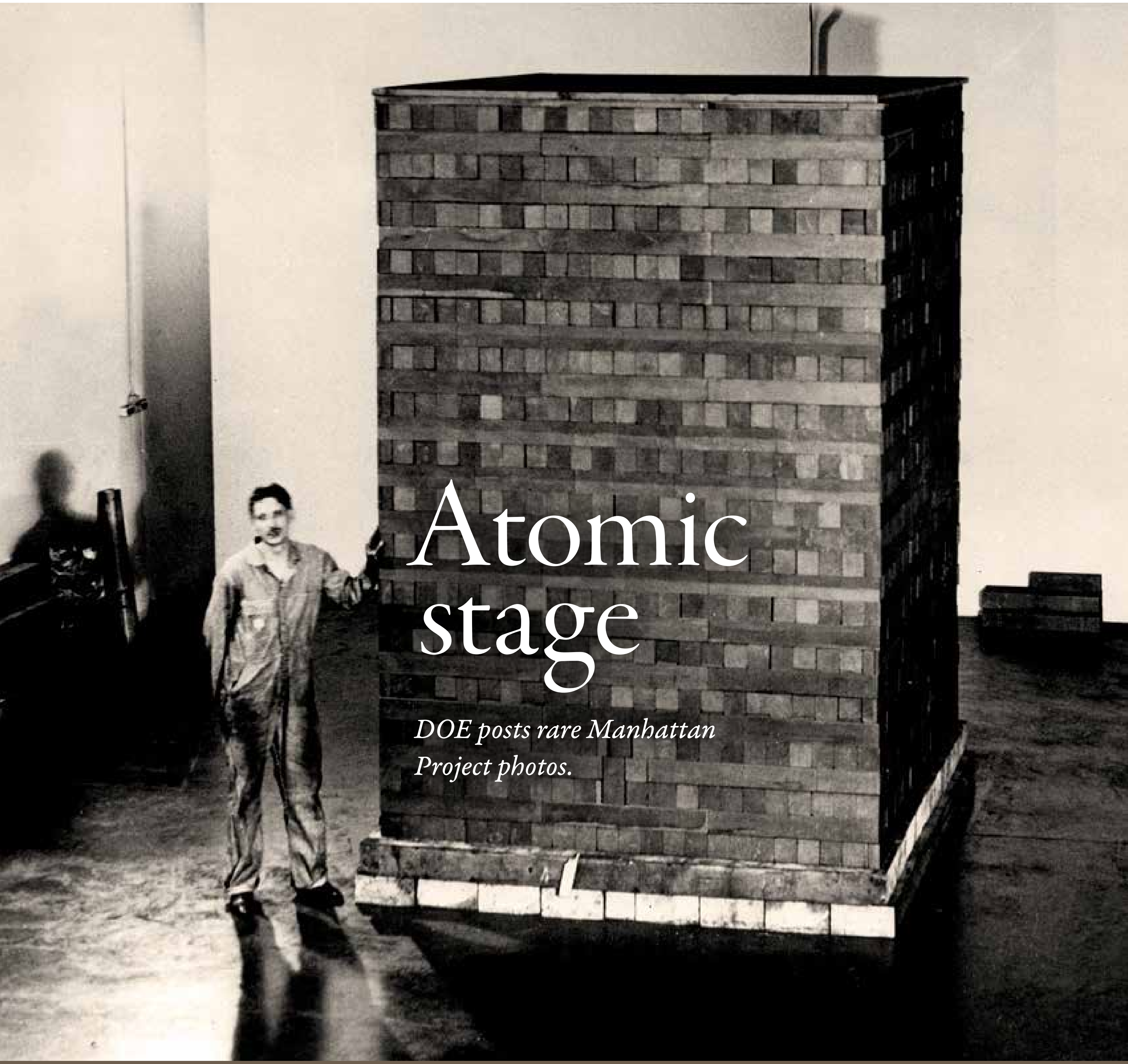
NEWS FROM THE UNIVERSITY OF CHICAGO PHYSICAL SCIENCES DIVISION

# INQUIRY



## Atomic stage

*DOE posts rare Manhattan Project photos.*

SPRING / SUMMER 2014

THE UNIVERSITY OF CHICAGO

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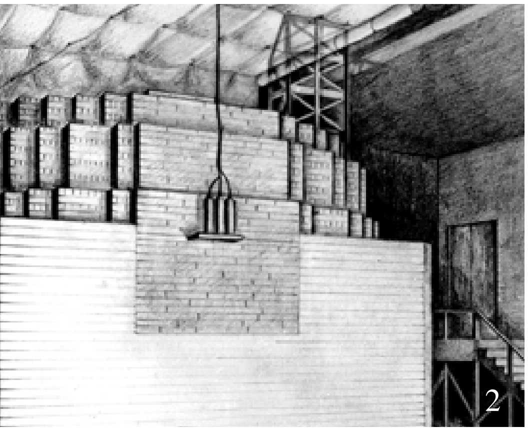

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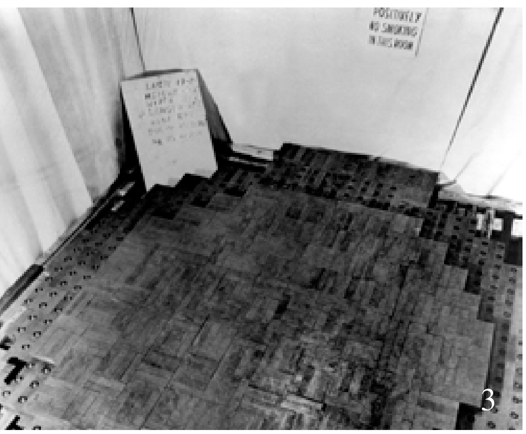

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**Cover:** On December 2, 1942, Enrico Fermi and colleagues achieved the first man-made, self-sustaining, controlled nuclear chain reaction. Their nuclear reactor, an atomic pile called Chicago Pile 1 (CP-1), was a 57-layer lattice of 40,000 graphite blocks enclosing 19,000 pieces of uranium metal and uranium oxide inside a 24-square-foot wooden framework. Neutron-absorbing cadmium rods were inserted to control the reaction. In November 2013, the Department of Energy posted 21 pictures showing the construction of CP-1 and the birth of the atomic age. View them all at magazine.uchicago.edu/inquiry/cp1.

(Cover) One of at least 29 atomic piles built for the Manhattan Project. (1) Birthplace of the atomic age, the squash court under the west stands of Stagg Field. (2) Sketch of the world's first nuclear reactor, CP-1, which was constructed under the football grandstands. (3) The only photograph made during the construction of the first nuclear reactor. *Photos courtesy DOE*



# Bon voyage

*Ed Stone tracks* Voyager 1 *as it enters interstellar space.*

Stone stands in front of a full-scale model of *Voyager* in 1992, 20 years after the mission began.

