

PUBLISHED FOR ALUMNI AND FRIENDS OF THE CALIFORNIA INSTITUTE OF TECHNOLOGY

## A tenth planet for the solar system?



Chiron, a newly discovered planet-like body, circles the sun between the orbits of Uranus and Saturn. About 100 to 400 miles in diameter, it is approximately one-tenth the size of Mercury, the solar system's smallest planet. This photograph was taken through the 48-inch Schmidt telescope at Palomar Observatory. See the accompanying story on the second page.

## Two new trustees

### Mrs. Frost and Robert Galvin elected to Board

The election of Mrs. F. Daniel Frost and Robert A. Galvin to the Caltech Board of Trustees has been announced by R. Stanton Avery, Board chairman.

For Mrs. Frost, election to membership on the Board of Trustees is a fulfillment of a long-term loyalty. "I learned about Caltech through osmosis," she says. "Because of my family's involvement with the Institute, I've felt a part of it for a long time."

Mrs. Frost is the daughter of Mrs. Norman Chandler and the late Mr. Chandler, who was a trustee from 1941 until his death in October 1973. Mrs. Chandler has been an honorary life trustee since 1974.

Memories of field trips to Caltech as a student at Polytechnic School constitute her earliest association. More recently, as a long-time member of the Pasadena Art Alliance, she has renewed ties to Caltech through the recent affiliation of this support group with Baxter Art Gallery.

A resident of Pasadena and a leader in civic affairs there and in Los Angeles, Mrs. Frost is a trustee and vice president of the Los Angeles County Museum of Art and treasurer and a director of Chandis Securities Company. She is an alumna and a trustee of Wellesley College, and she has been a member of the executive committee of the Junior League of Pasadena, and a trustee of Pasadena's Westridge School.

Exposure to scientific material as a Caltech trustee will be a particular

pleasure for Mrs. Frost. As a student at Wellesley College, she majored in biological science with a special interest in marine biology. Through reading, she satisfies a keen and continuing interest in this field. "Being apprised of Caltech's pioneering research in many scientific areas will be an added dividend as a trustee," she says.

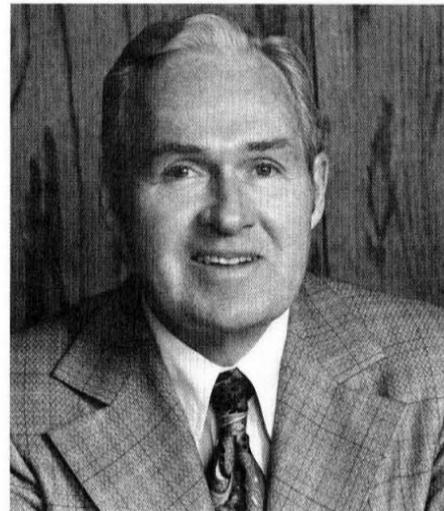


Mrs. F. Daniel Frost

Robert A. Galvin brings to the Board his many years of experience as a leader in the electronics industry. In 1940 he joined Motorola Inc., which was founded by his father, Paul V. Galvin, and he is now the corporation's board chairman and chief executive officer.

Galvin worked closely with his father to guide the wartime and postwar expansion of Motorola, and in 1956 he became the corporation president. He was elected chairman of the board in 1964.

Honored on numerous occasions for his leadership, he is a director and past president of the Electronic Industry Association and the recipient of the association's 1970 Medal of Honor for outstanding contributions



Robert A. Galvin

to the industry's advancement. In 1973 the Chicago Association of Commerce and Industry named him "Decision Maker of the Year."

Galvin is a Trustee of the Illinois Institute of Technology, one of the 12 Fellows of Notre Dame University, and a former member of the President's Commission on International Trade and Investment. He is also a director of Junior Achievement of Chicago and a Trustee of the Chicago Museum of Science and Industry. He attended the University of Notre Dame and The University of Chicago, and holds honorary degrees from Quincy College, St. Ambrose College, De Paul University, and Alabama State University.

## Anderson urges full mobilization to solve energy problems

An all-out mobilization of our country comparable to that during World War II will be necessary to meet the energy crisis, Robert O. Anderson, chairman and chief executive officer of the Atlantic Richfield Company, told members of The Associates and their guests at the annual dinner.

Anderson said that the energy crisis is probably even more serious than we have been led to believe. He termed it "the issue that will decide whether a society such as ours can meet a major problem — short of war — and solve it in a voluntary manner."

"All-out mobilization is an awesome spectacle, one that we haven't experienced since World War II," Anderson said. "Such mobilization will involve 200 million people, all working toward a common goal and making sacrifices that are proper if we consider that we are engaged in the moral equivalent of war."

"I believe we need such a test to restore our belief in our free and open society and to prove to ourselves that we can stand together to fight and solve this problem. If we close ranks we have everything we need: time (although just barely enough), and the resources, including the finest minds in the world."

Anderson said that an institution such as Caltech is an important asset in such a crisis, for "without the skilled technicians of our country we are doomed. But fortunately we have these technicians, and in substantial numbers."

He pointed out that people generally view the energy problem from one of two perspectives. "Those with perspective A argue that we can only meet the problem if we restore and utilize our free market mechanisms to the maximum," he said. "They believe that controls may be necessary from time to time but that we should use them sparingly and not rely on them as a major method of policy. Most of us here are of this persuasion."

"The free market system," he added, "has served us for 200 years. It has responded in time of shortage and problems, and it will respond again. We can't preserve the individual in this rather complex world if we take away the will to move freely in the economic sense."

Those who favor perspective B believe that our society must reduce demands to the level of the energy that is available, he said. "These people are dedicated, or at least resigned, to the inevitability of ration and allocation rather than to the operation of a free market. They believe in no growth, or zero growth."

Continued on next page

# An upset for third-grade science

"How many planets are there in the solar system?"

Some of those people with advance word of Charles Kowal's discovery tried to trip up their friends before the public announcement by asking this question. For Kowal's find — an object circling the sun between the orbits of Uranus and Saturn — cast doubt on a familiar third-grade science truism.

The object, which is 100 to 400 miles in diameter and circles the sun every 115 years, moves in a planet-like orbit, unlike that of any known comet or asteroid. But it is only one-tenth the size of Mercury, the smallest planet in the solar system. Kowal has named the object "Chiron," for one of the centaurs in classical mythology.

Astronomer Kowal discovered it on November 1, as he was examining photographic plates taken on October 18 and 19 through the 48-inch Schmidt telescope at Palomar Observatory. He studied the two plates

on a "blink microscope," in which rapidly alternating views of the same portion of one plate and then the other can be seen through the eye-



Charles Kowal

piece. In his examination he detected the movement of a tiny, faint trail from plate to plate, indicating an object that was moving in relation to the stars.

Kowal's discovery was verified on plates of the same section of the sky made on October 11 and 12 by Tom Gehrels, visiting astronomer from the University of Arizona. Caltech Research Fellow Richard Green also found the object on plates taken November 3 and 4.

Although it is possible that the object could be a comet that has been captured by the solar system, Kowal says that this is unlikely. Its image is extremely sharp, in contrast with the fuzzy image presented by comets. Also, Kowal adds, the object orbits the sun in approximately the same plane as the other planets — unlikely if it had been captured from the fringes of the solar system.

Kowal is best known for his discovery of the 13th and probably 14th moons of Jupiter. He has also discovered, during a 13-year search, 80 supernovae including one in 1972 that was the brightest to be discovered in 35 years and the fourth brightest ever recorded.

## Fossil clam's protein survives 80 million years

A fossil clam containing protein 80 million years old but still virtually intact is described in the Proceedings of the National Academy of Sciences by two Caltech scientists and a former graduate student. The men are studying the evolution of life on earth by comparing the protein structures of ancient and extinct creatures with those of living animals; they are Heinz Lowenstam, professor of paleoecology; Leroy E. Hood, BS '60, PhD '68, the Ethel Wilson Bowles and Robert Bowles Professor of Biology; and Stephen Weiner, PhD '77, now with the Weizmann Institute, Israel.

The 80-million-year-old protein-bearing fossil is the second discovery of its type. Weiner and Lowenstam first found such a specimen in clay beds laid down near Coon Creek, Tennessee, by an ancient sea. They located the second in sediments in northern Baja California.

Before these shells were discovered, the oldest well-preserved protein known to scientists was only hundreds of thousands — rather than millions — of years old.

Lowenstam said the shell and its protein were in such good condition because they were covered in sand containing just enough clay to keep fresh water from contaminating them. The shell's original pigmentation seems to have been its only loss.

