

## Thorne believes

# Cygnus X-1 X-ray source probably is a black hole

Evidence strongly suggests that the powerful X-ray source in Cygnus X-1, a double star system within the Milky Way Galaxy, is a black hole, according to a Caltech scientist.

In a recent issue of *Astrophysical Journal Letters*, Kip Thorne, Caltech professor of theoretical physics, and Richard H. Price, assistant professor of physics at the University of Utah, describe the X rays emitted from Cygnus X-1. The scientists have compared these X rays with those that, theoretically, the double star system should be emitting if it is really a black hole, and they have reached their conclusion.

"I'm about 80 percent convinced that Cygnus X-1 contains a black hole," Thorne said.

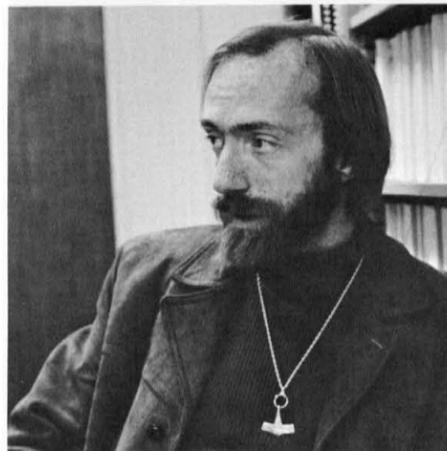
The name "black hole" has been given to a phenomenon that has yet

to be proved but that scientists believe exists: the remains of a huge star that collapsed inward with tremendous velocity when it exhausted its nuclear fuel. The remains of such a star would be very small—about 50 kilometers, or 30 miles, in diameter—with as much mass compressed into its very small volume as that contained in 30 suns.

A black hole would have such tremendous gravity that nothing—not even a beam of light—could ever escape it; hence its name.

Thus far, black holes have existed only as a theoretical concept. Because they emit no light, scientists deduce their existence through their effects on matter, particularly other stars. The strong X-ray source in Cygnus X-1 is the most likely candidate that has yet emerged.

Astronomers are in general agreement that black holes exist, not as single objects, but as silent partners in binary, or double, star systems. Cygnus X-1 is one such system. It consists of a large, visible star and an unseen X-ray source about one-tenth as far from the star as the earth is from the sun. The two are linked gravitationally and the periodic eclipse of the visible star would seem to suggest that they orbit about a common center every 5.6 days.

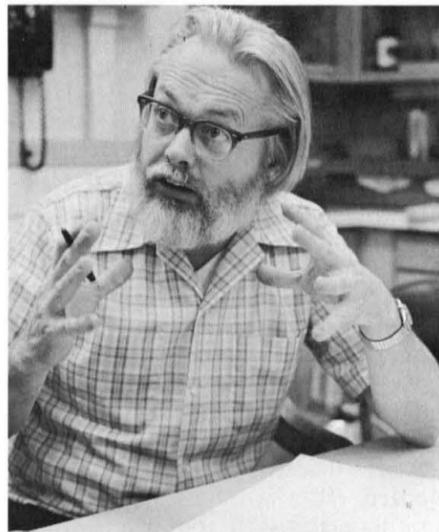


Kip Thorne

Theoretically, black holes with companion stars are strong emitters of X rays. The dark object in Cygnus X-1 is one of the strongest emitters of X rays in the sky, and, Thorne estimates, is eight times more massive than the sun.

Some of the observed characteristics of X rays emitted from Cygnus X-1 are in agreement with the most widely accepted theory on the behavior of X rays associated with black holes. For example, it is believed that the gas particles in the disk become more excited as they spiral in toward the center of the black hole and encounter increasingly strong magnetic fields. As the particles speed in, the space between them should decrease, and a large quantity of high-energy X rays should be emitted.

Analyses of X-ray measurements gathered by a variety of sensors aboard satellites, rockets, and balloons, Thorne said, point to precisely such conditions in Cygnus X-1.



James A. Westphal

## Westphal designs energy-saving fluorescent tube

An electricity-saving device designed by a Caltech scientist to conserve power on campus may soon become available for commercial production.

The fixture, a "phantom" fluorescent tube, was developed by James A. Westphal, associate professor of planetary science and staff member of the Hale Observatories. The tube can cut the energy consumption of a standard two-tube light fixture by 62 percent, while reducing the fixture's amount of illumination by only 58 percent.

Westphal designed the special tube at the request of the committee working to conserve power on campus. The committee noted it was necessary to turn off entire fluorescent fixtures to save electricity because there was no way to decrease the amount of light emitted by individual units.

"A spotty, unpleasant pattern of illumination results from turning off alternate units," Westphal said. "But in many locations, a fixture emitting only 40 percent of its lighting capacity can still provide the necessary illumination."

Most fluorescent light fixtures contain a pair of tubes. Because they are wired to operate in series, if one tube is removed the other will not light. The phantom tube, which looks like a real one, is substituted for one of the pair in a fixture. The phantom, which fits into the real tube's sockets, contains a capacitor or condenser, which maintains the circuit.