*Photo courtesy NASA*

In 1957, Ed Stone, SM'59, PhD'64, was returning to the University of Chicago for his second year as a graduate student. He had planned to pursue nuclear physics—the frontier of his field at the time—but then *Sputnik* launched October 4. "The space age began, and suddenly there was another whole frontier." Less than a year later, Stone joined John Simpson's lab to study astrophysics.

Now a Caltech professor and retired NASA Jet Propulsion Laboratory director, Stone has been an investigator on more than a dozen NASA missions. The most extraordinary, he says, is the *Voyager* mission. Stone has been its sole project scientist since the mission's 1972 inception, and last year NASA commended this work with the Distinguished Public Service Medal, its highest civilian honor.

In 1977, five years after the mission began, two identical, nuclear-battery-powered *Voyager* spacecraft were launched with the goal of conducting a "grand tour" of our planets—each visiting Jupiter and Saturn, and *Voyager 2* continuing on to Uranus and Neptune. Each craft carries ten instruments, including cameras; particle, wave, and magnetic field detectors; and tools that measure cosmic rays and determine what elements are present.

Both *Voyagers* have sent back revelatory information: Jupiter's moon Io has ten times more volcanic activity than Earth; Neptune's moon Triton, only 40 degrees above absolute zero, has geysers erupting from its polar cap; Saturn's moon Titan has a nitrogen atmosphere. Previously, the only known active volcanoes, geysers, and nitrogen atmospheres were on Earth. "We realized we were in for not just more understanding of what we already knew but in fact things we could not have imagined."

*Voyager 2* took its last picture in 1989 during the Neptune flyby. *Voyager 1* cameras, off since 1980 after visiting Saturn, were briefly turned back on in 1990 for a solar system "family portrait," a mosaic of 60 frames. It includes the famous "pale blue dot" photograph. NASA then permanently turned off its cameras to preserve power. Tour completed, there was nothing left to see within *Voyager*'s life span. But both spacecraft continue to collect data on whatever invisible mysteries lay beyond.

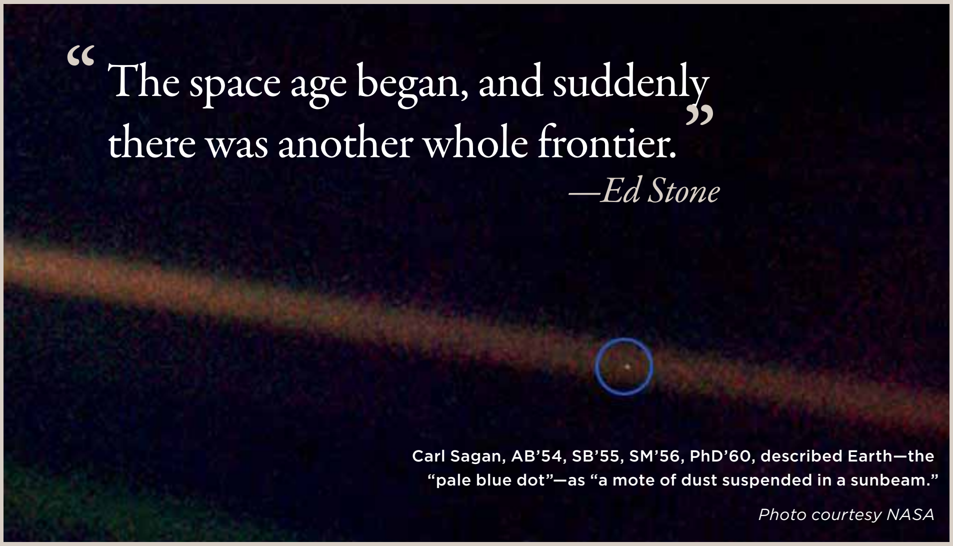
Thirty-five years after launch, *Voyager 1* entered interstellar space, leaving the bubble of our plasma-filled heliosphere. Yet NASA couldn't confirm the spacecraft had left for more than a year, making the official announcement September 12, 2013.

Stone needed three signs to prove *Voyager 1* had crossed the heliosphere's boundary: more galactic cosmic rays, denser plasma, and a shift in magnetic field. Galactic cosmic rays—high-energy particles created by distant supernovae—can penetrate our heliosphere bubble, but the slowest are deflected by solar wind. Models predicted that galactic cosmic rays would increase dramatically outside the heliosphere, while low-energy particles from inside would disappear. On August 25, 2012, *Voyager 1* data revealed exactly that. But this data was not enough to prove its crossing.

The strongest evidence would be the density, temperature, and speed of the plasma itself, but *Voyager 1*'s plasma instrument hasn't been functional since 1980. Stone relied on magnetic field measurements as a proxy for plasma density because plasma carries magnetic field lines. In August 2012, when the galactic cosmic rays were spiking, the magnetic fields strengthened by 60 percent, but the direction changed by no more than two degrees, far less than expected.

Without direct observation of plasma density or corroborating magnetic field shift, Stone could say only that *Voyager* was in a new but undetermined region. But in April 2013, there was a "large outburst from the sun like a tsunami, which reached *Voyager*" and disturbed its surrounding plasma. *Voyager 1* still has a functional plasma wave instrument, "which can't measure the plasma directly but measures electrical waves," says Stone. "The plasma is an ionized medium, so when it oscillates, it generates an electric field,

"The space age began, and suddenly there was another whole frontier."
—*Ed Stone*



Carl Sagan, AB'54, SB'55, SM'56, PhD'60, described Earth—the "pale blue dot"—as "a mote of dust suspended in a sunbeam."

*Photo courtesy NASA*

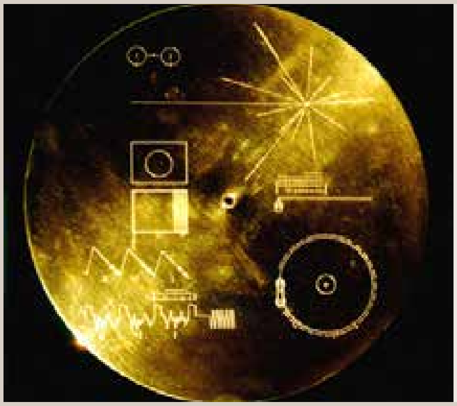
which also oscillates." The waves produce "a particular tone that tells you how dense the plasma is. It turns out it was 80 times denser than it had been. So then we knew we were indeed outside."

Extrapolation between that solar tsunami and a previous weaker disturbance indicated *Voyager 1* entered interstellar space around August 25, 2012, confirming the cosmic ray measurement. Because the magnetic field did not shift as expected, the models needed to be refined.