The ancient fossilized mussel is a bivalve called a *Scabrotrigonia thoracica*. It lived during the Cretaceous period, which ended about 75 million years ago. Although it thrived in several oceans, it was especially fond of tropical waters. Between 80 and 90 million years ago, it disappeared from most of its habitats for unknown reasons. Today its descendants live only off the east coast of Australia.

Weiner, who was recently a graduate student of Lowenstam's, learned that contemporary proteins show little evolutionary change when they are compared with the protein in the ancient shells, and that both the ancient and contemporary protein contain the same repeating sequence of amino acids.

The scientists also discovered that the protein molecules still maintain their original molecular weight — proof that these components haven't degraded during the 80 million years since they were deposited.

Weiner and Lowenstam found that aragonite — a dense form of calcium carbonate — creates the crystalline structure in both the ancient and contemporary shells.

## Schmidt to direct Hale Observatories

Maarten Schmidt, whose studies of quasars changed the way astronomers picture the universe, will be the next director of the Hale Observatories. Schmidt, 47, will succeed H. W. Babcock when Dr. Babcock retires June 30, 1978. Caltech's Acting President Robert F. Christy and Philip H. Abelson, President of the Carnegie Institution of Washington, announced the appointment.

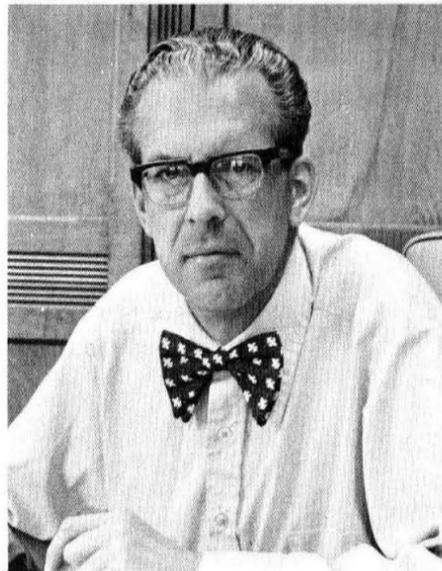
Schmidt was a staff member of the Hale Observatories and an associate professor at Caltech in 1963 when he deciphered the spectrum of light from quasars — mysterious celestial objects discovered by radio astronomers in 1960. Astronomers were baffled by the light spectra from quasars because the spectra didn't match those of any known chemical elements.

Schmidt recognized a pattern of lines in the quasars' light spectra as a familiar hydrogen group that had been stretched out and displaced from its normal position from the blue into the red part of the spectrum. The implications of Schmidt's discovery astounded the scientific community. The displacement of spectral lines is considered a reliable indicator of the speed and direction of an object in space: A shift to the blue means the object is moving toward the observer; a shift to the red means it is moving away. The larger the shift, the greater the velocity of the object that produced it. Because of their tremendous redshifts, quasars had to be the most distant and powerful astronomical objects ever detected. Some are so far away that their light has been traveling for three-fourths the age of the universe.

After taking his doctorate at the University of Leiden in 1956, Schmidt came to the United States for two years' study at the Hale Observatories. He returned to California in 1959 as associate professor at Caltech and staff member of the Hale Observatories. He was appointed to professor in 1964 and in 1972 he was

named executive officer for astronomy by Caltech. In 1975 he was selected chairman of the Division of Physics, Mathematics and Astronomy, the position he now holds.

Horace W. Babcock, director of the Hale Observatories since 1964, is well known for his studies of the magnetism of the sun and other



Maarten Schmidt

stars, and for his design of improved instrumentation for telescopes.

The Hale Observatories, named for the founder of Mount Wilson Observatory, George Ellery Hale, are jointly operated by the California Institute of Technology and the Carnegie Institution of Washington.

## Pings heads AGS

Cornelius J. Pings, BS '51, MS '52, PhD '55, has been elected president of the Association of Graduate Schools and will serve in this role until October 1978. Pings is professor of chemical engineering and chemical physics, vice provost, and dean of graduate studies at Caltech.

A member of the faculty since 1959, Pings is involved in research in applied chemical thermodynamics, statistical mechanics, and liquid state physics. He has received many awards for his technical work, and is involved in numerous professional, civic, and government activities.

## Anderson: energy crisis urgent

Continued from first page

They see our society as wasteful and extravagant, and the energy issue as one that can't be left to private forces.

"But there are holes in this position. The policies of perspective B would cause employment to decline, our economy to slacken, and our national security to be impaired."

No matter which position we accept, Anderson said, we must realize that we have moved beyond the era of cheap energy, and rising costs are inevitable. "Energy costs about \$2 per million BTU's, and we are going to see a doubling, perhaps a quadrupling, of this figure before we strike a balance between supply and demand," he said. He added that it

will be 20 to 30 years before new, clean, renewable sources of energy become available.

Anderson said he is confident that we will mobilize to meet the energy challenge because "hope is the most powerful ingredient in the world, and we have it. The American dream isn't dead," he concluded. "It has just been asleep."

Some 570 members of The Associates and their guests attended the dinner. They were welcomed by William H. Corcoran, vice president for Institute relations; Joseph B. Earl, president of The Associates; and Acting President Robert F. Christy. Olaf Frodsham and Monica Roegler directed the Caltech Glee Club in several songs during the evening.

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#### EDITORIAL STAFF

Executive editor: Winifred Veronda.  
Staff associates: Phyllis Brewster, Paula Hill, and Kay Walker.  
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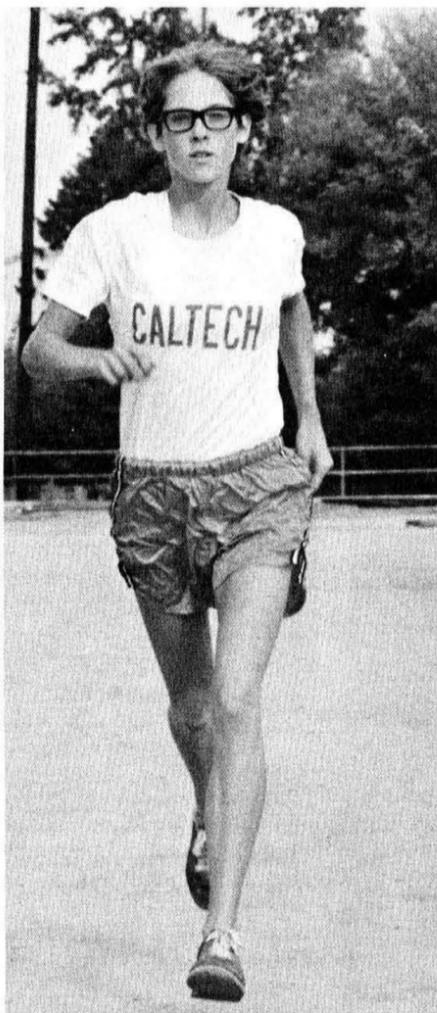
# Celia's off to a fast running start

Celia Peterson is blonde, blue-eyed, and slight — 5'5" and 105 pounds. More definitively, she runs 75 miles a week, is a member of Caltech's otherwise all-male cross country team, and has set her sights on the 1984 Olympics. She came to Caltech this fall from Bloomington, Indiana, to major in "either chemistry or biology" and to continue running in cross country, marathons, and road races.

Her place among the all-male cross country competitors is not a cause célèbre for equal rights, and it is only one of her running roles at Caltech. This year the SCIAC added a women's division in cross country. But Celia was the only female runner to report at Caltech, so she ran as a member of the 15-member men's team, in addition to competing in the women's division. Among the male runners, she ranks fourth.

This season's cross country schedule then became a shuttle situation for Celia — back and forth between the men's and women's competition. Halfway into the schedule, the SCIAC officials ruled against women competing on men's teams, and Celia was transferred to the distaff side of the sport. Pitted against a rather thin representation of women from other conference schools, she consistently finished one to two minutes ahead of the field. In non-conference meets, however, Coach Leroy Neal continued to enter her in the men's races, where she regularly placed in the top ten.

The weekend of November 5 was a special one for Celia, for she won two cross country championships



Celia Peterson

that week: those of the women's SCIAC division and of the women's junior division of the Southern Pacific Amateur Athletic Union.

Although Celia's Caltech sports involvement is in cross country, her abilities and preferences are for the longer pulls — marathons and road races — which she enters independently.

"Distance is definitely my strength," she says, and her record proves it. In the five-mile cross country course she averages a mile in a little under six minutes, and her best time in a marathon is three hours, three minutes.

At her present rate of improvement she could be among the top 30 women marathon runners in the country, Neal says, and he predicts that if the International Olympics Committee adds a women's marathon in 1984, she will be in line to represent the U.S.