Thus far, about 120 prototype phantom tubes have been built in Caltech's physical plant department and installed on campus. Some of these have been in use for over a year.

The Institute has applied for a patent on the device, Westphal said, and plans to license the patent for commercial production.

"The capacitor has considerable potential as an energy saver," he said. "Because of the rapidly rising cost of electricity, companies are becoming increasingly concerned about reducing their power consumption. If the tubes can be made available at a reasonable price, I believe they will be used."

## Brown: alumni career patterns are changing

Brown bags in hand, Caltech students and a few inquiring members of the administrative staff gathered in the Y Lounge one recent lunch hour to hear Harold Brown talk about his job as Caltech president and to ask him questions. Of particular interest to many of them was the relationship between Caltech faculty and students, and the career outlook for graduates.

Students are good for the Caltech faculty, Brown emphasized.

"Students are a constant, visible reminder to the faculty that other people in the world are at least as bright as they are, and this keeps them on their toes," he said.

In implanting career goals, Brown said, the faculty tends to try to replicate itself by producing research scientists, but this pattern is changing.

"Today, the faculty recognizes that fewer academic jobs are available, and that a larger proportion of Caltech students are entering careers in government or industry. This trend is necessary because of the many problems that must be solved if the human race is to survive."

He said that the trend is evident in the percentage of students who go on to graduate school. In 1965, 84 percent of Caltech students went on to graduate school after receiving their BS degree; in 1974, that figure had dropped to 56 percent.

"In part, this decline may be due to the fact that more graduates are delaying their entry into graduate school until after a period of employment," he said. "But in part it represents a diversity in career objectives."

"I would be sorry to see too great a shift on the part of our graduates away from research science, but I am not sorry to see some shift because the balance needs changing to meet external needs," he said. "And I am convinced that a well-trained technical person can receive satisfaction from applied work or from nontechnical work that requires an applied background."

Brown said that another indication of diversity in career goals on the part of Caltech graduates is the number of those who are going on to graduate work in medical or business school.

## Alumni Seminar Day speakers are announced

"Askers, Seekers, and Knockers, and the National Cancer Program" will be the title of a talk by Jonathan E. Rhoads, M.D., at the general session of Alumni Seminar Day on Saturday, May 17. Rhoads is director of the department of surgery at Pennsylvania Hospital, and is nationally known for his work in the field of cancer.

Previewed on page three are Seminar Day talks to be given by faculty members.

The new Seeley G. Mudd Building of Geophysics and Planetary Science, completed in October, will be open throughout the day. Of special interest to visitors are recorders in the lobby of the Mudd Building that register telemetered data from three seismic stations in California, instruments that measure both Moonquakes and Marsquakes, the Ross McCollum Space Photography Library where photographs of space missions are on display, and The Helen and Roland W. Lindhurst Laboratory of Experimental Geophysics.

In this laboratory, alumni can view the light gas gun. This instrument is used in experiments to gain information about the behavior of rocks and minerals under tremendous temperatures and pressures.

A special session has been designed this year for sons and daughters of alumni who are interested in applying for admission to Caltech. They will take part in campus tours, and in conferences with members of the admissions staff.

Luncheon will be served picnic style in the Athenaeum. A social hour will be in the Athenaeum at 5:30 p.m., followed by dinner at 6:30 p.m. The Caltech's Women's Glee Club, the Chamber Singers, and the Varsity Quartet will perform in Ramo Auditorium at 8 p.m.—providing an ideal way to end the day.

## Chemical society honors Vaughan

Robert W. Vaughan, 33, associate professor of chemical engineering at Caltech, has won the Fresenius Award of the national honorary chemical society, Phi Lambda Upsilon. Selection is made by a committee of eminent scientists.

The award, presented to scientists under 35, is given in recognition of "outstanding contributions to chemistry through research, education, or administration in pure and applied chemistry."

*With student help:*

## Alumnus designs devices for the deaf

To help the deaf keep in touch with those who can hear is the newest priority for a small company that has been formed by a Caltech alumnus with the help of a Caltech student.

Glenn F. Hightower, BS '72, MS '73, 25, and John S. Denker, 20, a senior in electrical engineering at Caltech, operate the Aph Technological Consulting Company, a firm that was conceived to match Caltech's student talent with short-term technological needs of business, industry, and the scientific community. Hightower described the students as "an enormous reservoir of expertise."

The firm's involvement in work on devices for the deaf sprang from conversations with an orthodontist, Dr. James C. Marsters, who has been totally deaf for as long as he can remember. These talks resulted in Hightower and Denker's designing some of the equipment that deaf people really need.

One of the firm's major projects is a small teleprinter by which a deaf person can telephone someone who has a similar device. An extensive network of teleprinters already exists throughout the country, but most of the machines are surplus mechanical

models that have become obsolete.

