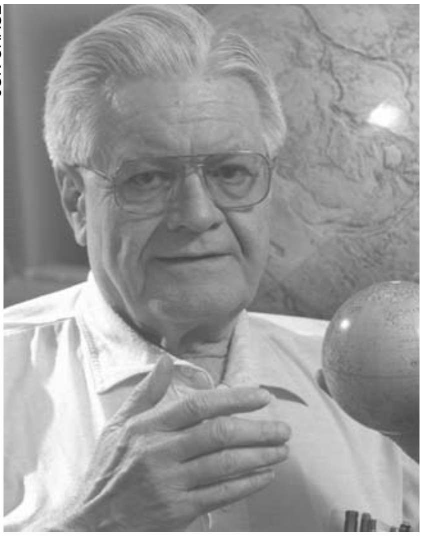
JON CHASE



Alastair Graham Walter Cameron

institutions and, with David Arnett, Carl Hansen, and James Truran, produced massive lecture notes—really outstanding monographs.

When Harvard University decided in 1973 to renovate its astronomy department, Al was invited to join the faculty and played a guiding role in the renovation. The result was the Harvard–Smithsonian Center for Astrophysics. He served on the National Academy of Sciences's committee for planetary and lunar exploration (COMPLEX) and as chairman of the NAS space science board, where he played a leading role in defining scientific goals of space exploration. On his "retirement" in 1999, he joined the faculty of the Lunar and Planetary Laboratory of the University of Arizona.

Some kids are very happy if they can find a couple of pieces that fit into a puzzle, and they will try hard to fill out the rest. Al had a very different approach. Having found or identified a few pieces of the puzzle, he then created a whole structure from a detailed ab initio model based on theoretical considerations and embedded the pieces in that structure. His deep insights, knowledge of physics, and powerful computational abilities led to structures of great complexity and texture.

In 1975, Al gave a joint Caltech–Jet Propulsion Laboratory colloquium entitled "The Origin of the Solar System" to an audience of several hundred scientists. Starting with the ISM, gas dust, and plasma, Al traced formation of the Sun, protoplanetary disk, giant gaseous planets, rocky terrestrial planets, and the Moon. He stood stationary and spoke in a steady clear fashion, guiding the audience through the detailed dynamics he had obtained through massive computation. Occasionally he would raise a hand to emphasize a point; the gesture seemed to be a way of pointing to one of the computers that had been grinding through a program. At the end, the audience sat in awed silence until someone in the rear of the room asked, "What did you do on the seventh day?" Al responded, "I rested."

Al's ability to formulate broad problems in an even broader framework was a resource for the whole scientific community. Nuclear astrophysics, star formation (including metal-free stars), interstellar communication, giant gaseous protoplanets, terrestrial planets, asteroids, meteorites, making the Moon by a giant impact—all these were his playthings. His re-investigations of each problem of "formation" led to new versions and visions of how things were formed. Al was a sort of cosmic Buddha who could tell you detailed histories of each of the universes he had thought about; each was a full thing unto itself. Al's general approach used first principles and theory as both guides and methods, and he incorporated some data that were critical and some that simply caught his fancy. Because of his great intellect and powerful analytical and computational powers, he tended to hold phenomenological models in disdain. Al once told authors of a new phenomenological model, "I have noticed over the years that the arguments that appeal to you are primarily observational and experimental and that theory is secondary. For me it is the other way around: Theory and theoretical consistency are primary and observations are secondary (which is not to say that they are not of primary importance and on occasion can be the tail that wags the theoretical dog)."

Al would appear at meetings in a suit, his shirt pocket bulging with pens of all colors, and he'd be carrying some calculating device, which grew from a pocket slide rule to a hand calculator to a series of laptop computers. He would eagerly show the simulation of a Mars-sized projectile impacting proto-Earth or a supernova shock wave hitting the protosolar nebula. He was always helpful in explaining things that one needed to know or ought to have known. A very work-centered person, Al was never egocentric and almost never criticized others. He simply wanted to get on to the next piece of intellectual excitement and the intense pleasure of orchestrating a bank of computers to play some scientific symphony that he was composing. He considered that he worked on cosmogony—the generation or creation of the universe (or parts thereof). Cosmology was just discourse on the science of the universe.

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Shiing-Shen Chern

On 3 December 2004, Shiing-Shen Chern died in Tianjin, China, of a heart attack, and the mathematics community lost one of its legendary greats. Chern's pioneering ideas influenced not only his own field of differential geometry, but also many parts of mathematics and theoretical physics. He played a crucial role in the founding of mathematics institutes in both the US and China. As a teacher, colleague, and friend, he was revered for his warmth and gentle nature.