Celia is mindful of that year and that possibility. "I'll be 24 then, with my best running years ahead of me," she says. Distance runners, unlike sprinters and swimmers, do their best performing in their late twenties and early thirties.

Celia took up running, seriously, at 14. Before that, in junior high school, she ran because "it was popular" with her brother and her boyfriend and all her neighborhood chums.

Here in California Celia misses the rural running courses of Indiana. In Bloomington she was among the wheatfields and pastures after her first couple of miles; in Pasadena it's hard surface streets and car exhausts all the way. Still, she counts it a plus to enjoy year-round good weather and to be able to pursue her daily jogs without rain or snow gear.

But whatever the environment she'll continue to run, "because I love it — and I enjoy competition."

Not a bad combination of essentials for a successful 1984.

## Soccer

The Caltech soccer team finished fifth in the conference with a 3-8-1 record and 15 goals for, 37 against. The season included several exciting games in which the team played well, including both games against Claremont-Harvey Mudd, a league leader. In the first game, the score was tied 1-1 at the end of regulation play after brilliant performances by the Caltech defense, but Claremont-Harvey Mudd prevailed in overtime, 3-1. In the return match, Caltech won 3-1. In the season's final game, Caltech defeated Occidental 1-0 with a goal by sophomore Ed Chan in the last minute of the second overtime period.

For the third consecutive year, seniors Lee C. Aydelotte and Bruce Baker were selected All-Conference. But reversing previous years, Aydelotte was selected first team goalie and Baker was chosen as fullback. Aydelotte's teammates chose him as the season's outstanding player.

The soccer program at Caltech appears to be alive and well, based on the numbers turning out. This year's roster included 31 students, the largest number on record to come out for soccer here.

## Water Polo

The Caltech water polo team started off the 1977 season with a 17-4 loss in the opener against a well-conditioned alumni team. Steve Sheffield, BS '72, Tom Crocker, BS '64, Ed Evans, MS '68, Eng '71, and Russ Desiderio, BS '75, powered the alumni against the varsity, led by seniors Jim Findley (2 goals) and sophomore Doug Jones (2 goals). Since that opener, the varsity, under senior captain Chris Sexton's leadership, has been gaining momentum.

The Tech team is missing three of last year's starters through transfers or leaves of absence. Says Coach Ed Spencer, "There is no doubt that the loss of these players has cost Tech in its win-loss record, because four of its losing games have been decided by one or two goals.

"We have an excellent nucleus of players and plenty of young, eager newcomers. What we need to do now is to get everyone interested in playing during the spring and summer so we can start off next year where we leave off here."

## Cross Country

The Caltech cross country team finished the season with a 10-7 record and a fourth-place standing in the SCIAC ranks. Junior Robert Bourrett paced the harriers, setting a school record on his home course with a time of 26:29.7 for 4.75 miles. He also placed first in a meet with Ambassador College. Freshman Glen George ranked as the number two runner on the team and Sophomore Bill Gould, the "most improved runner," ranked third. Freshman Celia Peterson drew the fourth-place spot for her team performance and was honored as Caltech's "most consistent runner."

## Alumni Fund on way to new records

Caltech's 1977-78 Alumni Fund is running ahead of 1976 in both dollars received and number of contributors, and appears to be headed towards another record breaking year, according to Ed Foss, BS '32, national chairman. On December 1 the Fund had received \$213,000 from 838 donors, compared with \$168,000 from 743 donors at the same time a year ago.

Foss said that a generous gift from Richard L. Hayman, Ex '36, played a major role in the Fund's fine early beginning this fall. Hayman, who has made the largest gift to the Fund each year for the past four years, contributed \$45,000 toward the current goal.

"Caltech is deeply grateful to Dick for his continuing generosity," Foss said. "His loyalty to the Institute, as demonstrated through his gifts to the Alumni Fund, play an important role in enabling Caltech to retain its independence and to remain a leader in science and technology."

Foss said that an outstanding group of alumni have volunteered to assist this year and are now making their contacts. "In over two-thirds of the Fund's 85 areas, we know that teams of volunteers have already been recruited and are calling on prospective donors," he said. "Others

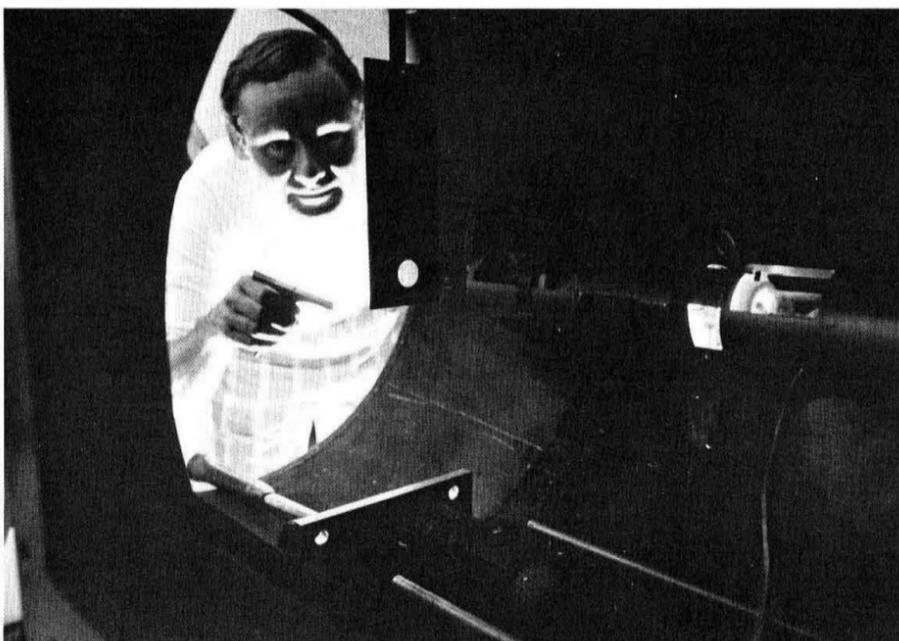
are now in the process of organizing their areas."

Foss noted that Fund leaders this year have set a goal of 750 volunteer workers — an increase of about 100 over last year's total. "If our Area Chairmen continue to recruit workers as successfully as they have done

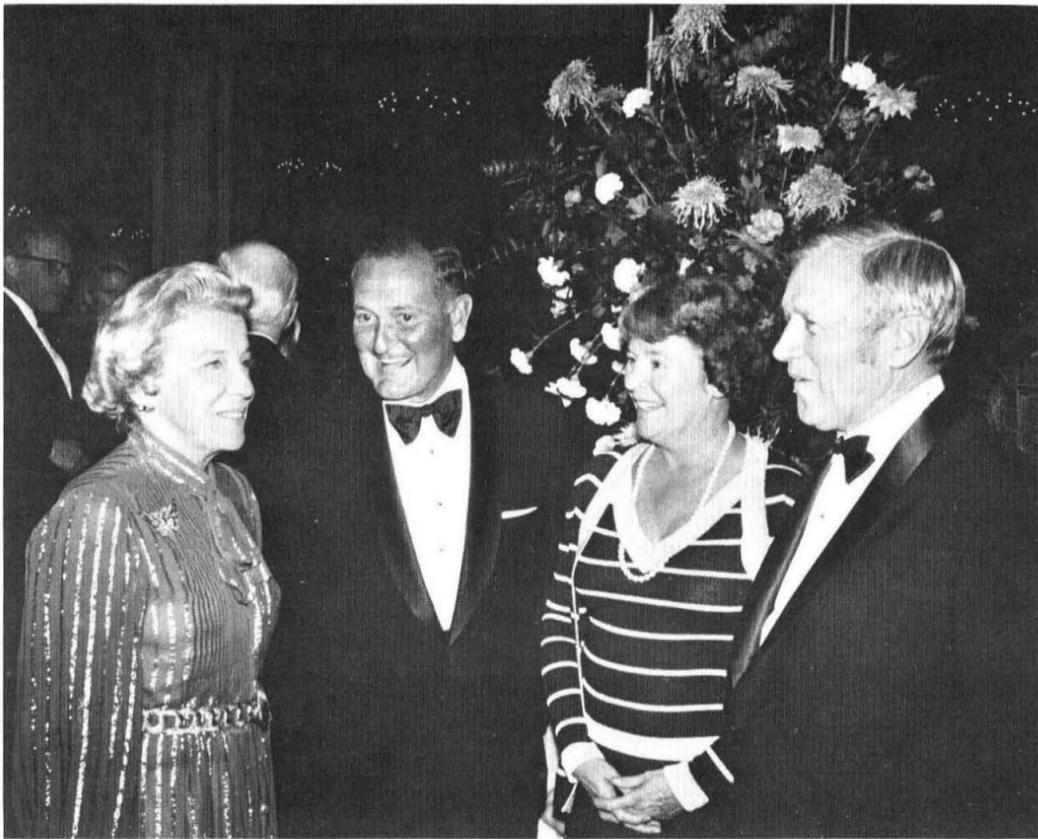
thus far, then we'll reach this goal along with our objectives of \$750,000 from 4,500 donors," Foss said.