But had *Voyager 1* really left the solar system? Not exactly. While "solar system" usually means planetary system in vernacular, it technically encompasses the entirety of the sun's influence. That includes gravity, which dominates halfway to the closest star, where that star's gravity becomes stronger. Outside the heliosphere, there is a cloud of comets anchored by our sun's gravity, called the Oort cloud. "It will be 300 years before we reach the inner edge and 38,000 years before we finally get through the cloud."

If *Voyager* were still collecting data after traversing the Oort cloud, astrophysicists might find that some of the outer comets actually orbit another star. But, says Stone, "by 2025, we will have turned off the last instrument, and after that the spacecraft will orbit the center of the Milky Way" as a silent ambassador—a lifeless vessel carrying a message from Earth in the form of a golden record.

As long as *Voyager* transmits, *Voyager 1* from north of the planetary plane and *Voyager 2* from south, two or three years from interstellar space, Stone will be listening. In the meanwhile, he turns his attention the other way, toward the innermost reaches of the solar system. In 2018, NASA will launch *Solar Probe Plus*, a spacecraft, carrying an instrument that Stone helped develop, on a mission to study the sun's corona where the solar wind begins.—*M. S.*



## Residents of far skies

Both *Voyagers* carry identical golden records containing images, natural and mechanical sounds, music, and greetings in 55 languages. The records are encased in aluminum and affixed to the outside of the vessels—a representation of the human species for any intelligent alien life. Learn more by visiting mag.uchicago.edu/residents-far-skies.

*Photo courtesy NASA*

# Model economist

*Lars Peter Hansen explains the work that won him the 2013 Nobel.*

Hansen receives the 2013 Nobel Prize in Economic Sciences from Sweden's King Carl XVI Gustaf at the Stockholm Concert Hall, December 10, 2013.

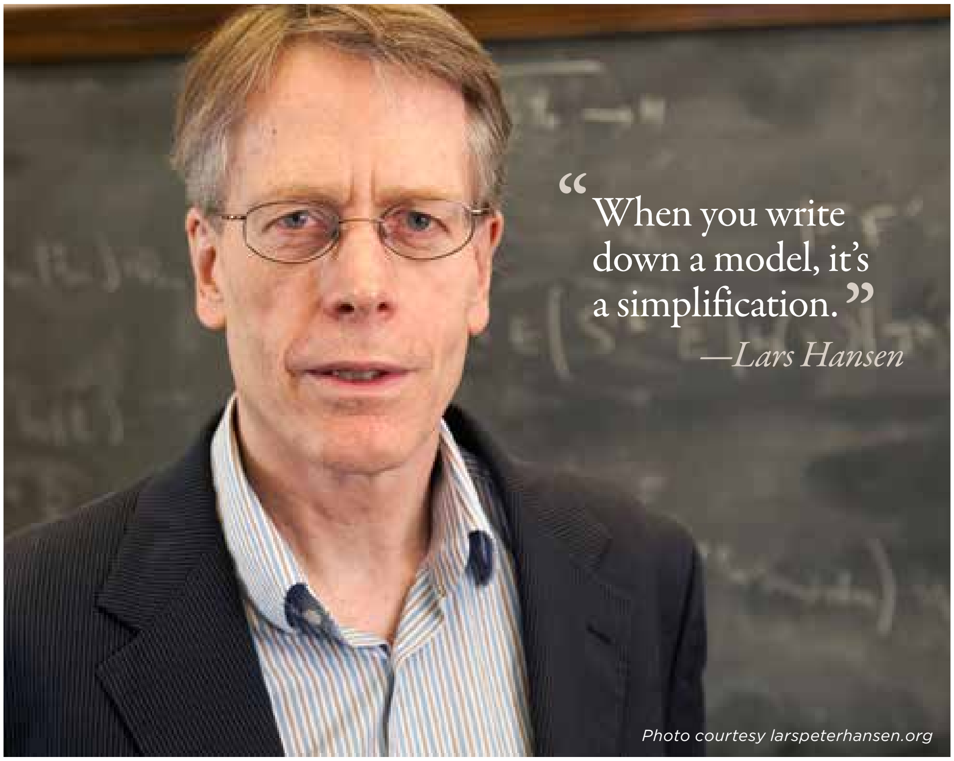
*Photography by Frank Augstein/AP for the University of Chicago*

In October, Lars Peter Hansen, the David Rockefeller distinguished service professor in economics and statistics, shared the 2013 Nobel Prize in Economics with finance professor Eugene Fama, MBA'63, PhD'64, and Yale's Robert Shiller, all cited for their contributions to asset price analysis. Hansen is recognized for his work on a statistical technique called the Generalized Method of Moments (GMM), a method that lets you "do something without having to do everything," he says. Building on these theoretical advances, Hansen and coauthors applied the methods to understand better the linkages between financial markets and the macroeconomy.

The GMM is designed to help statisticians make more accurate conclusions about the relationship between certain variables in a stochastic economic model without having to consider formally the dynamic evolution of all model components. It can also be used to estimate and test existing models, including those advocated by Fama and Shiller. The GMM can function as a skeleton key to unlock strengths and weaknesses of important elements of an economic model that pertain to the returns to alternative investments opportunities.

**You work in econometrics, at the intersection between economics and statistics. What is the benefit of adding mathematical modeling to economics?** Some people view the role of formal mathematics with skepticism, arguing that the field is too mathematical. A reason that I use math is to provide clarity. By the time you translate something into mathematics, you have to be clear what you're trying to say, and you open the door to a formal analysis of the strengths and weakness of the models that interest us.

**What are the practical applications of the Generalized Method of Moments?** A lot of it is about assessing and testing models. Some of the papers that I received a lot of attention for were exposing problems in models, exposing what their gaps were. How do we fill those gaps? How do we build new models that can address the empirical shortcomings of the initial set of models?




In a paper that I wrote with Stanford's Ken Singleton, we took a model that was in common use among economists and showed that if you looked at it from a formal statistical perspective, it had some major problems in terms of connecting the macroeconomy and financial markets.

My work isn't telling people how to go out and make money; it's asking how can we build models that work better and are more useful for thinking about important policy questions.

**How can your research affect the average citizen?** I'm interested in the concept of uncertainty, how people respond to and cope with it. This work should have ramifications for how people make decisions.

When we build models as economists, and when people build and use models in the private sector, these models are not perfect. If you take them too literally, you can make mistakes. How do you use models in sensible ways without pretending that they get everything correct? That's a really important challenge for the private sector, the public sector, and for academic economists interested in uncertainty.

**How does your method take into account that uncertainty?** When you write down a model, it's a simplification. It's not going to capture everything in reality by its very nature. How do you approach that? Well, you can start doing things like sensitivity analysis—to see what happens if you start changing aspects of the model. What happens to the probabilities? How much do they change, which probabilities change a lot, and which ones don't change much?

These questions often do not translate into complete probabilistic statements because when a model is wrong, if you knew how to fix it, then you could make it right. Typically you don't quite know how to fix it, but you can analyze it to at least get some idea of where the important sensitivities are. From the decision-maker's standpoint, you want to know where a mistake in the model would have the biggest consequences.