Chern was born in China's Zhejiang province on 28 October 1911. His undergraduate education was at Nankai University in Tianjin. In 1936 he completed his doctoral work with Wilhelm Blaschke at the University of Hamburg in Germany. Chern spent a year in Paris studying with Élie Cartan before returning to China to assume a professorship at Tsing Hua University. He visited the Institute for Advanced Study in Princeton, New

Shiing-Shen Chern

Jersey, in 1943–45, and it was then that he began to produce his profound work on characteristic classes and curvature. After his return to China in the late 1940s, he helped establish a mathematics institute at the Academica Sinica in Beijing. He moved to the United States in 1949 to assume a post at the University of Chicago and in 1960 moved to the University of California, Berkeley. His originality in differential geometry and his lectures on that subject were legendary, as was his mentoring of young mathematicians, many of whom are now leading researchers in geometry.

Upon his retirement in 1979, he helped found the Mathematical Sciences Research Institute in Berkeley, California, and served as its first director (1981–1984). In 1985, he founded and directed the Nankai Institute of Mathematics in Tianjin. In 2000, following the death of his wife, Chern moved from Berkeley to Tianjin, where he remained until his death.

A major theme of Chern's mathematical work was the relationship between curvature and topology. Consider a curved surface, such as a sphere or a torus, sitting in space. In the first part of the 19th century, following the work of earlier geometers, Carl Friedrich Gauss introduced the curvature that bears his name and proved the Gauss–Bonnet theorem: The total curvature of a surface—that is, the integral of the curvature over the entire surface—is determined by its topology, specifically its Euler characteristic. (The Euler characteristic of a surface is $V - E + F$, where in any triangulation V is the number of vertices, E is the number of edges, and F the number of faces. It is 2 for the sphere and 0 for the torus.)

Differential geometry in higher dimensions was developed in the second half of the 19th century through the work of Bernhard Riemann and his successors. In the early 20th century, Albert Einstein's general relativity gave a big boost to the study of differential geometry. Yet not until 1943, in a paper Chern considered to be his best work, was the link between curvature and topology established intrinsically in higher dimensions. André Weil and Carl Allendoerfer had just proved a formula expressing the Euler characteristic of a manifold in terms of curvature, but their proof is for submanifolds of Euclidean space. Chern's proof is intrinsic—that is, it applies to abstract manifolds and uses only the geometrically relevant information. His intrinsic point of view led him to introduce new techniques in the theory of fiber bundles, techniques that had a profound effect on geometry and physics in the latter part of the 20th century.

Imagine a manifold as a model of spacetime. In Einstein's theory the manifold is 4-dimensional, in superstring and M-theory it is 10- or 11-dimensional, and for mathematical purposes it can have any number of dimensions. A fiber bundle over the manifold attaches to each point of spacetime some internal space. In statistical mechanical models, for example, one might imagine a spin taking values in this internal space, which is typically a sphere or a finite set of points. In particle physics the internal space represents the quantum state of a particle, such as a photon or neutron, in which case the space is linear. As one moves around spacetime, the internal space may twist, and the theory of characteristic classes was developed by Chern and others in the mid-1940s to measure the twisting. As with the formula for the Euler characteristic, there are close ties to curvature. There are also important "secondary" invariants—the Chern–Simons invariants, introduced by Chern and James Simons in 1971—which appear in a differential geometric context. All of these mathematical ideas enter profoundly into condensed matter physics (Berry's phase), quantum field theory, and superstring theory—indeed, the ideas are embedded into our modern notions of geometry.

Chern was honored with many prizes, including the National Medal of Science (1975); the Wolf Prize (1983); and the first Shaw Prize (2004), which cited Chern's "initiation of the field of global differential geometry and his continued leadership of the field, resulting in beautiful developments that are at the centre of contemporary mathematics, with deep connections . . . to all major branches of mathematics of the last sixty years."

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Frederick Hendrick Fisher

Frederick Hendrick Fisher, an ingenious experimentalist in ocean acoustics, died unexpectedly on 4 May 2005 in San Diego, California, following a stroke. From laboratory studies of sound absorption to at-sea observations of the details of sound propagation, Fred had made notable contributions to our understanding of underwater acoustics.