In the past five years the Alumni Fund has raised over \$2.5 million, primarily for Caltech's operating fund. Last year 4,369 donors contributed \$704,000 to the Fund.

## High pressure testing



Using his research cannon, Caltech Geophysicist Thomas J. Ahrens subjects a piece of forsterite, an iron-free form of olivine, to the pressure of the earth's lower mantle, 1,600,000 times that of sea level. The result is a new form of forsterite, about five percent more dense than any previously believed to exist. Olivine is thought to be the main ingredient in the earth's lower mantle, about 2,000 miles inside the earth.



Mrs. George D. Jagels, Mr. and Mrs. H. Warner Griggs, and Mr. Jagels. The Associates' program chairman, Mr. Jagels will be president of the organization in 1978. Mr. Griggs is a former president.



Harry Wilson, Caltech Glee Club member Robert Maffit, and Mrs. Roland W. Lindhurst. Mrs. Lindhurst is a life member of The Associates.



Dr. Arnold O. Beckman, Chairman Emeritus of the Caltech Board of Trustees, and Mrs. Beckman, left, and Mr. and Mrs. Robert O. Anderson.

## The Associates honored at annual dinner

More than 570 members of the Caltech Board of Trustees and The Associates, along with their guests and members of the Caltech faculty, gathered last month for a reception and dinner in the Beverly Wilshire Hotel. The annual event honored members of The Associates and other friends of the Institute for their contributions. As the keynote speaker, Robert O. Anderson, chairman and chief executive officer of the Atlantic Richfield Company, and a member of the Caltech Board of Trustees, shared his views on a national program to solve the country's energy problems.



Noyes H. Roach of The Caltech Associates and his guests, Mr. and Mrs. A. Whittel, Jr., and Mrs. Dorothy Halston.



Frederick G. Larkin of the Caltech Board of Trustees and Mrs. Larkin, and Caltech Glee Club members Jennifer and Gary Gray.



William H. Corcoran, vice president for Institute relations, and Robert O. Anderson of the Caltech Board of Trustees, who addressed guests at the dinner. Both are members of The Associates.



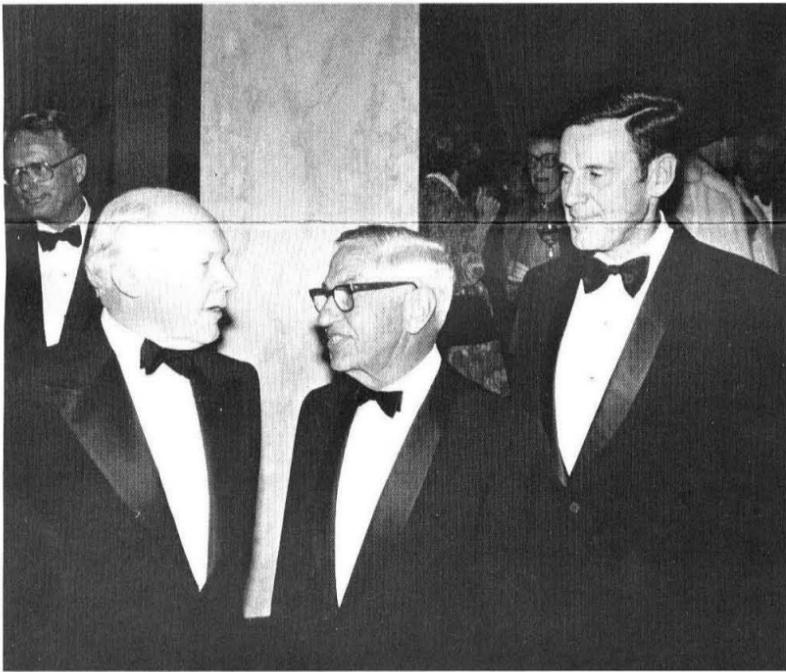
Mr. and Mrs. Lester M. Finkelstein, contributing life members of The Associates. In the background are Associates Dr. Henry Lee, Jr., and Mr. and Mrs. Don Hayden Rose.



Theodore H. Smyth, a member of the Board of Directors of The Associates, and Mrs. Smyth, right, with Capt. and Mrs. Forrest Tucker of Santa Barbara.



Robert O. Anderson, Joseph B. Earl, president of The Associates, right, and Mrs. Earl.



Robert O. Anderson, Caltech President Emeritus Lee A. DuBridge, and Acting President Robert F. Christy.



Caltech Trustee Harry J. Volk and Mrs. Volk, left, and Mrs. William H. Corcoran.



Mr. and Mrs. Richard L. Hayman, contributing life members of The Associates.



H. Warner Griggs with Mr. and Mrs. W. Morton Jacobs. Mr. Jacobs is a former president of The Associates.

# PERSONALS

1933

MOSES B. WIDESS, MS '34, PhD '36, received the 1977 Kauffman Gold Medal Award from the Society of Exploration Geophysicists for his contributions to geophysical exploration. Widess is retired from Amoco Production Company.

1941

LAWRENCE C. WIDDOES, vice president of Magna Corporation of Houston, Texas, was elected a fellow of the American Institute of Chemical Engineers in recognition of his administrative input to technical problems in the nuclear industry and in the petroleum and petrochemical industry.

1945

OTIS E. LANCASTER, Eng, Westinghouse Professor, Pennsylvania State University, has been elected president of the American Society for Engineering Education.

1949

MYRON LIPOW, senior staff engineer with the TRW Defense and Space Systems Group, writes that he has just published the second edition of *Reliability: Management, Methods, and Mathematics*, originally published in 1962. David K. Lloyd is the co-author and co-publisher. The major change in the new version, according to Lipow, is a new chapter on "Software Reliability," a topic of increasing importance in embedded computer systems.

WALTER G. PREVOST received a master of divinity degree from Cincinnati Christian Seminary in May and has been assigned to Thailand as a missionary with the South East Asia Evangelizing Mission.

1957

KIRK S. IRWIN has been named president of Aero Spacelines, Inc., the Santa Barbara firm that developed the Guppy family of aircraft. The firm has discontinued the Guppy projects and has diversified, moving into new aerospace engineering and manufacturing fields.

A. D. MacGILLIVRAY, MS, PhD '60, has been appointed to a two-year term as chairman of the department of mathematics at the State University of New York at Buffalo. A member of the faculty since 1964, MacGillivray last year received the SUNY Chancellor's Award for excellence in teaching.

MATTHEW MESELSON, PhD, Thomas D. Cabot Professor of the Natural Sciences at Harvard University, has been appointed a Phi Beta Kappa Visiting Scholar. In this role he will visit eight universities, where he will meet with faculty and students to discuss such topics as gene control and evolution in higher organisms, arms control of chemical and biological weapons, and chemicals and cancer.

1960

CARLETON B. MOORE, PhD, professor of geochemistry at Arizona State University, received an honorary doctorate of science degree from Alfred University in New York at the institution's commencement in May.

JAMES C. SORENSON, with Air Products and Chemical Inc. since 1964, has been appointed commercial manager for the company's energy systems department. In this capacity he will develop the department's business plans and have commercial responsibility for all energy systems projects.

ROBERT C. THOMPSON of Easton, Maryland, is in private practice in orthopaedic surgery. Thompson writes that he's active in barbershop quartets and sings competitively in the Mid-Atlantic area. He says he's interested in hearing from other Caltech grads who are involved in barbershop music.

1966

WILLIAM F. ORR writes, "In the summer of 1976 I spent three weeks at the Rijksuniversiteit Antwerpen in Belgium, teaching geometry courses in Esperanto, probably the first time that the subjects of hyperbolic and finite geometry have been taught in the international language. I am currently a member of Lehman Engel's BMI Musical Theatre Workshop in New York City, and I have received a grant from the New Mexico Arts Council to write a musical play to be presented in 1978 by the Santa Fe Musical Theatre Association."

1968

MICHAEL H. McLAUGHLIN, MS, Eng, has been appointed technical administrator of the Power Generation and Propulsion Laboratory at the General Electric Research and Development Center. There he will serve as an administrator for Ho-Kang Liu, manager of the laboratory. With the center since 1960, he most recently worked on projects involving flow regimes in fluidized beds.

STEVEN E. POLTROCK recently received his doctorate in psychology from the University of Washington and is now an assistant professor at the University of Denver.