**How does this work affect policy making?** The financial crisis exposed gaps in our understanding of the linkages between the financial markets and the macroeconomy. Those linkages now have to get repaired. If you look at what's required in policy-making circles, there's this pressure to question how we can do a better job of monitoring financial markets.

Recently, a lot of that's been done in very informal and ad hoc ways because the models out there were not so useful as guides. So what I've been trying to do through the Becker Friedman Institute and with scholars all around the country is to determine how we can build the next generation of models that will be useful for quantitative purposes and will put us in a better position to think about sensible ways to monitor financial markets.—*M. S.*

## *Hansen's Professional Highlights*

### EDUCATION

1978 PhD (Economics)
University of Minnesota

1974 BS (Mathematics)
Utah State University

### ACADEMIC POSTS

1981–present University of Chicago

1978–1981 Carnegie-Mellon University

### HONORS

2013 Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel (w/ E. Fama, R. Shiller)

2011 BBVA Foundation Frontiers of Knowledge Award in Economics, Finance and Management

2008 CME Group-MSRI Prize in Innovative Quantitative Applications

2006 Erwin Plein Nemmers Prize in Economics

1984 Frisch Medal, Econometric Society (w/ K. Singleton)

# Life cycle

*Dorian Abbot studies the water cycle of extrasolar planets.*

Geophysical sciences assistant professor Dorian Abbot grew up in the coastal town of Yarmouth, Maine, where his engineer grandfather and uncle would take him out on ships and talk about the waves and weather. He now studies climate dynamics through Earth's paleoclimate and exoplanet habitability, both of which often depend on the presence and behavior of water.

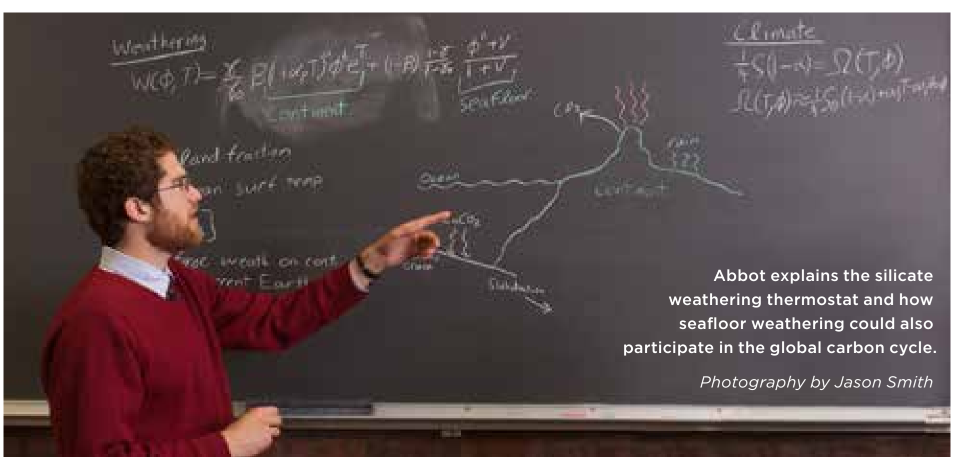
Abbot earned three degrees at Harvard—a bachelor's in physics and a master's and doctorate in applied mathematics—and completed postdoctoral fellowships there and at UChicago before joining the faculty in 2011. Because the University encourages crossing departmental boundaries, he can use both his physics and math backgrounds. "I'm not a guy who likes to stay working on the same thing forever," he says.

In 2013, Abbot developed predictive models that defined more precisely the boundaries of the habitable zone, the area around a star where planets have the temperature and atmospheric pressure to maintain liquid water. Too close to the star, all water evaporates; too far, it freezes. He focused on red dwarfs, common stars smaller and cooler than the sun, and their closest planets, which are often tidally locked with one side always facing the star.

Original habitable zone climate models were 1-D and neglected clouds. Abbot and Jun Yang, a postdoc working with him, applied 3-D models that also incorporate cloud behavior. On Earth, and presumably on other planets with atmospheres, clouds have a cooling effect by reflecting light from the sun before it reaches the planet. They also have a warming effect by trapping energy leaving the planet, deflecting it back down.

"If the clouds were to stop doing their warming, then we would be a snowball Earth, and if they were to stop cooling, we would turn into Venus. Whole oceans would evaporate—we would just be frying," says Abbot. "That's how important clouds are." According to his calculations, thick clouds would form under the star on tidally locked planets thought too close to their star to sustain life, cooling and stabilizing the climate and preventing water from boiling off. This model expands the inner edge of the predicted habitable zone. Crucially, this model makes predictions that will be testable with the James Webb Space Telescope, due to be launched in 2018.

More recently, Abbot has been studying super-Earths, exoplanets with masses greater than Earth but less than giants like Neptune and Uranus. If a rocky super-Earth orbits within the habitable zone and contains water, it could theoretically support life. But geophysicists expect it to be completely covered by ocean; high mass planets should tend to have deeper oceans and higher surface gravity that would cause smoother topography. Land wouldn't rise high enough to break the ocean surface. Abbot's research, however, suggests that these presumed water worlds may in fact have exposed continents. This possibility matters because planets need dry land to activate the silicate weathering thermostat, a temperature-dependent process that regulates atmospheric carbon dioxide and makes possible a stable climate.




Abbot explains the silicate weathering thermostat and how seafloor weathering could also participate in the global carbon cycle.

*Photography by Jason Smith*

Like cloud-based climate control, this stabilization is also related to a water cycle. But instead of atmospheric cycling, Abbot and Northwestern University astrophysicist Nicolas Cowan developed models based on water cycling between ocean and mantle—the deep water cycle.

Earth maintains dry continents by partitioning and cycling water between oceans and the rocky mantle beneath its crust. In this process, mantle rock is exposed at mid-ocean ridges—underwater mountain ranges created by plate tectonics—and degasses, which releases water trapped in the rock into the ocean. Water is also incorporated into oceanic crust, which plate tectonics pushes into the mantle, closing the water cycle.

Based on these processes, Abbot and Cowan developed a hydrosphere model, which indicates that a terrestrial planet, regardless of mass, could maintain dry continents like on Earth. Seafloor pressure is proportional to surface gravity, and higher seafloor pressure reduces water degassing and increases ocean crust hydration. So a super-Earth would theoretically store more water in its mantle than on the surface.

This proposition, however, depends on several assumptions: that the rocky planet has plate tectonics; that Earth's mantle actually stores a considerable amount of water, which thus far has been impossible to quantify; and that the planet's mass is less than 0.2 percent water (about ten times more water than Earth has). Any more would create a true water world where the mantle doesn't store enough water to create continents or an ocean planet covered with water hundreds of miles deep where no amount of mantle reserve could expose dry land.

