Ahlstrand *Sophomore, Linguistics* *Pitzer College* *NSF-SURF*	Testing the New World of Computing System	Thompson, F. B. *Professor of Applied Philosophy and Computer Science*
Raza Akbar *Sophomore, Ae*	Study of Flow Effects on a Special Hydrofoil	Acosta, A. J. *Professor of Mechanical Engineering*
Heidi L. Anderson *Sophomore, APh* *Weingart-SURF*	English Costume as a Reflection of the Industrial Revolution	Searle, E. M. *Professor of History*
Laura M. Anderson *Junior, Ma*	Geometry of Sporadic Groups	Aschbacher, M. *Professor of Mathematics*
Leila C. Astarai *Junior, EE/CS* *U C Berkeley* *NSF-SURF*	Liquid Phase Growth of the High T_c Superconductor, $Ba_2GdCu_3O_x$	Goodstein, D. L. *Professor of Physics and Applied Physics* Housley, R. M. *Visiting Associate in Physics*
Mihai D. Azimioara *Sophomore, Ch* *NSF-SURF*	Laser Induced Isotope Separation	Beauchamp, J. L. *Professor of Chemistry*
Eric K. Babson *Junior, Ma/Ph* *Weingart-SURF*	Committee Policy Equilibria	McKelvey, R. D. *Professor of Political Science*
Jerome D. Banks *Sophomore, Eng & ApSc*	Development of a Document Preparation System for ASK	Thompson, F. B. *Professor of Applied Philosophy and Computer Science*
Fortunato Barajas *Sophomore, Ma* *East Los Angeles City College* *NSF-SURF*	Optimization with a Distributed-Memory Parallel Processor	Fox, G. C. *Professor of Theoretical Physics*
Kelly V. Beck *Sophomore, Ay* *Vassar College* *NSF-SURF*	Metallicity of Galactic Star Clusters in High Signal to Noise Spectroscopy	Boesgaard, A. M. *NSF Visiting Professor of Astronomy*
Joseph R. Beckenbach *Junior, Eng & ApSc*	Integration of a Word Processor with the ASK System	Thompson, F. B. *Professor of Applied Philosophy and Computer Science*

STUDENT	TOPIC	SPONSOR
Jason R. Beresford *Junior, Ae*	The Cretaceous-Tertiary Extinction Bolide Impactor	Ahrens, T. J. *Professor of Geophysics*
Munir F. Bhatti *Sophomore, Ph*	Watching for Small Protons: A Test of Color Transparency	Filippone, B. W. *Assistant Professor of Physics*
Sandip Biswal *Freshman, Bi* *Bristol-Myers-SURF*	The Pattern of Gap Junctional Formation in Developing Embryonic Rat Hepatocytes	Revel, J-P. *Albert Billings Ruddock Professor of Biology*
Brian L. Biswell *Freshman, Ay*	Comparison of HI Radio Emission with IRAS Infrared Emission in the Galactic Plane	Scoville, N. Z. *Professor of Astronomy*
J. D. Bondy *Sophomore, Bi/Ch* *Texas A & M* *NSF-SURF*	Growth of Crystals in a Centrifuge	Shlichta, P. J. *Member of the Technical Staff, JPL*
David J. Bruning *Junior, Bi* *Krown-SURF*	The Organization and Connections of Striate and Extrastriate Visual Cortex in the Rat	Van Essen, D. C. *Professor of Biology*
Cameron D. Campbell *Sophomore, Eng &* *ApSc/His* *Lang-SURF*	Chinese Population History: Rural Liaoning 1774-1873	Lee, J. Z. *Associate Professor of History*
Jeffery A. Cavallaro *Sophomore, EE*	Automated Superconductor R/T Measurements	Goodstein, D. L. *Professor of Physics and Applied Physics*
Suman Chakrabarti *Junior, Ae*	CANSAT SURF—Satellite Operations	Smith, J. G. *Manager, Telecommunications and Data Acquisition, Technology Development, JPL*
Hasok Chang *Sophomore, Ph/SS*	An Axiomatic Analysis of Newtonian Mechanics	Woodward, J. F. *Assistant Professor of Philosophy*
Tylis Y. Chang *Junior, Bi*	The Role of a Specific Brain Area in Song Recognition by Female Canaries	Konishi, M. *Bing Professor of Behavioral Biology*
Kay-Yut Chen *Sophomore, Ph* *IBM-SURF*	Cipheronic Computing Algorithm	Haff, P. K. *Sr. Research Associate in Physics*
Stanley Chen *Sophomore, Ma*	Integration of a Word Processor with the ASK System	Thompson, F. B. *Professor of Applied Philosophy and Computer Science*
Christopher M. Chu *Sophomore, EE* *Pacific Telesis-SURF*	Cosmic Ray-Related Single Event Upset Errors of Spaceborne Integrated Circuits	Kuberry, R. W. *Group Supervisor, Electromagnetic Radiation Environment, JPL*

