Val L. Fitch

1923–2015

BIOGRAPHICAL *Memoirs*

A Biographical Memoir by
A. J. Stewart Smith,
James W. Cronin,
and Pierre Piroué

NATIONAL ACADEMY OF SCIENCES

VAL LOGSDON **FITCH**

March 10, 1923–February 5, 2015

Elected to the NAS, 1966

Photography by Orren Jack Turner.

Val Fitch

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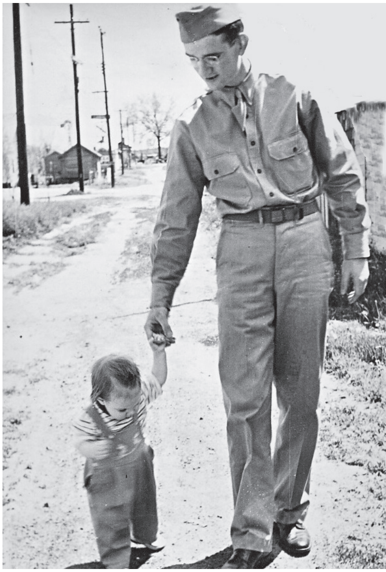
Val L. Fitch, who was James S. McDonnell Distinguished Professor, Emeritus, at Princeton University, died one month shy of his 92nd birthday, in Princeton, NJ, where he had spent virtually all of his professional life. He was born in Nebraska, the youngest of three children, on a cattle ranch about 40 miles southeast of Wounded Knee, which his parents Fred and Frances (née Logsdon) Fitch had acquired just 20 years after the massacre. As Val wrote, "The Sioux were very much a part of our environment, and my father, while not fluent, spoke their language. They recognized his friendly interest on their behalf by making him an honorary chief, naming him Eagle Star, and presenting him with a beautiful chief's headdress."

Life on the ranch must have been terribly hard for Val's parents, especially his mother, who had been brought up in a family with three sisters in a rather protected environment. The lone woman on the ranch, she often remarked that there would be periods of six weeks or so in the winter when she would never see another woman. The closest town, Merriman, was 5 miles distant from the ranch. One traveled either on horseback or by horse and buggy.

"The sheer physical labor for my parents was immense. The saying goes that ranching is hell for women and horses." Indeed, Val's memories of ranching were not the romantic ones of rounding up and branding cattle but rather of oiling windmills and fixing fences.

Not long after Val's birth, his father was badly injured when a horse he was riding fell on him. As a consequence, the family moved to Gordon, NE, about 25 miles away, where his father entered the insurance business and all of Val's schooling through high school was in the town's public schools. From an early age, he was passionate about the world around him. When Val was not in school or visiting the Gordon library, he spent considerable time working in his "laboratory" in the basement of the family home, once he had honored his father's insistence that Val connect his laboratory's electrical circuits

Val Fitch, on ranch, Merriman, NE, circa 1940.
(Photo courtesy of the Fitch family).



Fitch with his niece, circa 1944.
(Photo courtesy of the Fitch family).

to a separate fuse box to prevent inopportune blackouts elsewhere in the house. He writes, "I had the usual chemistry set, an Atwater Kent radio (ca. 1930), and a spark coil from a Model-T Ford. I built go-carts and lifting devices. It was a rich life for [some] one interested in what made the world tick. Around 12, I learned there was a profession devoted to such things. It was called physics."

Graduating from Gordon H.S. in 1940 as valedictorian, Val followed his older siblings to Chadron State College until being drafted, during his sophomore year, in 1943. While still in basic training, Val was selected for the Army Specialized Training program at Carnegie Tech and soon afterward for the Manhattan Project—as the only recruit chosen out of 1,200 candidates. He was sent to Los Alamos, NM, where he "learned well the techniques of experimental physics. I observed that the most accomplished experimentalists were also the ones who knew most about electronics, and electronic techniques were the first I learned. But mainly I learned, in approaching the measurement of new phenomena, not just to consider using existing apparatus but to allow the mind to wander freely and invent new ways of doing the job."