The teleprinter being built by Aph is an electronic device designed primarily for personal use, and it will be more convenient to use than existing models. A nearly complete prototype weighs about 16 pounds, and its designers say that it is compact and easily portable. It will also be much quieter than the old-fashioned teleprinters now in use.

"The deaf are not bothered by the racket made by the old machines," Hightower said, "But members of their families certainly don't appreciate the noise."

Denker is working on some of the circuit design for the new teleprinter in his Caltech electronics class.

He and Hightower are concerned with ways to hold down the cost of the unit. "Deaf people, as a group, are not wealthy," Hightower explained. "We want to build things for them at a cost they can afford."

Another device being developed by Aph is a signaler that will flash lights on and off throughout the house in response to a signal from a telephone, doorbell, kitchen timer, or an alarm. The pattern of the blinking lights on the signaler indicates which device is its source.

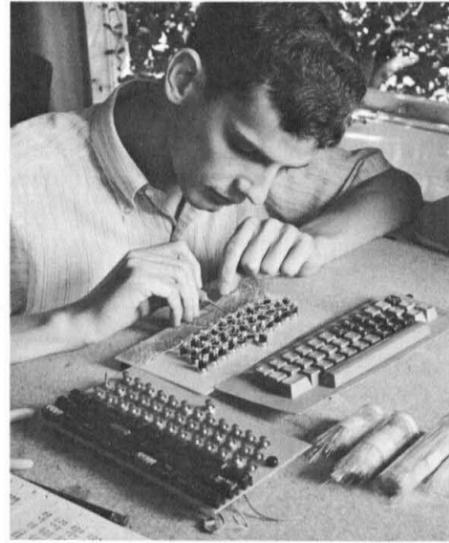
A series of devices to help the deaf develop more pleasing voice quality

is also under consideration by Aph. Deaf people tend to speak in the nasal tones picked up by their hearing aids, and it is difficult for them to feel how their voices sound, Hightower said. "We have some ideas for devices that will help them to feel and see their voices."

Vibrations from a chest transducer or a microphone could be picked up and displayed on an oscilloscope, or converted into vibrations that a deaf person would be able to feel through a hand instrument.

"The history of deaf people has been filled with attempts to sell them instruments that those who can hear think they need," Denker said. "But the deaf have a different attitude toward language than the hearing, for they think in paragraphs and abstract terms rather than in words. By relying heavily on advice from Dr. Marsters, we hope to create instruments that effectively meet these special needs of deaf people."

Hightower and the Caltech students in his employ have also taken on such jobs as computer programming or designing and building electronic systems and subsystems. Two of their recent projects have been a liquid nitrogen flow monitoring system and a computer data acquisition interface.



Glenn F. Hightower constructs a teleprinter with which a deaf person can communicate with another deaf person using a similar device.

## Fowler: APS vice president

William A. Fowler, PhD '36, Institute Professor of Physics, has been elected vice president of the American Physical Society. He will automatically assume the presidency in 1976.

Fowler is involved in research on nuclear forces and reaction rates, nuclear spectroscopy, the structure of light nuclei, thermonuclear sources of stellar energy, the synthesis of chemical elements in stars and supernovae, and the study of general relativistic effects in quasar and pulsar models.

He has twice been awarded a Guggenheim Fellowship to the University of Cambridge, England, and has served on many governmental agencies dealing with scientific activities, including those of the National Science Board, National Science Foundation, National Aeronautics and Space Administration, Office of Naval Research, and Atomic Energy Commission.

### Notice of Annual Meeting:

NOTICE IS HEREBY GIVEN that pursuant to the bylaws of the Alumni Association, California Institute of Technology, the annual meeting of the members thereof will be held Thursday, the nineteenth day of June, nineteen hundred and seventy-five at 6:00 p.m. at the Athenaeum, 551 South Hill Avenue, Pasadena, for the purpose of receiving results of the election of officers and directors and for the purpose of transacting any and all business that may properly come before such meeting of the members.

RAYMOND L. HEACOCK, BS '52, MS '53, President

P. DOUGLAS JOSEPHSON, BS '65, Secretary

### CALTECH NEWS

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*At Founders' Day dinner:*

## Gnomes balance tradition, change

*by Winifred Veronda*

"Sergeant at arms, examine all present to see that they are Gnomes in good standing, or honored guests. Make fast the portals."

"Mr. President, all are qualified to remain and the portals are secure."

Repeating a formula that originated 78 years ago, the Gnomes, members of Caltech's first social organization, opened their annual Founders' Day Dinner, and carried on a tradition begun in 1897.

Tradition and heritage are important to the Gnomes, but flexibility and change are priorities of equal strength. The traditional greeting to "Brother Gnomes" this year was addressed to "Brother and Sister Gnomes," for the club has elected its first women members.

"In its present form, the Gnome Club is an organization of graduates dedicated to the welfare of the Institute," said President Oliver H. Gardner, BS '51. "Each year, the Gnomes elect to membership students who have been leaders on campus as well as high achievers academically. Once women were admitted to the student body and became active in its events, it was inevitable that some would become members."