STUDENT	TOPIC	SPONSOR
Diana C. Chu *Sophomore, Eng & ApSc* *NSF-SURF*	Computer Simulations in Elementary Science Education	Pine, J. *Professor of Physics*
Dolly Chu *Sophomore, EE*	Laboratory Process Control Using μ Synthesis	Doyle, J. C. *Associate Professor of Electrical Engineering* Morari, M. *Professor of Chemical Engineering*
Yong Song Chu *Sophomore, Ph*	Measurement of 5-Minute Solar Oscillation	Libbrecht, K. G. *Assistant Professor of Astrophysics*
Rachael A. Clark *Sophomore, Bi* *NSF-SURF*	T_2 Dependence of Whole Blood on Hematocrit and Hemoglobin Oxygenation State at 90 MHz	Roberts, J. D. *Institute Professor of Chemistry*
Neil Crawford *Junior, ChE* *U C Berkeley* *NSF-SURF*	A Tracer Study Conducted During the 1987 South Coast Air Quality Study	Shair, F. H. *Professor of Chemical Engineering*
James N. Daniel *Junior, Ph*	The Possible Pulsational Instability of Brown Dwarfs	Stevenson, D. J. *Professor of Planetary Science*
Vivek R. Dave *Sophomore, Eng & ApSc* *GM-SURF*	Software-Controlled Materials Testing System	Fultz, B. T. *Assistant Professor of Materials Science*
Xi-Yang Deng *Freshman, CS*	Three Dimensional Display of Neuron Activities	Bower, J. M. *Assistant Professor of Biology*
Jeffrey J. Flint *Sophomore, Ph/SS*	The Dynamics of Interest Group Membership	Rothenberg, L. S. *Assistant Professor of Political Science*
William J. Foster *Junior, Ph* *NSF-SURF*	Analysis and Modeling of Electron-Nucleus Scattering Experiments from SLAC	Filippone, B. W. *Assistant Professor of Physics*
Michael J. Freeman *Freshman, EE*	Analysis of Neural Activity	Bower, J. M. *Assistant Professor of Biology*
Charles Chien-Wen Fu *Freshman, CS/Ma*	Vector Riccati Differential Equations	Lagerstrom, P. A. *Professor Emeritus, Applied Mathematics*
Lisa M. Giaimo *Junior, Ch*	Hydrogen Atom Abstraction by Binuclear Platinum	Gray, H. B. *Arnold O. Beckman Professor of Chemistry*
Amy Goodlow *Junior, Ch* *Jackson State Univ.* *NSF-SURF*	The Preparation of Polymeric Microspheres by Ultraviolet Irradiation	Rhim, W.K. *Member of the Technical Staff, JPL*