Given responsibilities far beyond his formal draftee status, under British physicist Ernest Titterton's supervision Val designed and built the apparatus to trigger the detonation of the first bomb on July 16, 1945, at Alamogordo, NM. After the explosion, he encountered a guard who had not been told what to expect: "He was absolutely pale, and a look of incredible alarm was on his face. I simply said what was on my mind, 'The war will soon be over.'"

Val remained at Los Alamos for a year after the war, concentrating on electronics. A notable product of his work was a state-of-the-art oscilloscope, which Val described as "the forerunner of the modern Tektronix oscilloscope."

> No equipment for such an experiment was available commercially, so Val built everything himself: scintillation counters, high-resolution sodium iodide,...photon detectors, and, most remarkably, a pioneering multichannel analyzer. Further, every piece of electronics was home-designed and constructed in house.

At Titterton's suggestion, Val studied electrical engineering at McGill University, graduating in 1948. He then entered Columbia University for graduate study, and was assigned by I. I. Rabi to work with nuclear physicist James Rainwater. It was the perfect time and place for research in subatomic physics, as the kaon and pion had just been discovered in cosmic rays and produced artificially at the 184-inch cyclotron in Berkeley, CA; and the new 300 MeV Columbia Nevis synchrocyclotron was about to turn on, with the main purpose of producing copious beams of pions and their decay products, muons. Rainwater handed Val a paper by Princeton's John Wheeler proposing a novel way to determine nuclear radii—by measuring the energies of X-rays emitted from negative muons as they transition between Bohr orbits around a nucleus. Because muon orbits, 210 times smaller than those for electrons, penetrate well within the volume of large nuclei, the transition energies depend on the nuclear charge distribution within the orbit.

Rainwater suggested that these phenomena might make a good thesis topic, and Val "took it and ran!" The experiment featured several notable innovations and new technologies, which Val and Rainwater put to great use in constructing a high-quality muon beam and a high-resolution detector. The beam was focused by pairs of crossed magnetic quadrupoles, a new configuration invented by Roy Britten and others at Princeton. The detector also presented major challenges because no equipment for such an experiment was available commercially; so Val built everything himself: scintillation counters, high-resolution photon detectors using sodium iodide (recently developed by Robert

Hofstadter), and, most remarkably, a pioneering multichannel analyzer. Further, every piece of electronics was home-designed by Val and constructed in house.

Rainwater insisted that his students also perform some significant theoretical calculations, so while building the experiment Val worked to solve the Dirac equation for the energy levels, assuming a nucleus with a uniform charge distribution with various radii. Computers were not yet available, so he had to perform his calculations laboriously on a Marchand calculator.

The results were auspicious. Based on previous experiments (electron scattering, transitions between mirror nuclei), Wheeler had calculated, for example, that the 2P→1S transition from lead would produce a 4.5 MeV X-ray peak. Instead, Val and Rainwater found a peak at 6.02 MeV, which implied that nuclei were about twice as dense, and hence much smaller, than previously measured. They went on to measure X-rays from muon capture on many different nuclei, from aluminum to bismuth, finding the nuclear radius R, as a function of the atomic mass number A, was $R = 1.2\ A^{1/3} \times 10^{-13}$ cm, in contrast with the $R = 1.5\ A^{1/3} \times 10^{-13}$ cm from electron-scattering experiments. A second result of the experiment, the measurement of fine structure splitting, was strong evidence confirming that the muon was a spin-1/2 particle. Finally, by extending their measurements to 3D→2P and 4F →3D transitions, they found significant effects of vacuum polarization. In May 1953, Val and Rainwater shared the front page of the *New York Times* with Hillary's ascent of Everest, and the issue of *Newsweek* with Elizabeth II's coronation.

This spectacular work formed the basis of Val's Ph.D. thesis, modestly titled "Studies of X-Rays from Mu-Mesic Atoms," which was published in the November 1, 1953 issue of *The Physical Review.*

Val was awarded the Ph.D. from Columbia in 1954 and stayed on for a few months as an instructor, but at the urging of John Wheeler he left Columbia to join Princeton's physics department as an assistant professor. He then embarked on a pioneering series of experiments in the burgeoning field of high-energy physics—in particular the weak interactions and the marvelously rich physics of the recently discovered K mesons.