All of this theorizing also rests on a massive assumption—"that water is essential for life," says Abbot. "All of biology is hampered by the fact that we only know about one type of life. It's hard for people to define what life is. Every time someone comes up with what they think is a good definition, people will find some counterexample." But scientists have to start somewhere. "If there are other types of life that aren't at least somewhat similar to us, we'll never find them anyway because we won't know what we're looking for or where to find it." So we look for the best possible candidates: planets with liquid water and a stable climate.—*M. S.*

# Master class

*PSD faculty and others learn the keys to communicating science.*


Alan Alda delivers his keynote for a Kavli Institute-sponsored workshop on science communication.

*Photography by Robert Kozloff*

In his Ryerson Physical Laboratory office, professor of mathematics Benson Farb is picking up something heavy. He’s doing it the right way, lifting with his knees. But the thing is—there’s nothing there.

Farb is demonstrating an exercise, a little bit of improv, that he says contributed to a “transformative” weekend last fall—three days of intensive training with the instructors of Stony Brook University’s Alan Alda Center for Communicating Science. Farb’s fellow students included faculty, staff, and leadership from across the Physical Sciences Division and Argonne National Laboratory, as well as physicians from the University of Chicago Medicine, faculty and graduate students from other area universities, even an educator from the Adler Planetarium.

And yes, Alan Alda was there too. The actor, writer, and director has dedicated much of his after-*M*A*S*H* career to making science accessible to the general public (or at least those who watch PBS). He was there throughout the weekend, kibitzing as UChicago faculty and others were put through their paces in three-hour sessions of improv and mock on-camera interviews, with plenty of feedback in between. Alda also delivered a keynote address, “Helping the Public Get Beyond a Blind Date with Science.”

In his talk, Alda explained why the ability to communicate science to a lay audience is so crucial: put simply, that audience includes the elected officials who hold the purse strings, as well as the voters who give them the strings to loosen and tighten as they see fit. On a more poetic level, Alda said, speaking for all nonscientists, we’re “hungry to know more. We’re human and we have this need to understand”—this was the heart of his message—“one of the great beauties of humanity, which is science.”

Just in case it’s not already clear, this was no communications boot camp for beginners. “I walked into the weekend thinking, ‘I’m a pretty good communicator,’” says Doug MacAyeal, a UChicago geophysical sciences professor who specializes in glaciology. “I’ve been on TV; I’ve been in a movie”—Werner Herzog’s *Encounters at the End of the World*—“I’ve talked to newspapers. I should be really good at this.” He pauses. “It was the most exhausting training I have ever done short of building an igloo in Antarctica and having to sleep in it through the night without getting any sleep.”

Farb says he has given “hundreds of talks” in his career, to both expert and general audiences. But, he states, “This made me better.” The improv work helped him shift his focus from himself—“the words coming out of my mouth, the thoughts in my head”—to his audience and connecting with them. One of the most powerful demonstrations of making that connection occurred during an exercise that required Farb to enter a room and communicate to the others that he was there to visit his grandmother (played by another participant) without, of course, just saying, “Hi, Grandma!” The first time, no one guessed the situation. Farb stepped out of the room to regroup and try again. “This time, I walked up to the other person, took their hand gently in mine, and just softly stroked it,” Farb says, miming his movements again. “Everyone got it right away. It was all about the body language.”

MacAyeal feels he received the most “useful and practical” advice during the mock interviews, which were conducted by a former *60 Minutes* producer. “The trick is to get people to ask questions that just ‘pop into their mind’ because I put them there.” That way, he says, the conversation can be a “pas de deux,” with graceful handoffs, rather than a wrestling match between interviewer and interviewee.

It was a hard-won lesson. Both Farb and MacAyeal attest to grueling sessions in front of the camera. But, Farb says, “When it’s a guy from *60 Minutes* critiquing how you present your ideas, you listen.” MacAyeal says the Alda Center faculty were “nice people, but they were like drill sergeants. They scared me. That’s why it was good to have Alan Alda there to come out and say, ‘You know what, you guys? Even when you’re not communicating perfectly, it’s still important that you’re trying.’”

One theme that ran through the weekend—from Alda’s keynote to the final feedback session—was the power of storytelling to connect audiences to the subject. It’s an approach Farb has taken to heart. In two recent talks, instead of simply walking his audience through a theorem, he describes how he and a former student proved it. “And it’s a really good story,” he says. “For a while, the computer was telling us we were wrong. But we were so convinced we had it right, we dug into the software code, where we found an error. Once we fixed that, everything just fell into place.” Farb’s hands float down in front of him, fingers fluttering, to illustrate the arrival of the elegant cascade of data they had expected all along—and, consciously or not, to illustrate how storytelling and a little body language can bring science to life for any audience.

*—Sean Carr, AB’90*

# Southern exposure

*Josh Frieman illuminates dark energy with a telescope and a camera.*

Frieman looks for "pottery shards" with Ryerson Physical Laboratory's rooftop telescope.

*Photography by Drew Reynolds*

When Josh Frieman, PhD'89, was an undergrad at Stanford, famed British cosmologist Dennis Sciama gave a physics colloquium there that inspired Frieman to view cosmology as archaeology on the grand scale. A scientist can study distant objects in the universe—how they are distributed and how they are moving—and fit them together like pottery shards to discover what the early universe looked like.

As a UChicago astronomy and astrophysics professor and Fermilab staff scientist since 1988, Frieman builds on this idea of piecing together observations of the universe to understand how it evolved and what it's made of. He leads the Dark Energy Survey (DES), a project launched last August that takes photographs of distant galaxies using a 570-megapixel camera mounted on the Victor M. Blanco Telescope at the Cerro Tololo Inter-American Observatory in the Andes mountains of Chile. The survey, which brings together more than 300 scientists from 25 organizations around the world, takes about 200 pictures every night, each logging about 80,000 galaxies, and over five years the survey will document more than 300 million of them. Frieman hopes to better understand dark energy, contributing to his already considerable work, for which the Royal Astronomical Society named him a 2014 honorary fellow.

Ninety-five percent of the universe is thought to be dark—25 percent dark matter, which holds galaxies together, and 70 percent dark energy, which pushes galaxies apart. Matter and dark matter both obey laws of gravity, scientists believe, so if the universe were composed of only matter, "we would expect the expansion of the universe to gradually slow down," says Frieman. Instead, the expansion is accelerating. "There must be something pushing matter away from other matter. Dark energy is something we invented that has that property, that it's gravitationally repulsive. But we don't know what it is."

One possible explanation is the energy of empty space. According to quantum mechanics, energy can be "borrowed" from a vacuum by way of "virtual particles." Energy can convert into a particle and an anti-particle—like an electron and its oppositely charged counterpart, the positron—and those particles immediately annihilate each other and disappear back into energy. "Empty space isn't completely empty; we rather think of it as a kind of roiling sea of virtual pairs of particles continuously popping out of and back into the vacuum." That energy of the vacuum would act as a gravitationally repulsive force that could accelerate the expansion.