STUDENT	TOPIC	SPONSOR
Eva Graham *Senior, Ch* *Xavier College* *New Orleans* *NSF-SURF*	The Donor/Acceptor Project	Coulter, D. R. *Technical Group Supervisor, JPL*
Claire Griffin *Sophomore, CS* *Pasadena City College* *NSF-SURF*	Use of Computer Simulations in Teaching Elementary School Science	Pine, J. *Professor of Physics*
Jung S. Gwon *Junior, EE*	Modeling of Internal Electrostatic Discharge Phenomenon	Leung, P. L. *Member of the Technical Staff, JPL*
Kin Ha *Sophomore, Ph* *LA Times-SURF*	The Politics Behind Science Funding	Cain, B. E. *Professor of Political Science*
Yuk Lung Ha *Sophomore, ChE*	Numerical Advection by Conservation of Fourth-Order Moments	Yung, Y. L. *Professor of Planetary Science*
Chris D. Habecker *Sophomore, APh* *IBM-SURF*	Noncoherent Image Processing Using Rotational Shearing Interferometry	Breckinridge, J. B. *Technical Section Manager, Optical, Sciences and Applications, JPL*
Gregory M. Harry *Sophomore, Ph*	High Temperature Superconducting Neural Network Project	Stephens, J. B. *Member of the Technical Staff, JPL*
Brian T. Hayes *Sophomore, Ph*	^{54}Mn: A New Clock for the Heavy Cosmic Rays?	Garrard, T. L. *Member of the Professional Staff, Physics* Mewaldt, R. A. *Senior Research Associate in Physics*
Kenneth D. Haynes *Junior, Ph* *Colvin-SURF*	The Italian Background to the *Cantos*	Bush, R. L. *Professor of Literature*
Timothy A. Hochberg *Sophomore, APh*	CANSAT SURF—Stabilization	Smith, J. G. *Manager, Telecommunications and Data Acquisition, Technology Development, JPL*
Nam Tong Hua *Sophomore, CS* *Pasadena City College* *NSF-SURF*	Batteries and Bulbs	Pine, J. *Professor of Physics*
Earl A. Hubbell *Sophomore, Ma/Ph*	Optical Properties of Ammonia Ice Particles	West, R. A. *Member of the Technical Staff, JPL*
Peter J. Hughes *Junior, CS* *NSF-SURF*	Freeway Observations and Computer Modeling of Traffic Jams	Whitham, G. B. *Charles Lee Powell Professor of Applied Mathematics*

STUDENT	TOPIC	SPONSOR
Glen E. Ivey *Freshman, CS*	Process Control Using a Block Oriented System	Morari, M. *Professor of Chemical Engineering*
Maneesh Jain *Freshman, EE/Ph* *AMETEK-SURF*	Optical Parallel Processing and Pattern Recognition	Psaltis, D. *Associate Professor of Electrical Engineering*
Adam L. Janin *Sophomore, Ph* *IBM-SURF*	Study of Manufacture and Use of $YBa_2Cu_3O_{6.5}$	Lawson, D. D. *Member of the Technical Staff, JPL*
Robert L. Jarecki *Junior, ChE*	Propulsion Applications of High Critical Temperature Superconductors	Jan, D. *Member of the Technical Staff, JPL*
Joseph B. Jensen *Freshman, Ay*	Continuity of Globular Cluster Formation in the Large Magellanic Cloud	Mould, J. R. *Associate Professor of Astronomy*
Nikhil R. Joshi *Sophomore, Ay*	Optical Features of Solar X-Ray Bright Points	Zirin, H. *Professor of Astrophysics*
Randall D. Kamien *Junior, Ph* *NSF-SURF*	Universal Aspects of Large Hermitian Ensembles	Wise, M. B. *Professor of Theoretical Physics*
Yoo Chun Kim *Junior, Ph*	Better Helmholtz Coil	McKeown, R. D. *Associate Professor of Physics*
Allen I. Knutson *Freshman, Ma*	The Macintosh Hypercube	Fox, G. C. *Professor of Theoretical Physics*
Edward L. Koo *Junior, Ph* *NSF-SURF*	Energy Straggling Measurements Using Nuclear Resonant Reaction Analysis	Tombrello, T. A. *Professor of Physics*
Erik P. Krumrey *Sophomore, APh*	Construction of a Prototype Camera for a Mars Balloon Probe	Murray, B. C. *Professor of Planetary Science*
Sho Kuwamoto *Junior, Ph* *AMETEK-SURF*	Applications Software for the Macintosh Hypercube	Fox, G. C. *Professor of Theoretical Physics*
Philip Kwan *Junior, EE* *IBM-SURF*	Updating Procedure For Determining the Geometric Parameter of Two New Film Recorders	Brandt, R. D. *Member of the Technical Staff, MIPL* *Hardware Engineer, JPL*
Ali R. Lashgari *Junior, Bi/Ch* *Bristol-Myers-SURF*	Characterization of the Leukocyte Common Antigen Gene and its Homologue	Saito, H. *Dana Farbor Cancer Institute, Harvard*
Karen C. Lassey *Freshman, Ph/Ma* *Amherst College* *NSF-SURF*	Distances to M5 and M92	Cohen, J. G. *Associate Professor of Astronomy*