BERNARD TIEGERMAN, MS, received his PhD in aerospace engineering from Cornell

University in August 1975. Since April 1976 he has been doing postdoctoral work in biomedical engineering at the State University of New York, Buffalo.

RICHARD B. WRIGHT, Eng, is one of 12 new legal scholars and practitioners appointed to the faculty of Yeshiva University's Benjamin N. Cardozo School of Law. In line with his special interests in resources, law and economics, technology and public policy, and environmental protection, Wright is teaching a seminar in which he analyzes law and technology in a democratic society. He lives in Dobbs Ferry, New York.

1969

DANIEL E. NEMZER has joined the staff of the American Chemical Society's Chemical Abstracts Service in Columbus, Ohio. He works as an applications programmer in the research and development division.

1970

RICHARD A. STRELITZ writes that he received his PhD degree in geophysics from Princeton, married Patricia Davis, and moved to Houston to join the staff of the Lunar Science Institute "all in two weeks late in August. Prior to that," he adds, "I did nothing of note."

1975

POCHI A. YEH, MS, received the Schlumberger Fellowship in Physics from Caltech where he is working on his doctorate. Honored for making important advances in optics, Yeh worked with Amnon Yariv, his supervisor, to develop a theory which describes the creation of new light frequencies by mixing two light sources.

JAMES R. CELONI, MS '75, received his MS in computer science from Stanford this year and has entered the Society of Jesus to study to become a Jesuit priest.

## Help us find these lost alumni

The Institute has no record of the addresses of these alumni. If you know the current locations of any of them, please relay the information to the Alumni Office.

Adodra, Surendra	1967	Cheng, Che-Min	1949
Alexander, Joseph	1950	Cheng, Ju-Yung	1937
Aliferis, Eudoxia	1964	Christensen, Nephi	1934
Allen, Robert	1916	Christensen, Ronald	1959
Allen, Thomas	1949	Chu, Djen-Yuen	1936
Allison, Charles	1946	Chu, Tao-Hung	1948
Allison, Donald	1930	Chung, Ta-San	1947
Alpan, Rasit	1944	Clark, Albert	1948
Amster, Warren	1944	Clark, Morris	1941
Andrew, James	1969	Clarke, Fredric	1947
Andrews, Thomas	1949	Clements, Robert	1947
Anspach, Kenneth	1943	Clementson, Gerhardt	1945
Aranguren, Luis	1971	Coles, Alan	1970
Arbo, Paul	1952	Collins, Burgess	1948
Arcoulis, Elias	1952	Collins, Hugh	1947
Ari, Victor	1945	Compton, Arthur	1940
Arosemena, Ricardo	1951	Conrad, Robert	1946
Asher, Rolland	1947	Cooke, Charles	1944
Atencio, Adolfo	1947	Cooper, Harold	1949
Au, Yin-Ching	1948	Couch, Harold	1966
Audet, Clement	1962	Cousin, Michel	1962
Badger, Frederick	1950	Cox, Edwin	1922
Baekelandt, Victor	1959	Crawford, William	1948
Barriga, Francisco	1944	Creighton, Thomas	1962
Barron, Robert	1966	Crosthwait, Ted	1943
Baumann, Laurence	1949	D'Arbaumont, Michel	1962
Baumgarten, Werner	1941	Dagnall, Brian	1947
Bebe, Mehmet	1942	Daleon, Benjamin	1943
Behroon, Khosrow	1946	Davidson, Harold	1949
Bell, William	1944	Davis, John	1967
Bendix, Peter	1968	Davis, Roderic	1937
Benjamin, Donald	1944	Dawson, Thomas	1959
Berkant, Mehmet	1944	De Medeiros, Carlos	1944
Bertram, Edward	1935	De Witte, Leendert	1947
Birlik, Ertugrul	1944	Delsemme, Jacques	1973
Bissett, Charles	1952	Dessinger, Jerry	1967
Blondy, Philippe	1967	Dickinson, George	1966
Boissaye, Eric	1972	Diercks, Allen	1956
Boss, David	1970	Dirickson, Luiz	1953
Bowen, Mark	1946	Dorlhac, Jean-Pierre	1962
Bowman, Robert	1966	Doyle, Richard	1970
Boyd, James	1967	Drake, George	1970
Bradford, Robert	1956	Dubois, Jean	1962
Brethes, Alain	1955	DuPont, Michel	1967
Brinkhaus, Harvey	1946	Dyson, Jerome	1946
Brody, Julian	1950	Easley, Samuel	1941
Brown, James	1943	Easton, Anthony	1937
Brown, John	1949	Eaton, Warren	1943
Brownlow, Leonard	1968	Edsforth, John	1957
Bucy, Smith	1952	Edwards, Robert	1956
Bunce, Capt. V.	1948	El-Hussaini, Jassim	1954
Burch, Joseph	1944	Ellison, William	1937
Burk, Thomas	1933	Emre, Orhan	1942
Burke, William	1944	Engholm, Bernard	1952
Burnight, Thomas	1937	Eris, Altan	1966
Byles, David	1958	Esner, David	1946
Byun, Chai	1959	Evans, M.	1935
Campbell, Richard	1951	Facon, Pierre	1963
Carroll, Clark	1959	Fagundes, Helio	1970
Caulley, Joseph	1960	Farley, Alan	1957
Cebeci, Ahmed	1944	Fateh, Hassan	1946
Cerne, James	1969	Fitzgerald, Larry	1962
Chalier, Philippe	1965	Fleuret, Jacques	1968
Chandra, Subhash	1961	Fong, Conrad	1946
Chang, Hung	1926	Forrester, Herbert	1950
Chang, Tzeu-Ching	1964	Fossard, Andre	1959
Chao, Chung-Yao	1930	Foster, Francis	1949
Cheema, Inder	1965	Foster, R.	1946
Chen, Ke-Yuan	1946	Freire, Luis	1946

Garmany, Jan	1972	Koch, Robert	1943
Geitz, Robert	1941	Kontaratos, Antonios	1956
Genachte, Paul	1935	Krasin, Fred	1949
Gentner, W.	1940	Kraus, Alfred	1953
Gibson, Arville	1940	Krauss, Max	1949
Gibson, Charles	1945	Kuo, I.	1941
Gill, George	1946	Kwok, Chung-Mo	1964
Gillam, Eric	1947	Labanauskas, Paul	1944
Giraubit, Georges	1964	Lacrouts, Jean	1958
Girguis, Atef	1970	Lafdjian, Jacob	1951
Given, Frank	1942	Lanz, William	1949
Go, Chong-Hu	1942	Larsen, William	1933
Goehring, E.	1944	Latson, Harvey	1948
Gold, E.	1956	Lau, Kam	1929
Goldstein, Mark	1969	Leeds, William	1943
Goldwasser, Robert	1967	Lejeune, Jacques	1967
Goodell, Howard	1951	Lennox, Stuart	1953
Goodman, Hyman	1938	Lenz, John	1938
Graham, Ralph	1971	Leo, Fiorello	1947
Grange, Jean-Marie	1964	Leonard, Ronald	1959
Grant, Edmund	1930	Leoux, Pierre	1949
Green, William	1940	Levin, Daniel	1942
Grey, Jerry	1952	Lewis, Frederick	1946
Gridley, Horace	1924	Lewis, Stanley	1911
Gross, Arthur	1938	Li, Chung	1950
Grove, Gerald	1969	Liang, Car	1939
Guebert, Wesley	1954	Linton, William	1947
Guillemet, Michel	1959	Liu, Yun	1934
Gutierrez, Arnulfo	1938	Lo, Shih-Chun	1951
Halvorson, George	1946	Lotzkar, Harry	1937
Hamel, Armando	1959	Lovoff, Adolph	1940
Hansen, Raymond	1925	Low, Frank	1938
Hardy, Donald	1949	Lowrey, Richard	1949
Harrington, Walter	1947	Lunday, Adrian	1952
Harrison, Charles	1944	Luo, Peilin	1952
Harshberger, John	1934	Macduffie, Duncan	1956
Harvey, Donald	1941	Majerovicz, Isaac	1970
Hatch, G.	1967	Mampell, Klaus	1943
Hauviller, Claude	1972	Manoukian, John	1947
Hayne, Benjamin	1946	Mantarakis, Petros	1970
Heiman, Jarvin	1949	Marshall, John	1944
Hemmingway, Richard	1959	Martin, Francis	1928
Henry, Irvin	1954	Martinez, Victor	1942
Ho, Chung-Pen	1945	Martinez-Garcia, Mario	1968
Hoge, Edison	1918	Mason, Herman	1948
Holdridge, Douglas	1957	McBreen, Kenneth	1944
Holm, Col. J.	1948	McDaniel, Patrick	1966
How, Kum	1966	McElligott, Richard	1949
Hsu, Chang-Pen	1940	McNeal, Don	1935
Hsu, Chi-Nan	1947	Menis, Luigi	1940
Hsu, Robert	1969	Meyer, Robert	1964
Huang, Ea-Qua	1947	Michal, Edwin	1933
Huang, Fun-Chang	1935	Miles, Kenneth	1930
Huang, Y.	1926	Miller, James	1907
Huber, William	1955	Moise, Norton	1959
Hutchinson, James	1970	Molloy, Charles	1967
Hylton, Frank	1949	Molloy, Michael	1947
Imbert, Nicole	1970	Moorehead, Basil	1947
Ingram, Wilbur	1946	Morane, Didier	1959
Isaacs, Ernest	1960	Moyers, Frank	1930
Jimenez, Herberto	1954	Moyson, Jean	1967
Joffres, Pierre	1960	Muller, Jerry	1933
Johnson, Gary	1967	Neil, Harvey	1923
Johnson, William	1944	Nelson, Julius	1929
Jones, Paul	1937	Nixon, Stanley	1946
Jones, Winthrop	1939	Norton, Frank	1906
Kane, Richard	1943	Oakley, Spencer	1939
Kanus, Karl	1964	Oliver, Edward	1948
Karubian, Ruhollah	1940	Olson, Raymond	1947
Keenan, Robert	1963	Onstad, Merrill	1944
Kelley, William	1930	Orr, John	1947
Kelly, James	1956	Ozkaragoz, Ethem	1944
Kendall, George	1943	Padgett, Joseph	1951
Killian, Roy	1945	Palmiter, Hugh	1958
King, Edward	1943	Parker, Dan	1949
Kitten, Roland	1961	Parnes, Basil	1952
Koch, A.	1933	Paulson, Robert	1950