This was an opportune moment, as ample research funds were available through an existing laboratory at Princeton that was supported by the Office of Naval Research (ONR). Coincidentally, a 3-GeV particle accelerator called the Cosmotron was newly in operation at the nearby (~ 2.5-hour drive) Brookhaven National Laboratory, and the machine had sufficient energy to produce *K* mesons and the other strange particles discovered in the cosmic rays. Using the Cosmotron to explore the cosmic-ray data marked the beginning of what many have called the Golden Age of Particle Physics -- . so many experimental opportunities could be pursued with small groups, even those comprised of a single professor and a student. What were needed were incisive experiments carried out with creative instrumentation, and in that spirit Val, with his talent for electronics and instrument design, turned his attention to the fascinating behavior of *K* mesons.

In 1955 Val was at the Cosmotron measuring the lifetimes of K^+ mesons, as they were identified by their particular decay mode, to shed light on the "$\tau - \theta$ puzzle:" unstable particles θ and τ, having the same mass within experimental uncertainties, were observed to decay into three pions (τ) and two pions (θ), respectively. These final states had opposite parity, so τ and θ were either separate equal-mass particles or two decay modes of the same particle. The latter hypothesis would revolutionize physics by requiring the overthrow of parity conservation, as at that time it was thought that all the laws of physics were the same under three discrete symmetry transformations: reversal of charges (charge conjugation *C*), reflection of spatial coordinates (parity transformation *P*), and time inversion (*T*). Moreover, the fundamental symmetry of nature, expressed by the *CPT* theorem, required the laws of physics to be the same under simultaneous *C*, *P*, and *T* transformations.

Hence the measurement of a possible difference in the lifetimes of the θ^+ and τ^+ decay modes was of urgent interest, and Val was carrying out this experiment with his graduate student Robert Motley. Val had invented a velocity-selecting Cherenkov counter, which was the heart of his *K* meson beam; it allowed him to transcend previous experiments by cleanly separating *K* mesons from the beam's protons and pions. Appropriately named the Fitch counter, it has been a workhorse for particle physicists ever since.

The counter was sensitive from its threshold velocity (β=0.62) up to the velocity at which the Cherenkov angle was large enough that the Cerenkov light was totally reflected internally (β=0.78). These characteristics spanned the velocity range of K^+ mesons in Val's magnetically selected 480 MeV/c positive beam. The *K* mesons were brought to rest in an arrangement of absorbers, Cherenkov counters and scintillation counters that were able to select a specific decay mode. The times and pulse heights of the counters were displayed on an oscilloscope, which were then photographed. To be certain of the time calibration, the *K*-meson stop signal was redisplayed with a 200 nsec delay, thereby

Val in the counting house, Brookhaven, circa 1960.

confirming the oscilloscope's sweep speed on an event-by-event basis. The delay was provided by a 200-foot-long 300-ohm TV cable, passed through a window in Val's counting room far out into the yard and returned. And as he had done at Columbia, he designed and built all of his electronic equipment himself.

One of us (Cronin) was doing experiments on the Cosmotron at the same time that Val was using another beam. It was in the early days of the machine, and its dayshift hours were allocated to engineers and other physicists for machine diagnostics and improvements. Experiments were scheduled to begin about 6 p.m., and tended to run through the night until 8 a.m. the next morning. Rarely, however, did the actual running begin until much later than 6 p.m. — often midnight. To pass the time, it was common to discuss physics in Val's counting room; and also to play bridge, the "usual foursome" consisting of Val, Cronin, Motley, and a fourth enlisted in the hallway.

Val's lifetime results: θ^+ ($K^+ \rightarrow \pi^+ \pi^0$) $= 12.1\ (+1.1 - 1.0)\ 10^{-9}$ sec and τ^+ ($K^+ \rightarrow \pi^+ \pi^+ \pi^-$) $= 11.7\ (+0.8 - 0.7)\ 10^{-9}$ sec, were by far the most precise at the time, and strongly suggesting that the τ and θ lifetimes were equal. This discovery deepened the $\tau - \theta$ puzzle, as there was no experimental evidence that τ and θ decays showed different properties. Therefore it seemed that all the different K decay modes came from an identical particle.

