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Vernon Smith ’49 gets ready to meet the press at Virginia’s George Mason University after learning that he is corecipient of the 2002 Nobel Prize in Economics.

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Vernon Smith ’49, a professor of psychology at Princeton. He now becomes Caltech’s 29th Nobel laureate, and the winner of the Institute’s 50th Nobel Prize, counting the two won by Linus Pauling, PhD ’25, who taught Smith chemistry in the 1940s.

According to the Royal Swedish Academy of Sciences, Smith won the Nobel “for having established laboratory experiments as a tool in empirical economic analysis, especially in the study of alternative market mechanisms.” Over a nearly 50-year career, Smith founded and promoted the field of experimental economics, changing economics from a science of observation to one where theories could be tested and confirmed or refuted through controlled experiments. While the trend toward experimentation has met resistance from some economic theorists, numerous institutions, including Caltech, have established experimental economics programs. In a few cases, the discipline has changed the way business and government are practiced.

Smith’s first introduction to economics came at Caltech. The son of socially conscious parents with eighth-grade educations, Smith grew up in Wichita, Kansas. Smith says he was an average student. He first heard about Caltech as a high-school senior when he went to the local library to gather information on universities. He picked up a book that pronounced Caltech the best institution of higher learning in the country. “So, I said to myself, ‘Why not just go there?’” says Smith. After taking a year of science and math courses at a local college, he passed the Caltech entrance exam and went off to Pasadena in 1945.

“I just worked for four straight years at Caltech, including weekends,” he recalls. “I didn’t have a social life. I worked very hard and never regretted it.”

Smith’s father, a machinist, had instilled in him a desire to understand how things work. Taking his first economics course his senior year, Smith recalls, “I guess I realized that economics was not that different from physics.”

But unlike physics, “economics didn’t have a foundation in empirical work. It was not clear that the way it was taught was how things actually worked.” Theories were just accepted without proof. Smith would eventually challenge that notion.

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As it launches its ambitious campaign to raise $1.4 billion over the next five years, Caltech has chosen a motto symbolizing the Institute's century-plus record of achievement at the frontiers of science and technology: "There's only one. Caltech."

At an October 25 kickoff celebration marking the start of the campaign's public phase, David Baltimore explained the significance of those simple-yet-evocative words. "The phrase tells it all. There is no other place like this one," Caltech's president told some 400 Institute friends, donors, and supporters who filled a voluminous party tent pitched on the campus athletic field. Charlie Rose, the Emmy award-winning public-television interviewer and the evening's master of ceremonies, put it this way: "What is the most influential thing that will have the most impact in the new century? Clearly, science and technology is the answer. What Einstein did in the 20th century is probably what someone from Caltech will do in the 21st."

Rose, who hosts The Charlie Rose Show on PBS, also served as moderator for a series of panel discussions held the following day in Caltech's Beckman Auditorium. "A Celebration of Caltech Science" included faculty presentations and discussions of the latest Institute research into the brain, earth science, and the universe, and showcased the Institute's interdisciplinary strengths, which form a cornerstone of the campaign.

Scheduled to run until 2007, the campaign is chaired by Wally Weisman, the vice chair of the Caltech trustees, who will work closely with Gary Dicovitsky, Caltech's new vice president for development and alumni relations, and his campus development staff. (In an interview on page 14, Dicovitsky offers his perspective on the campaign.)

At the kickoff celebration, guests caught their first glimpse of some of the themes that will define the Caltech fund-raising drive as they watched a specially commissioned campaign video entitled Infinite Possibilities, which includes, among many other vignettes, Provost Steve Kostin's recipe for Institute success: "You take small, interdisciplinary, and bold, put them together, and magic happens."

That unique intellectual alchemy has been part of the Caltech scene for decades, said Ben Rosen '54. The chair of the Institute's board of trustees told the audience that the Caltech of today exudes a passion for knowledge and discovery that is as strong today as when he stepped on campus as a freshman 52 years ago.

Looking toward the Caltech of tomorrow, Baltimore characterized the $1.4 billion campaign figure as ambitious, yet realistic. The monetary goal reflects the aspirations and dreams of the faculty, he said, and also takes note of nuts-and-bolts needs, like replacing and upgrading campus infrastructure. Key components include funding to enrich student life, to support innovative research programs, and to construct new buildings. "Of course, for a school with fewer than 20,000 living alumni, it may seem like hubris to try to raise such a remarkable sum," Baltimore told the audience.

But he noted that the Institute had already been the beneficiary of a remarkable gift—$600 million from Trustee Chair Emeritus Gordon Moore, PhD '54, and his wife, Betty, and the Moore Foundation. Caltech showed its appreciation at the kickoff event, when JPL director Charles Elachi, PhD '71, announced the naming of an asteroid in Moore's honor and presented the couple with a commemorative plaque about "asteroid 8013 Gordonmoore" and a desktop model of the Mars Exploration Rover, which is slated to explore the Red Planet in 2004.

Along with the Moore gift—the largest commitment in the history of higher education—Caltech has raised approximately $300 million during the "quiet" period of the campaign, for a total of about $800 million.

With slightly less than half their monetary goal to go, Caltech leaders are banking on a successful campaign that will allow the Institute to carry out a wide range of groundbreaking research, from new investigations into the large-scale structure of the universe to the fabrication of revolutionary devices at the nanolevel of atoms and molecules. Said Baltimore, "We want to find the big new opportunities in the intellectual world, the great unknowns." All these endeavors will require state-of-the-art facilities and equipment to ensure that Caltech can continue to attract and support the most outstanding scholars and students.

The campaign goals fall into three major areas: endowment, which encompasses funds for people and programs; buildings; and equipment. The $810 million earmarked for endowment will be used to support new professorships, faculty reinvention funds for professors wishing to change direction in their research, and faculty start-ups. This category also includes the visiting scholars program; graduate and postdoctoral fellowships; and Discovery Funds, which enable faculty to pursue promising, untried avenues of research without going through the usual bureaucratic funding hurdles. This support will also be applied to undergraduate financial aid; the Summer Undergraduate Research Fellowships (SURF) program; and the President's Fund, which fosters enhanced JPL-campus interactions.

The Institute is seeking $400 million for buildings, more than half of which is designated for the renovation and expansion of existing structures. These include undergraduate and graduate student residences, Dahley Hall for the Humanities, the Robinson Laboratory of Astrophysics, biology laboratories, and the Caltech Children's Center. Funds in this category will also be applied to campus infrastructure renewal and an Athenaeum maintenance endowment.

As for new structures, Caltech has a wish list of facilities that will support world-class interdisciplinary research. The Institute is seeking funds for a new astrophysics laboratory that would unite campus astronomy and astrophysics under one roof; a multidisciplinary information sciences building; a chemistry teaching/research laboratory that

Continued on page 14
Two Caltech faculty awarded MacArthurs

Award and the American Astronomical Society's Helen B. Warner Prize. Paul Wennberg, who holds joint appointments as a professor of atmospheric chemistry and of environmental science and engineering, examines how natural and human processes affect the atmosphere. He is particularly interested in the impact of substances called radicals on both the health of the ozone layer and the proliferation of greenhouse gases, and he has earned recognition for developing airborne sensors to study them. One early result from these measurements contradicted conventional thinking about how ozone is destroyed in the lower stratosphere and has led to new assessments of the environmental impacts of chlorofluorocarbons and stratospheric aircraft.

He was "blown over by the award" when he found out, Wennberg said, adding, "It is a wonderful recognition of the work that I have done in association with the atmospheric scientists working on NASA's U-2 aircraft chemistry program. I have been pondering how I might use the funds, but have no concrete plans at the moment. It will certainly enable me to do things I wouldn't have thought possible—perhaps even take up the bassoon again!"

A graduate of Oberlin College and Harvard, Wennberg was a research associate at Harvard before joining the Caltech faculty. In 1999, he received a Presidential Early Career Award in Science and Engineering.

New MOSH with Caltech roots looks to sow seeds of change

Caltech undergraduates attend "the hardest educational institution in the world," says Catherine Jurca, Caltech's new master of student houses. Her goals, then, are twofold: to improve the quality of undergraduate life and to improve communication among students, faculty, and administrators. And, if she can get students out of the lab to watch a little NFL football on Sundays, she says, "all the better."

"I've always been drawn to the undergraduates here," says Jurca, an associate professor of literature and unabashed NFL fan ("Always have been, don't ask me why," she says with a laugh). "Caltech students are quirky, sweet, and very smart. But too many students come here and feel isolated and overwhelmed. Many of them spend almost all their time studying, tend to socialize almost exclusively with other members of their house, and they can miss out on the breadth of experiences Caltech can offer."

Jurca knows whereof she speaks. She's been a Caltech faculty member since 1995 and comes from a long line of Techers—her father—Joseph Jurca '59, MS, '64—and grandfather—George Merrill Berkeley '33—are alumni. (She broke tradition by doing her undergraduate work at Johns Hopkins.)

Like her predecessors in the MOSH job, Jurca plans to hold weekly dinners with faculty and students at Steele House, the traditional location for MOSH activities, and to host off-campus events such as trips to the theater and opera. In a break with tradition, however, she won't be inviting students to MOSH dinners on the basis of which residence they live in, but rather on the basis of their options. That way, undergraduates meeting one another for the first time will automatically have something in common with other students and faculty at the table.

Jurca's position also carries with it the new responsibility of acting as a liaison between students and administration, in an effort to bridge communication gaps that may occur between the two sides. "Part of the job is to meet on a more regular basis with student leaders and attend faculty board meetings," she says. "I know the points of view on both sides of an issue," she says.

In consultation with students, Jurca intends to examine various Caltech policies to see if there are ways to make undergraduate life a bit easier. For example, "most of the students I've talked to are not happy with the core course curriculum that is mandated for the first two years of study," she says. "It makes it difficult for many to select an option at the end of their freshman year because, often, they've had no exposure to any classes in the fields they might be interested in."

She hopes the option dinners will improve this situation, since they will enable freshmen to meet faculty and upper-class students to discuss option prospects before making their choices.

At the same time Jurca doesn't necessarily see herself as an advocate for all student issues. "I like to think I'll be able to present their viewpoints fairly to the administration, even if I personally disagree with it," she says. "But even so, I've found that students' opinions are often extremely well thought out and articulate; you have to be on your toes with them."

