

**JESSE L. GREENSTEIN
1909 – 2002**


Jesse L. Greenstein, the DuBridge Professor of Astrophysics, Emeritus, died last October 21, three days after falling and breaking his hip. He was 93.

Greenstein grew up in New York City in a family that encouraged his scientific interests. He entered Harvard at the age of 16, where he earned his bachelor's degree in 1929 and master's in 1930, and (after a stint in his family's real estate and finance business during the Depression) his PhD in 1937, with a thesis on interstellar dust.

It was as a 16-year-old undergraduate at Harvard that he met his wife, Naomi, who died earlier last year after a marriage of 68 years. At the memorial service in Dabney Lounge February 11, Professor of Astronomy Anneila Sargent, who presided, noted that "we're here to combine our memories to make a lasting picture of a remarkable man and a remarkable life." And, she added, "It's hard for many of us in this room to say just 'Jesse'; it's often Jesse and Naomi."

After Harvard, Greenstein joined the University of Chicago's Yerkes Observatory, first as a postdoc and after 1939 as a member of the astrophysics faculty. When he came to Caltech in 1948

to organize a new graduate program in optical astronomy in conjunction with the new 200-inch Hale Telescope on Palomar Mountain, he brought a lot of Yerkes with him. At the memorial service, Donald Osterbrock, now professor emeritus at UC Santa Cruz and Lick Observatory, recalled "how he was a product of his 11 years at Yerkes Observatory." Greenstein built the Caltech department, mostly out of Yerkes PhDs, one of whom was Osterbrock, who came in 1953. "Jesse was my first boss . . . Best boss I ever had," he said.

Osterbrock illustrated his remarks with slides of meetings and conferences from the '30s and '40s showing the young Greenstein with most of the great names in early 20th-century astronomy. "As a young student, postdoc, and junior astronomer, Jesse was inspired by all those research scientists, but in his turn, he inspired a whole new generation of outstanding research astronomers and astrophysicists here at Caltech," he said.

Robert Kraft, who, like Osterbrock, is professor emeritus at UC Santa Cruz and Lick Observatory, surveyed briefly Greenstein's lifetime of work ("just about everything in astrophysics"), published in more than 400 papers. This work ranged from his initial interests at Harvard to his turn toward high-resolution stellar spectroscopy at Yerkes, the famous project from 1957 to 1970 on abundances of the elements, and later, after he "retired," his study of white dwarfs. Kraft noted Greenstein's generosity on the issue of author order on papers: "In most of the abundance papers, Jesse is almost always not the first author; he generally stepped aside, permitting his younger colleagues to have their place in the sun.

"Jesse was one of the great

figures of American astronomy in the 20th century," said Kraft, who, as a Mount Wilson observer in the '50s and '60s, had "family status" at Caltech during what Kraft referred to as the "famous days of the Mount Wilson and Palomar Observatories."

Jerry Wasserburg, the MacArthur Professor of Geology and Geophysics, Emeritus, recalled meeting the Greensteins in 1955 when he was a new assistant professor. "The hospitality in the Greenstein home was fabulous," he said, with both Jesse and Naomi offering a "liberal education to us technocratic characters to improve our view of life"—an education in things like art and wine.

Lunches at the Athenaeum also remained firmly in Wasserburg's memory—Greenstein's elegant Schimmelpfennig cigarillos and Willy Fowler's cheap mentholated cigars; Greenstein turning over the placemats: "He would pull a pen out from his vest immediately upon any argument and cover the placemat with incisive calculations, where numbers in many powers of 10 would appear and disappear in some wonderful juggle. And you were trying to follow it from across the table."

Wasserburg mentioned Greenstein's view of the famous paper on element abundances by Burbidge, Burbidge, Fowler, and Hoyle, popularly known as B²FH: "The B²FH business was full of conflicts for Jesse. He knew and thought this was all-important, and he was a big supporter and contributor to that effort. But having a bunch of nuclear physicists who did not know any *real* astronomy say where the elements came from, which he had been measuring, while he was trying to measure them and at the same time trying to educate these nuclear physics savages into real

astronomy, was painful to him.”