STUDENT	TOPIC	SPONSOR
James M. Layland *Sophomore, EE*	Optical Properties of CdTe Crystals for Stratospheric Wind Measurement	Rider, D. M. *Member of the Technical Staff, JPL*
Quynh-Thu X. Le *Sophomore, Bi/Ch* *Class of '36-SURF*	*Bicoid* Expression in *Dicephalic* Mutants	Lipshitz, H. D. *Assistant Professor of Biology*
Ming F. Lee *Freshman, Ae/APh*	Mechanism of Oxidation of Alcohols by 2,2,6,6-Tetramethylpiperidine Oxide in Aqueous Media	Anson, F. C. *Professor of Chemistry*
Brian E. Lemoff *Sophomore, Ph* *GM-SURF*	Gravity Wave Detector Alignment System Automation	Drever, R. W. P. *Professor of Physics*
Jerome E. Lengyel *Junior, CS* *AMETEK-SURF*	Dynamic Assembly and Behavioral Simulation of the Flagellar Axoneme	Barr, A. H. *Assistant Professor of Computer Science*
Lisa A. LePome *Sophomore, Ch* *NSF-SURF*	Examination of the Effect of Lead on Oxidative Stress in Red Cells and on Hemoglobin	Gray, H. B. *Arnold O. Beckman Professor of Chemistry*
Randy S. Levinson *Sophomore, Bi*	Optimization In Vitro of a Viral-Specific RNA Polymerase Activity from Sindbis Virus Infected Cells	Strauss, J. H. *Professor of Biology*
Huan Lin *Freshman, Ae*	Investigation of Superconductor Applications for NASA	Strayer, D. M. *Group Supervisor for Low Temperature Physics, JPL*
Windsor W. Lin *Junior, Eng & ApSc* *Lester Lees-SURF*	Crack Propagation Between Two Dissimilar Material	Knauss, W. G. *Professor of Aeronautics and Applied Mechanics*
Barry J. Lind *Sophomore, SS* *Weingart-SURF*	The Voting Rights Act: How California Municipalities are Affected	Cain, B. E. *Professor of Political Science* Kousser, J. M. *Professor of History and Social Science*
Peter A. Lindstrom *Sophomore, Ch*	The Synthesis of Asymmetric Pinacols	Myers, A. G. *Assistant Professor of Chemistry*
David H. Lipin *Junior, Eng & ApSc* *LA Times-SURF*	The Politics Behind Science Funding	Cain, B. E. *Professor of Political Science*
Robert E. Lister *Sophomore, AMa*	Analysis of Radar Echo Spectra for Asteroid 3199 Nefertiti	Ostro, S. J. *Scientist Technical Staff, JPL*
Harvey I. Liu *Sophomore, EE*	Characterization of Museum Dust Particles with Electron Microscopy	Cass, G. R. *Associate Professor of Environmental Engineering*