Fred was born in Aberdeen, Washington, on 30 December 1926. After graduating from high school, he joined the US Naval Reserve and was admitted to the US Naval Academy in 1945. In 1946 he transferred to the University of Washington, where he received his AB in physics in 1949. Continuing as a graduate student at UW, he became interested in physical acoustics, which had become an active field of research after World War II. During the war, the absorption of sound in seawater was found to be considerably greater than expected; in the late 1940s, physicists at UCLA and at the university's Marine Physical Laboratory (MPL, now part of the Scripps Institution of Oceanography) in San Diego had isolated the presence of magnesium sulfate as the cause. Eager to understand the details of this phenomenon, Fred joined Leonard Liebermann's research group at MPL in 1955. Fred devised methods for studying the properties of magnesium sulfate solutions at high pressure and completed his University of Washington PhD in physics in 1957 under Liebermann's supervision.

Following a year as a research fellow with Frederick (Ted) Hunt's underwater acoustics group at Harvard University and chemist Benton Owen at Yale University, Fred joined the MPL research staff. In addition to continuing his laboratory research on magnesium sulfate, he began investigating sound propagation at sea—in particular, the accuracy with which sound could be used to determine the direction to a distant target. After conducting initial experiments using a US Navy submarine, he realized that a special platform would be required to support this work. Discussions of how best to make the necessary measurements led Fred and one of us (Spiess), stimulated by a comment by Woods Hole Oceanographic Institution's Allyn Vine about turning a submarine on end, to the concept of the floating instrument platform (FLIP)—a manned craft 110 meters long that could easily be towed to an open ocean research site where tanks could be flooded and the ship upended to provide a research platform with 90-meter draft. The platform is not only very stable relative to ocean surface waves, but its underwater structure allows hydrophones and other sensors to be mounted at positions accurately known in relation to the exposed, above-water laboratory structure.

Bringing the FLIP concept to reality involved a number of challenges; two in particular resulted in new approaches. First was the concept of shaping the hull to minimize heave response. Philip Rudnick did the theoretical design and Fred, in parallel, did tank experiments with models. The more challenging aspect was understanding the dynamics of flipping from horizontal to vertical and back again. Fred took this on and, with the MPL shop, built a variety of 10-meter-long models and flipped them in San Diego Bay. This fun learning period had the eventual payoff of translating the models, with the help of naval architect Lawrence Glosten, into the full-size version, which flipped for the first time in Puget Sound in 1962.

In addition to supporting Fred's research for more than three decades, FLIP was and is still used today by other acousticians, physical oceanographers, and atmospheric scientists. After carrying out the bearing-accuracy experiments that were the original goal (and that motivated the US Navy to fund the construction), Fred devised vertical hydrophone arrays that capitalized on FLIP's stability and could be deployed below to study the vertical directionality of ambient noise and to sample the entire water column for studying sound transmission.

For Fred and others, FLIP's stability at sea provided a personal advantage. Fred's seasickness was substantially mitigated once FLIP was vertical and it was time to deploy equipment and collect data.

Fred was not only an ingenious experimentalist in the laboratory and at sea, but he also enjoyed being with people and helping them work together. He was an outstanding tennis competitor, and shared the NCAA doubles championship in 1949 while at the University of Washington.

A central figure in the underwater acoustics community, Fred served in many roles, including president of the Acoustical Society of America (ASA) in 1983–84. Most recently, Fred was involved in a rather complex effort to declassify and ultimately publish scientific documents produced during the cold war that were related to the US Navy's fundamental efforts in undersea warfare.

We will all recall his many contributions to our understanding of ocean acoustics but, even more, his cheerful, friendly approach to life—embodied in his ever-present garish aloha shirts. Fittingly, ASA will honor his memory at its 2006 meeting in Hawaii where all his friends and colleagues can pay tribute and say, "Aloha, Fred."

William Kuperman
Fred Spiess
University of California, San Diego

SCRIPPS INSTITUTION OF OCEANOGRAPHY

Frederick Hendrick Fisher

Paul Aveling Redhead

Paul Aveling Redhead, one of the founders of vacuum technology and surface science, died on 9 July 2005 in Ottawa, Canada, after a long battle with heart disease.

Born on 25 May 1924 in Brighton, England, Paul received his BA from Cambridge University in 1944 and joined the British Department of Naval Ordnance, where he worked on tubes for microwaves and proximity fuses. After World War II, he undertook research on experimental vacuum tubes for the Services Electronics Research Laboratories. He was awarded an MA from Cambridge in 1948 for that work; in 1969 he re-