Besides nuclear physics, Greenstein was also interested in radio astronomy. Marshall Cohen, professor of astronomy, emeritus, who joined the Caltech faculty in 1968, noted that Greenstein wrote a paper on radio astronomy in 1937 while he was a grad student at Harvard, in the days when most optical astronomers were indifferent to the field. This changed, said Cohen, in 1951, when a compact radio source was first identified with a distant galaxy. “This excited Jesse, and he began to lobby the Caltech administration to set up a radio astronomy program,” he said.

“Jesse organized the famous conference at the Carnegie Institution in Washington, in January 1954,” recounted Cohen. “That meeting catalyzed the founding of the National Radio Astronomy Observatory and Caltech’s Owens Valley Radio Observatory. OVRO was dedicated in 1958 and quickly became one of the premier institutions in the country.”

Greenstein also played a part in the discovery of quasars. Maarten Schmidt, the Moseley Professor of Astronomy, Emeritus, recalled the fateful afternoon exactly 40 years ago when he suddenly discovered that the spectrum of a radio star, 3C273, showed a redshift of 16 percent. “I was stunned,” he remembered. “Could this bright star really be at a distance of a billion light-years? Pacing back and forth, I saw Jesse in the hallway and told him what had happened. After a while Jesse got his observations on 3C48 [the first discovered radio star], and in 10 or 15 minutes, we succeeded in finding that it had a redshift of 37 percent. We made so much noise in discussing the consequences that Bev Oke came in to find

out what was happening. We tried to find alternative explanations that would not require a redshift at all, but we failed. By the end of the day, the three of us were off to the Greenstein house, where Naomi was astounded when we all had a stiff drink. That was the beginning of quasars in astronomy.”

About the article they subsequently wrote, Schmidt said, “Some of the parts Jesse wrote are breathtaking, even to me. . . . I think it was probably the most exciting scientific venture in his life.”

Radio astronomer Anneila Sargent, who had been a graduate student during Greenstein’s reign, pointed out that he was “way before



his time” in bringing in female grad students. “There were more women in astronomy by percentage than in most of the other divisions at Caltech. Jesse was often teased about it,” she said. She was also Greenstein’s research assistant for a number of years and collaborated on his 300th paper. Sargent is a past president of the American Astronomical Society, as are Osterbrock, Kraft, and Schmidt.

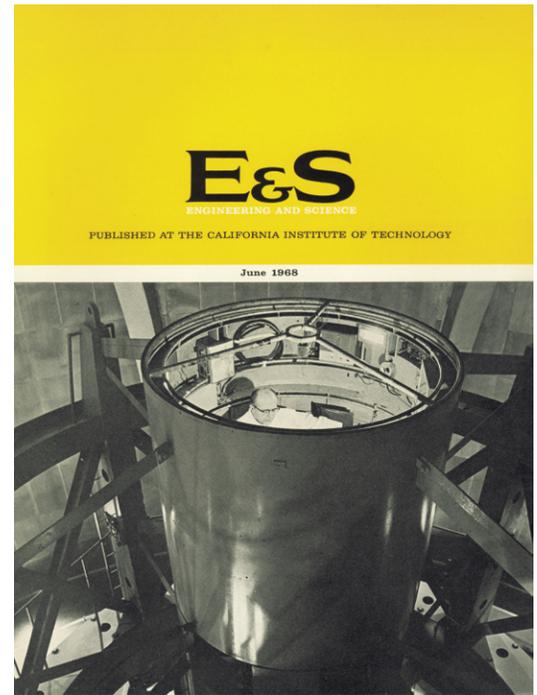
Greenstein also loved music and art. His younger son, Peter, spoke at the memorial of growing up in a household filled with all kinds of classical music, but “in the latter part of my father’s life, he narrowed his interests down to chamber music, lieder, and opera,” he said. He admired the string quartets of Hayden, Mozart, and Schubert, but reserved his highest reverence for those of Beethoven, especially the last quartets. Peter then introduced a quartet of string players, who performed the *Cavatina* movement of Beethoven’s Quartet no. 13, op. 130. His brother, George, noted later that this movement is included on a

disk headed for space aboard Voyager 1 (see page 17).