The MOSH position is a five-year, half-time administrative appointment, and Jurca does not expect her new role to slow her research pace. Currently she is writing a book on post-World War II Hollywood, in which she pursues the view that the propaganda aspects of World War II films gave way in the post-war period to a type of public relations emphasis of particular business enterprises and the business community in general. The films she considers include Mildred Pierce, Mr. Blandings Builds His Dream House, and Miracle on 34th Street.

As several Moshes have before her, Jurca will live in Steele House "rattling around," as she puts it, in the huge second-floor space that will be her personal quarters. The first floor and large backyard will be used for the weekly social gatherings.

And if she can twist the administration's arm for a big screen TV, what better way to spend a Sunday afternoon than with a group of students, watching NFL football?
HUMANS AND CHIMPS MAY BE A LITTLE LESS CLOSELY RELATED, NEW RESEARCH SHOWS

For the last two decades, genetic studies have estimated that humans and chimpanzees possess genomes that are about 98.5 percent similar. In other words, of the three billion base pairs along the DNA helix, nearly 99 of every 100 would be exactly identical.

Now, however, new work by one of the codevelopers of the method used to analyze genetic similarities between species says the figure should be revised downward to 95 percent.

Roy Britten, a Caltech biologist, reported in the October 2002 issue of Proloudings of the National Academy of Sciences that the large amount of sequencing that has been done in recent years on both the human and chimp genomes—and improvements in the techniques themselves—allow for the issue to be revisited. In the article, he describes the method he used, which involved writing a special computer program, to compare nearly 780,000 base pairs of the human genome with a similar number from the chimp genome.

To describe exactly what Britten did, it is helpful to explain the old method as it was originally used to determine genetic similarities between two species.

Called hybridization, the method involved collecting tiny snips of the DNA helix from the chromosomes of the two species to be studied, then breaking the ladder-like bases apart into strands. Strands from one species would be radioactively labeled, and then the two strands recombined.

The helix at this point would contain one strand from each species, and from there it was a fairly straightforward matter to “melt” the strands to infer the number of good base pairs. The lower the melting temperature, the less compatibility between the two species because of the lower energy required to break the bonds.

In the case of chimps and humans, numerous studies through the year have shown that there is an incidence of 1.2 to 1.76 percent base substitutions. This means that these are areas along the helix where the bases (adenine, thymine, guanine, and cytosine) do not form a bond at that point.

The problem with the old studies is that the methods did not recognize differences due to events of insertion and deletion that result in parts of the DNA being absent from the strands of one or the other species. These are different from the aforementioned substitutions. Such differences, called “indels,” are readily recognized by comparing sequences, if one looks beyond the missing regions for the next regions that do match.

To conduct the more complete survey, Britten wrote a Fortran program that did custom comparisons of strands of human and chimp DNA available from GenBank.

INSTITUTE WELCOMES AFGHAN OFFICIALS TO CAMPUS

Caltech students and faculty welcomed a delegation of women from Afghanistan's new government to the Athenaeum in October for lunch and a discussion about their roles in rebuilding their war-ravaged nation.

The invitation grew out of a Caltech professor's recent trip to Charles, and an interest in the history and culture of Pakistan and women’s role in that nation.

Caltech planetary scientists have discovered a sizable spherical body in the outskirts of the solar system. The object, which circles the sun every 288 years, is half the size of Pluto and larger than all of the objects in the asteroid belt combined. It has been named "Quaoar" (pronounced KWAh-o-ar) after the creation force of the Tongva tribe, who were the original inhabitants of the Los Angeles basin.

The discovery was made by Associate Professor of Planetary Astronomy Mike Brown and postdoctoral scholar Chad Trujillo. The duo detected Quaoar on a digital sky image taken on June 4 with Palomar Observatory's 48-inch Oschin Telescope.

Quaoar is located about 4 billion miles from Earth in a region beyond the orbit of Pluto known as the Kuiper belt. This is the region where comets originate and where planetary scientists have long expected to eventually find larger planet-like objects. Quaoar is by far the largest object found so far in that search.

Currently detectable a few degrees northwest of the constellation Scorpio, Quaoar demonstrates beyond a doubt that large bodies can indeed be found in the farthest reaches of the solar system. The discovery offers hope that more large bodies will be discovered there, some as large or even larger than Pluto. (Caltech News first wrote about Brown's Kuiper-belt research in 1999. Check out the article, "The Objects of His Affection," on the Caltech News Web site at http://pr.caltech.edu/periodicals/CaltechNews/articles/v33/n3/brown.html.)

More controversially, the discovery supports the emerging view that Pluto itself is best understood as a Kuiper belt object. A growing number of planetary scientists hold that Pluto was the first Kuiper belt object to be discovered, long before the age of enhanced digital techniques and light-detecting charge-coupled (CCD) devices, because it had been kicked into a Neptune-crossing elliptical orbit eons ago. Will the next generation of astronomy textbooks describe a solar system made up of eight planets?

"Quaoar definitely hurts the case for Pluto being a planet," says planetary scientist Brown. "If Pluto were discovered today, no one would even consider calling it a planet because it's clearly a Kuiper-belt object."

To confirm their June 4 finding of Quaoar, Brown and Trujillo looked through archived images of the same region of sky taken by a variety of instruments. They soon found images taken in the years 1983, 1996, 2000, and 2001 that not only allowed them to establish the distance and orbital inclination of Quaoar, but also to determine that the body is revolving around the sun in a remarkably stable, circular orbit.

"It's probably been in this same orbit for 4 billion years," Brown says. In fact, Quaoar apparently was first photographed in 1982 by then-Caltech astronomer Charlie Kowal in a search for the postulated "Planet X," or the "tenth" planet. Kowal unfortunately never found the object on the plate—much less Planet X—but the image was left for posterity.

Because the precise location of Quaoar on the old plates is highly predictable, its orbit is thought to be quite circular for a solar system body, and far more circular than that of Pluto. In fact, Pluto is relatively easy to spot—at least if one knows where to look. This is because Pluto comes so close to the sun for several years in its 248-year eccentric orbit that the volatile substances in its atmosphere are periodically heated, which increases its reflectance, or albedo, to such a degree that it is bright enough to be seen even in small telescopes.

Quaoar, by contrast, never approaches the sun in its circular orbit, which means that its volatile gases never are excited enough to kick up a highly reflective atmosphere. As is the case for other bodies of similar rock-and-ice composition, Quaoar's surface has been bathed by faint ultraviolet radiation from the sun over the eons, and this radiation has slowly caused the organic materials on the body's surface to turn into a dark graphite substance. As a result, Quaoar's albedo is about 10 percent, just a bit higher than that of the moon. By contrast, Pluto's albedo is 60 percent.

Regarding spin rate, the scientists know that Quaoar is rotating because of its slight variations in reflectance during the six weeks they've observed it. But they're still collecting data to determine the precise spin rate. They will also probably be able to figure out whether the spin axis is tilted relative to the ecliptic plane.

The Kuiper belt can be thought of as a band extending around the sky, superimposed on the path of the sun. Brown and Trujillo's research method, in effect, is to take repeated exposures of a several-degree swath of this band and then use digital equipment to check and see if any tiny point of light has moved relative to the stellar background.

Brown and Trujillo are currently using about 10 to 20 percent of the available time on the 48-inch Oschin Telescope, which was used to obtain both the Palomar Sky Survey and the more recent Palomar Digital Sky Survey. The latter was completed just last year, freeing up the Oschin Telescope to be refitted by JPL for a new mission to search for near-Earth asteroids. About 80 percent of the telescope time is now designated for the asteroid survey, leaving the remainder for scientific studies like Brown and Trujillo's.

Since Quaoar's discovery, the scientists have used other telescopes to study and characterize it, including the Hubble Space Telescope and the Keck Observatory on Mauna Kea. Information derived from these studies will provide new insights into the precise composition of Quaoar and may answer questions about whether the body has a tenuous atmosphere.

There's good news here too for the serious amateur astronomer: he or she doesn't necessarily need a space telescope or 10-meter reflector to get a faint image of Quaoar. Armed with precise coordinates and a 16-inch telescope fitted with a CCD—the kind advertised in magazines such as Sky and Telescope and Astronomy—it should be possible to obtain images on successive nights that will show Quaoar as a faint dot of light in slightly different positions.

As for Brown and Trujillo, the two are continuing their search for other large Kuiper belt bodies. Some may be larger than Quaoar, which can only be glimpsed as a speck inside the circle, was found. For more images and information on Quaoar, go to http://www.gps.caltech.edu/~chad/quaoar.

Recognition

Yaser Abu-Mostafa, PhD '83, professor of electrical engineering and computer science, and Oscar Bruno, professor of applied and computational mathematics, are recipients of the 2002 Graduate Student Council Teaching Awards.

Frances Arnold, Dickinson Professor of Chemical Engineering and Biochemistry, has been selected by the Delaware Section of the American Chemical Society to receive the 2003 Carothers Award, for her "outstanding contributions and advances in industrial applications of chemistry."

James Arvo, associate professor of computer science, Vladimir Baranovsky, Taussky-Todd Instructor in Mathematics, Beth Pierce, assistant professor of applied and computational mathematics, John Presskill, MacArthur Professor of Theoretical Physics, John Sutherland, visiting professor of literature, and Darryl Yong, von Kármán Instructor in Applied and Computational Mathematics, are recipients of the 2002 ASCIT (Associated Students of Caltech) Teaching Awards. At the same time, Michael Shurnate, '64, lecturer in applied physics, has been honored with the 2002 ASCIT Lifetime Achievement Award.

Jacqueline Barton, Hanisch Memorial Professor and professor of chemistry, has been chosen by the American Chemical Society to be the 2003 recipient of the Ronald Breslow Award for Achievement in Biomimetic Chemistry. Sponsored by the Breslow Endowment, the award recognizes "outstanding contributions to the field of biomimetic chemistry" and consists of $5,000 and a certificate.

Pamela Bjorkman, professor of biology at Caltech and investigator of the Howard Hughes Medical Institute (HHMI), has been elected a member of the American Philosophical Society in recognition of her work with molecules needed for cell-surface recognition, and their role in the immune system.

Founded by Benjamin Franklin in 1743, the society is the oldest learned society continued on page 9...
University of Kansas and got a master's degree in economics in 1952, and then went to Harvard, where he got his PhD in economics in 1955. At Harvard, he was influenced by a professor who provided classroom demonstrations to show that the prevailing theories of competition among small groups of individuals were unrealistic.