STUDENT	TOPIC	SPONSOR
Wayne W. Lukens *Junior, Ch* *NSF-SURF*	Bs: An Intramolecular Metallation Proof Ligand	Bercaw, J. E. *Shell Distinguished Professor and Professor of Chemistry*
Ke-Ming Ma *Freshman, Bi/Ch*	The Formation of Gap Junctions	Revel, J-P. *Albert Billings Ruddock Professor of Biology*
Timothy J. Ma *Junior, EE* *NSF-SURF*	Investigation of Airflow Adjacent to Indoor Surfaces	Cass, G. R. *Associate Professor of Environmental Engineering*
Michael E. Malcom *Sophomore, EE*	Temperature, Chemical and Cloud Properties of Jovian Atmosphere From Ground-based Infrared Scans	Orton, G. S. *Member of the Technical Staff, JPL*
Frederick K. Mallon *Freshman, Ch* *Calreco-SURF*	A Conformational Study of Succinic Acid	Roberts, J. D. *Institute Professor of Chemistry*
Saroj Manandhar *Junior, Eng & ApSc* *Ford-SURF*	3-D Surface Geometry Measurement and Analysis	Antonsson, E. K. *Assistant Professor of Mechanical Engineering*
Christina Mannino *Junior, Ph* *U C Irvine* *NSF-SURF*	The Effect of Physical Aging on the Glass Transition Behavior in Polymer Blends	Cebe, P. *Technical Group Leader, JPL*
Stefan C. Marelid *Junior, EE* *IBM-SURF*	Fiber Optic Network Performance Characterization and Modeling	Bergman, L. A. *Group Leader, Optical Fiber Networks, JPL*
Heath Maxfield *Junior, APh* *Ford-SURF*	High Temperature Superconducting Neural Network Project	Stephens, J. B. *Member of the Technical Staff, JPL*
Michael P. McDonald *Sophomore, EE*	State Tax Amnesty Programs	Wilde, L. L. *Professor of Economics*
Sean C. McNamara *Junior, Ph*	Determination of Asteroid Spin Vectors from Light Curves and Radar Observations	Harris, A. W. *Supervisor, Earth and Planetary Physics, JPL* Ostro, S. J. *Supervisor, Earth and Planetary Physics, JPL*
Sonja Y. McNeil *Freshman, Ch* *Jackson State Univ.* *NSF-SURF*	Crystallization of Various Proteins	Rhim, W. K. *Member of the Technical Staff, JPL*

STUDENT	TOPIC	SPONSOR
Michael Y. Meckler *Freshman, Ph* *NSF-SURF*	Using Computer Simulations in Grade School Science Education	Pine, J. *Professor of Physics*
Bassem N. Mora *Sophomore, Bi/Eng & ApSc*	In Vivo Functional Localization of the Human Visual Cortex Using Positron Emission Tomography and Magnetic Resonance Imaging	Allman, J. M. *Professor of Biology*
Lev Nayvelt *Junior, Ph* *Alumni-SURF*	Original Configuration and Evolution of Cosmic String	Preskill, J. P. *Associate Professor of Theoretical Physics*
Charles F. Neugebauer *Junior, EE/Ph* *NSF-SURF*	Neural Nets and Optical Data Processing	Yariv, A. *Thomas G. Myers Professor of Electrical Engineering and Professor of Applied Physics*
Johnny Ng *Freshman, Bi/Ph*	Electrophysiology of Gap Junctions	Revel, J-P. *Albert Billings Ruddock Professor of Biology*
Kwok L. Ngan *Junior, Ph*	Acoustic Oscillations of the Sun and the Stars	Libbrecht, K. G. *Assistant Professor of Astrophysics*
Hung P. Nguyen *Sophomore, Ph*	Measurement of Lifetimes by the Electron Impact Method	Srivastava, S.K. *Member of the Technical Staff, JPL*
Christopher S. Nolle *Junior, Ph* *NSF-SURF*	Investigating a Liquid Argon Calorimeter	Porter, F. C. *Assistant Professor of Physics*
J. Andrew O'Dea *Junior, EE* *IBM-SURF*	Application of Neural Networks to Real-Time Spectral Pattern Analysis and Interpretation	Solomon, J. E. *Senior Member of the Technical Staff, Technical Group Supervisor, JPL*
Teresa N. Ollick *Sophomore, Bi* *Calreco-SURF*	Effect of Extra Loop Size on Recognition of a +RNA by its Cognate Amino Acid Synthetase	Abelson, J. N. *Professor of Biology*
Keith J. Owens *Junior, Ae* *NSF-SURF*	Acoustical Analysis of a Two Phase Flow	Brennen, C. E./Acosta, A. J. *Professors of Mechanical Engineering*
Marios-Cristos Papaefthymiou *Junior, EE*	The Convergence of Neural Networks	Abu-Mostafa, Y. S. *Assistant Professor of Electrical Engineering and Computer Science*
Thai N. Pham *Junior, Ae* *GM-SURF*	Correlation of Cavitation in Hydraulic Equipment	Acosta, A. J. *Professor of Mechanical Engineering*