Greenstein owned an extensive collection of Japanese paintings and prints and was a member of the board of trustees of Pasadena’s Pacific Asia Museum. David Kamansky, director of that museum, spoke of how they had become fast friends through their mutual interest in Japanese painting. Greenstein gave most of the collection that was displayed in his home to the Pacific Asia Museum when he and his wife moved into a retirement home with far less wall space.

“The final gift of paintings from Jesse, his favorite ones, was given only a few months before his death,” said Kamansky. “He’d kept them to enjoy, under his bed, where he would take them out for anyone interested in seeing and talking about them. He told me he enjoyed them for many years, but now it was time to place them in the public trust, where they would be enjoyed by generations to come and studied and learned from.”

Kamansky noted a particu-



larly favorite painting of Greenstein's. "The signature says 'Katsushika Hokusai, an old man mad about painting.' And I think of Jesse in the same way."

Elder son George Greenstein, also an astrophysicist, remembered his mother's Playreaders, a group she helped found, and noted that astronomy played only a walk-on role in the Greenstein home: "It made just brief appearances in the family life. It was certainly important, but maybe not that important."

George Greenstein said that his father "loved observing. It's very sad nowadays that people don't really observe." And he quoted something his father had written about astronomical observing: "This is not a normal way of life. Very few people in the world do the same thing, but for all my unknown colleagues in some other dawn on another mountain, thoughts will be similar. There is a deep content at having been awake with the universe, at watching the faint glow of some part of it. Possibly I have tonight even asked it an important question."

He also remembered a question he had asked his father very late in his life about a "dirty little secret of science": "What do you do if you just can't do it, if you don't know how to solve that problem? And what he said, very quietly and peacefully, was, 'I always knew I could do it.'"

Granddaughter Ilana Greenstein recalled a number of anecdotes of the grandfather she had gotten to know well only as a teenager, having grown up on the opposite coast. "Jesse lived his life in a state of constant anxiety, constant friction, constant discontent," she remembered. "He was a dark, complicated, dazzling

person, but there was a sweetness to him."

She talked about the last time she saw him, last July, when, uncharacteristically, "he didn't seem to need time to rest. And it was the first time I had ever seen Jesse at peace. He wasn't worried; he wasn't anxious; didn't have any interest at all in the things that had always dominated his conversation before. He didn't want to talk about politics or the stock market or the space-time continuum or his memories of the past. He just lay back on his pillows, smiling and relaxed, and all he wanted was to hear us talk. He seemed to be happy, happy to be fading out of the world, secure in the knowledge that it would spin on in all of its joy and mystery without him. He looked contented for the first time I can remember." □ —JD



WHEELER J. NORTH 1922 – 2002

Wheeler J. North, professor of environmental science, emeritus, died on December 20. He was 80.

Born in San Francisco, North moved with his family soon afterward to San Diego, where he began exploring tide pools at the age of seven. He also developed an early interest in kelp beds, which would turn out to be his life's work.

North received his first BS (in electrical engineering) from Caltech in 1944, then returned to Pasadena after the war to earn a second one, in biology, in 1950. His MS and PhD are from the University of California (1953). After several years at Scripps Oceanographic Institution, he returned to Caltech in 1962, first as visiting professor of biology, then as associate professor of environmental health engineering, and finally as professor of environmental science.

Although he taught a popular marine biology course (among others) on campus, North spent much of his time working out of Caltech's Kerckhoff Marine Laboratory in Corona del Mar, studying the complex ecosystem of the giant kelp (*Macrocystis pyrifera*) off the California coast. He determined that the kelp beds were shrinking as sewage fed the sea urchin population, which in turn fed on the kelp. He also studied the effect of humans on kelp, in particular the warm-water discharge from the San Onofre nuclear power plant, which deterred kelp development; and oil spills, an environment in which kelp thrive. He devised techniques for restoring and farming kelp forests.

North was one of the pioneers of scuba diving for scientific research, making his first dive in 1949. He purchased one of the first 10

Aqua-Lungs sold in the U.S.; since wet suits did not yet exist, he put on woolen underwear.

