ANDREW LANGE

1957–2010

Andrew Lange, the Goldberger Professor of Physics at Caltech, passed away on January 22, 2010. He was 52.

Lange had been at Caltech since 1993. He graduated from Princeton University with his BA in 1980 and received his PhD from UC Berkeley in 1987. He first came to the Institute as a visiting associate in 1993–94, was appointed a full professor in 1994, and was named the Goldberger Professor in 2001. In 2006 he was named a senior research scientist at the Jet Propulsion Laboratory and in 2008 was appointed chair of the Division of Physics, Mathematics and Astronomy. He had recently resigned from his chairmanship of the division.

The principal focus of Lange's research was the cosmic microwave background, or CMB—the afterglow from the Big Bang that fills the entire universe. He developed a new generation of radio-frequency detectors that he employed as the leader of a string of experiments to study the CMB. He is perhaps best known for coleading the BOOMERanG (Balloon Observations Of Millimetric Extragalactic Radiation and Geophysics) experiment. BOOMERanG was the first experiment to map the CMB in fine enough detail to show that the universe is flat, meaning that space is neither closed, like the surface of a sphere, nor open, like a hyperbolic saddle. The data also measured the abundance of the dark matter known to hold galaxies together, and supported previous measurements that suggest that the universe's expansion is proceeding at an ever-increasing rate, implying either a violation of Einstein's general relativity or that the universe is filled with "dark energy," some exotic, unknown repulsive force. BOOMERanG also confirmed the predictions of the inflationary theory, which aims to explain the very earliest fraction of a nanosecond after the Big Bang.

Lange's subsequent work improved upon these measurements and attempted to detect gravitational waves by their effect on the CMB.

Lange was also one of the leaders of the recently launched Planck satellite, a collaboration between U.S. and European scientists designed to image the CMB with unprecedented precision.

Lange was a member of the American Academy of Arts and Sciences, the National Academy of Sciences, and the American Physical Society. Lange and Saul Perlmutter (from the Lawrence Berkeley National Laboratory) were jointly named the 2003 California Scientist of the Year for their seminal contributions to cosmology. Lange shared the 2006 Balzan Prize for Observational Astronomy and Astrophysics with Paolo de Bernardis (of the University of Rome), his BOOMERanG coleader. The two shared the 2009 Dan David Prize with Paul Richards, a coleader of the parallel MAXIMA experiment.

He is survived by three sons, ages 12, 14, and 20; his sister, Karen; his brother, Adam; and his parents, Joan and Alfred. A memorial service is being planned. E&S

LEW ALLEN JR.

1925–2010

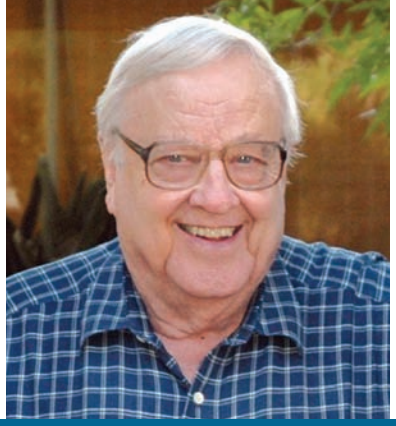
Former director of NASA's Jet Propulsion Laboratory Lew Allen Jr. passed away on January 4 at the age of 84, in Potomac Falls, Virginia. He led the laboratory from 1982 to 1990, during a period that included the launches of the Galileo mission to Jupiter, Magellan to Venus, and the Infrared Astronomical Satellite, as well as Voyager 2's Uranus and Neptune flybys.

Allen was born on December 30, 1925, in Miami. He studied at the United States Military Academy at West Point, New York, and had a distinguished career in the U.S. Army and the Air Force, where he remained until 1982, achieving the rank of four-star general and serving as chief of staff of the Air Force.

In 1954, while still an Air Force officer assigned to the Los Alamos National Laboratory in New Mexico, Allen completed his doctorate in nuclear physics. He specialized in the potentially damaging effects of high-altitude nuclear explosions on the ground and on spacecraft.