The Gnomes broke with another tradition this year; for the first time wives and other guests were invited to join the club members for dinner. "Do you say that every year?" one wife whispered to her husband as she heard the ritual words that opened the meeting.

Warm memories of past years at the Institute were exchanged. Honorary alumnus Robert L. Daugherty, professor of mechanical and hydraulic engineering, emeritus, recalled the days when Einstein visited the campus, and the crowds of people who congregated around his home. Daugherty described how Einstein confounded a reporter who had slipped into a closed meeting, masquerading as a physicist, and found



Elmer E. Frey, BS '07, the oldest member to attend the Gnomes' Founders' Day Dinner, said he only recently retired from his business as a consulting engineer because his customers wouldn't let him quit. With Frey are Gnome President Oliver H. Gardner, BS '51, and Lisa Anderson, BS '74, one of the first three women to be initiated into the organization.

a seat in the front row. Einstein proceeded to give his address in German, all the while staring fixedly at the reporter, who was forced to pretend he understood every word.

And there were memories of an era without parking problems, of driving down the weed-lined lane that was Wilson Avenue to park under the old oak tree beside Dabney Hall—an area that met most of the parking needs of the entire Institute.

Of all the campus fraternities, only the Gnomes continue to initiate new members, and thus maintain the organization as a vigorous group of alumni. Its members have been among Caltech's most enthusiastic and hard-working graduates.

About 65 Gnomes attended the dinner, representing the club's 649 members scattered throughout the world. The oldest member present was Elmer E. Frey, BS '07, the 97th person to be initiated into the Gnomes. One of the youngest was senior Gregory L. Simay, who was elected to membership last year.

Members brought pictures showing the club's beginnings in Throop Polytechnic Institute, through the

days of the fraternity houses on Euclid and Madison Avenues, up to the time when Caltech disbanded the fraternities in 1931 and the student Gnomes became members of Ricketts House.

Elected to office at this year's meeting were: Oliver H. Gardner, BS '51, president; Peter S. Blumfield, BS '68, vice president; Hiroshi Kamei, BS '51, MS '52, secretary; Russell Pinizzotto, BS '72, treasurer. Directors are: Cornelius J. Pings, BS '51, MS '52, PhD '55; James E. Pearson, BS '67, MS '68; Fred A. Wheeler, BS '29; and Willis K. Drake, Jr., BS '70.

To conclude the meeting, Wheeler J. North, professor of environmental science, gave a slide talk about his kelp research. The lengthy and spirited question-and-answer session that followed demonstrated the zest for the new in scientific developments among the oldest of those present.

"The hour for closing is upon us." With still another traditional sentence, the Gnomes concluded one more Founders' Day Dinner—at which pride in Caltech's past and keen anticipation of its future had been clearly demonstrated.

# Seminar Day talks previewed

## Satellite Photography and Computers: New Views of the Earth

Alexander F. H. Goetz, manager Planetology and Oceanography Section  
The Jet Propulsion Laboratory  
The Earth Resources Technology Satellite (ERTS) with its four-color camera has produced spectacular pictures of much of the surface of the earth. These pictures are useful for many purposes, including mineral exploration, geologic mapping, and monitoring of water quality. In many cases, computer processing is the key to the extraction of useful information.

## The Universe—Open or Closed?

James E. Gunn  
Professor of Astronomy  
One of the outstanding questions in the study of dynamics and structures of the universe is that of the mean density of matter—which determines both the geometry of space and the ultimate fate of the universe. Will the universe ultimately stop expanding and collapse, or will it expand forever? A variety of arguments from many fields of astrophysics suggest that the density is very low and that the universe will go on expanding indefinitely.

## Oxygen Transport by Real and Synthetic Blood

Harry B. Gray  
Professor of Chemistry  
The problem of how oxygen is carried in the blood has been studied at Caltech for 40 years. Our own red-blood protein, hemoglobin, which contains iron, has been of the greatest interest. However, red-purple and—shades of Star Trek's Mr. Spock!—copper-based blue blood proteins also have been examined. Recent work has provided reasonably good synthetic copies of the iron and copper parts of all three blood proteins. Our current understanding of oxygen transport by both real and synthetic blood will be discussed.

## Do We Need Airline Regulation?

Michael E. Levine  
Luce Professor of Law and Social Change in the Technological Society

The air fare from Boston to Washington (406 miles) is \$45. The fare from Los Angeles to San Francisco (355 miles) is \$20.25. Why? If you fly from San Antonio to Dallas, you must pay \$32 if you buy your ticket outside Texas. But if you buy it in Texas, you can fly for \$25 or even \$15. Why? An economist estimates that the minimum Los Angeles-New York fare is \$123. But the airlines charge \$180. Why? The higher ticket prices are brought to you by the U.S. Civil Aeronautics Board, which protects airlines at your expense. Why not go back to free competition?