In 1972 North described his work to *National Geographic*: “At day’s end, I often relax by lazily roaming the upper branches of the tall forest where I work. Creatures bizarre and beautiful swarm about me. Overhead, the tangled foliage almost obscures the daylight. But I need no tree climbing irons; only swim fins. The air I breathe is carried on my back. I am a scuba forester and the ‘trees’ I tend are giant vine-like streamers from the ocean floor off Southern California.”

A memorial service was held on February 22 at the Ocean Science Center in Dana Point, where friends, colleagues, students (including five of his ten PhD students), and family gathered to reminisce and “tell Wheeler stories.” Chuck Mitchell, president of MBC Applied Environmental Sciences, who organized the occasion and presided over it, told of meeting North in 1955, after lying about his age (“I told everyone I was 16”) to get a summer job at Scripps. “He was unique,” said Mitchell. “He had life-changing, life-directing effects, and we probably didn’t even know it at the time. We have all been spread over time and space, and I’m glad that we have the opportunity to get together here today to compare notes on this phenomenon.”

Mitchell, who was also one of the pioneer divers, recalled his friend’s optimism, curiosity, and patience; the “stratigraphy” of his desk, files, and storerooms. With slides as illustrations, he reviewed some of North’s familiar characteristics (to much amused laughter): his early, self-made diving gear, his shoes with flapping soles, the patches on his wet suit (he used to hold his suit together

with bits of old underwear), his string of decaying, uncared-for automobiles and boats, and an ancient tuxedo with a hole in the knee (“he was going to paint his knee but got the hole mended”).

Jim Morgan, the Goldberger Professor of Environmental Engineering, Emeritus, had a very clear memory of his “job seminar” as a prospective faculty member in 1965: “Sailing along talking about particles and polymer chemistry and God knows what else, I happened to look down at the first seat in the front row, only to see Wheeler sound asleep! I wondered, was my future academic fate already sealed?” He was assured by a colleague afterward that Wheeler always slept through seminars (“I think it’s all that scuba diving”), and “that was the beginning of a 38-year beautiful friendship.” And reciprocity—“Wheeler would sleep through most of my seminars, and I would sleep through his.”

Morgan noted North’s “visionary pursuit of an idea for ‘kelp farms’ for energy generation,” and another idea (on which Morgan had collaborated as an aquatic chemist) for forming carbon dioxide hydrate solids in seawater, which North envisioned as a potential process for storing carbon dioxide from combustion in power plants in deep coastal waters. Morgan also showed slides, including the *E&S* cover shown on the previous page, and the 1972 *National Geographic* cover (“when very few people were even using the words ‘environmental science’”); also pictures of North “obliterating sea urchins with a hammer,” introducing new Caltech undergrads to his ice chest full of sea creatures at Freshman Camp, and dressed in a tuxedo as Morgan accepted the Clark Award three years ago.

Another pioneer diver, who became Scripps’s diving officer and helped spread the techniques of scientific diving, was North’s friend Jim Stewart. He joined Scripps as a volunteer diver in 1952 and helped start the kelp study project with North—“over the years we’ve moved a lot of kelp.” He told anecdotes of storms and rescues in the *Orca*, a converted yacht, and fishing for dinner off the back of the boat. “Wheeler and I worked together on a lot of projects, conducted an awful lot of studies, and had a lot of fun,” said Stewart.

One of his fondest memories was what Stewart called the “Tampico days.” In 1957, the *Tampico Maru*, a 360-ft. tanker out of San Pedro, went one degree off course, and “put that thing right up there on the rocks at 4 a.m.,” spilling about 20,000 barrels of diesel oil into a small cove. North and his team arrived soon thereafter to study what happened to the marine life and found that the oil killed all the animals that grazed on the kelp, allowing a vast kelp forest to flourish. North and his colleagues studied its growth, and published the first data in 1964 and several papers thereafter.

“Compared to other spills,





the *Tampico Maru* was right up there with them—huge,” said Alan Mearns, senior staff scientist with NOAA (National Oceanic and Atmospheric Administration). “It was the largest diesel spill on the West Coast and the first spill followed by longterm biological monitoring.” Before leaving for NOAA’s oil spill team in Seattle, Mearns had worked with North in the ’70s on the Southern California Coastal Water Research Project, surveying the coast for water pollution from Point Conception to the border.