When Smith left Harvard for his first teaching job at Purdue University, he began to set up experiments using students to simulate different market situations. Challenging classical economic theory of supply and demand, Smith showed that markets could work efficiently even if buyers and sellers had incomplete information about each other's strategies and preferences.

"The more you know about the circumstances of other people, the more you should be able to use that to your advantage," he says. "But what you know may be inaccurate. Having more information may not be better."

Smith left Purdue in 1967, was at Brown University briefly, and then went to the University of Massachusetts. In 1973, he returned to Caltech as a Sherman Fairchild Distinguished Scholar and, along with Charles Plott (today Caltech's Harkness Professor of Economics and Political Science), taught a course in experimental economics in which faculty members sitting in the class outnumbered the students by a margin of two to one. Plot had introduced experimental economics to Caltech the previous year and, when Smith returned, they conducted experiments that advanced the discipline and helped make Caltech the nation's leading center of experimental economics.

"Vernon is the prime evangelist for the whole field of experimental economics," says Ross Miller '75, one of the students who took the Plott/Smith class. Miller's book about Smith and the field he established, Paving Wall Street: Experimental Economics & the Quest for the Perfect Market, was published in 2002. "He's wonderful in all dimensions; a great teacher and researcher who has influenced hundreds of students over time," said Miller, a financial consultant.

"When he returned to Caltech as a Fairchild Scholar, Vernon brought with him a wealth of knowledge of techniques that he had learned in the '60s," says Plot. "He had stopped doing experimental economics for several years, and this brought him back to experimentation. He was the first person to observe the law of supply and demand working in its quantitative form and, if nothing else, he deserved the Nobel Prize for that."

Plot, who had been an associate professor of economics at Purdue before coming to Caltech, had been Smith's fishing buddy in Indiana, and the two spent countless hours driving to lakes and rivers to fish for bass during the two years that Smith was teaching at Caltech.

"We just talked economics the whole time," Smith says. It was the middle of the Arab oil embargo and the energy crisis, when gas stations' supplies were limited by the government, based on quotas that were linked to the stations' previous year's sales. Smith recalls that while the gas stations in Pasadena were running low on gas, he and Plot would pass stations after station in the desert that were overflowing with supply that they couldn't sell because urban residents were passing up road trips for fear that there would be no gas available to get them home.

"You could see the economics of controls working so badly," Smith says.

The market effects of government regulations would figure in Smith's experiments and in the applications of his research. After leaving Caltech, he went to the University of Arizona, where he established a research group in experimental economics in 1973.

Expanding his research into so-called rational markets, Smith saw that government regulations, which purport to create fairness by establishing a level playing field with a free flow of information, often create unfair situations. In the case of auctions for oil drilling rights, for example, Smith says that the government not only publishes successful bids but also the names of the bidders, which he says makes it easier for collusion to take place.

Over the past few years, Smith has focused on the creation of private markets for trading electricity, a sore subject for many U.S. consumers, who watched their utility bills skyrocket in 2001 thanks to the artificially inflated prices orchestrated by rogue companies like Enron.

His research has had a positive influence in Australia and New Zealand, where he has helped those countries develop a spot market for electrical power. Due to increased competition among utilities and a proliferation of technologies that allow consumers to automatically limit their electricity usage during peak periods, prices have dropped.

Smith and his experimental economics group left Arizona in 2001 and moved to George Mason University in Virginia. Caltech's newest Nobelist says that he will give his half of the approximately $1.07 million Nobel award to the International Foundation for Research in Experimental Economics, the foundation he established in 1997 to support his group's research.

And Smith definitely won't let his newfound fame keep him away from his own active role in that research. "The Nobel Prize is only the beginning for experimental economics," he says. "There is still much to do."
“Both physics and Buddhism are interested in going beyond our intuitive understandings of the world so as to access a reality that is more fundamental.”

José Cabezón’s Unexpected Discovery

by Rhonda Hillbery

José Ignacio Cabezón ’78 was a budding scientist when a chance purchase at the Caltech Bookstore foretold his true calling. The physics major would subsequently go on a spiritual journey—living for years with Tibetan refugees in India, traveling and translating for the Dalai Lama, and becoming a Buddhist monk.

Now he is serving as the first XIV Dalai Lama Professor in Tibetan Buddhism and Cultural Studies at UC Santa Barbara, a major center for the study of world religions.

Cabezón was recruited by UCSB in 2001 to develop undergraduate and graduate programs in Tibetan religion and culture, including Tibetan language studies. His appointment, which the university calls the only endowed program and professorship of its kind on the West Coast, is supported by funds raised from various donors over a decade. The endowment was inspired by the Dalai Lama’s campus visit in 1991.

Cabezón’s early years didn’t foreshadow a life of world travel, Eastern religion, or academia. His family moved from Cuba to the United States when he was four years old. Growing up in a hard-working Boston blue-collar family, a university education was not a given, he says. Today, sitting in his UCSB office, where the wall is adorned with a Tibetan prayer cloth and the windows overlook campus bluffs that lead to the beach, he recalls, “I had to make the case with my parents for the importance of the intellectual life.”

At a young age, he became interested in science, which brought him to Caltech.

“In a way, what drew me to physics was the same thing that later drew me to Buddhism. Both physics and Buddhism are interested in going beyond our intuitive, often naïve, understandings of the world so as to access a reality that is more fundamental.” A good example of this, he says, is the way students of physics make the early realization that our seemingly solid world is actually composed entirely of minute atomic and subatomic particles.

For Cabezón, the big-picture aspects of the science became more interesting than its equations and algorithms. “At some point, I realized that I was always interested more in the philosophical questions of physics. And, in retrospect, probably, I was less interested actually in the science itself than in those questions.”

In a turn of events that some might not think at that point I even consider fate, during Cabezón’s junior year a friend offered to buy him a book as a birthday present. Perusing the shelves at the Caltech Bookstore, he chose one on Tibetan Buddhism. He is still not sure why.

“I don’t think at that point I ever would have said that I was interested in Buddhism. I think I developed an interest as a result of reading about it.”

The book made a strong enough impression to convince him to completely change his academic universe—just a few courses shy of a completed physics major. Since Buddhist studies aren’t part of the standard Caltech curriculum, Cabezón informed the Institute that he wanted to enroll in the independent studies program. “To my surprise, I received a great deal of support, especially from the then head of the independent studies program, planetary-science professor Andy Ingersoll.”

His search for a university program matching his newfound interests drew him to the Midwest. “I spent the first half of my senior year at the University of Wisconsin-Madison studying Tibetan language and Buddhist philosophy, and the second half in Dharamsala, India, studying at the Library of Tibetan Works and Archives. That’s when I realized that this is what I really wanted to do.”

During the period he was earning his PhD, Cabezón completed much of his doctoral work while living for six years with Tibetan refugees and studying at the Sera Je Monastic University in India.

In India he met the Dalai Lama, who later asked Cabezón to travel with him in Spain, Mexico, and Costa Rica to translate his teachings and texts. In addition to his expertise in Tibetan and Spanish, Cabezón also has some fluency in Sanskrit, Pali, Japanese, Hindi, Latin, French, and German.

Some of the professor’s Dalai Lama-related work is available in U.S. bookstores, including Answers: Discussions with Western Buddhists. Cabezón compiled and edited the text, which is drawn from informal group discussions between the Dalai Lama and Western Buddhists that took place at a village in North India, where the Dalai Lama travels annually to give teachings. “The Dalai Lama is a very impressive person who tries to live out the tradition of Buddhist values and to be an example for people all over the world,” says Cabezón.

“He is one of those rare individuals who manage to live our day to day the values that he espouses.”

Around the same time that Cabezón was rising at dawn to pray at Sera Je Monastery, American readers were...
Cabezón has led department-sponsored programs that include a film series, lectures on different aspects of Tibetan culture, and performances by troupes of monks.

Last summer, Cabezón traveled to Tibet and India to gather data for a history of Sera Je Monastery, which he calls "one of Tibet's great scholastic educational institutions."

When all is said and done, this Tibetan Buddhist scholar might be expected to offer an explanation, or at least an interpretation, of why the book he chose at the Caltech bookstore all those years ago set in motion such profoundly life-changing events. But true to his tenets, Cabezón refuses to tie life events into neat packages. The most he'll say is, "I don't think I have an answer to that. If there is an answer, it is beyond me."

Caltech News welcomes comments and thoughts from readers on how their lives and career paths were affected by their years at Caltech. Write to his@caltech.edu.

Cabezón spent 12 years as a professor at the Iliff School of Theology, in Colorado, teaching courses in world religions, Buddhist philosophy, and comparative philosophy. He was then recruited to Santa Barbara as the Dalai Lama Professor, and delivered his inaugural lecture in November 2001. A university leader notes that Cabezón emerged early as a standout when it set out to appoint the chair. "After a rigorous, international search, Professor Cabezón was identified as one of the most outstanding scholars of Buddhism in the world today," says David Marshall, UCSB's dean of humanities and fine arts.

One of Cabezón's colleagues offers a similar assessment. "He is a first-rate scholar, and a prolific publisher; he has enormous linguistic skills," says Sheila Greeve Davaney, a professor of theology at Iliff. "When we hired him, one of his letters of recommendation said he was the premier linguist of his generation."

Cabezón's breadth of scholarship also sets him apart, taking him from ancient Buddhist texts to contemporary monastic Buddhist issues including sexuality. Davaney adds that as a practicing Buddhist, Cabezón offered a different perspective to Iliff students, especially those training to be Christian ministers or leaders of other religious communities. "I used to kid him that before he was a Buddhist he was a Catholic," Davaney says. "But he always insisted, 'No, before I was a Buddhist I was a scientist.'" The scientific grounding gained from his earlier studies appears in his rigorous approach to academia and Buddhism, she adds. "He is very opposed to any intellectual stereotypes in the world. He was insistent that you bring all your intellectual powers to your practice," not merely accepting doctrine on blind faith.

Cabezón's scholarship focuses broadly on Buddhist texts and Tibetan philosophy, religions, and cultures. His research interests include the intersection of Buddhism and popular culture and the ways in which the religion has been turned into a commodity through its growing popularity in the West. These arc interests he will cover in an upcoming book, tentatively titled Consuming Tibet. He is also researching Buddhism and the ethics of sexuality, and is working on an annotated translation of a 15th-century Tibetan book on the theory of emptiness. "This year has been tremendously busy but also tremendously exciting," Cabezón says of his first year's activities, which included organizing a national conference on Tibetan animalities at UCSB in May. To help fulfill a cultural outreach and cultural mission, Cabezón has been quite excited because I thought it was agreat opportunity."