## The Chances of Being Lucky

Gary A. Lorden  
Associate Professor of Mathematics  
Gamblers wait anxiously for a run of luck that will expand their small stake into a large bundle of money. Statisticians abhor so-called "lucky runs" because they often lead to wrong conclusions. Some new methods have been developed by which the chances of being lucky can be calculated. These methods can help gamblers choose what to bet on and how much to bet. They also aid statisticians in their design of accurate tests.

## New World of Computers

Carver A. Mead  
Professor of Electrical Engineering  
Modern integrated circuit technology has given us the ability to create data-processing hardware at only 1/10,000th its cost ten years ago. The challenge of the next decade will be to use this rapidly evolving technology to create machines more transparent to system designers and more friendly to system users than those to which we have become accustomed.

## Nature, Nurture, and Nerve Cells

John D. Pettigrew  
Assistant Professor of Biology  
One of the oldest philosophical questions concerns the relative contributions of heredity (nature) and environment (nurture) to human perception. New insights into this question can be gained from the study of individual nerve cells in the visual brain of animals. Many of the specialized properties of these nerve cells are dependent upon particular aspects of the visual environment present during a critical period of early post-natal life. The insights gained from the physiology of a single nerve cell have recently been used to define the critical period for binocular vision in humans.

## The Mythical Mojave-Sonora Megashield: California's Link to the Atlantic Ocean?

Leon T. Silver  
Professor of Geology  
Long-term Caltech studies of the geological history of the continental crust along the Pacific margin of the United States and Mexico have suggested, unexpectedly, the former existence of an ancient fault zone (megashield), longer and with greater displacement than the modern San Andreas fault system. By a jig-saw puzzle approach, the most ancient blocks of the crust of southwestern North America can be theoretically re-assembled. The hypothesis would tie this fault movement to the early opening of the Atlantic Ocean when North America broke away from a former supercontinent about 150-200 million years ago. Efforts to test this hypothesis are continuing, partly because of its implications in the search for mineral deposits in the Pacific borderlands.

## A New Automobile Engine for the 1980's and 1990's?

R. R. Stephenson  
Systems Analysis Section Manager  
The Jet Propulsion Laboratory  
The technology of a variety of alternate engines has been examined and compared with the conventional internal combustion engine. It has been found that during the next five to ten years,

the emissions problem can be alleviated and savings in fuel consumption can be obtained as the result of vehicle changes and engine improvements. During this period, the development of advanced engines should be pursued, for these alternate engines can save an additional 30 percent of our scarce liquid fuel and substantially reduce exhaust emissions.

## Twenty-Four Hour Clocks in the Nervous System

Felix Strumwasser  
Professor of Biology  
Most of our knowledge of the way in which nerve cells carry out their special functions has been gained from research on invertebrates and lower vertebrates which have unique giant nerve cells and synapses. Twenty-four-hour clocks in particular nerve cells have been directly measured and investigated. They are known to control sleeping and waking in certain animals and are likely to affect other behaviors, such as reproduction, feeding, and migration.

## How Does Chinese Writing Work?

Nicholas W. Tschoegl  
Professor of Chemical Engineering  
Why does a nation of 700 million use a seemingly impossibly difficult script? It turns out that there is logic in what appears to the uninitiated to be a mere jumble of strokes. There is also an intimate connection between the Chinese script and Chinese language and art.

## How Close Are We to Accurate Earthquake Prediction?

James H. Whitcomb  
Senior Research Fellow in Geophysics  
Research on methods and effects of earthquake prediction has expanded greatly in the past two and a half years at Caltech. Major observation programs, using sophisticated measurement techniques, have been initiated in southern California. All of these techniques measure parameters that are believed to change before earthquakes. The primary goal is to develop and confirm a working physical model with which the prediction of at least some types of earthquakes can be successfully accomplished.



Eleanor Helin

## Science prompts search for Eros

It was science, not love, that prompted Eleanor Helin, Caltech researcher, to look for Eros. And her search was successful.

In January, Eros, the asteroid that is named after the Greek god of love, flew closer to the earth than at any time in this century. A brick-shaped rock about 35 by 16 by 7 kilometers (23 by 10 by 4½ miles), Eros circles the sun every 1.76 earth years in an elliptical orbit. The asteroid made its closest approach—14 million miles away—on January 22.

Helin photographed Eros with the 18-inch Schmidt telescope at Palomar Observatory, a facility of the Hale Observatories that are operated by Caltech and the Carnegie Institution of Washington. The miniplanet was at 8th magnitude—a little too faint to be seen with binoculars—and was in the constellation of Gemini.

Although small in size, Eros is one of the most notable of the celestial bodies. When it was near the earth in 1900-01, and again in 1930-31, it was used to determine the distance from the earth to the sun and was a key tool in developing the parallax geometric yardstick for measuring distances to the planets and nearer stars. It was discovered in 1898.