When Mearns and North ran into each other again in 1997, Mearns realized what a wealth of data North had collected in the aftermath of the *Tampico Maru*. “This was an important spill because it was a diesel spill. We had very few cases of documented diesel spill and effects, and here we had 20 years of documented study.” North got his unpublished data together, and NOAA will shortly publish a technical memo under North’s name on the 20-year history of records from the *Tampico Maru*. “I have to help finish this particular part of the story that Wheeler began,” Mearns concluded.

Lee Peterson, BS ’64, MS

’66, PhD ’74, was a graduate student of North’s, whom he credited with the inspiration to learn to fly, as well as dive (flying was another passion of North’s). He fondly recalled flying out to a site, diving, then getting on the airplane again and going up to 10,000 feet. “That’s really a no-no,” he said. “Sometimes my nails were getting blue.” He spoke of towing kelp plants from Newport to Palos Verdes and tying them to chains underwater. The air in the crew’s tanks lasted about 45 minutes, “but Wheeler would be out for two hours on one tank,” said Peterson. “To this day, I don’t understand how he could last so long. But he was so relaxed, and he loved being down there so much, maybe he just didn’t breathe.”

North’s family joined in the remembrances. Brother-in-law Dennis Moyer (whose remarks were read in his absence by his wife, Elizabeth Best Moyer) offered his own “brushstroke” to the other “elegant, revealing, and often humorous brushstrokes that create this most personal portrait of Wheeler.” Moyer remembered North’s “impishly fine wit” and “loved the fullness and patient clarity with which he answered my questions about his work.”

He also noted his selfless devotion to their mother-in-law toward the end of her life. “I, we, will be eternally grateful for his singular sense of familial duty, friendship, and love.”

North’s wife, Barbara, described the “family airplane.” When he couldn’t get anyone else to photograph the kelp beds from the air, “he went and bought an airplane,” and Barbara got her own pilot’s license before she would set foot in it. When he realized that it’s hard to take pictures from a low-wing plane, North “cut two huge holes in the bottom of the plane, one under each seat, so you could look down. I don’t think the FAA ever knew what we had done to this plane.”

Like several of the other speakers, Barbara had met Wheeler at the Scripps student summer program, where she also dove to study the kelp beds and hung around to spend thousands of hours underwater. Eventually, “Wheeler incurred the displeasure of some of the senior research staff at Scripps by pointing out to them that perhaps it was more effective to actually go into the kelp bed and study it instead of sitting on a boat deck and speculating about it. Caltech understood that perhaps the

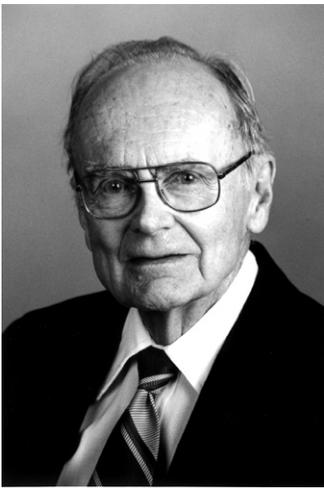
direct approach was better and stole him away from Scripps. He was forever grateful about that.”

“When I was a kid,” said North’s son, also named Wheeler, “if you were going to do something with Pop, that meant that you got stuck in the back of an [open] truck on top of a big pile of gear and ropes, and you were tied in and spent four or five hours watching the world go by backwards. And eventually, you got to some really neat place and spent a couple of weeks running around, but learning a lot about life and science.” His father, he said, exuded happiness and brought out happiness in others: “We would walk down the street, and people would walk by and just start smiling.”

Wheeler North, Sr., loved limericks, so his son read a long limerick that he had composed for the occasion, “A Poem of a Sort about Wheeler J. North,” which began: “There once was a man named Whee/ Deep secrets he teased from the sea. . . .” and went on to tell the story of his father’s life in numerous, humorous stanzas.