Perrin, John	1967	Swain, John	1948
Peterson, Frank	1927	Swatta, Frank	1947
Peterson, Roger	1965	Takahashi, Nobuyoshi	1953
Petrulas, Thomas	1949	Tanyildiz, R.	1944
Petty, Charles	1949	Taylor, Garland	1944
Pi, Te-Hsien	1944	Tezduyar, Tahsin	1972
Pines, Barry	1962	Thompson, Russell	1947
Pjerrou, Gerald	1958	Thompson, Wilfred	1925
Potter, Philip	1954	Tileston, Peter	1943
Prasad, K.	1946	Tracy, Willard	1924
Rau, William	1932	Treyer, Andre	1957
Reed, Dwain	1961	Trimble, William	1944
Reimers, George	1941	Taso, Chi-Cheng	1938
Rhett, William	1938	Tso, Wai	1960
Rice, Jonathan	1945	Tung, Yu-Sin	1946
Rice, Winston	1933	Turkbas, Necat	1945
Riddell, Richard	1944	Turteltaub, Matias	1965
Ridlehuber, Jim	1944	Uthoff, John	1957
Ringness, William	1949	Unayral, Mustafa	1944
Rivas, Dagoberto	1935	Uyterhoeven, Willem	1929
Roberts, Fred	1943	Van Hise, Albert	1951
Robinson, Frederick	1941	Van Riper, Dale	1936
Robinson, True	1929	Vanden Huevel, George	1947
Robison, William	1952	Vicente, Ernesto	1943
Roe, George	1948	Vidal, Philippe	1965
Roesch, Louis	1961	Voelker, William	1948
Roesch, William	1949	Waddington, Bruce	1972
Rogers, Berdine	1954	Waits, Harold	1964
Romney, Carl	1945	Walker, Conrad	1925
Rona, Yavuz	1969	Wan, Pao	1947
Rosen, Moe	1936	Wang, Chi-Shin	1970
Roth, Stanley	1959	Wang, Tsun-Kuei	1938
Rouvillois, Xavier	1959	Wang, Tsung-Su	1940
Rubin, Arthur	1960	Warzecha, Wayne	1973
Salbach, Carl	1946	Washburn, Courtland	1943
Samuelson, Lee	1963	Watkins, James	1940
Sappington, Merrill	1947	Watson, James	1938
Savage, Kevin	1969	Weaver, Robert	1941
Sayegh, Samir	1965	Weeks, Richard	1952
Scaevenc, Michel	1967	Wegener, Paul	1971
Schaefer, Brian	1968	Welch, Donald	1955
Schmidt, Howard	1950	Wellman, Alonzo	1947
Schneider, William	1950	Welte, Robert	1950
Scholz, Dan	1943	West, William	1931
Scott, Francis	1954	White, Dudley	1930
Senhouse, Lionel	1964	White, Ray	1957
Serafin, Robert	1966	Whitehill, Norris	1950
Servet, Abdurahim	1937	Whitney, James	1948
Shannon, Leslie	1943	Widess, Paul	1960
Shappell, Maple	1933	Widess, Ruben	1931
Shaw, Thomas	1937	Wiget, Clark	1937
Shepard, Elmer	1946	Wight, D.	1944
Shuler, Ellis	1937	Wilkening, John	1949
Shults, Mayo	1944	Wilkinson, John	1961
Silgado, Enrique	1944	Wilson, Howard	1952
Sledge, Edward	1946	Wilson, Warren	1939
Slusher, John	1948	Wimberly, Clifford	1947
Smith, Harvey	1946	Winniford, Robert	1948
Smith, Lewis	1961	Winters, Edward	1947
Smith, Warren	1933	Winters, Herbert	1954
Snow, Neil	1935	Wiren, Jean	1949
Solehac, Bernard	1965	Wolf, Paul	1944
Solomon, Salim	1949	Woo, Sho-Chow	1931
Spence, William	1956	Wood, Jesse	1943
Spiegelman, Will	1963	Woodbury, William	1938
Srinivasan, Prabandam	1956	Woods, Marion	1948
Stadum, C.	1941	Wright, William	1969
Standridge, Clyde	1941	Writt, John	1944
Stanford, Harry	1944	Wu, John	1963
Steimle, Juan	1970	Yee, Thomas	1974
Stein, Roberto	1944	Yik, George	1944
Stenberg, Gunnar	1958	Ying, Lai-Chao	1947
Stephens, Melvin	1965	Yoshioka, Carl	1931
Stuteville, Joseph	1957	Young, Larry	1936
Summers, Allan	1951	Yui, En-Ying	1941
Sunalp, Halit	1944	Zola, Colman	1941
Sutton, Donald	1952	Zukerman, Abraham	1958

JAMES R. CELONI, MS '75, received his MS in computer science from Stanford this year and has entered the Society of Jesus to study to become a Jesuit priest.

## OBITUARIES

1923

BASIL HOPPER on September 30. During most of his business career he was with Union Oil Company; he retired from the firm in 1949 as vice president for manufacturing. Later he lived in the San Marcos-Fallbrook area and was active in avocado ranching. At Caltech, Hopper helped found the Pharos fraternity. He is survived by his wife, Cecile, and a son, Bill, of San Diego.

1926

JOSEPH MATSON, JR., on September 21. He was retired and a resident of Leisure World, Laguna Hills, California. He served as a reserve officer in the U.S. Army Corps of Engineers for 34 years after four years of active duty during World War II. During his career he was a civil engineer with the territorial government of Hawaii, worked for the Waialu Agricultural

# Films grow up and come to college

by Phyllis Brewster

Going to the movies was once a simple childhood pleasure. Saturday matinees featured Roy Rogers and Trigger and popcorn and Milk Duds — and few social messages beyond the “good guys against the bad guys.”

Today Trigger is stuffed and in a museum in Victorville, California, and the 10-cent admission ticket is long out of print. But films, like the children who watched them, have grown up and gone to college. Caltech students of all disciplines, like their colleagues on campuses throughout the country, sit in darkened lecture halls, studying movies, not only as art forms but also for insights into history, psychology, drama, and social consciousness.

At Caltech the most recent such venture is a course taught this fall

they have fewer preconceptions about it. He insists that an underlying sympathy exists between gifted scientists and gifted artists. “The scientist deals with the ‘new universe’ in technical terms; the artist, in sensual terms,” he says.

Sherman's is not the first course in cinema to turn off the lights at the Institute. In 1972, movie director and producer Frank Capra, BS '18, supported a program for student film making at Caltech. And last spring Roman Gubern of the University of Barcelona came to Caltech to teach his second cinema course here, “Horror Films — A Mirror of the Social Unconscious.”