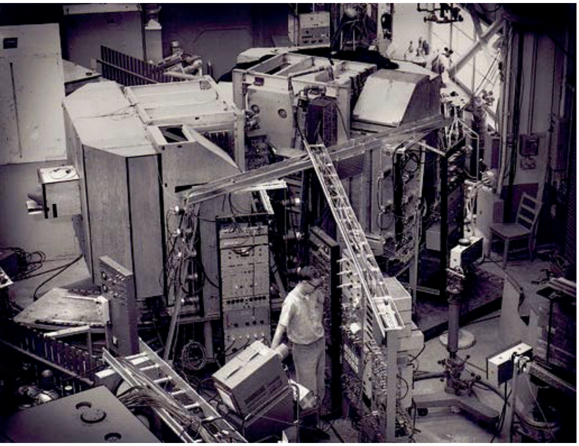
The thorough work of Val and many others led theoretical physicists T. D. Lee and C. N. Yang of the Institute for Advanced Study to point out that, surprisingly, parity conservation in weak interactions had not been tested experimentally, and to propose experiments to address the question. In 1957, only a year later, experiments led by C. S. Wu, R. Garwin, L. M. Lederman, and V. L. Telegdi showed conclusive evidence for the violation of parity conservation in weak interactions.

Val's infatuation with K mesons was to last a long time. After the work cited above, he turned his attention to the particle-mixture picture of neutral K mesons by M. Gell-Mann and A. Pais, whose prediction of a long-lived K_2 in addition to the short-lived K_1 had been unaltered by the replacement of the assumed charge-conjugation symmetry (C) with the combined symmetry of parity and charge conjugation (*CP* invariance). K_1 and K_2 are the symmetric and antisymmetric combinations of K^0 and $\bar{K}^0$, respectively. *CP* invariance was quickly accepted, as it was a consequence of the two-neutrino hypothesis that explained the nonconservation of parity. Pais and O. Piccioni predicted another remarkable phenomenon of the particle mixture, called regeneration: when a K_2 beam passes through an absorber, K_1's appear because the $\bar{K}^0$ component is more strongly absorbed.

The K_2 meson was discovered by Lederman and colleagues in 1956 at the Cosmotron, before parity violation was discovered, in an experiment in which events were detected in a cloud chamber. All the decays were three-body, as predicted by Gell-Mann and Pais. In spring 1957, Wolfgang ("Pief") Panofsky was a visitor at Brookhaven. There he met Val, and the pair quickly designed an experiment to detect electronically the long-lived K_2 mesons. The decay modes were principally $\pi e\nu$ and $\pi\mu\nu$. Borrowing some large blocks of plastic scintillator from Columbia University, Val and Pief were involved in the construction of the experiment along with student Motley and a new Brookhaven postdoc, Walter Chesnut (who incidentally became the fourth in Val's bridge games). They spent hours polishing the scintillator with Colgate toothpaste. The main detection scheme was to spot the π or μ coming to rest in the scintillator, followed by a delayed pulse from a μ decay. A small fraction of the events, called "golden," were coincidences between both charged decay products. In addition to verifying the cloud-chamber result, Val and Pief hoped to confirm the particle mixture picture by measuring the total cross section of the K_2's in copper, expected to lie between that of a K^+ and a K^-. There were insufficient data to confirm the particle-mixture prediction, but the effort showed Val's determination to investigate all the details implicit in the particle-mixture theory.

In the late 1950s, transistors began to replace vacuum tubes. Val was developing his expertise with transistor circuits, which grew to the point that he wrote an article, "Use of Transistors in High-Energy Physics," for David Ritson's book on techniques in high-energy physics. Val also proceeded to expose his colleagues to the "new electronics," which was much simpler than vacuum tube-based circuitry. But the process was hazardous: transistors then cost about $5 each, and it was easy to blow one out through a misstep. Nevertheless, we all learned from Val, and we designed and built our own electronics for the next 10 years.

In spring 1963, Val approached Cronin, who had joined the Princeton physics faculty in 1958, with an irresistible suggestion. At Brookhaven, the physicist Robert Adair



The *CP* discovery experiment at the Brookhaven AGS, 1964.

had done an experiment in which the regeneration in hydrogen of K_1's from a K_2 beam was found to be much larger than expected. Val proposed that he and Cronin check this result, which had been dubbed "anomalous regeneration," with the apparatus Cronin had built to study the decay of ρ mesons to $\pi^+\pi^-$. The apparatus, consisting of a double-armed magnetic spectrometer viewing a 4-foot-long hydrogen target, was ideally suited to detecting the two-pion decay of regenerated K_1 mesons. The trajectories in each spectrometer arm were recorded by spark chambers.