At the end of the ceremony, it was announced that the Southern California Academy of Sciences was establishing the Wheeler North Award for Scientific Excellence. “The recipient of the Wheeler North Award will have demonstrated commitment to research that emphasizes the Southern California area and a commitment to the Southern California scientific community.” □ —JD

**WILLIAM R. SEARS
1913 – 2002**



William Rees Sears, one of Theodore von Kármán's earliest and most renowned doctoral students at Caltech, died on October 12, 2002, in Tucson, after a brief illness. Sears held the position of Emeritus Professor of Aerospace Engineering at the University of Arizona at the time of his death.

Sears was born on March 1, 1913, in Minneapolis, the son of William and Gertrude Sears. He earned his BS degree from the University of Minnesota in 1934. Following the recommendation of his advisers, he moved to Caltech to study under Theodore von Kármán, who, five years earlier, had agreed to become the permanent director of the Guggenheim Aeronautical Laboratory (GALCIT). Upon his arrival, he was struck by the person-

alities and the warmth of von Kármán and his secretary, Mabel Rhodes. He worked diligently for the first and married the second. These two individuals, in their own ways, greatly influenced his life and career. Sears was awarded his PhD in 1938, writing a remarkable thesis concerning airfoils in non-steady motion, a classic work that laid the foundations for future developments in that field.

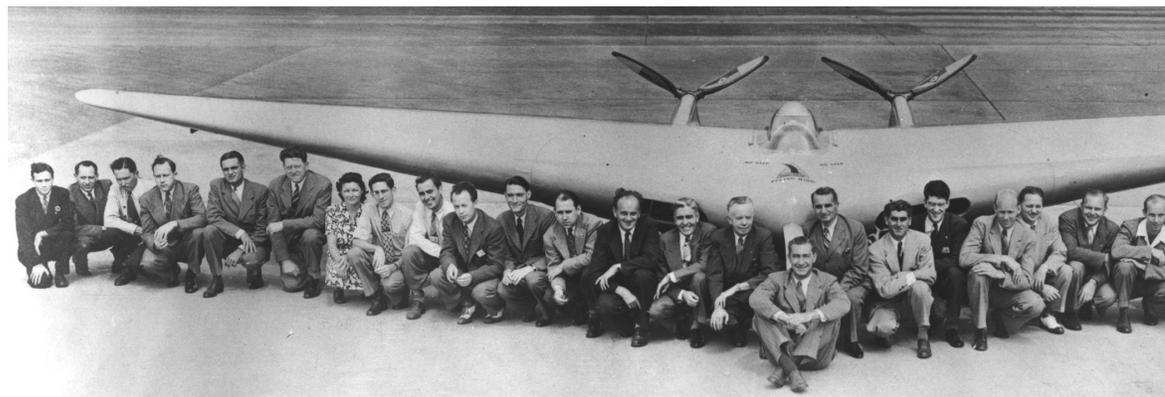
In 1937, Sears had been appointed instructor in aeronautics, and in 1940, he was promoted to assistant professor. Through von Kármán's friendship with Jack Northrop, Sears became involved in some of the aerodynamic problems at Northrop Aircraft Corporation, and in 1941, with the United States' entry into World War II becoming more evident, Sears accepted Jack Northrop's offer to be chief of aerodynamics and flight testing.

The next five years at Northrop presented an abundance of opportunities for Bill, but none more exciting than heading the team that designed the first Flying Wing aircraft and the P-61 (the so-called Black Widow). Near the end of the war, Bill was appointed, as a civilian expert, to a Navy group that was to visit and debrief German engineers and scientists. He did not mention to the Navy that he was a naval

reserve lieutenant; if he had, he would have traveled under much less comfortable circumstances than he did.

Despite Jack Northrop's strong assurance that he had a bright future in industry, Sears chose to return to academic life in 1946. He joined the faculty of Cornell University as the founder and first director of its Graduate School of Aeronautical Engineering. Bill's technical excellence and magnetic personality assured his success in building an outstanding faculty and in attracting a highly competent and devoted student body. Within a surprisingly few years, the Cornell Graduate School of Aeronautical Engineering was ranked among the world's best. He and his many students pioneered research in wing theory, unsteady flow, magnetohydrodynamics, and sophisticated wind tunnel design to study transonic flight. For many years, the administrative team of the GSAE consisted of Sears and his highly capable and unflappable secretary, Alice Anthony. He remained very close to von Kármán, who was a frequent visitor to the Cornell aero school. In 1962, he was named the J. L. Given Professor of Engineering, and in 1963, he decided it was time for a change and stepped down as director of the aero school after 17 years. In 1962, he founded and became director of Cornell's Center

Northrop engineers pose with the first Flying Wing in September 1943. Sears is fourth from right. Von Kármán is just to the right of the nose of the plane.



of Applied Mathematics.