The Tibetan government went into exile following the Chinese invasion of Tibet in 1959. Since then, Buddhism has flourished internationally despite efforts to suppress it in Tibet, where, under the Chinese occupation, thousands of monasteries were destroyed and more than one million Tibetans were either killed or died of starvation. Still, the visibility and popularity of the exiled Dalai Lama has only grown more pertinent to the human condition and more than one million Tibetans have turned Buddhist scholar, Cabezón, who is the most outstanding scholars of Buddhism in the world today, says David Marshall, UCSB's dean of humanities and fine arts.

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As a Caltech-trained physicist turned Buddhist scholar, Cabezón has his own views about the apparent parallels between quantum physics and Eastern religious beliefs. "When I first read about The Tao of Physics, I became quite excited because I thought it was a kind of bridge between science and Buddhism. I'm not so sanguine about this anymore. I think that those similarities tend to be only on the surface. They're superficial. What's interesting to me, and where my approach is quite different, is in exploring those differences."

"In the end, science is not a failure but it has limitations. And so I find Buddhism, because of its concern with both the outer and inner world, to be more pertinent to the human condition viewed holistically. I don't want to paint science in a negative light. But overall, the scientific world view has an uncompromisingly materialist stance that I think from a Buddhist point of view isn't entirely valid."

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"Space Travel Is Utter Bilge"

Said British Astronomer Royal Sir Richard Woolley in 1956. Now, a JPL scientist pays tribute to the visionaries who, in the face of skepticism and gravity, opened the way to interplanetary flight.

By Donald Yeomans

Until a few decades ago, interplanetary travel was the stuff of dreams and fantasy. But it was a fantasy in which the flights in space were the stuff of dreams and only co point to the birds to demonstrate that the air would one day support flight. However, it was a fantasy in which the flights in space were the stuff of dreams and only co point to the birds to demonstrate that the air would one day support flight. But it was a fantasy in which the flights in space were the stuff of dreams and only co point to the birds to demonstrate that the air would one day support flight. But it was a fantasy in which the flights in space were the stuff of dreams and only co point to the birds to demonstrate that the air would one day support flight. But it was a fantasy in which the flights in space were the stuff of dreams and only co point to the birds to demonstrate that the air would one day support flight.

The younger generation of rocket engineers is just beginning. They are of the new generation to which space travel is not going to be a dream of the future but an everyday job with everyday worries in which they will be engaged.

—Willy Ley, spaceflight pioneer and historian, 1951

While the conquest of the skies via heavier-than-air vehicles did not arrive until the Wright brothers' historic flights in 1903, earlier dreamers needed only to point to the birds to demonstrate that the air would one day support human flight. But travel beyond Earth's atmosphere was only conceivable through their flights of imagination.

Early in the 17th century the noted astronomer Johannes Kepler penned a treatise entitled "The Dream" (Somnium), in which the central character, Duracetus, takes a voyage to the moon. The story is based loosely upon Kepler's own life, and the lunar voyage is facilitated by Duracetus's mother. She is in league with four demon boys that can, on occasion, provide the necessary transportation to the moon. Once in space, Duracetus proves himself from the rarified air by applying damp sponges to his nostrils, while noting that the pushing supplied by the lunar demons is no longer necessary once he has ascended beyond Earth's orb. Kepler, who would be remembered for his laws of planetary motion, did not dare publish his book during his lifetime. However he was read in manuscript form and was partially responsible for his mother's being tried as a witch. Fortunately, she was freed in October 1621 after spending 14 months in custody.

The English bishop Francis Godwin published another lunar fantasy entitled The Man in the Moon in 1638. Its hero, a shipwrecked mariner named Domingo Gonsales, wishes only to escape the uninhabited island on which he is stranded. He trains a flock of wild swans to fly him back to civilization, but the birds' migration season has begun and they have turned out to be . . . on the moon. After a 12-day voyage, our hero arrives at the moon to find the inhabitants there to be much larger than those on Earth. The lunarians are an average of 28 feet tall. Despite his puny stature, Domingo is well-treated by the lunarians, and after enjoying their company he returns to Earth safely, although two of his swans have died and the rest "beg [n] to drop.

In 1827, in an early example of American science fiction, George Tucker, writing under the pen name Joseph Atterley, wrote A Voyage to the Moon. The spacecraft was a copper vessel loaded with scientific equipment and powered by lunarium, an antigravity metal with no more validity than moonbound wild swans.

It was a Russian schoolteacher, Konstantin Tsolkovsky, who would be the first to seriously consider realistic means for achieving spaceflight. Born on September 17, 1857, 100 years and 17 days before his countrymen launched Sputnik, Tsolkovsky contracted scarlet fever as a child and became nearly deaf. Unable to attend the local schools, he began an intensive course of self-study into the natural sciences. In 1879, he passed his teaching examinations without having attended any of the lectures and began teaching outside the local schools.

Konstantin Tsolkovsky

Moscow in Kaluga province. What spare time he had was devoted to research into aeronautics.

At age 26, he wrote a short treatise entitled "Free Space" and stated that the path to space was through rocket propulsion. Rockeiners were certainly not a new concept, having been invented by the Chinese by the 13th century, but Tsolkovsky was the first to note that only rockets could serve the needs of space travel. He is also credited with a variety of forward-thinking ideas on spaceflight, including a theory of rocket travel that took into account the rocket's changing mass; the use of liquid hydrogen and oxygen for rocket fuel; multistage launch vehicles; the effects of atmospheric drag and solar light pressure on space vehicles; the nature of weightlessness in space; and geosynchronous orbits, whereby a satellite could always remain above a single location on Earth's surface.

Did Tsolkovsky's advanced ideas find easy acceptance or support? They did not. Up to the time of the Russian Revolution in 1917, he was either ignored or considered a crazy inventor and rootless dreamer by the recognized scientific community of tsarist Russia. However, his ideas for using technology to overcome gravity meshed with the Marxist philosophy that machines would be indispensable for the construction of a communist society. Thus, in 1919, the now-ruling Communist Party yanked Tsolkovsky from obscurity and appointed him to the Socialist Academy, which later became the Soviet Academy of Sciences. In 1921, at the age of 64, he was given a personal pension, which allowed him to devote himself entirely to his scientific research. While he still worked alone, he now had government assistance for publishing his works and to republish some that had appeared earlier in very limited printings, published at his own expense. In the 1920s his work on spaceflight began to receive international recognition.

There are many similarities between Tsolkovsky's life and that of the American rocket pioneer, Robert Hutchings Goddard. Goddard also worked in relative obscurity, and he did not receive the credit due him until after his death in 1945. Like Tsolkovsky, Goddard taught school—he was a professor at Clark University in Massachusetts. But whereas Tsolkovsky never attempted to actually build a rocket, Goddard developed and flew various rockets, as well as conceiving many new ideas in the theory of rocket flight.

Early visions of human spaceflight spanned centuries and continents. Clockwise, from far right: In American Joseph Atterley's A Voyage to the Moon, published in 1827, the spacecraft was loaded with scientific instruments and powered by "lunarium." In 1925, German civil engineer Walter Hohmann demonstrated how Earth's atmosphere could capture a spacecraft returning to Earth, a technique that was recently used to ease the Mars Odyssey spacecraft into orbit around the Red Planet. The book cover illustration is from Russian schoolteacher Konstantin Tsolkovsky's Dreams about Earth and Sky, published in 1827. A space station loaded with scientific equipment and powered by "lunarium." In 1925, German civil engineer Walter Hohmann demonstrated how Earth's atmosphere could capture a spacecraft returning to Earth, a technique that was recently used to ease the Mars Odyssey spacecraft into orbit around the Red Planet. The book cover illustration is from Russian schoolteacher Konstantin Tsolkovsky's Dreams about Earth and Sky, published in 1827. A space station loaded with scientific equipment and powered by "lunarium." In 1925, German civil engineer Walter Hohmann demonstrated how Earth's atmosphere could capture a spacecraft returning to Earth, a technique that was recently used to ease the Mars Odyssey spacecraft into orbit around the Red Planet.
Goddard published the first of two important monographs in the January 1920 Smithsonian Miscellaneous Collections. In a slim paper entitled "A Method of Reaching Extreme Altitudes," he discussed his theories and experiments concerning the efficiency of the ordinary rocket. He provided calculations for the minimum rocket mass needed to raise one pound to various altitudes in the atmosphere and calculations for the minimum mass required to raise one pound to escape Earth. In an effort to demonstrate that a rocket could escape Earth and reach the moon, Goddard had worked out how much flash powder would be needed for an observer on Earth to see the flare through a one-foot aperture telescope when the rocket crashed into a dark region of the lunar surface. But he was completely unprepared for the publicity that greeted this scenario. The press termed him the "moon man," and made him the butt of jokes. Never an outgoing person to begin with, Goddard responded by withdrawing further into professional and private seclusion, so that his work was generally not well known during his lifetime.

Goddard demonstrated the first flight of a liquid-fuel rocket in Auburn, Massachusetts, in March 1926. The rocket reached an altitude of 41 feet and covered a mostly horizontal distance of 184 feet, roughly comparable with the distance covered by the second flight of the Wright brothers' airplane in 1903. Like Tsiolkovsky before him, Goddard realized the liquid-fuel rockets were more efficient than those powered with dry, or solid, fuels. The 1926 rocket flight was documented 10 years later as part of Goddard's second significant publication, entitled "Liquid-Propellant Rocket Development."

Goddard's extraordinary achievements did not go entirely unnoticed. The aviator Charles Lindbergh and the secretary of the Smithsonian Institution, Charles Abbot, were influential in helping him secure a $50,000 grant from the Guggenheim Fund for the promotion of aeronautics. Using this substantial award, Goddard, his wife, and four assistants established a research area near Roswell, New Mexico. There in the desert, between 1930 and 1941, they undertook one of the most amazing lone-wolf efforts in the history of technology. In tests conducted at this site, Goddard's liquid-fuel rockets reached speeds of 700 mph and altitudes above 8,000 feet. His innovations included the use of fuel-injection systems, regenerative cooling of combustion chambers, and...
In spite of the opinions of certain narrow-minded people... we shall one day travel to the moon, the planets and the stars with the same facility, rapidity and certainty as we now make the ocean voyage from Liverpool to New York.

—Jules Verne, 1865

There is no hope for the fanciful idea of reaching the moon because of insurmountable barriers to escaping the earth’s gravity.