The Adair experiment had used a small hydrogen bubble chamber that had very poor energy resolution, but Val realized that adding a spectrometer capable of operating in an intense K_2 beam would allow the checking of the Adair result with far greater precision. So Val and Cronin proposed to do just that at Brookhaven's new 30 GeV Alternating Gradient Synchrotron (AGS). They also recognized that the experiment could measure other phenomena, including the regeneration of K_1 mesons and a search for the decay of K_2 mesons to two pions in "vacuum" (in actuality, a helium bag), which was forbidden by *CP* conservation. No two-pion decays of K_2 had been observed among the ~300 events observed in cloud-chamber experiments.

Val and Cronin quickly presented their proposal, only two pages long, to the AGS program committee in spring 1963, and it was accepted as an experiment that would run in parallel with the facility's main experiment, which was muon scattering. Cronin's spectrometer had just finished its ρ meson run at the Cosmotron, and was moved to the AGS in early June 1963. With a few modifications it was ready for a run in July, by which time a postdoc from France, René Turlay, and a graduate student, Jim Christenson, had joined the experiment.

The run went rather smoothly. In four weeks the experiment had been tuned up, made studies of regeneration, repeated the Adair measurement with the hydrogen target, and searched for the "vacuum" decays. The analysis tools had already been developed, but the time- consuming part was measuring the spark chamber photos. The group placed analysis priorities on the Adair effect and on regeneration studies, which gave almost-immediate results, including a measurement of the $K_1 - K_2$ mass difference. Ironically, lowest priority was placed on the search for $\pi^+\pi^-$ decays, as it was expected to yield only a much-improved limit on *CP* conservation.

During the regeneration runs, Val invented a method for measuring the mass difference, which was independent of the actual properties of the regenerating materials. The regeneration was produced in two copper blocks with a variable spacing; the curve produced by the interference between the two blocks depended only on the distance between the blocks and the momentum of the beam. This new technique, which yielded a precise value of the mass difference—0.5 in units of the inverse decay rate of the K_1, or about 3.0×10^{-6} eV/c^2—was a source of great pride for Val. (Some years before, in 1959, he had attempted to measure the mass difference at the Berkeley Bevatron, but with limited success.) This time, however, Val's detailed paper in *The Physical Review* in 1965 could document the observation of many predicted aspects of the regeneration phenomenon.

In the meantime, Turlay was measuring the "vacuum decay" events, and by Christmas 1963 there was definite evidence of the decay of the K_2 to $\pi^+\pi^-$. These events captured the group's attention, and Val, being its most experienced physicist but also its most cautious member, did not immediately accept the conclusion of *CP* violation. All the events were remeasured with much greater accuracy, which only made the evidence stronger, with 45 events that fit the two-pion decay.

Val and his colleagues made great efforts to find other explanations for the effect, with no success. After allowing for and subtracting background from three-body decays, 45 ± 10 events were found, giving a branching ratio $R = (K_2 \rightarrow \pi^+\pi^-)/(K_2 \rightarrow \text{all charged modes}) = (2.0 \pm 0.4) \times 10^{-3}$. A paper describing this result was published in the July 27, 1964, issue of *Physical Review Letters*, creating a sensation. (Only a few lines in the paper stated that the "anomalous regeneration" of Adair, the original motivation for the experiment, was not verified.) The publication just preceded the International Conference on High Energy Physics held in Dubna, USSR, and Val's presentation there proved to be its highlight.