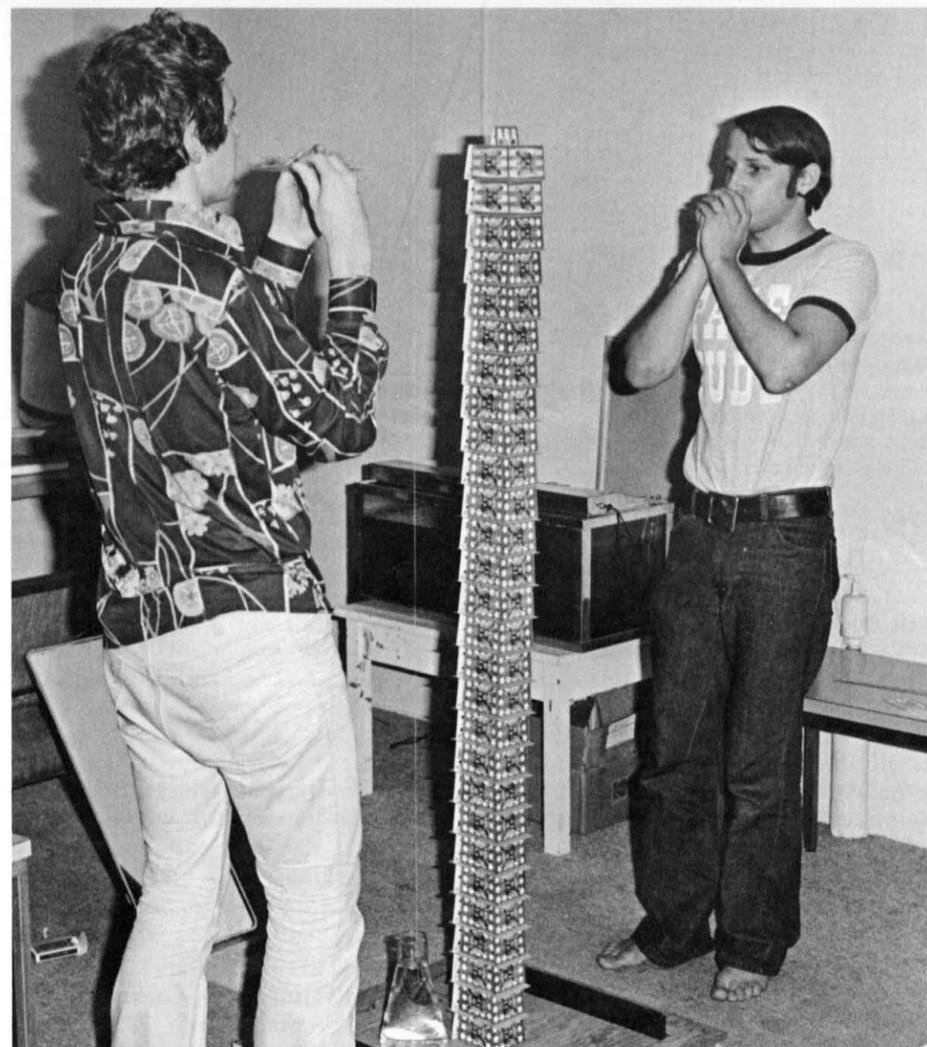
As it orbits close to the earth, scientists at several observatories are studying the composition, shape, and texture of Eros by means of infrared, radar, and spectroscopic equipment.

## British society gives Gold Medal to Greenstein

Jesse L. Greenstein, Lee A. DuBridge Professor of Astrophysics at Caltech, has been awarded the Gold Medal of the Royal Astronomical Society of Great Britain. One of the oldest honors in its field, the medal dates back to 1824.

According to the Royal Society, Greenstein was honored for his "outstanding contributions to astrophysics and his leadership in the department of astrophysics at Caltech." In particular, the Society stressed the importance of Greenstein's astrophysics work concerning the determination of abundances in various kinds of stars and the nucleosynthesis of elements, the study and classification of white-dwarf spectra, and the analysis of physical conditions in supernovae, quasars, and other astronomical bodies.

He was also recognized for his "outstanding leadership of the brilliant school of astrophysics at Caltech" and for his important work in planning future requirements for ground-based astronomy in the U.S.



Seniors Ted Z. Michon, left, and David B. Novikoff, right, decided they'd like to set a world record. As they looked through the Guinness Book of World Records, they discovered that the height record for a house made of playing cards was 27 stories. Two days later, after much experimentation and many failures, they had built a house of cards that was 28 stories tall. The completed structure stood more than five and a half feet high and contained 224 cards. Twice the tower collapsed at 27 stories; a videotape showed that it wasn't straight enough. Novikoff said, "If we had failed on our last try, we were going to start using lasers to align the stories."

# PERSONALS

1926

VICTOR F. HANSON, after retiring from the du Pont Company as director of engineering physics research, established a research laboratory at the Henry Francis du Pont Winterthur Museum in Delaware in 1969. He recently received the William Meggers Award from the Society for Applied Spectroscopy for his paper, "Quantitative Elemental Analysis of Art Objects by Energy-Dispersive X-Ray Fluorescence Spectroscopy," which appeared as a featured article in the September-October issue of *Applied Spectroscopy*.