After leaving Los Alamos in 1961, Allen served in various scientific posts within the Office of the Secretary of Defense and the Office of the Secretary of the Air Force. He became director of the National Security Agency in 1973. He was also a member of the National Academy of Engineering and the Council on Foreign Relations.

A funeral service will be held at Arlington National Cemetery on March 22. A memorial service at JPL is being planned for the near future. *— JP* E&S



JAMES K. KNOWLES

1931–2009

James K. Knowles, Kenan Professor of Applied Mechanics, Emeritus, died November 1. He was 78.

Knowles made fundamental contributions to the theory of nonlinear elasticity and the mathematical theories of materials and structures. His work provided important insight into how various materials and structures behave, and enabled him and others to develop predictive theories.

Born in Cleveland, Ohio, on April 14, 1931, Knowles grew up in Phoenix, Arizona. He entered MIT in the fall of 1948, earning his bachelor's and doctoral degrees, both in mathematics, in 1952 and 1957, respectively. He then stayed at MIT for an additional year as an instructor in mathematics.

Knowles joined the faculty at Caltech in 1958 as assistant professor of applied mechanics; he was named associate professor in 1961, followed by full professor in 1965. He spent the remainder of his academic career at Caltech, becoming professor emeritus in 1997.

Considered a remarkable teacher and mentor, Knowles inspired and influenced generations of students and scholars through classes in mathematics and mechanics. A visionary thinker, he recruited and mentored a number of junior colleagues who took Caltech in new and fruitful research directions. He had a deep affection for Caltech and served in various administrative capacities.

"Jim was the greatest mentor I ever had. He held my hand when I first came to Caltech as an assistant professor. He also taught me how to teach," says Ares Rosakis, chair of the Division of Engineering and Applied Science, and Von Kármán Professor of Aeronautics and professor of mechanical engineering. "He would look for the spark in people's eyes and help them make their dreams a reality. As we at Caltech seek to create the best mentoring opportunities for our young faculty, we should be guided by Jim's example."

Knowles's research was primarily focused on mathematical problems in structural mechanics, and in particular on linear and nonlinear elasticity, which is the study of how bodies deform reversibly under stress. In 1960, he provided the first solution for a dynamical problem in finite elasticity, and in 1966, he published what would turn out to be a seminal paper concerning the foundations of Saint-Venant's principle in linear elasticity theory.

His later papers on the influence of nonlinearity on point singularities, such as those found at the tip of a crack, demonstrated how they could lead to new phenomena.

In 1979, Knowles published a paper concerning the dissipation of mechanical energy during quasi-static motions of elastic bodies. This led to his later work on the evolution of metastable states of equilibrium, which had applications in phase transformations.

Knowles's contributions are described in more than 100 journal publications. In 1998, he authored a textbook for grad students entitled *Linear Vector Spaces and Cartesian Tensors* (Oxford University Press).

In 1991, he was made an honorary member of the Caltech Alumni Association in recognition of his distinguished service. That same year, the *Journal of Elasticity* dedicated an issue to Knowles on the occasion of his 60th birthday for "seminal contributions made to the field of elasticity."

"He set an example of scholarship and fundamental thought, both broad and deep, that challenged students as well as researchers," says Roger Fosdick, editor in chief of the *Journal of Elasticity*. "He was highly inquisitive, deeply thoughtful, masterfully insightful and always seeking an explanation. He made indelible marks of value during his life both personally and professionally, and he will most certainly be missed."

Knowles's contributions were also recognized by the Society of Engineering Science with the Eringen Medal, and by the American Society of Mechanical Engineers with the Koiter Medal.

Knowles was a fellow of the American Academy of Mechanics, the American Society of Mechanical Engineers, and the American Association for the Advancement of Science, and was associate editor for the *Journal of Applied Mechanics*. From 1985 to 1986, he served as president of the American Academy of Mechanics.

Knowles was known outside the classroom for his paintings and baritone voice. He was a regular member of the Caltech Stock Company, an ensemble of musically inclined faculty, staff, students, and friends best described as Caltech's own version of the Capitol Steps.