At about this time the nomenclature changed, recognizing the fact that the short and long lived *K* mesons were no longer eigenstates of *CP*. The K_1 was now called K_S, and the K_2 was called K_L. Meanwhile, numerous proposals were being made to "save" *CP* conservation, and Val realized that to prove that *CP* was violated, one must show that the pions from the K_L decay are coherent with the pions from K_S decay. Thus in fall 1964 he began building at the AGS a new instrument, with a much larger acceptance of neutral *K* decays than the apparatus of discovery, to further study the K_L decays. With his new apparatus he employed a simple arrangement to demonstrate the coherence, a diffuse regenerator made of thin beryllium plates, the mean density of which was adjusted to produce a regenerated amplitude for K_S mesons equal to the amplitude for $K_L \rightarrow \pi^+\pi^-$. If the two sources of pions were coherent, then the net rate, being the square of the sum of the amplitudes, would in general differ from the sum of the rates. Through this clever technique, Val was the first to show that the *CP*-violating amplitude was essentially in phase with the regeneration amplitude (fully constructive interference). All the creative-yet-fruitless attempts to "save" *CP* violation were unnecessary, as *CP*-violation had now been established. This result was published in preliminary form in *Physical Review Letters* in July 1965, and comprehensive results from the new apparatus appeared in *The Physical Review* in 1967.

By 1967, the outstanding experimental challenge was to measure the *CP* violation in the decay of K_L to two neutral pions. One needed to compare the ratio of rates $K_L \rightarrow \pi^0\pi^0/K_S \rightarrow \pi^0\pi^0$ to the equivalent ratio for charged pions. If the two ratios were different, *CP* violation would be characterized by two parameters, the second of which would be called "direct *CP* violation." These ratios were designated $|\eta_{00}|^2$ and $|\eta_{+-}|^2$, respectively. $|\eta_{+-}|^2$ had been well measured by then to be $(3.6 \pm 0.2) \times 10^{-6}$.

With his students and young colleagues, Val investigated the neutral decays, as did many others. The backgrounds for this measurement were huge—the rate of K_L decay to 3 neutral pions was about 300 times the anticipated decay to two neutral pions. An early experiment indicated that $|\eta_{00}|^2$ was as large as $(25 \pm 5) \times 10^{-6}$, so Val's null result $(-2 \pm 7) \times 10^{-6}$ was significant, not for its precision but for its indication that the large results might be in error. By 1968 new experiments were consistent with $|\eta_{+-}| \sim |\eta_{00}|$, and by 1972 further experiments indicated that the two quantities were equal within 5 percent. Only in 2002 did experiment finally establish that the two quantities actually differed by a few tenths of a percent, signaling a small "direct" *CP* violation.

To further study the charged decays of K_L, in 1970 Val built a third apparatus with the capability to identify the decay products as pion, muon, or electron. With this equipment he made a precision measurement of the $K_L - K_S$ mass difference, (0.460 ± 0.006) in units of the inverse decay, and measured the electron-charge asymmetry of the

$K_L \rightarrow \pi e \nu$ decay mode, finding $(N^+ - N^-)/(N^+ + N^-) = (3.18 \pm 0.38) \times 10^{-3}$, another manifest example of *CP* violation. The *CPT* theorem requires that *CP* violation must be accompanied by a violation under the reversal of time (*T*), and subsequent experiments by Val and others soon unambiguously confirmed this.

The *CP* discovery also had consequences extending beyond particle physics. In 1967, Andrei Sakharov described a scenario in which a combination of proton instability, *CP* violation, and thermal nonequilibrium could explain a matter-dominated universe evolving from the Big Bang. This would imply a *CP* violation involved in the very-high-energy particle physics of the early universe, much larger than the *CP* violation discovered in 1964. Further, *CP* violation provides the only way for travelers to or from a distant planet to communicate, whether they are made of matter or antimatter, and thus ensure they don't annihilate each other on contact. In 1980, Val Fitch and James Cronin received the Nobel Prize for their discovery of *CP* violation 16 years earlier.

Val Fitch, James Cronin Samuel Ting, C. N. Yang, and I. I. Rabi.

"It was Val who suggested the use of my apparatus, which made the discovery," Cronin reflected after being awarded the prize. "I do not think I would ever have thought of this application. But it was good fortune that a suitable apparatus existed to reduce significantly the limit on K_2 decaying to two pions. None of us thought we would actually find events."


Teaching the freshman course on electromagnetism, mid 1980's.