1929

THOMAS H. EVANS, MS '30, writes that he is now retired from Fresno State College where he was a professor in the school of engineering and that he and his wife spent most of January and February on an extended tour of Australia and New Zealand. "We covered the east coast of Australia from Sydney north to the Great Barrier Reef by car. This included two days on the Reef at Heron Island. The New Zealand part of the journey was a leisurely motor coach tour of both islands. The south island has particularly spectacular scenery with its glaciers, fiords, and high, rugged mountains. The many hydropower projects were especially interesting. Of the 64 million sheep in New Zealand, I believe we saw at least 50 million. The north island is principally beautiful pastoral land. The trip was well worth the long flight down under."



Edward A. Flinn



Leland R. Gardner

1938

HARPER Q. NORTH is in charge of the electronics area of the Naval Research Laboratory in Washington, D.C.

1943

W. LARRY COLLINS was selected new city manager of East Detroit, Michigan. He was formerly deputy city manager of Battle Creek, Michigan.

1949

ARTHUR O. SPAULDING, MS '58, is regional general manager of the Rocky Mountain Oil and Gas Association in Denver, Colorado. He was formerly petroleum administrator for the City of Los Angeles.



Max V. Mathews



Amos Levin

1950

MAX V. MATHEWS, director of the acoustical and behavioral research center at Bell Laboratories, Murray Hill, New Jersey, has been elected a fellow of the Institute of Electrical and Electronics Engineers. Mathews was cited for his advances in the analysis, synthesis, and recognition of speech and the generation of musical sounds by computer and electronic methods.

JAMES R. WILCOX has been elected director of the Association of Iron and Steel Engineers. Wilcox is chief engineer at the Los Angeles plant of Bethlehem Steel Corporation.

1951

LELAND R. GARDNER, MS, has been promoted to manager of the Pacific Gas and Electric Company's rate department in San Francisco, California. He is a member of the American Society of Civil Engineers.

1956

RICHARD H. SMALL received his doctorate from the University of Sydney, Australia, in 1973, and was recently appointed lecturer in the university's school of electrical engineering.

1958

HUGO B. FISCHER, MS '63, PhD '66, is professor of civil engineering at UC Berkeley.

1959

JOHN R. RICE, PhD, has received the George E. Forsyth Award for his contributions to numerical mathematics. He has been professor of mathematics and computer science at Purdue University since 1964, and, in addition, has recently been appointed editor-in-chief of a new journal, *ACM Transactions on Mathematical Software*, of the Association for Computing Machinery.

1960

EDWARD A. FLINN III, PhD, has been named director of lunar programs in the office of space science at NASA Headquarters, Washington, D.C. The lunar programs office is responsible for scientific exploration of the moon, involving analysis and interpretation of lunar data obtained from manned and automated space flights and planning of future missions.

1961

ALEXANDER F. H. GOETZ, MS '62, PhD '67, is manager of planetology and oceanography at JPL and is researching the use of earth-satellite data for reconnaissance purposes in mineral exploration.

1962

ERNEST R. SEYMOUR, AE, executive assistant and senior aide to the vice chief of naval operations in Washington, D.C., has been promoted to the rank of rear admiral.

1964

DAVID HOLTZ has been appointed assistant director of Butler University's Holcomb Research Center. He will be involved in environmental affairs programs.

1965

AMOS LEVIN is assistant controller of Eastern Gas and Fuel Associates. Based in Boston, Massachusetts, the major operations of this diversified energy company are in the bituminous coal, gas utility, river and ocean barge, and coke industries.



Ernest R. Seymour

1966

ALDEN D. HOLFORD is an attorney with the firm of Burns and Levinson, Boston, Massachusetts, and specializes in civil litigation. He received his JD degree from Harvard in 1973.

RICHARD ROCKE, PhD, is a senior staff engineer at Hughes Aircraft Corporation in Fullerton, California.

1972

ALAN M. BREAKSTONE received the master's degree in physics at UC Santa Cruz in December 1973.

NELSON (NICK) E. BRESTOFF, MS, writes, "I will receive my JD degree from USC Law School in June and will go to work for the Los Angeles city attorney, Burt Pines, after graduation."

## OBITUARIES

1922

HAROLD S. OGDEN in February. Ogden was retired after working 43 years as an engineer in General Electric Company's locomotive and car equipment division. He was a fellow of the Institute of Electrical and Electronic Engineers. Ogden is survived by a daughter and a son.

1931

CARL A. WEISE on September 11, 1974. He was a project engineer in advanced design with the McDonnell Douglas Corporation.

1938

ALBERT E. JURIS, JR., in February. Juris was associated for many years with the Stand and Jurs Company, a Berkeley engineering firm, and for the past five years he was owner of the Capricorn gourmet food stores in San Francisco and Mill Valley, California. He is survived by his wife, Charlotte, a son, and five daughters.