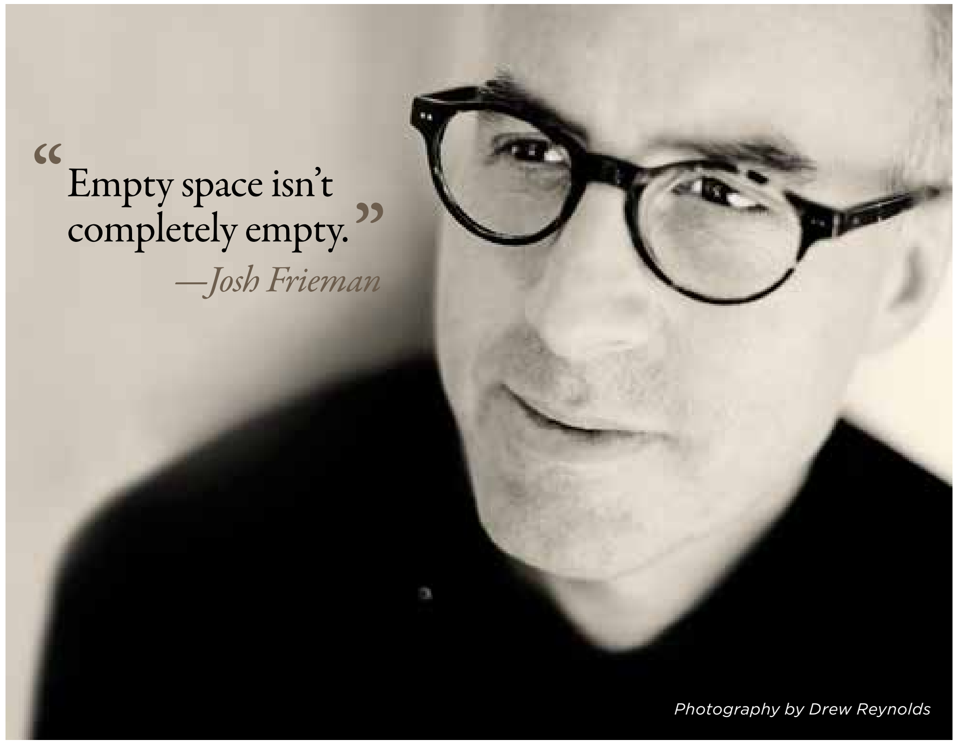
The Dark Energy Survey is actually two surveys in one: observing the history of the universe's expansion and investigating the growth of large-scale structures, which are increasingly larger organizations of matter, such as galaxy clusters.

Frieman and his team analyze cosmic expansion by taking pictures of the same spots every few nights, looking for supernovae. Frieman previously led the Supernova Survey that was part of the second Sloan Digital Sky Survey; from 2005 through 2007, it discovered and measured hundreds of type Ia supernovae, exploding stars that shine as bright as a whole galaxy for a couple of weeks and then fade over a few months. "They can be used as 'standard candles' to measure cosmic distances," Frieman explains, and were instrumental in discovering cosmic acceleration in 1998. Frieman and his colleagues will use the thousands of supernovae found in this new, deeper survey to compare how fast the universe is expanding today versus billions of years ago.

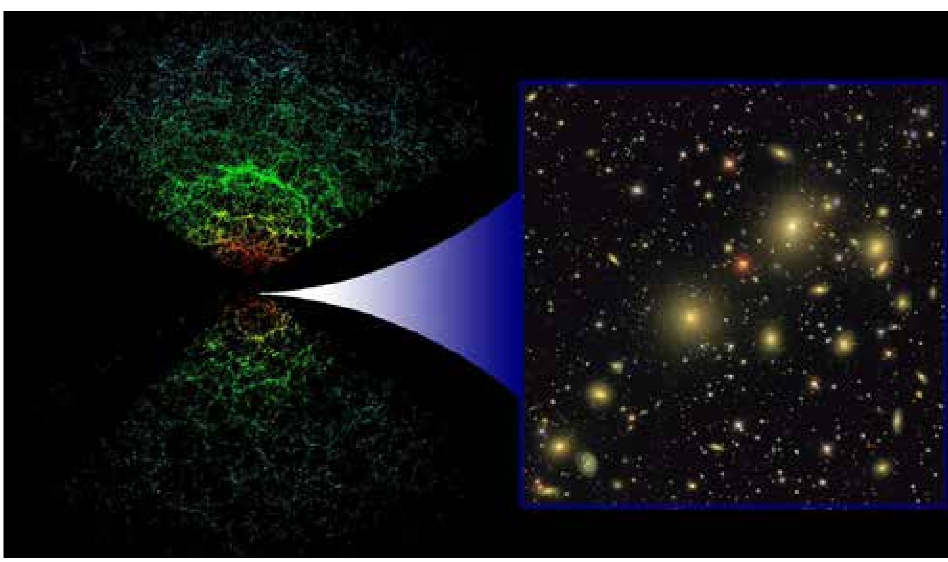
The survey of large-scale structure growth, on the other hand, will examine the tug-of-war between the gravitational pull from dark matter and gravitational repulsion from dark energy. Photographing one-eighth of the sky, survey researchers will apply three techniques to evaluate the data. One is to map galaxies and compare how tightly they are clustered compared to billions of years ago. The next technique is to "pan out" and take a census of galaxy clusters compared to billions of years ago.

The third technique considers the appearance of the individual galaxies themselves. When light leaves a distant galaxy, it travels in a straight line toward us, but gravity can bend the path of light. Because large-scale structures sit between us and the light source, and those structures exert a gravitational pull, the light we observe follows a curved path that makes the galaxy appear distorted, a tiny effect called "weak gravitational lensing." Frieman and his colleagues look at thousands of galaxies near each other to see if they are all distorted in the same way, and use the effect to map the large-scale dark matter structures.

The Dark Energy Survey could provide more precise measurements supporting the case that dark energy is the energy of a vacuum. Prior measurements are consistent with this explanation but have a great deal of uncertainty. Yet Frieman thinks it would be more interesting if the DES does not support vacuum energy, that it might be something else or something strange going on with gravity. "That would be tremendously exciting because it would mean that there's some new fundamental physics that we don't understand," he says. "We'll have to wait and see."—*M. S.*




*Photography by Drew Reynolds*



## The end

Cosmic elements aggregate into large-scale structures: stars into galaxies into groups into clusters into superclusters into a web of sheets, walls, and filaments. As sky surveys have grown—the Sloan Digital Sky Survey the largest yet—astronomers have been able to see larger and larger structures until no larger organization could be seen. This concept is called the "end of greatness."