Val left the study of *K* mesons in 1972, but continued his study of *CP* violation with an experiment at Fermilab to search for *C* violation; he proceeded by measuring charge asymmetries in the spectra of particles produced in proton-antiproton interactions. His null result enhanced the evidence that the source of *CP* violation lay in the weak interactions, not in strong or electromagnetic processes. Characteristically, for this effort he invented a new variant of Cerenkov counter, which he called "flower power," to improve selections of antiprotons in the beam.

After completing this Fermilab experiment, Val devised a form of Eotvos apparatus to search for anomalous short-distance gravitational forces, and conducted the experiment on the side of a cliff in Red Lodge, Montana. Again, no signal was found, but once again Val's technical creativity was on display as he trained outstanding students.

Val was often called upon for major service. He was a member of the President's Science Advisory Committee from 1970 to 1973; chair of the Princeton physics department from 1976 to 1981; president of the American Physical Society (APS) in 1988 and 1989—the only person since 1932 to serve two years.

Val Fitch, with yearly bound volumes of the *Physical Review* and *Physical Review Letters,* demonstrating the information explosion. The smallest stack on the left is from 1898, the next from 1908, continuing to the tallest stack (1978) on the right. According to the original caption in the *Physical Review* "...the 1988 stack was left out because it would have been much too high." (Photo Courtesy AIP Emilio Segre Archives.)

As physics department chair, Val sent a budget request to Princeton president William Bowen that included a now-legendary comment: “President Bowen, you can’t buy the world’s best physics department, but if you have it you have to pay for it.” Most important, Val recruited a remarkable set of new faculty, including Edward Witten, Joseph Taylor, and William Happer. He even shoveled snow from the walk of the physics building to make sure the staff would be safe when coming in to work.

During Val’s APS presidency, the society commissioned a distinguished panel to evaluate the technical issues involved in the Strategic Defense Initiative, informally known as “Star Wars.” When the panel’s deeply critical report was delivered, its members came under vicious personal attack. Val rose to their defense, dismissing the attackers’ technical claims as “errors in physics[,] extravagant assumptions[, and] unproven technologies” and their ad hominem diatribes as “a bizarre attack with no place in technical discussion.” Val and the report were completely vindicated.

Also while he was APS president, Val became convinced of the importance of the “information explosion.” To address the issue he convened an APS committee, whose recommendations were among the first to point the way to electronic publication.

In 1993, before the compulsory retirement of tenured professors became outlawed, Val was in the last “class” that had to retire at age 70. Princeton’s administration told Val they would make an exception for him if necessary, but asked him to consider instead an

Val Fitch receiving the National Medal of Science from President Clinton, 1993.

appointment as "lecturer with rank of professor." Val graciously accepted, and continued in this role for three years, during which time he led an AGS experiment that searched for 6-quark states, organized a major conference on Princeton's 250th anniversary, and wrote several historical articles on particle physics.

Val's influence on physics was enormous. As a developer of experimental technique, he was the first to use transistors in high-energy experiments. As a researcher, he kept his eye on the important physics, and as a teacher he was mentor to generations of students who themselves became major researchers. He was elected to the National Academy of Sciences in 1966 and received numerous other national honors during his career, including the National Medal of Science, the Franklin Medal, the Lawrence Award, and election to the American Philosophical Society. Nevertheless, he was modest and self-effacing, and remained true to his principles throughout his remarkable life.

When asked why he was so reluctant to talk about himself, Val replied: "My mother always told me that if you do anything worth praise, let others praise you. Don't praise yourself." To Val's friends and colleagues, this "says it all."

Val's first wife, Elise Cunningham, died in 1972. They had two sons, John (deceased in 1987) and Alan. Quoting from Val's Lawrence Award acceptance speech in 1968: "One doesn't do significant explorations without a superb base camp—a comforting retreat. My wife, Elise, shares this honor in every respect."

In 1976, Val married journalist Daisy Harper, who survives him. In their 39 years together, he and Daisy enjoyed warm connections with family and friends—in the Princeton community and around the world. They relaxed and sailed during their many summers at Smith's Cove, Nova Scotia, on the beautiful Annapolis Basin.

Val's professional life in physics coincided with, and contributed to, the golden era of particle physics. He was one of three physicists from the American west who enriched the period, the others being Robert R. Wilson and Ernest O. Lawrence. We bask in the nostalgia of that time.

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