Robert A. Rosenstone, professor of history, began to use one or two

Hollywood films in 1971 to supplement his freshman history class. The response was so successful that he later joined with Associate Professor of Psychology Louis Breger in a film-oriented course, and with Associate Professor of English Stuart Ende in “History and Literature through Film and Fiction.” Last year, Rosenstone brought forth his first full-fledged film-based contemporary American history course.

“The Hollywood film is a successful tool for helping audiences to understand social and historical issues,” Rosenstone says. “Although the films don't present literal facts, they provide dramatic portrayals of how historic issues — unemployment, Black power, juvenile delin-

quency, war — affect characters who become as real to the viewers as people they know.”

All the film-study courses at Caltech have attracted large enrollments. But the classes are far from being matinee larks for Caltech students. Lots of reading, lectures, and discussions are required in addition to film viewing.

“We need to work as hard to understand and appreciate the many levels of art in films as the artist works to make them,” Sherman says. He believes that, as one of society's newest art forms, films need to be studied, savored, preserved, and protected. From all indications a significant number of Caltech students heartily agree.

## David and Judy Thompson

# A husband-and-wife astronaut team?

They share an office, a profession, a marriage, and the intention of becoming the first husband-wife astronaut team in the U.S. space program.

They are David and Judy Thompson, Caltech graduate students who have been together in separate-but-related careers since high school. Now 23 and 22, they are working on their PhD's in aeronautics, and when NASA accepts the next batch of applications for the astronaut training program, some five years from now, the Thompsons' will surely be among them.

minute-and-a-half flight to a height of 2,000 feet. During the next two years he worked on another vehicle that made several 30-second trips with a monkey aboard.

Judy, in the meantime, was working with transcendental numbers and basic aspects of number theory. (“I never did understand her work,” David says.) They dated, competed for grades, and pursued their different approaches to science.

When Judy graduated from high school in Spartanburg, South Carolina in 1973, David persuaded her to marry him, and to switch her career emphasis to aeronautics.

the tunnel, traditionally solid and immovable, will consist of an array of flexible, computer-controlled, perforated panels, which can be adjusted to simulate the atmospheric conditions of free aerodynamic flow. The concept of the “smart” tunnel has been around for years, Judy says, but only recently has computer sophistication made it possible to build a working model.

David's research concerns advanced rocket engines (“the ones we'll actually be building 20 years from now”), possibly leading to a model that will burn two kinds of fuel and thus eliminate the necessity for the current multi-stage rocket vehicles. David's work is supported by a Hertz Foundation Fellowship, Judy's by a National Science Foundation Fellowship.

Working separately while staying together is nothing new for the Thompsons. Summer jobs since high school have taken them to four different aerospace research facilities where they sometimes have been on different assignments — and sometimes not. At the C.S. Draper Laboratory in Cambridge, Massachusetts, in 1976 they helped develop the space shuttle digital autopilot. Their offices were next door to each other. At NASA's Langley Research Center in Hampton, Virginia (summers 1973, 1974, and 1975) they were on opposite sides of an airfield. Judy's work involved transonic and hypersonic wind tunnels and David analyzed advanced launch vehicles. At JPL, in the summer of 1976, Judy worked on laser picture reconstruction for the Viking project, and David was assigned to landing site selection and surface ranging operations for the Mars lander.

This past summer at NASA's Johnson Space Center in Houston, the Thompsons worked on the space shuttle. Judy analyzed transonic wind tunnel test results, and David performed ascent trajectory analyses for the first orbital flight.

By the time NASA opens up the astronaut application program again the Thompsons will have their doctorates and be ready to apply. If they make it into the astronaut program, they may not only be wedded, and wedded to their work, but also working together outside this world.



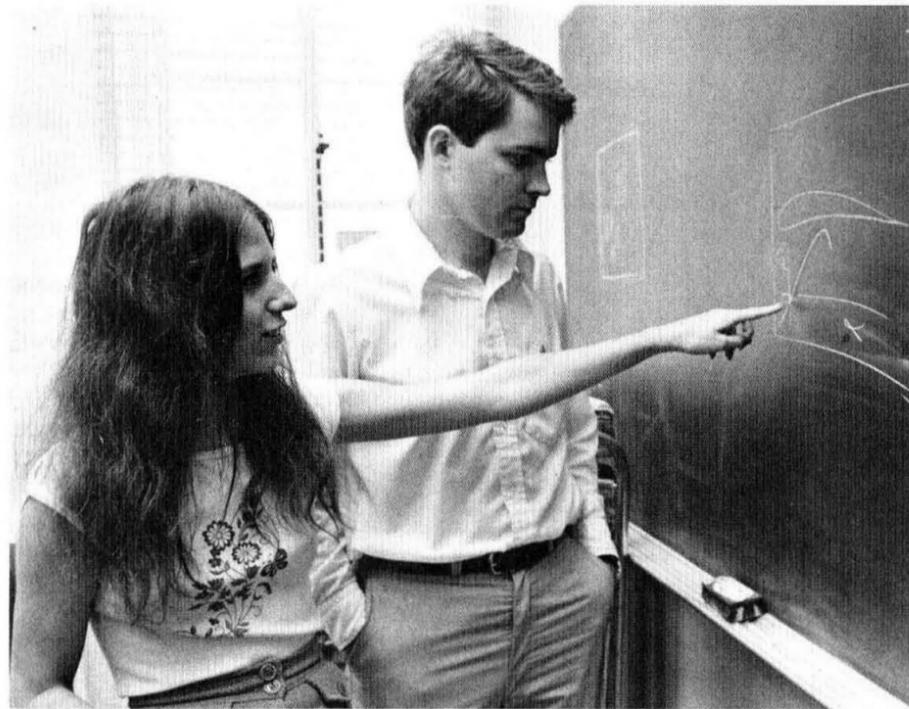
Eric Sherman

by the 37-year-old, award-winning filmmaker, Eric Sherman. Sherman, who directs, edits, writes, and photographs his own films and those of others in cooperation with such noted colleagues as Orson Welles, Felipe Herba, and Robert Edelstein, is the Andrew W. Mellon Lecturer in Cinema at Caltech from September through December. In this role he leads his students and audience through an examination of the emotional and artistic levels in films.

Sherman believes that movies provide rarefied experiences that one can't get from life. In films, the directors express their deepest feelings and most intense viewpoints, reflecting not only their personal selves, but also their reactions to the society in which they live. On the screen they project their dreams and fantasies, including their darker and more destructive visions.

The son of Hollywood feature film director Vincent Sherman, Eric Sherman graduated from Yale in 1968 as Scholar of the House in Film, cum laude, honores. His ten-week course screens the works of some of the country's greatest directors. These motion pictures include dramas, comedies, westerns, adventures, and animation, as well as experimental films in which the directors define traditional values and concepts such as family, space, time, matter, and violence.

Sherman believes Caltech students are particularly receptive to new ideas in film consciousness because they often have had limited exposure to this art medium and therefore



Judy and David Thompson discuss air flow and its relationship to wing design—one of the many interests they share as graduate aeronautics students who are also husband and wife.

Judy and David Thompson are very much at home in the space program. They've spent five years together in aeronautics and astronautics work and education. They also view the world from that space-age perspective that is characteristic of children of the 1950's.

“I was three years old when I saw Sputnik II in flight — the one with the dog on board.” David says. “Now I'm working on the design for a launch vehicle that may take people to an orbiting hotel for the weekend.”

In the fifth grade David built his first rocket engine. In the tenth grade he designed and constructed a rocket that carried two mice on a

Newlywed, they went off to work for NASA at Langley Field, Virginia, and then to school at MIT. There Judy studied aerodynamics, while David emphasized rocket propulsion and space vehicle engineering. Consistent with these interests, Judy was awarded an Amelia Earhart Scholarship and David a Robert H. Goddard Scholarship. Together they built an experimental gaseous bipropellant rocket engine.

Although the Thompsons now share a Caltech office, they work on independent projects. Judy is concentrating on experimental aerodynamics and is building a model of a “smart” wind tunnel for testing aircraft models. The walls of

Paul Ré

# Expressing the art in physics

by Winifred Veronda

What do art and physics have in common? A great deal, says Paul Ré, BS '72, and he has ample reason to know. Since he graduated from Caltech with his degree in physics — near the top of his class — he's been earning his living as an artist, and today his works are in collections around the world.

Ré has set a goal in communicating with his fellow alumni, and that's to help them understand the relationships between science and art. For he feels that when artists or scientists move deeply into their work, they deal with the same reality: life as a natural, evolving process.

Ré emphasizes that it didn't really take too much courage to give up the prospects of an assured career in research physics for an uncertain career in art. He believes the harmony that the physicist and artist encounter permeates all of life, and that he made the only move that would bring his life into tune with this harmony.