The Division of Engineering and Applied Science has established the James K. Knowles Lecture and

Engineering & Science welcomes letters. Send correspondence to Douglas L. Smith, editor, *E&S* magazine, Caltech mail code 1-71, Pasadena, CA 91125, or e-mail dsmith@caltech.edu. We reserve the right to edit any letters selected for publication for length, content, and clarity.

Caltech Solid Mechanics Symposium, to be delivered annually by an internationally recognized scholar chosen by the faculty. The first lecture, by Rohan Abeyaratne of MIT, is scheduled for February 27 at 9 a.m. in Beckman Institute Auditorium. The lecture will be followed by a daylong program of talks by 12 current grad students and postdocs from the Division of Engineering and Applied Science. Open to the public, the Knowles lecture and symposium will commemorate his contributions to solid mechanics, his love for Caltech, and his encouragement of young researchers.

Knowles leaves behind a wife, Jacqueline, and sons John, Jeff, and James, and their families. — *JW* E&S

F. BROCK FULLER

1927–2009

F. Brock Fuller, emeritus professor of mathematics, died on November 6 at the Rafael Convalescent Hospital in San Rafael, California, four years after being diagnosed with diffuse Lewy body disease. He was 82.

After receiving his bachelor's, master's, and PhD degrees from Princeton, Fuller came to Caltech in 1952 as a research fellow. He became an assistant professor of mathematics in 1955 and was appointed associate professor in 1959, and professor in 1966. In 1994, he became professor emeritus.

Fuller worked on the topology of how curves twist and coil, an endeavor prompted by the need for a quantifiable description of the supercoils being found in double-stranded DNA helices. A DNA supercoil forms when the famed double helix is itself twisted and coiled, the way the cord on the wall phone in your kitchen likes to do. A DNA molecule can be thousands of times longer than the cell whose blueprints it contains, so twisting it into compact supercoils allows it to fit inside the cell. Fuller developed a quantity called a writhing number, which is the number of times the double helix crosses over itself. The sum of the writhing number and another quantity called the twisting number, which Fuller defined as the number of times each DNA strand twists around the other, together measure the amount of supercoil in the DNA.

In the early 1980s, Fuller—who was also an audiophile—was involved in analyzing digital recording technologies as they began to reach prominence in the audio-entertainment industry. Working alongside Caltech colleagues such as Gary Lorden (BS '62) and James Boyk, Fuller examined music piped into Thomas Laboratory from Dabney Lounge, comparing various signals.

Fuller moved to San Rafael, in northern California, in 1996. He is survived by his wife, Alison Clark Fuller of San Rafael; his daughter, Lynn D. Fuller of San Francisco, her husband, William Bivins, and their four children, Samuel, Zachary, Elizabeth, and Claire Bivins; and his sister, Cornelia Fuller of Pasadena.
— *JW,MW* E&S

I take issue with a statement you make in your article: "Unfortunately, burning carbon dioxide back into hydrocarbons is very, very hard." It is only hard for human beings. Some species of algae find this task very easy. Melvin Calvin, a Nobel Prize winner from UC Berkeley, spent 25 years of his life studying plants that make hydrocarbons.

Calvin identified the genus *Botryococcus* as a remarkable source of hydrocarbons. He reported that the dry weight of this algae is 86 percent hydrocarbon! He identified the structures of some of the major components in the mixture. They fell into two groups: linear isoprene oligomers and cyclized steroids. Both of these products could be burned instead of coal to produce electricity and be fed to refineries in place of petroleum.

The work you wrote about requires two major investments to produce a feedstock that will replace coal or oil. The first is the solar power tower. The second is the Fischer-Tropsch unit. Neither is cheap compared to digging up coal or pumping up oil. The two investments cannot compete with skimming algae off the ocean surface and pressing out their hydrocarbons.

Too many entrepreneurs brag about how their invention will be competitive with petroleum in a few years. They are careful not to specify the price of the petroleum they are competing against. This is a real problem. The winning solution will be the one that requires the least new capital investment.

Frank Weigert [PhD '68]
Wilmington, DE