—Dr. F. R. Moulton, University of Chicago astronomer, 1932

Professor Goddard with his “chair” in Clark College and countering of the Smithsonian Institution, does not know the relation of action to reaction, and of the need to have something better than a vacuum against which to react. Of course, he only seems to lack the knowledge laddered out daily in high schools.


(On July 17, 1969, the New York Times commented that “further investigation and experimentation have confirmed the findings of Isaac Newton in the 17th century, and it is now definitely established that a rocket can function in a vacuum as well as in an atmosphere. The Times regrets the error.”)

Space Travel... from page 11:

gyroscopic stabilization and control, instrumented payloads and recovery systems, guidance targets in the exhaust plume, gimbaled and clustered engines, and aluminum fuel and oxidizer pumps.

By the early 20th century, the works of Tsiolkovsky and Goddard had clearly shown that spaceship was theoretically possible. Assuming that a sufficiently powerful rocket-launcher could be developed, Isaac Newton’s 17th-century formula that for every action there is an equal and opposite reaction provided the basis for rocket flight. Nevertheless, there continued to be a consensus. My held belief in the impossibility of flying a rocket in space, where “there was nothing for the rocket to push against.” Many who understood that rockets need not push against anything simply denied that rocket technology would ever advance to a point where enough power could be generated to achieve the 11.2 km/s velocity required to escape Earth’s gravity.

Fortunately, none of these objections was enough to deter a new generation of dreamers, many of them in Germany, who, like Goddard, combined technical training and expertise with a commitment to furthering the possibilities of spaceship.

One of them was Hermann Oberth, who from boyhood was fascinated by the possibility of space travel. By 1920, he had derived the formulas for calculating the impulse necessary to achieve escape velocity. Born in Transylvania in 1894, Oberth produced a treatise on rockets and interplanetary travel as his doctoral dissertation at the University of Heidelberg. But since neither his advisor, the well-known astronomer Max Wolf, nor anyone else on the faculty would declare themselves competent in this subject, he was unable to submit it for a degree. His thesis was also rejected 20 times by various publishers before the firm of Oldenbourg agreed to issue it, with the proviso that Oberth pay for the printing costs himself. Today The Rocket into Interplanetary Space is recognized as a classic in the early theory of spaceflight. In it Oberth established that a rocket could operate in a void and could travel faster than the velocity of its own exhaust. He also discussed the merits of alcohol and hydrogen as rocket fuels and outlined a type of rocket that he felt could be used to explore the upper atmosphere.

In the only section that was relatively free of complex equations, Oberth dealt with the physiological and psychological problems of manned flight, including acceleration, weightlessness, loneliness, and claustrophobia. He also discussed the possibilities for satellites, space stations, and space mirrors that could beam sunlight to the dark side of Earth.

You have ignited the flame, and we shall not permit it to be extinguished.

—Hermann Oberth to Konstantin Tsiolkovsky, 1929

Like Tsiolkovsky and Goddard before him, Oberth had been inspired as a youth by the rich stories of Jules Verne, particularly by Verne’s 1865 work From the Earth to the Moon. Unlike them, he worked hard to publicize rocketry in general and his own work in particular. In 1930, he became a technical advisor to the Fritz Lang movie Girl in the Moon. As a publicity stunt for the film, Oberth and his assistants were asked to design, build, and launch a rocket. For all his theoretical genius, Oberth was not a rocket engineer and, like the movie itself (a silent film in an era of talkies), the rocket was unsuccessful. Never left the ground.

In the 1920s, while the work of Oberth in Europe was being discussed within a small circle of followers, and the work of Goddard was closely followed by an even smaller group of American dreamers, the general public remained mostly unaware of the work being done to free the human race of Earth’s grasp. In Germany, however, the spark of interplanetary travel continued to be fanned by two other dreamers—Walter Hohmann and Hermann Noordung.

Born in 1880, Hohmann became the city architect in Essen, near the German-Dutch border, in 1912. While his day job was that of a civil engineer, he spent all his free time investigating the possibilities of space travel. His The Attainability of the Heavenly Bodies, published in 1925, was prescient for the ideas it advanced, and many of them seem remarkably modern even today. Among them are the variable-pitch wing for dynamical control of the spacecraft during landing, the use of nose cones and parachutes for successful landings, the manufacture of rocket fuel from planetary resources to save weight, and the use of a surfacelander that would detach from a planetary orbiter. However, Hohmann is best-remembered for what is known today as the Hohmann trajectory—the formulation that the optimal energy transfer orbit between planets is an ellipse that is just tangent to the orbits of both planets.

Ironically, Hohmann, who did not participate in the intensive rocket development projects in Germany during World War II, was killed in an Allied bombing raid on Essen in 1945, just two months before the war ended. Hermann Noordung, whose real name was Herman Potocki, was an Austrian army officer. Although his life was cut short by tuberculosis in 1929 (he was 36), the year of his death saw the publication of his classic The Problem of Space Travel. Though much of the book was based upon Oberth’s 1923 work, Noordung proposed an impressive number of innovative ideas, particularly with regard to space stations. He suggested placing a space station in geosynchr...
In 1927, Oberth, Holm, and Wernher von Braun, Willy Ley and other German space enthusiasts formed the Society for Space Travel (Verein für Raumschiffahrt, or VfR). Among the research efforts they discussed were those of Robert Goddard, and their goal was to work toward the day when their rocket technology could be used to send spacecraft to explore the solar system. However, this club of rocket enthusiasts was operating at the margins: their research was largely self-funded and their rocket experiments did not initially attract the kind of governmental support needed to get past the hobbyist stage.

Three years later, across the Atlantic, a group of international scientists founded the American Interplanetary Society. Partly as a result of the ridicule aroused by the V-2 (Vengeance) rockets that Hitler fired into England in the waning months of the war. It has been pointed out that the 25,000 slave laborers, forcibly transported to Germany from all over occupied Europe, who perished in hellish conditions while building the V-2 at the underground Mittelwerk factory and the Dora concentration camp were 10 times greater in number than the British civilians killed during the V-2 attacks. Von Braun's role in this program has been called into question on more than one occasion. A high-ranking Nazi party member, he also held the rank of major in the SS. Nevertheless, with an allied victory assured in May 1945, the American military took over control of Peenemünde, who perished in hellish conditions while building the V-2 attacks. Von Braun's role in this program has been called into question on more than one occasion. A high-ranking Nazi party member, he also held the rank of major in the SS. Nevertheless, with an allied victory assured in May 1945, the American military took over control of Peenemünde, who perished in hellish conditions while building the V-2 attacks. Von Braun's role in this program has been called into question on more than one occasion. A high-ranking Nazi party member, he also held the rank of major in the SS.

While it would be nice to outline a scenario whereby the bumbling German and American rocket scientists cooperated, the reality was quite different. The sponsor that momentum wheels could be used to maintain control of a spacecraft's orientation in space. Finally, Noordung proposed several possible uses for a space station: as a site for doing physical and chemical experiments in the absence of gravity and heat; as an astronomical observatory above Earth's atmosphere; and as a platform for a panoptic satellite mirror for weather control and military advantage.

The great rocket pioneer Robert Goddard had died four days before the end of World War II, but with the dawn of a new space age, he was as late as anyone to reaped the recognition he deserved. NASA's Goddard Space Flight Center was dedicated on May 1, 1959. The following year, the United States government awarded Goddard's widow, Esther, $1 million in settlement for the government's use of more than 200 of Goddard's patents for rocket hardware.

To place a man in a multi-stage rocket and project him into the controlling gravitational field of the moon (and return him) to Earth—all that constitutes a wild dream . . . I am bold enough to say that such a man-made voyage will never occur regardless of all future advances.

—Lee De Forest, "Father of radio," 1957

Yuri Gagarin has been launched into utter ilige.

—The Times of London in April 1961, commenting on the world's first manned spaceflight, by Soviet cosmonaut Gagarin

The race to outer space was on. In 1961, President Kennedy committed the United States to landing a man on the moon "and returning him safely to Earth" by the end of the decade. The successful Apollo program was the result, an effort initiated primarily for political posturing but nevertheless achieving superb scientific goals.

With the close of the 20th century, our generation has been privileged to witness several lunar landings and the continued opening of the solar system frontiers, with the exploration of eight of the nine planets and dozens of natural satellites, comets, and asteroids.

"Centuries hence," planetary scientist and science writer Carl Sagan said, "when current social and political problems may seem as remote as the problems of the Thirty Years War are to us, our age may be remembered chiefly for one fact: It was the time when the inhabitants of the earth first made contact with the vast cosmos in which their small planet is embedded."

Indeed, we are living in that privileged era that Tsiolkovsky, Oberth, Holm, Noordung, Goddard, and other visionaries hoped would one day come.

Donald Yeomans is a JPL senior research scientist and supervisor of the Lab's Solar Systems Dynamics Group. He's also manager of NASA's Near-Earth Object Program Office, and, as such, he's often the voice through which public media are able to deliver the latest satellite and asteroid news to the world. He is also an astrophysicist as well as a scientist, he combined these roles in his 1991 book Comets: A Chronological History of Observation, Science, Myth, and Folklore, and has written and lectured frequently about the history of space science.
Fresh from directing a successful five-year capital campaign at Pomona College, Gary Dicovitsky finds himself the point person in Caltech’s mission to raise $1.4 billion over five years. The institute’s first vice president for development and alumni relations was recruited in October from Pomona College, some 25 miles east of Caltech in Claremont. The liberal arts college set out in 1997 to raise $130 million and under Dicovitsky’s watch closed its books in 2002 having raised $260 million. Prior to joining Pomona in 1995, Dicovitsky served as director of planned giving at Princeton and held senior positions at the University of Virginia and Dartmouth. Dicovitsky took time out during his first days on campus to talk to Caltech News writer Rhonda Hillaby about his plans and his impressions of the Institute.

How do you calibrate priorities while simultaneously starting a new job and kicking off a major campaign?

The campaign is central to everything at the Institute. The campaign is the most important thing we’ll be doing for the next five years. Every major decision will be affected by its success, or lack of success. Everything that is going on in Development right now will be guided by the campaign needs. If I had had a choice, I would have wanted to have had more time to understand Caltech’s culture before I jumped into this endeavor. At the same time, no matter when you choose to kick off a campaign, there is always going to be something that you think could have been better. In our case, in my mind, that something is the economy. We’re not going to control that, no matter what we do. But a lot of thought went into why our specific campaign needs emerged above so many others at the Institute. It is clear to me even after my short time on the job that Caltech’s needs are real and immediate, and that fulfilling them can really make a huge impact on what our faculty and students want and aspire to do here. So I think that perspective will be our guiding light when we run into things we can’t control, such as the economy. People will see and understand that this is not a frivolous undertaking.