After 28 years at Cornell, Sears joined the faculty of the department of aerospace and mechanical engineering at the University of Arizona in 1974. Four years later, he was named emeritus professor but remained an active faculty member and completed much of his important analytical and experimental work on adaptive-wall wind tunnels during these years.

Sears was a member of the National Academy of Sciences, the National Academy of Engineering, the American Academy of Arts and Sciences, and Mexico's Academia Nacional de Ingeniería. He was an honorary fellow of the American Institute of Aeronautics and Astronautics and was editor of the *Journal of the Aeronautical Sciences* from 1955 to 1963. During his lifetime, he received many honors and awards, including the Guggenheim Medal and the Prandtl Ring of the German Aeronautical Society. In 1988, Caltech gave him its Distinguished Alumni Award. He was also named an outstanding alumnus of the University of Minnesota and was awarded an honorary doctorate from the University of Arizona.

When Sears was a junior faculty member at Caltech, he was asked to direct the Civilian Pilot Training Program, a federal program that offered young people the possibility of earning a private pilot's

license and receiving preparation for possible military flying in the event that the United States entered the war. Bill not only administered the program but took the opportunity to get his own license. Although his work at Northrop offered him little opportunity to fly, his move to Ithaca provided the incentive. In more than 50 years as a private pilot, he logged 8,000 hours before retiring from flying in 1990. He owned several small airplanes over the years, the last one his beloved Piper Twin Comanche.

Sears was also an accomplished musician, first as a percussionist. He worked his way through college as a drummer in dance bands and, after moving to California, was tympanist with the Pasadena Symphony for a couple of seasons. Later, at Cornell, he became an expert recorder player with a university group interested in medieval music. He played with the Collegium Musicum at the University of Arizona for 20 years.

He is survived by his wife, Mabel, of Tucson; their daughter, Susan Sears, of Indianapolis; son, David Sears, of Bethesda, Maryland; and grandchildren Colin and Shelby Sears, of Portland, Oregon. He also leaves many friends, colleagues, and former students, whose lives he touched and enriched.

William Rees Sears cast a bright, stimulating, and cheerful light on countless people around the world, a light that will be sorely missed. □

*Frank E. Marble,
Hayman Professor of Mechanical
Engineering and Professor of Jet
Propulsion, Emeritus*

Faculty File



Niles Pierce, assistant professor of applied and computational mathematics, was awarded the 2003 Richard P. Feynman Prize for Excellence in Teaching, which carries a cash award of \$3,500 and an equivalent raise in salary.

According to the citation: "He teaches without oversimplifying and without intimidating, making the material accessible to the diverse group of students. He possesses an uncanny ability to anticipate the frustrations and challenges of the students, and has been able to hold the students' attention, and attendance, throughout the quarter."

HONORS AND AWARDS

Paul Asimow, assistant professor of geology and geochemistry, has been selected to receive the F. W. Clarke Award, which "is given to a young scientist in recognition of a single outstanding contribution to geochemistry or cosmochemistry, published as a single paper or a series of papers on a single topic." The award will be presented during the plenary session of the 2003 Goldschmidt Conference in Kurashiki, Japan. In addition, the Alfred P. Sloan Founda-

tion has chosen Asimow for a Sloan Research Fellowship. "Coveted as an extraordinarily competitive award, the Sloan Research Fellowship carries with it a grant of \$40,000 to be used in a flexible and largely unrestricted manner so as to provide the most constructive possible support of the professor's research."

John Baldeschwieler, the Johnson Professor and Professor of Chemistry, Emeritus, and a former chairman of the Division of Chemistry and Chemical Engineering, has