*Photo courtesy the Sloan Digital Sky Survey*

# DIVISIONAL NEWS

### CHEMISTRY
## OFF TO OXFORD

Fourth-year College student Samuel Greene, '14, majoring in chemistry, has won a Rhodes Scholarship to continue his studies this fall at Oxford University. Thirty-two American students were selected this year, and Greene is the 49th UChicago student to earn the Rhodes Scholarship. Also the recipient of a Goldwater Fellowship for students in science, Greene studies the possibility of producing biofuel from organic material. He plans to pursue a PhD in computational physical chemistry and hopes to continue working on renewable energy technologies.

### COMPUTER SCIENCE
## CHICAGO COMPUTATION

This May the computer science department hosts the Third Annual Greater Chicago Area System Research (GCASR) Workshop at the Logan Center. The workshop provides a central forum for systems research, bringing together technologists from Chicago's major research institutions to collaborate on topics including Internet services, networking, big-data systems, and high-performance computing.

### MATHEMATICS
## WOMEN IN MATHEMATICS HONORS UNDERGRAD

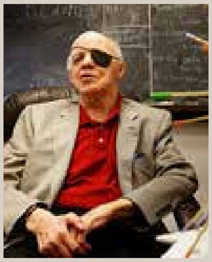
Fourth-year College student Sarah Peluse, '14, was awarded the Alice T. Schafer Mathematics Prize by the Association for Women in Mathematics. Peluse, who was recommended for the honor by the late professor Paul Sally, joined UChicago as a transfer student after starting college at 15 and completing all of her school's math classes within two years. She spends summers conducting mathematics research across the country, including multidimensional continued fractions at Williams College, and is a research assistant for assistant professor Maryanthe Malliaris. Peluse plans to pursue a PhD in mathematics and to continue studying analytic number theory.

### PHYSICS
## PHYSICIST PROVOST

Physicist Eric D. Isaacs, director of Argonne National Laboratory, succeeds Thomas F. Rosenbaum as provost of UChicago. Isaacs holds appointments in the physics department, the James Franck Institute, and the College, and he has been instrumental in creating the Institute for Molecular Engineering and expanding the Computation Institute. As provost, Isaacs serves as the University's chief academic officer, governing 13 divisions, schools, and institutes with the ability to appoint faculty. He also oversees budgeting, space allocation, and other forms of academic development. His appointment began March 31.

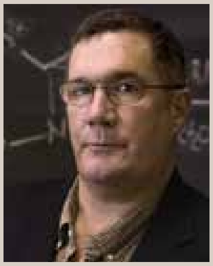
# IN MEMORIAM

### Paul J. Sally Jr. (1933–2013)

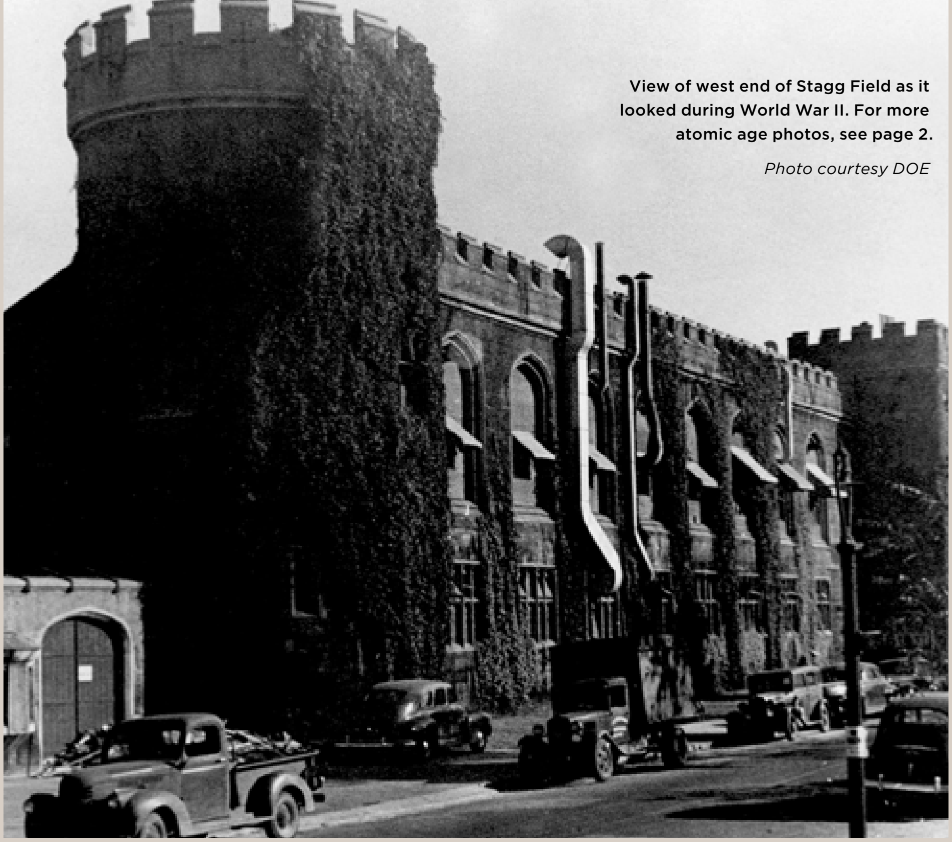


Paul Sally, professor of mathematics and the College, died December 30 of congestive heart failure. He was 80. Born in Boston, he received his BS and MA from Boston College and PhD from Brandeis University. He taught at Washington University before joining UChicago in 1965. Sally's work contributed to harmonic analysis, the mathematical study of overlapping waves used in quantum mechanics, neuroscience, and signal processing. Nineteen students earned doctorates under his tutelage, and he directed undergraduate studies in mathematics for nearly 30 years. He pioneered outreach programs in mathematics education for elementary- and secondary-school teachers and students, including the Seminars for Endorsement of Science and Mathematics Educators. Sally served as the first director of the UChicago School Mathematics Project, taught in the Urban Teacher Education Program, and cofounded the Young Scholars Program. His honors include the Quantrell Award for Excellence in Undergraduate Teaching (1967), Boston College Alumni Award for Excellence in Education (1999), the American Mathematical Society Award for Distinguished Teaching (2002), and the University of Chicago Provost's Teaching Award (2005).

### Gregory L. Hillhouse (1955–2014)



Gregory Hillhouse, professor of chemistry and the College, died March 6 of cancer. He was 59. Born in Greenville, South Carolina, he received a bachelor's degree from the University of South Carolina in 1976 and a doctorate from Indiana University in 1980. He held a postdoctoral fellowship at Caltech before joining UChicago in 1983. Hillhouse worked to create organometallic compounds to stabilize and isolate molecules thought to exist briefly during catalytic reaction processes called reactive intermediates. These compounds provide insight into processes including physiological regulation, automotive catalytic converter operation, rocket fuel combustion, and the production of pharmaceutical compounds. He also revolutionized the way chemists think about multiple bonding with late-transition metals; in 2001, he synthesized a nickel-nitrogen molecule with a double bond, previously thought impossible. Hillhouse received the ACS National Award in Organometallic Chemistry and the University's Quantrell Award for Excellence in Undergraduate Teaching (1997) and Norman Maclean Faculty Award (2011).