Ré had no thought of becoming an artist when he enrolled at Caltech. Here he quickly earned a reputation as a brilliant and dedicated student. "He was quiet and intense," says Professor of Theoretical Physics Kip Thorne, "one of our most brilliant physics students."

"He was an interesting person with tremendous capabilities," says Professor of Chemical Engineering Frederick Shair, who worked with Ré in a teaching laboratory for two years and sometimes took him home to dinner. "A brilliant student, he put incredible pressure on himself to achieve. He'd work well into the night to finish a project that he could have spread over a couple of days."

A resident of Dabney House, Ré concentrated almost exclusively on physics. "Besides teaching myself to play the guitar — and occasionally playing for friends — I didn't do much but study. Playing the guitar and walking were virtually my only outlets," Ré says. "Physics was very important to me."

"I'd make some changes in the way I lived as a student if I could do it over. I'd take more advantage of the extracurricular activities on the campus. I could have learned a lot from those activities that would have made life easier later on."

Through the late Caltech Professor of Philosophy Charles E. Bures, Ré learned of the Oriental philosophy of Taoism, which teaches that a person can find happiness through bringing his own personality into balance with the basic principles of nature. He made this philosophy an essential part of his life and a basic factor in his motivations; he continues to do so today.

What impressed Ré most about physics as he studied it at Caltech was its harmony and simplicity. These qualities stirred traits that had always been part of him: the need to work with his hands, and a consciousness of small, beautiful compositions that occurred in nature. He spent the summer before his senior year in his home state of New

Mexico, experimenting with different art media and deciding to concentrate on pencil drawings. He came back to school determined to become a professional artist.

"He'd been a rather moody young man before," says Shair. "He seemed a lot happier after that summer."

Ré committed himself to his decision with the intensity that he brought to his scientific work. He completed his Caltech degree, and then he took a job in Caltech's engineering laboratories, working for Shair and for Professor of Mechanical Engineering Rolf H. Sabersky on pollution control projects. Over a ten-week period he earned \$1,500 and he saved all of it.

"Now," says Ré, "I had enough money to spend all of my time teaching myself to be an artist."

He moved to Berkeley where he vows that the money stretched over two years as he developed his artistic style and became established in professional art circles. "I lived frugally," he admits.

"Ré could manage it if anyone could," says Shair. "He had a great deal of self discipline."

In Berkeley Ré found life in the professional art milieu less harmonious than the processes he discov-



Paul Ré

ered at work in physics and in his own creative life. "I didn't know what I was getting into," he acknowledges.

But he persevered, and gradually his work found increasing success. Today it is regularly exhibited at Gumps in San Francisco and is found in collections in many countries. His art has found a special acceptance in Japan where Ré has a good client. Income flows to an artist in an erratic and unpredictable manner, but Ré is content, and he can call on his self-discipline for back-up when necessary.

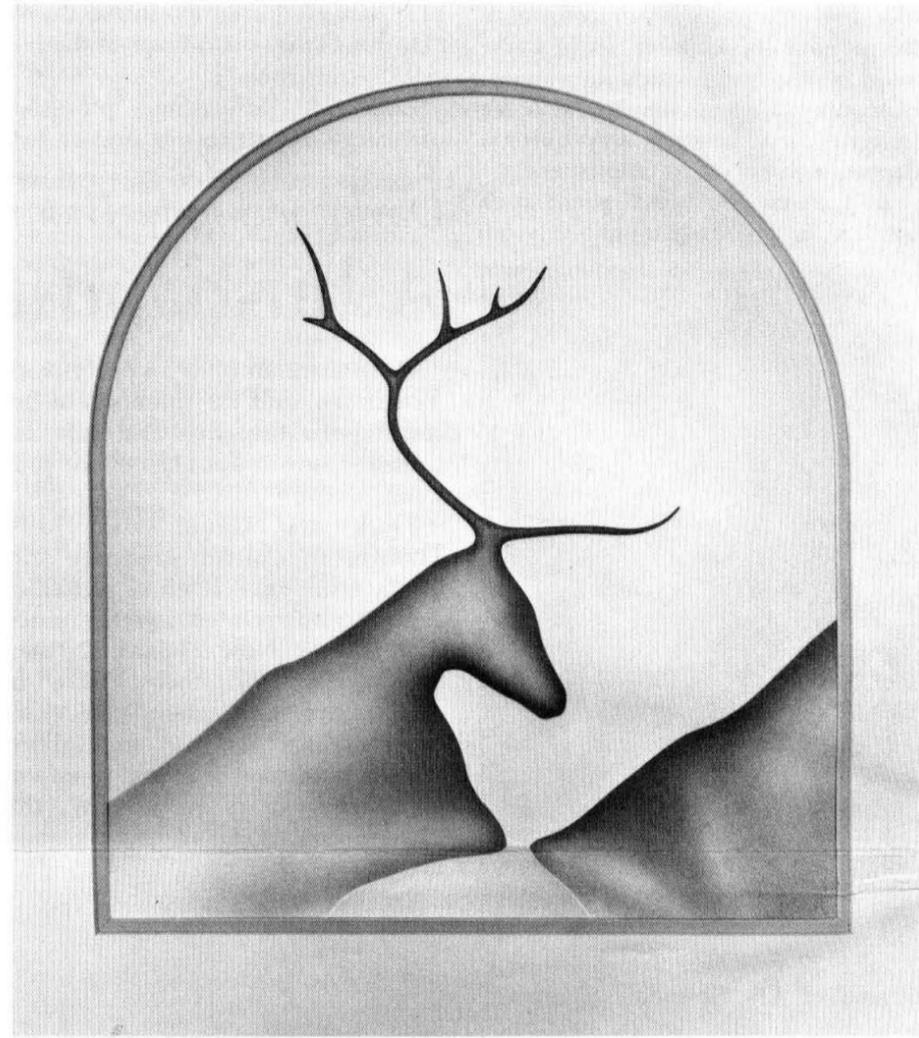
Recently Ré moved back to New Mexico where he can live quietly, close to nature. There he continues to develop a style that he believes expresses in a visual way the processes at work in physics.

"In the processes of physics and of art there are strong parallels," he says, "a feeling of continuity, an orderly evolution, a simplicity and precision. When a physicist immerses himself in his work, he eventually reaches a level where his efforts become highly intuitive. I believe that all great physicists treat their work as an art."

In his style, he says he tries to bring into play the principles that he acquired in his physics studies. He removes all details that aren't absolutely essential and emphasizes a clarity in meaning. "I try to present the beauty of physics in a visual manner," he says. "Many people enjoy my work, but I believe that people who understand physics can appreciate it even more."

dull his artistic insight. But if he appreciates the beauty of his discipline, then studying it will make him more artistically sensitive, and will refine his insights and capabilities."

Ré has no regrets about his decision to shift careers. But then he really doesn't feel that he has made a shift. "I planned to become a research physicist," he says, "and what I do now is research in form,



Harmony and simplicity characterize both art and physics, according to Paul Ré. Ré, who majored in physics at Caltech, expresses his artistic style in this pencil drawing, "deer," now in the collection of James Freeman.

Does the study of science encourage artistic awareness in a person? Ré says that depends on the individual's motivations. Ré believes, "If the person's interests focus on the power to be derived from technical knowledge, then scientific work may

with the results presented as drawings and paintings."

And so Ré feels that when art and science are done with understanding, they are not separate, but, rather, are both concerned with the natural unfolding of life.

## Solar cells' efficiency increased

Caltech chemists have developed a device that can capture and concentrate the rays of the sun more efficiently than lenses or other devices currently in use. The invention promises to solve some of the thorniest problems faced by researchers who are attempting to increase the efficiency of silicon cells that convert sunlight into electricity.

Its developers are Ahmed Zewail, assistant professor of chemical physics; graduate student Barry Schwartz, and Terry Cole, a Fairchild Scholar visiting Caltech from the Ford Motor Co.

The device consists of a sheet of transparent plastic permeated with several kinds of special fluorescent dyes. When sunlight shines onto the plastic sheet, molecules of dye absorb light rays that are outside the range of wavelengths that can be

efficiently absorbed and changed into electricity by the silicon cells. These dyes then transfer the energy into other dyes within the plate. These dyes reemit the light that is close to the narrow wavelength band that the silicon cells use most efficiently.

The light that is reemitted is concentrated, by internal reflection, on the edge of the plastic sheet. Then a silicon solar cell at the edge of the concentrator receives an intense flux of light at wavelengths that it can use efficiently to produce the electricity.

"The device is called the "multiple-dye planar solar concentrator." It enormously increases the efficiency of the solar cell's ability to convert sunlight into electricity over that of a solar cell in bright sunlight with no concentrator.