STUDENT	TOPIC	SPONSOR
Ky-Anh D. Phan *Junior, EE*	Frequency Multiplier Design	Riley, A. L. *Group Supervisor Spacecraft RF Development Group, JPL*
Dana M. Pillsbury *Junior, Ae* *TRW- SURF*	Development of an Instrument to Measure Shear Stress in a Dusty Gas Boundary Layer Behind a Normal Shock Wave	Behrens, W. *Department Manager, TRW*
Michael Pravica *Junior, Ph/AMa* *Ford-SURF*	Enhancement of NMR Signals	Weitekamp, D. P. *Assistant Professor of Chemistry*
Mitch Pravica *Freshman, Ph/EE*	Investigation of Self-Insulating Solid Cryogens	Stephens, J. B. *Member of the Technical Staff, JPL*
Phyllis C. Pugh *Junior, Bi* *Bristol-Myers-SURF*	Characterization of a Purkinje Cell Antigen	Bower, J. M. *Assistant Professor of Biology*
Mary E. Ramsay *Junior, AsPh* *Wellesley College* *NSF-SURF*	Lithium in the Pleiades and Alpha Persei Clusters	Boesgaard, A. M. *NSF Visiting Professor of Astronomy*
Edward Ratner *Freshman, Ph/AMa*	The Study of Cu-Er Amorphization by X-Ray Diffraction and DSC	Cotts, E. J. *Research Fellow, Applied Physics*
Richard R. Reid *Sophomore, EE*	CANSAT SURF—Receiver System	Smith, J. G. *Manager, Telecommunications and Data Acquisition Technology Development, JPL*
Mark D. Rintoul *Sophomore, Ph*	Distinguishing Electromagnetic and Hadronic Particles in an Electromagnetic Calorimeter	Newman, H. B. *Associate Professor of Physics*
Roberta L. Robb *Junior, Ec*	Consequences of the Pearson Commission Report on International Development	Oliver, R. W. *Professor of Economics*
Douglas A. Roberts *Junior, Ph* *IBM-SURF*	RADFET Project	Newman, H. B. *Associate Professor of Physics*
Frederick G. Roeber *Sophomore, Ph*	Study on the Radiation Damage of BGO Crystals, and A New Design of Targets for L3 BGO Calibration Target	Newman, H. B. *Associate Professor of Physics* Zhu, R. Y. *Senior Research Fellow in Physics*
Arthur W. Rossiter *Junior, Eng & ApSc*	Remote Sensing of Icy Satellites	Buratti, B. *Member of the Technical Staff, JPL*
Eric G. Scharin *Junior, ChE*	An Engineered Disulfide Bond in Crambin	Arnold, F. H. *Assistant Professor of Chemical Engineering*