How do you plan to surmount the challenges of the economy in your appeals to potential donors?

This is not simply a capital campaign—that is, one aimed exclusively at raising funds that can be applied toward capital projects. It is a comprehensive campaign that really aims to increase the Caltech endowment. The schools with which we compare ourselves and that compare themselves to us are better endowed, and I think we can make an excellent case there. We also have to raise current-use funds that can be applied immediately to programmatic needs and equipment needs, and to a number of other projects that are priorities. If you look at specific sources of support, it’s true that foundations might not give to endowment, but they might help us both on capital projects and programmatic needs. We need to go to the corporate sector more than we have in the past. Every appeal we make should broadly acknowledge that we have some of the greatest faculty in the world, and that they need to be supported with resources and equipment so that they can go on to do things that in some cases may even change the world. Overall, we are very well-positioned on many fronts for our challenges. People understand that Caltech can and is doing things that no other institution in the world can do. And that fact will get people’s attention.

Will you talk a bit about the strategy that you and your staff will use regarding fund-raising?

This is not going to be a campaign that you do by writing letters. We need to be out in the field, getting to know our constituencies more personally. We’re going to have to be out there hearing what people are interested in and matching up interests to needs, and that is going to require a very personal approach. That also takes time. No matter what has been done at the Institute in the past, we will need to ratchet up our activity level. Fund-raising basically works the same way in all institutions, whether they’re corporate, charitable, or nonprofit. It’s about building and sustaining relationships. So we need to get to know the Caltech faculty better as a group so that we can communicate their needs and aspirations effectively. We also must focus on five or six priority campaign projects at a time, instead of simultaneously trying to raise funds for the 30 or so identified needs. This will limit the potential for spreading our resources too thinly and will allow us to more intelligently approach our finite number of support constituents.

How will you spend the next weeks and months?

There are no shortcuts. I believe the most important thing to do initially is to meet with people and to learn about the real culture of a place. It is something that you can’t pick up from reading. Getting out and listening is really how I’d sum it up. Before I can start making decisions, I would like to solicit a fair amount of input, and I’d like that input to be as broad as possible.

Campaign... from page 3

would meet both present and future needs for undergraduate and graduate chemistry instruction; and a new campus-center building. The $190 million earmarked for equipment will support the design and acquisition of an array of state-of-the-art instrumentation. This includes a design proposal to construct a new telescope three times the size and with nine times the light-gathering power of the two Keck Telescopes on Mauna Kea. Funds will also be used to relocate the Owens Valley Radio Observatory and to support the creation of a Combined Array for Research in Millimeter-Wave Astronomy (CARMA). The Institute also envisions creating a first-of-its-kind center that will bring seismology, space geodetic techniques, and field geology to bear on the global study of tectonic plate movement.

Moving from the extremely large scale to the extremely small, instrumentation needs also include a cryoelectron microscope, imaging magnets, nanofabrication facilities, and a synchrotron beamline that will be used to probe and study the structures of proteins. Funds in the equipment category will also help pay for instrumentation and distributed and central computation in all divisions.

Reflecting on Caltech’s unique character, Baltimore talked at the campaign kickoff about streams of visitors to campus who ask him how to replicate the Institute. “I wish them well, but they are doomed to failure because you can’t create a place like this overnight.” Thanks to George Ellery Hale’s foresight and Robert Millikan’s devotion, Caltech found its enduring ideology, he said. The financial backing of the local community, coupled with contributions from America’s first great philanthropists, brought that philosophy to life. “The secret of Caltech is that it was born from the vision of a few great people who believed that a new type of institution could be built in Southern California and who then made it happen.”

Of course, it will take more than imagination and vision to help Caltech achieve its current goal and fulfill its aspirations for the future. Baltimore emphasized that the Institute will be asking for the help of a great many people, from individual donors to corporate and foundation sources. “Research and education are expensive today, and particularly expensive when you are pushing the frontier,” Baltimore said. “We will need the help of every person here, as well as every person who knows and believes in the vision of Caltech. We can make unique contributions to America and the world bar we can only do it with the commitment of those who believe as we do that a society which builds on knowledge and adapts technology to enrich life is a society in which each individual can fulfill his or her greatest dreams and loftiest goals.” More information on the campaign can be found at http://one.caltech.edu.

President David Baltimore (left) joins the applause, as JPL Director Charles Elachi announces that an asteroid has been named for Gordon Moore and presents Gordon and Betty Moore with a commemorative plaque.
ASSOCIATION PRESIDENT FINDS CLASS OF ’06 "AN IMPRESSIVE AND INTERESTING GROUP"

I have had the good fortune this year to spend time with the new freshman class—both at Freshman Camp in the mountains of Idyllwild and at the annual freshman pizza party at Alumni House. Since I sent my own first-born east to his first year of college this fall, this had a special significance for me.

While Freshman Camp was a lot more fun than my own CalcTech orientation (which was held that one year on campus), it reaffirmed that many of the factors that defined the Institute for me and my class continue to be the same today. The new Tchers heard David Baltimore tell them that the Honor System is more than just a set of standards for academic integrity—it is a way of life. They came to know Jean-Paul Revel as a comedian and as a resource when things get tough, and soon they will come to know him as the pioneering biologist he is. They learned about exciting research that they might be a part of during their undergraduate years. They heard that homework problems are assigned with the expectation that no student can finish them working on his or her own, and that they will need to form study groups and work collaboratively if they are to succeed. They had the opportunity to get to know one another—before being separated by house rivalries and academic majors.

The new freshman class is an impressive and interesting group. Its members come from 36 states and 12 foreign countries. For 56 out of the class of 253, English is not their first language. The majority believes that they will major in physics, engineering and applied science, or biology, and two have stated a preference for economics. Eighty-one percent went to public schools; four students were home-schooled.

Eleven of the new freshmen had parents who attended Caltech—and two of them are the offspring of two parents who attended Caltech. Interestingly, 13 freshmen are the first in their families to attend college.

As expected, this group of entering students has stellar academic credentials. Forty percent were class valedictorians, and an additional 8 percent were salutatorians. They also demonstrate proficiency in a wide range of other areas: 10 have or are pursuing a ham radio license, two have pilots' licenses, two are currently taking flying lessons, and one is learning to fly a helicopter! Thirty-five play piano, 16 play violin, 10 play the trumpet, and another 32 play other instruments, including one who plays the zither. Twenty-six play competitive chess. Others were writers and editors on yearbooks, literary magazines, and school newspapers; there are also thesis- and debaters among the entering class. And, not surprisingly, more than half were on math teams or in math clubs.

The number who participated in high-school athletics is certainly much different than it was when I arrived at CalcTech.

Twenty-seven played interscholastic tennis, 25 were on cross-country teams, and 16 were on track and field teams. Eighteen played soccer, six played basketball, and five played football. Entering students also played water polo, pursued martial arts, rowed, figure-skated, fenced, golfed, and played lacrosse and numerous other sports.

They were not focused only on self-achievement, but also displayed a deep commitment to community. One hundred sixty-one of them volunteered their time and talents to help others. They worked as volunteer tutors, and also in nursing homes, libraries, zoos, nature centers, and museums. They built houses for Habitat for Humanity, worked with autistic children and the deaf, and participated in numerous other community-service activities.

On a personal level, I have been pleased by the enthusiastic reception that the freshmen have given the traditions and values of Caltech. That they are excited about the challenge of the coursework, even as they are somewhat apprehensive about it. They are enraptured by the Caltech legends. We were blessed with the presence of Tom Apostol at the freshman pizza party. Although he no longer teaches, his book is used for freshman calculus. When they realized who he was, many freshmen ran back to their Houses to get their math books for him to autograph. The freshmen I have spoken with are fascinated by the Honor System and its possibilities. After talking with them and watching their adjustment to Caltech, I have confidence that these young men and women are well-equipped to thoughtfully continue the Caltech traditions as well as to establish some of their own, and that they will continue to advance science at an ever-increasing pace as they take their places in the road of time.

Caltech made them an offer they couldn't refuse! Top Photo: Members of the new freshman class settle in to hear about campus life and lore, and, above, one of those Institute moments that may or may not make it into the record: As an Alley Upperclassman Committeeman in Ruddock House in the '70s, future Association president Debbie Bloom Hall (center) dons Godfather gear to issue an Alley Challenge to fellow Ruddock residents, flanked by molls and mobsters (from left) Kelly Beatty '73, Marie Bell '75 (with violin case), Jean Claire "Jinkie" Asgargev '76, and Doug Jones '77.

Alumni Activities

February 21, Chicago Reception, with Caltech president David Baltimore. Rich Carlton, 5:30-7:30 p.m.

March 22, Mini Alumni College, on the topic of Information Science and Technology, New York. For more information, contact the Alumni Association at 626/395-6592.

May 15, Reunions for the classes of '38, '43, '48, '53.

May 16, Half Century Club Luncheon.


May 17, Alumni Association's 66th Annual Seminar Day.

Nominate an Alum

The Alumni Association is now accepting nominations for the 2004 Distinguished Alumni Awards. Alumni interested in submitting a nomination can request a nomination packet from the Association by calling 626/395-6592. The deadline for nominations is March 28, 2003.

The Distinguished Alumni Awards are given in recognition of extraordinary achievement by Caltech graduates. Alumni who have earned a Caltech degree (BS, MS, Engineer's Degree, or PhD) may be nominated. Graduates who are currently on the Institute faculty or staff are not eligible.

Recognize...from page 9 his particularly being noted for the invention of bulk metallic-glass-forming alloys and for the development of bulk metallic glasses as structural materials. He has also been selected to receive the 2003 Fellow Award and the 2004 Robert Franklin Mehl Award, both from the Minerals, Metals and Materials Society (TMS) in recognition of his contributions to materials science. In addition, he has received a Highly Cited Researchers Certificate from the Institute for Scientific Information in honor of "his accomplishments as one of the most highly cited and influential researchers in his field."

Joe Kirschvink '75, MS '75, professor of geobiology, has been elected a 2001 Fellow of the American Association for the Advancement of Science for his "unique capabilities in producing innovative ideas for linking geologic events and biologic evolution through a study of rock and paleomagnetism and biomagnetism."