View of west end of Stagg Field as it looked during World War II. For more atomic age photos, see page 2.

*Photo courtesy DOE*

# FACULTY AWARD AND HONOR HIGHLIGHTS

**Maureen Coleman (geophysical sciences)**
Selected as a 2014 Alfred P. Sloan Research Fellow in Ocean Sciences

**Gregory Engel (chemistry)**
Received the Federation of Analytic Chemistry and Spectroscopy Societies' Innovation Award for 2013

**Daniel Fabrycky (astronomy and astrophysics)**
Selected as a 2014 Alfred P. Sloan Research Fellow in Physics

**Karl Freed (chemistry)**
Awarded the American Physical Society 2014 Polymer Prize

**Haryadi Gunawi (computer science)**
Recipient of an NSF Career Award

**Kwang-Je Kim (physics)**
Awarded the 2014 Robert R. Wilson Prize for Achievement in the Physics of Particle Accelerators

**Raymond Pierrehumbert (geophysical sciences)**
Awarded the King Carl Gustav Professorship at Stockholm University

**Paul Sally (mathematics, deceased)**
Named the first recipient of the American Mathematical Society's Award for Impact on the Teaching and Learning of Mathematics

**David Schuster (physics)**
Recipient of a Packard Foundation Fellowship in Science and Engineering

# FACULTY ADDITIONS

**Bryan Dickinson**, assistant professor of chemistry (July 1, 2014)

**Zheng (Tracy) Ke**, assistant professor of statistics (July 1, 2014)

**Keerthi Madapusi Pera**, SM'07, PhD'11, assistant professor of mathematics (September 1, 2014)

**Nikita Rozenblyum**, assistant professor of mathematics (September 1, 2014)

**Erik Shirokoff**, assistant professor of astronomy and astrophysics (July 1, 2014)

**Suriyanarayanan "Suri" Vaikuntanathan**, assistant professor of chemistry (August 1, 2014)

# A GREAT WAY TO GIVE AND RECEIVE

Did you know that you can make a gift to the PSD and receive income for life in return? A gift annuity provides you with a fixed income stream backed by the University's endowment. Here are a few more facts:

- You must be at least 55 to fund an immediate gift annuity, but you can fund a deferred gift annuity at any age. The longer you delay the payments, the greater the charitable deduction and the higher the payout rate.
- You can use cash or appreciated securities to fund your gift annuity. You will be entitled to a charitable deduction, and a portion of the income you receive will be tax-free.
- If neither you nor your spouse need future income, consider a gift annuity that pays income to a parent, sibling, or cherished friend.

**SAMPLE CURRENT CHARITABLE GIFT ANNUITY RATES**

| AGE | IMMEDIATE | DEFERRED 10 YEARS |
|---|---|---|
| 60 | 4.4% | 7% |
| 65 | 4.7% | 7.9% |
| 70 | 5.1% | 9.3% |
| 75 | 5.8% | 10.7% |

AMERICAN COUNCIL ON GIFT ANNUITIES, EFFECTIVE 1/1/2012

# LEARN MORE

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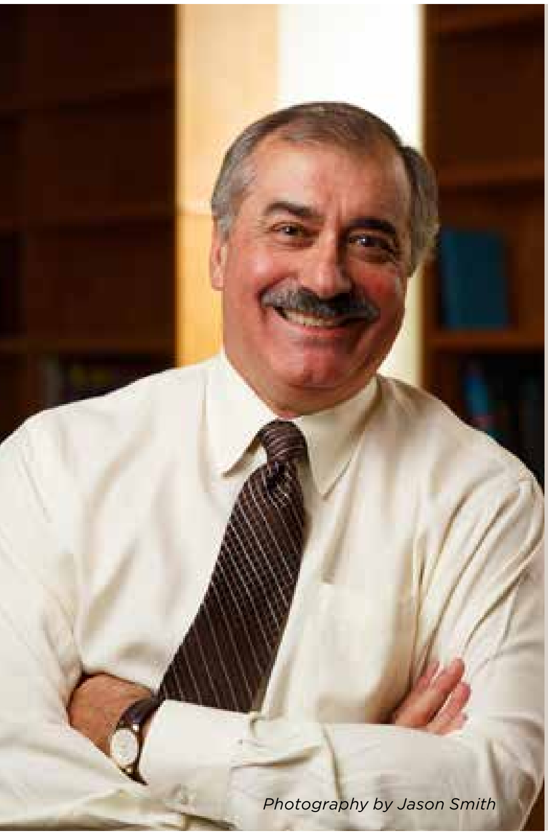
# INQUIRY

*Inquiry* is produced for alumni and friends of the Physical Sciences Division.
Editor: Maureen Searcy

Contact *Inquiry* at psd-inquiry@uchicago.edu.
To give to the Physical Sciences Division, contact Brian Yocum at byocum@uchicago.edu.

*Photography by Jason Smith*

NOTE FROM THE DEAN

## *Broad shoulders of giants*

The University of Chicago is an intellectual destination that provides serious scholars a rigorous environment, cutting-edge facilities, and a supportive academic community. But the same can be said for many eminent research universities. What makes us unique? Why Chicago?

In addition to our location in a dynamic urban setting with partners including hospitals, national laboratories, and research institutions, what sets us apart is one of our founding principles, particularly evident in the Physical Sciences Division: interdisciplinary research. We invented it; it defines us and propels us; it makes us masters of discovery and design. We create the new fields—like particle cosmology and cosmochemistry—that other institutions build upon. We celebrate intellectual synergy. In 2013, a PSD faculty member won a Nobel Prize in economics! (“Model Economist,” page 4)

Because we don’t restrict our research with barriers between departments or divisions, we forge ahead in directions that aren’t always popular but often become the standard, changing the course of science. George Ellery Hale, at UChicago from 1893 to 1905, pioneered observational astrophysics, leading to the largest sky surveys ever made, like the Sloan Digital Sky and Dark Energy Surveys (“Southern Exposure,” page 8). Physicist John Simpson came to the University in 1943 to join the Manhattan Project. He later turned his eye to the stars to probe cosmic rays, and from his lab emerged an alumnus who sent a spacecraft farther than any manmade object has ever traveled (“Bon Voyage,” page 2).

The work of our scientific community exemplifies brave, bold exploration; risk-taking, rule-breaking, fearless venture. And when those successes become foundations and those failures become lessons, we keep going.

With all best wishes,

Rocky Kolb

Edward “Rocky” Kolb, Dean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Physical Sciences Division