1945

JOHN B. LYON, JR., of cancer on February 24. He was an assistant program manager on the technical staff of the Hughes Aircraft Company in Culver City and Canoga Park, California, where he participated in

the development of sophisticated defense systems. He was a member of the American Physical Society. Lyon is survived by a sister.

1946

EDWARD E. CARR on September 20, 1974. He was chief meteorologist with R. Dixon Speas Associates of Manhasset, Long Island, New York.

1947

RICHARD B. SMALL, MS, on October 30, 1974. He was an engineer with Texas Instruments of Dallas.

1949

FRED G. ROSICKY, MS, of a heart attack on February 10. He was a research chemist for Duart Manufacturing Company in San Francisco.

1957

WILLIAM T. BRADY, JR., MS, on January 16 of acute pulmonary congestion. He was retired due to illness.

1962

GUY J. LAFONT, MS, on February 15.

## ALUMNI EVENTS

May 16

*Reunion, class of 1950.* Campus tours, 4 p.m.; cocktails, 5:30 p.m., the Athenaeum courtyard; dinner, 6:30 p.m., the Athenaeum. Husbands and wives are invited.

May 30

*Reunions, classes of 1955, 1965, and 1970.* Campus tours, 4 p.m.; joint cocktail hour, 5:30 p.m., the Athenaeum courtyard; dinners in separate dining rooms at the Athenaeum, 6:30 p.m. Husbands and wives are invited.

June 1

*Reunion, class of 1940, 2-5 p.m., at the home of Millard W. Jacobs, BS*

*'40, 1625 Kinneloa Mesa Road, Pasadena. Husbands and wives are invited.*

June 6

*Reunion luncheon, class of 1925.* Induction into the Half Century Club, 11:30 a.m., the Huntington Sheraton Hotel, as guests of the Alumni Association. Wives and guests are invited.

*Reunions, classes of 1930, 1935, 1945, and 1960.* Campus tours, 4 p.m.; joint cocktail hours, 5:30 p.m., the Athenaeum courtyard; dinners in separate dining rooms at the Athenaeum, 6:30 p.m. Husbands and wives are invited.

## CALENDAR

*Wednesday, April 16,* Ramo Auditorium. PERSPECTIVES lecture series: "Behavior Under Stress" by David Hamburg, Sherman Fairchild Distinguished Scholar, Caltech. Free.

*Monday, April 21,* Beckman Auditorium. THE EARNEST C. WATSON CALTECH LECTURE SERIES: "Earthquake Prediction Behind the Iron and Bamboo Curtains," by Clarence R. Allen, professor of geology and geophysics. Free.

*Friday and Saturday, April 25 and 26; and Thursday, Friday and Saturday, May 1, 2, and 3,* Ramo Auditorium. SPECTRUM PRODUCTION 8: An English version of Marivaux's "The Game of Love and Chance."

*Saturday, April 26,* Beckman Auditorium. MARY COSTA, lyric soprano, in a varied repertoire ranging from Vivaldi to Dvorák.

*Sunday, April 27,* Beckman Auditorium. COLEMAN CHAMBER MUSIC CONCERT: Amsterdam's Amati String Quartet performs the music of Bartók, Reicha, and Schubert.

*May 1, 2, and 3—Same as April 25 and 26.*

*Friday, May 2,* Beckman Auditorium. THE UNITED STATES ARMY CHORUS in concert, in conjunction with The Intercollegiate Music Council Seminar hosted at Caltech. Free.

*Saturday, May 3,* Beckman Auditorium. THE BIG SING, a multi-choir song fest, featuring men's glee clubs from several universities, in conjunction with The 1975 Intercollegiate Music Council Seminar.

*Friday, May 9,* Beckman Auditorium. MICHAEL LORIMER, classical guitarist.

*Saturday, May 10,* Ramo Auditorium. THE CALTECH WIND ENSEMBLE, under the direction of James Rötter, in The Hunter Mead Memorial Concert. Free.

*Monday, May 12,* Beckman Auditorium. THE EARNEST C. WATSON CALTECH LECTURE SERIES: "Developing the World: Investment or Charity?" by Robert W. Oliver, associate professor of economics. Free.

*Saturday, May 17,* Ramo Auditorium. SPRING JUBILEE, the annual spring concert of the Caltech Glee Club, presented this year by the Caltech Women's Glee Club directed by Monica Roegler. Other performing groups include The Chamber Singers, The Apollo Singers, and The Varsity Quartet.

### Placement Assistance To Caltech Alumni

The Caltech Placement Service may be of assistance to you in one of the following ways:

- (1) Help you when you become unemployed or need to change employment.
- (2) Inform you of possible opportunities from time to time.

This service is provided to alumni by the Institute. A fee or charge is not involved. If you wish to avail yourself of this service, fill in and mail the following form to:

Caltech Placement Service  
California Institute of Technology  
Pasadena, California 91125

Please send me: (Check one)

- An application for placement assistance.  
 A form indicating a desire to keep watch for opportunities although I am not contemplating a change.

Name .....

Degree(s) ..... Year(s).....

Address .....

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