Wolfgang Knauss '58, PhD '63, von Kármán Professor of Astronautics and Applied Mechanics, and Anatol Roshko, PhD '52, von Kármán Professor of Astronautics, Emeritus, were recently honored with special symposia at the 14th U.S. National Congress of Theoretical and Applied Mechanics, held June 24–28. Knauss was recognized for his "leadership and many contributions to the mechanics of structures and materials," and Roshko for his "seminal contributions to our knowledge of separated flows and shear-layer turbulence."

James Knowles, Kenan Professor and Professor of Applied Mechanics, Emeritus, has received the Warner T. Koiter Medal from the American Society of Mechanical Engineers, which is honoring him for "seminal contributions in nonlinear solid mechanics."

Shri Kulkarni, MacArthur Professor of Astronomy and Planetary Science, has been chosen as the 2002 Jansky Lecturer. Established in 1966 by the trust...
June 1; he was recognized for his 1972 Fluid Dynamics Prize.

John Cocke. The chairman and founder professor of engineering science, emeritus for science, and is awarded each year for his corecipients of the E. B. Wilson Medal career."

Fluid Dynamics Prize.

he was the recipient of the 1997 (1995, UCSD, EE and computer engineering), has moved into consulting in MEMS (Micro-Electro-Mechanical) and optical networks. Recently he has added film and video production to the skill list.

1986 Scott Karlin

As class agent, I have waited a long time to finally be able to pass on the news that I completed my PhD in computer science from Princeton in October. I am currently continuing my research there as I look for a full-time position that I can start next summer. As these notes go to press, my wife, Rosie, daughter Molly (9), and I are rehearsing for a local community theatre production of the musical, Annie. I’ll be playing the part of Balu’l Oliver Warbucks. My hope is that by the time you read this, we will have had a great run and that my hair will have already grown back. Based on the recent batch of class notes, it seems that everyone in the class of 1986 has been as busy as ever.

Robin Wilson writes, “To my surprise, I have found employment as a medical internist at Johns Hopkins Bayview in Baltimore.” She is preparing to start her three-year neurology residency at Johns Hopkins in July 2003, having graduated from the University of Pittsburgh medical school in May 2002. “My husband, Eric (a biologist), daughter, Alexandra (9), and I live in Mt. Airy, Maryland. In my spare time (when I’m not staying up all night at the birth of our third child, Deborah Alerha), SafeWeb, were the subject of a feature article about a year ago in Caltech News (issue no. 1, 2003). Felice Borisy Rudin and her husband, Nurain Rudin, are pleased to announce the birth of their third child, Deborah Alerha. “After an early start out the gate, baby, big brother Isaac, and big sister Shubana are all doing well,” says Felice. She is currently busy enjoying the many rewards of motherhood; a new home in Madison, Wisconsin; and teaching Sunday School on the side. She’d be happy to hear from classmates at frudin@chorus.net.

Hans Herrmann reports that he has been coaching his son Harry’s school soccer team.

"Life is very good, but of course I miss the friends I left in the Los Angeles basin, especially the Trench. EMBO to all you who are ‘modelles.’ "

Both Steve Hsu and his wife are professors at the University of Oregon in Eugene. He is a physics professor currently doing research in theoretical physics; she is a literature professor. Steve and his security and encryption company, SafeWeb, were the subject of a feature article about a year ago in Caltech News (issue no. 1, 2003).

Felicity Levin and her husband, Robert Levin, are pleased to announce the birth of their third child, Deborah Alerha. “After an early start out the gate, baby, big brother Isaac, and big sister Shubana are all doing well,” says Felice. She is currently busy enjoying the many rewards of motherhood; a new home in Madison, Wisconsin; and teaching Sunday School on the side. She’d be happy to hear from classmates at frudin@chorus.net.

Hans Herrmann reports that he has been coaching his son Harry’s school soccer team.
Although it is 60 percent 6th graders, there are also a few 7th and 8th graders. With two games and one tournament to go, it looks like we'll finish with a 500 season. So surprisingly, I find that running around in the afternoon with a bunch of kids is quite enjoyable and agrees with me.

Dan Loeb writes that he is still living in the Philadelphia area, doing programmed reading for Susquehanna Investment Group. Helen and the kids are doing well. Gabby's bat mitzvah is coming up in April. Jonathan (8) is an aspiring geologist. Benjamin (3) is practicing the violin.

"I am just in the midst of moving back to the States (Philadelphia) from Greece, where I have been working on international health issues," writes Yvette Madrid. "I am not quite sure what I will be doing in Philadelphia, but I plan to take a break to catch my breath and enjoy my family." Yvette has two daughters, Alessandra (4) and Paula (2), and a husband, Simone, who all manage to keep her extremely busy. She would especially welcome news from anyone else who might be in the Philly area.

In August 2002, Ken Poppleton was awarded his second patent, "Method and Apparatus for Multi-Level Image Alignment (6,433,840)."

After a grueling but wonderful four-year stint with nVidia, Charles Flaig and his wife, Heather, are happily retired in the Sonoma wine country. While their three-year-old daughter (Talyson) keep him pretty busy, especially since Talyson is not yet sleeping through the night, he reports that "it is nice to be able to have time to read books and work on hobbies again. I am becoming more active in my congregation, and hope to become a full-time minister at some point."

Hsiao-Tung Alex Yu has been selected as a Kauffman Fellow, a fellowship in the venture capital industry. Since May 2002, he has been working at Gabrielle Venture Partners, an early stage VC firm in the San Francisco Bay Area. "This firm has perhaps the highest concentration of Caltech EEs '86 of any VC firm because Scott Chou is a general partner here," he writes. "I am having a very fun time here and learning a ton."

Finally, we learn that Myles Susman has returned to Pasadena after 16 years and was pleased to discover that they 'll still give him a discount at Burger Continental. He's working for Luxtera, Inc., a startup company partly based on technology developed at Caltech. Luxtera is developing breakthrough nanophotonics products, "which is a funny thing for me to be working on, considering my degree is in aeronautics. When I'm not at work I can be found hanging out with my girlfriend, Tina, who is a fifth-grade schoolteacher in Ontario."

1927
John E. Marsland, of Eaton, Maryland, writes, "Today is September 5, 2002, 1953 days till my 100th birthday."

1934
J. Robert Schreck, of Los Altos, California, reports that he turned 90 on October 25. "Would like to hear from other classmates—if any."

1959
William L. Ko, MS, PhD '63, has been selected to receive a 2002 Dryden Peer Award, which comprises a plaque and a cash honorarium; he has been cited for "excellence in the category of Best NASA Series Report for 2001." He is currently working at the NASA Dryden Flight Research Center, Edwards, California, where he is conducting research on various thermostructural problems associated with future hypersonic flight vehicles. An accomplished watercolorist, he is preparing to publish a book entitled "Cloud Roads Short Stories and Railroad Fine Art," which will feature 12 of his own paintings.

1965
Virginia Trimble, MS, PhD '68, delivered the 22nd annual J. Robert Oppenheimer Memorial Lecture in Los Alamos, New Mexico, in July. Earlier in the year she was the Shaw Memorial Lecturer at Southern Illinois University, Edwardsville.

1966
Thomas B. McCord, MS, PhD '68, has retired as professor of planetary science at the University of Hawaii and has been professor emeritus since January 1, 2002. "This, perhaps premature, act is directed at forcing new experiences and providing positions for younger faculty at the University of Hawaii." He adds that he continues his career, working "with full vigor" as a scientist in the field of solar system exploration, focusing on determining and interpreting the surface composition of the planets, satellites, asteroids, and comets. He currently works out of his research center near his home in Winthrop, Washington, as well as from the University of Hawaii, and remains active as a science investigator on five deep-space missions: Galileo, Cassini, Mars Express, Rosetta, and DAWN. Last summer he completed a four-month residency at the University of Nancy, France, as a distinguished visiting professor under the sponsorship of the French Space Agency, CNES. He and his wife, Carol, also continue their long-term efforts at starting and developing small businesses.

1972
J. Robert Oppenheimer Memorial Lecture Entitled '68, delivered the 22nd annual J. Robert Oppenheimer Memorial Lecture in Los Alamos, New Mexico, in July. Earlier in the year she was the Shaw Memorial Lecturer at Southern Illinois University, Edwardsville.

1973
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1999
Joseph M. Colucci, MS, was elected to the National Academy of Engineering last February; the induction ceremony was held in Washington, D.C., on October 6. According to the NAE, this is "one of the highest distinctions that can be accorded an engineer," and Colucci's citation was "for leadership at the fuel/vehicle system interface leading to improved automotive fuel and vehicle quality and reduced emissions."

Colucci retired in 1995 as executive director, materials research, after 36 years with the General Motors Research and Development Center (formerly the General Motion Research Laboratories). He is currently president of Automotive Fuels Consulting, Inc., and he and his wife, Sue, live on a lake in Clarkston, Michigan. They have three grown children and eight grandchildren, and their hobby is traveling.
1934  
Mildred C. Childers, MS, MS '55, 60, of Laguna Niguel, California, on December 1, 2001; she was 88. A distinguished astrophysicist, she worked for Lockheed Aircraft from 1937 until 1952 on such aircraft as the P-38 Lightning, the Constellation, and the C-130 Hercules. He also worked on advanced research projects and consulted on the Atlas rocket, and for Lockheed Georgia on the graphite composite wing for the B-1 bomber. A lecturer at UCLA between 1941 and 1965, she wrote numerous technical papers on the materials, structures, and design of aircraft and spacecraft. She was awarded the Wright Brothers Medal in 1959 for a paper presented to the Society of Automotive Engineers, and in 1961 she was named San Fernando Valley Engineer of the Year by the California Engineering Society. She appeared twice in Who's Who in America. She died in 2001; she was 88.

1935  
Donald R. Rookie, of Fair Oaks, California, on October 18, 2000. He is survived by his wife, Barbara, and by a sister, Judith Schomaker.