STUDENT	TOPIC	SPONSOR
Jonathan J. Schiff *Junior, Ph* *U C Santa Cruz* *NSF-SURF*	Development of Software for the Hypercube Simulator	Fox, G. C. *Professor of Theoretical Physics*
Amish J. Shah *Sophomore, EE*	CANSAT SURF—X/Ka-Band Antenna Design	Smith, J. G. *Manager, Telecommunications and Data Acquisition Technology Development, JPL*
Joseph J. Shiang *Junior, Ch*	Numerical Simulation of a Low Reynolds Number Suspension of Hard Spheres Between Hard Oscillating Walls	Brady, J. F. *Associate Professor of Chemical Engineering*
Karen M. Siegrist *Junior, APh* *Pacific Telesis-SURF*	DC Helicity Injection Experiments in the Encore Tokamak	Bellan, P. M. *Associate Professor of Applied Physics*
Glenn A. Smith *Sophomore, Ph*	Undoing Atmospheric Speckle: Implementation & Testing of triple Correlation Speckle-Masking Algorithms for Application in Astronomy	Prince, T. A. *Associate Professor of Physics*
Michael D. Smith *Junior, Ph*	Automatic Feature Matching in Voyager Images of Jupiter	Ingersoll, A. P. *Professor of Planetary Science*
William C. Smith *Junior, Ph*	The Construction of an Ionization Chamber for Observing Double Beta Decay	Thomas, J. H. *Senior Research Fellow in Physics and Lecturer in Physics*
Bradley E. Solberg *Junior, Eng & ApSc* *NSF-SURF*	Freeway Observations and Computer Modeling of Traffic Jams	Whitham, G. B. *Charles Lee Powell Professor of Applied Mathematics*
Tab A. Stephens *Sophomore, Ph* *Texas A & M* *NSF-SURF*	The Feasibility of Vapor Transport Growth of $YBa_2Cu_3O_{7-x}$ Crystals	Shlichta, P. J. *Member of the Technical Staff, JPL*
Dawn Y. Sumner *Sophomore, Ge* *Krown-SURF*	Was the Earth Ever a Snowball? Evidence for Late Precambrian Equatorial Glaciation	Kirschvink, J. L. *Assistant Professor of Geobiology*
David M. Taub *Freshman*	The JPL Planetary Surface Laboratory	Smythe, W. D. *Member of the Technical Staff, JPL*
Jeffrey D. Tekanic *Junior, Bi/Ch* *Calreco-SURF*	Characterization of the Muscle (M) Actin Gene in Strongylocentrotus Purpuratus	Davidson, E. H. *Norman Chandler Professor of Cell Biology*
Eugene R. Thomas *Junior, Ph* *Flintridge Foundation-SURF*	Modeling of the IR Emission from Cold Dust Clouds	Mundy, L. G. *Senior Research Fellow in Astronomy*

STUDENT	TOPIC	SPONSOR
Minh Q. Tran *Junior, Ph* *IBM-SURF*	Beta Spectrometry Performance of a Voyager Detector for Magnetospheric Electrons	Cooper, J. F. *Research Fellow in Physics*
Charles S. Tsai *Sophomore, APh* *IBM-SURF*	Measurement of MeV Ion Implantation Damage in InP and Si Single Crystals by Rutherford Backscattering (RBS) Channeling	Tombrello, T. A. *Professor of Physics*
Jeff C. Tseng *Sophomore, Ph/H*	Equatorial Upwelling	Halpern, D. *Member of the Technical Staff, JPL*
Keith B. Vanderveen *Sophomore, Ma*	Two Paths to Forcing	Kechris, A. S. *Professor of Mathematics*
Sean R. Wakayama *Junior, Ae*	CANSAT SURF—Structural & Thermal Design	Smith, J. G. *Manager, Telecommunication and Data Acquisition, Technology Development, JPL*
Sophia Wang *Junior, ME* *MIT* *NSF-SURF*	A Radio Scintillation Study of Coronal Transients in the Solar Wind	Woo, R. T. *Research Scientist, JPL*
Alex Wei *Unitek-SURF* *Junior, Bi/Ch*	Enhancing Nitrogen-15 Signals in Nuclear Magnetic Resonance Using the Nuclear Overhauser Effect	Roberts, J. D. *Institute Professor of Chemistry*
Robert S. Williamson *Freshman, Ph* *Ford-SURF*	Design and Construction of a Nitrogen Laser for a Xenon Time Projection Chamber	Iqbal, M. Z. *Senior Research Fellow in Physics*
Felicity M. Wong *Junior, Ph*	Constraints on the Surface Properties of Titan	Stevenson, D. J. *Professor of Planetary Science*
Jorden E. Woods *Junior, Ph*	Original Configuration and Evolution of Cosmic String	Preskill, J. P. *Associate Professor of Theoretical Physics*
Chih-Meng (Jimmy) Yang *Sophomore, APh*	Autonomous Position Determination during Mars Surface Exploration	Bedard, R. J. *TASK Manager, JPL*
Kyuson Yun *Sophomore, Bi* *Krown-SURF*	Mitochondrial Targeting in Vitro	Emr, S. *Assistant Professor of Biology*

THE SURF HONOR ROLL OF DONORS

Caltech depends on the support of its alumni and other friends to maintain its commitment to provide the best education to its outstanding students. SURF has been the recipient of some of this important support, and we acknowledge with gratitude the following donors:

Corporate and Foundation Donors

The Caltech Alumni Association
American Honda Motor Co., Inc.
AMETEK, Inc.
Bristol-Myers Company
Calreco, Inc.
Flintridge Foundation
Ford Motor Company
General Motors Corporation
Greater Los Angeles Zoo Association
IBM Corporation
Los Angeles Times, Inc.
National Science Foundation
O.K. Earl Corporation
Pacific Telesis Foundation
Richter Foundation
TRW Space and Technology Group
Unitek Corporation

Individual Donors

Mr. Arthur Adams
Mr. Royal Akin
Dr. Irwin Alber
Dr. and Mrs. Tom Apostol
Ms. Valerie Bailey
Dr. and Mrs. Richard Batt
Dr. H. Wilhelm Beherns
Mr. Seymour Bogdonoff
Mr. Joel and Dr. Marcella Bonsall
Mrs. Hannah Bradley
Mr. Richard Burke
Dr. Phillip Cassady
Dr. James Chang
Dr. Robert Chapkis
Ms. Jerolyn Chittum
Mr. Clarence Cohen
Dr. Donald Collins
Mr. and Mrs. Lawrence Colony
Mr. and Mrs. Hugh Colvin
Mr. Phillip Cooke
Dr. John Cooper
Dr. Frank Davis
Dr. Anthony Demetriades
Dr. Richard Denison
Dr. Forbes Dewey
Dr. Paul Dimotakis
Dr. and Mrs. Lee DuBridge
Mr. and Mrs. Rodney Dunbar
Dr. Fernando Fernandez
Mrs. Dorothy Gantvoort
Dr. George Gleghorn
Dr. Harris Gold
Mr. Lee Gould
Mr. and Mrs. William Gould
Dr. Robert Gran
Dr. Harry Gray
Dr. Frederic Hartwig
Mr. and Mrs. Richard Hayman
Mr. Robert Herzog
Dr. and Mrs. Leslie Hromas
Mr. and Mrs. Theodore Hurwitz
Dr. Hideo Ikawa
Mr. George Jagels
Mr. and Mrs. Leigh Jones
Dr. James Kendall
Dr. and Mrs. Daniel Kevles
Dr. Joseph Kirschvink
Dr. John Klineberg
Mr. and Mrs. Denny Ko
Ms. Florence Kovacic
Mr. and Mrs. Samuel Krown
Dr. Toshi Kubota
Dr. Seymour Lampert
Mr. William Lang
Mr. David Lees
Dr. Jack Leonard
Dr. John Lewis
Dr. Chung-Yen Liu
Mr. Ross McCollum
Dr. Artur Mager
Dr. Gary Marlotte
Mr. John McCarthy
Dr. Howard McMahon
Mr. Dennis Meredith
Mr. and Mrs. Robert Moore
Mrs. Downie Muir
Mr. and Mrs. Douglas Nickerson
Mr. David Partridge
Mr. Harry Porta
Mr. Richard Powers
Mr. and Mrs. Ronald Probstein
Dr. Duncan Rannie
Dr. Barry Reeves
Dr. Eli Roshotko
Dr. Anatol Roshko
Mr. Steven Schneider
Mr. and Mrs. John Sellars
Mr. and Mrs. Robert Shafer
Dr. and Mrs. Fredrick Shair
Mr. Loyd Sigmon
Mr. Irvin Spielberg
Dr. Bradford Sturtevant
Dr. Tsung-Chow Su
Mr. George Tooby
Dr. Richard Tracy
Dr. Thomas Tyson
Dr. Alan Vetter
Mr. Victor Veysey
Dr. Keith Victoria
Mr. George Webster
Dr. David Welch
Dr. Arvel Witte
Dr. Richard Wood
Drs. James and Susan Wu

If you would like further information about how you can contribute to SURF, please contact:

Susan Pearce
Director of Development
California Institute of Technology
Pasadena, California 91125
(818) 356-6214

SURF Office
California Institute of Technology
Room 3 Dabney, Mail Code 101-40
Pasadena, California 91125
818-356-3675