1936  
Eugene Bollay, MS, of Santa Barbara, California, on November 28, 2001; he was 89. One of the first weather forecasters on Los Angeles television in the late 1940s and throughout the 1950s, he made meteorology the focus of his life. He taught at the U.S. Naval Academy and retired from the Navy with the rank of commander in 1950. In the late '30s and early '40s he started several businesses in the Pasadena and San Gabriel areas. He was an urban area meteorologist and a Weather Consultants, North American Instruments, and E. Bollay Associates. In 1971 he was appointed program director for the National Oceanographic and Atmospheric Administration, and in 1979 he was asked to join the UN's World Meteorological Organization, where he directed its precipitation and enhancement program. A past president of the American Meteorological Society and a fellow of the American Geophysical Union, his other affiliations included Sigma Xi, the American Society of Civil Engineers, and the American Association for the Advancement of Science. He wrote numerous reports on weather modification and coauthored and edited the Handbook of Meteorology. Predeceased by his wife, Virginia; a son, Eugene; and his eldest brother, William, he is survived by his special friend and companion, Lissa; three daughters, Barbara Merritt, Suzanne Kiez, and Kathy Ricarte; a son, Robert; and seven grandchildren and five great-grandchildren. His younger brother, Ronald, died the following day.

1937  
Frank W. Davis, of La Jolla, California, on July 15, 2001; he was 86. A naval aviator and Marine Corps officer, he started flying while still in high school. In 1951 he joined Douglas Aircraft Company General Dynamics as an engineer-test pilot, and he was the first pilot to fly a new aircraft as well as the first jet pilot for General Dynamics. For his work at that time he was elected an honorary fellow of the Society of Experimental Test Pilots. In 1971 he joined Convair in San Diego as chief design engineer and assistant to the vice president for engineering. For his work during the early years of developing aircraft, he was elected a fellow of the American Institute of Aeronautics and Astronautics in 1982, and F-106, as well as a associate received the Aircraft Design Medal from the American Institute of Aeronautics and Astronautics. In 1954 he moved to the Fort Worth Division of General Dynamics as chief engineer during the design stage of the B-57 bomber. He subsequently became president of the division, and in 1970 was assigned the added responsibility of the Burbank Division in San Diego. In 1974, elected to the National Academy of Engineering in 1967, he received Caltech's Alumni Distinguished Service Award in 1968 and an honorary doctor of science degree from West Virginia University in 1968 and from National University in 1984, as well as a Navy League Citation Honor. He was a registered professional engineer in Texas and California. Captain of the Caltech football team as an undergraduate, he was named to Sport Illustrated's All-American All-Sports Football Team. After retiring, he served on the boards of several companies and the board of overseers for the Department of the Army, the Department of the Army, the National Academy of Sciences and the American Association for the Advancement of Science. He wrote numerous reports on weather modification and coauthored and edited the Handbook of Meteorology. Predeceased by his wife, Virginia; a son, Eugene; and his eldest brother, William, he is survived by his special friend and companion, Lissa; three daughters, Barbara Merritt, Suzanne Kiez, and Kathy Ricarte; a son, Robert; and seven grandchildren and five great-grandchildren. His younger brother, Ronald, died the following day.

1938  
Ralph A. Naylor, of Flemington, New Jersey, on July 25, 2001. He worked for American Cyanamid for 42 years as a research chemist and developed many chemicals derived from rubber. He is survived by Nancy, his wife of 55 years; a daughter, Carol Donnelly; and two sons, Ralph Jr. and Robert.

1939  
Keith S. Ditman, MS, '64, Eng. '48, of Ashburn, Virginia, on April 24, 2001, he was 84. He received dual B.Ss in mechanical and aeronautical engineering. During the 1940s and 1950s he was associated director of the Southern California Cooperative Wind Tunnel, and later, at Rame-Windfold Engineering Corporation and the Space Technology Lab, he managed several projects, including the Reconnaisance Satellite Project Office, which oversaw the Discovery, Samos, and Midas systems. At North American Aviation, in the early 1960s he developed designs for the B-1 bomber and vertical-takeoff-and-landing aircraft. In 1967 he moved to the Washington, D.C., area, where he worked as an analyst and designer for the Institute for Defense Analysis and the Navy Department. He retired in the 1980s, after which he took up running, establishing records in his 75-80 age group for the 7256-meter race in 1997 Northern Virginia Senior Olympics, and placing fourth at the age of 80 in the 800-meter race during the 1997 National Senior Games. He is survived by Jean, his wife of 68 years; his daughter, Carol; two sons, Ralph and Richard; two grandchildren; a sister, Rose; and a brother, Roland.

1940  
Ralph G. Paul, of Santa Cruz, California, on October 3, 2001. He is survived by his wife, Doris.

1942  
Forest M. Clinkan, of Dunlap, California, on February 3, 2001. He was a captain in the U.S. Marine Corps, a member of the 9th Half Century Club. He is survived by his wife, Helen.

1943  
Charles W. Pearson, of Green Valley, Arizona, on March 5, 2001; he was 79. He is survived by his wife, Melissa.

1944  
Clarence E. Erickson, MS, of Tucson, Arizona, on March 11, 2001; he was 85. A captain in the U.S. Army Air Corps during World War II, he went on to serve as a meteorologist in the Department of the Army, which decorated him for meritorious service upon his retirement in 1970. He was for many years chief of the Atmospheric Sciences and Research Division at Fort Huachuca, Arizona. A 32nd-degree Mason, he was a member of the Sabara Shriners Temple, the Saba Temple Lodge, Grace St. Paul's Episcopal Church, and BPOE Lodge 305. He is survived by Jeanne, his wife of 55 years; two sons, Paul and Eric; six grandchildren; and his sisters, Ruth Erickson and Dorothy Anderson.

1945  
Elton L. Knapp, MS, Eng. of Indianapolis, Indiana, on September 13, 2001. He is survived by his wife, Marie.

1947  
Leigh Sheriffs, of Los Angeles, in July 2001; he was 74. He established Sheriffs Engineering, a mechanical-engineering and consulting company in 1959, and he served on the California State Building Standards Commission during the 1980s. He is survived by his wife, Edita; a daughter, Kathy; two sons, Richard and Russell; two grandchildren; a sister, Rose; and a brother, Rolland.

1948  
Josiah E. Smith, MS '40, Eng. '48, of Ashburn, Virginia, on October 17, 2001; he was 88. He received dual B.Ss in mechanical and aeronautical engineering. During the 1940s and 1950s he was associated director of the Southern California Cooperative Wind Tunnel, and later, at Rame-Windfold Engineering Corporation and the Space Technology Lab, he managed several projects, including the Reconnaisance Satellite Project Office, which oversaw the Discovery, Samos, and Midas systems. At North American Aviation, in the early 1960s he developed designs for the B-1 bomber and vertical-takeoff-and-lending aircraft. In 1967 he moved to the Washington, D.C., area, where he worked as an analyst and designer for the Institute for Defense Analysis and the Navy Department. He retired in the 1980s, after which he took up running, establishing records in his 75-80 age group for the 7256-meter race in 1997 Northern Virginia Senior Olympics, and placing fourth at the age of 80 in the 800-meter race during the 1997 National Senior Games. He is survived by Jean, his wife of 68 years; his daughter, Carol; two sons, Ralph and Richard; two grandchildren; a sister, Rose; and a brother, Roland.
Jesse Greenstein, 1909-2002

Jesse Greenstein, an astrophysicist whose many accomplishments included pioneering work on the nature of stars and quasars, died October 21, 2002, three days after falling and breaking his hip. He was 93.

A native of New York City, Greenstein grew up in a family that actively encouraged his scientific interests. At the age of eight he received a brass telescope from his grandfather—not an unusual gift for an American child, but Greenstein soon was experimenting in earnest with his own prism spectroscope, an arc, a rotary spark, a rectifier, and a radio transmitter. With the spectroscope he began his lifelong interest in identifying the composition of materials, a passion that would lead to his becoming a worldwide authority on the evolution and composition of stars.

Greenstein entered the Horace Mann School for Boys at the age of 11, and by 16 he was a student at Harvard. After earning his bachelor's degree in 1929 and his master's in 1930, he decided that it would be prudent, in the depths of the Great Depression, to join the family's real estate and finance business. He was a patern attorney in Washington, D.C., from 1935 to 1937, he served as professor and chairman of aerospace and mechanical engineering at California Institute of Technology, and he founded Evensen Engineers, his family's real estate and finance business.

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In 1939 he joined the university's astrophysics faculty, and during the war years did military research in optical design at Yerkes. He also spent time at McDonald Observatory, then jointly operated by the University of Chicago and the University of Texas, before accepting an offer from Caltech to organize a new graduate program in optical astronomy in conjunction with the new 200-inch Hale Telescope at Palomar Observatory.

The Caltech astronomy program quickly became a premier academic undertaking, with Greenstein serving as executive officer from 1948 to 1972. During the 24-year period, he spent more than 1,000 nights observing at Palomar and other major observatories, and also took up radio astronomy in 1955. He was a staff member at Mount Wilson and Palomar Observatories until 1980, when he retired from the Caltech faculty. He stopped observing in 1985, but continued to do research on white dwarfs, M dwarfs, and the molecular composition of stars.

Greenstein's research interests largely centered on the physics of cosmic objects. He studied stellar composition and the related topic of nucleosynthesis in stellar interiors, as well as the physical processes and radio-emitting sources. In 1963, working with his Caltech colleague Maarten Schmidt on the high redshift of quasars, he demonstrated that quasars are quite compact objects. In later years, he studied the magnetic fields of white dwarf stars, established their luminosities, and did ultraviolet spectroscopy with data obtained from the International Ultraviolet Explorer (IUE) satellite.

A common thread of his research efforts, Greenstein once wrote, 'was that they were pioneering thrusts, attempts to provide first tests of a variety of physical laws under extreme conditions in the inaccessible but convenient experimental laboratories of the stars.'

Greenstein was active in the establishment of the National Radio Astronomy Observatory (NRAO) and served as chair of the board of the Association of University Research in Astronomy. He played a pivotal role in organizing many national astronomical facilities, serving as a member of the 1970 decadal review of astronomy for the National Research Council and served on the National Academy of Sciences' committee on science engineering and public policy.

Elected to the National Academy of Sciences in 1957, Greenstein was named California Scientist of the Year in 1964, awarded the NASA Distinguished Public Service Medal in 1974, and the Gold Medal of the Royal Astronomical Society in 1975. He received the Centennial Medal from Harvard, and was named to the American Academy of Achievement in 1982. He is survived by two sons, Peter, of Oakland, California, and George, of Amherst, Massachusetts. Naomi Kitay Greenstein, his wife of 68 years, whom he met as a 16-year-old Harvard undergraduate, died earlier this year. The Greensteins were often commended for the warmth and hospitality they extended to astronomers from throughout the world.

A memorial service is planned for February 11 in Dalney Lounges at 3:30 p.m. For more information, call Gina Armel at 626/395-4671.