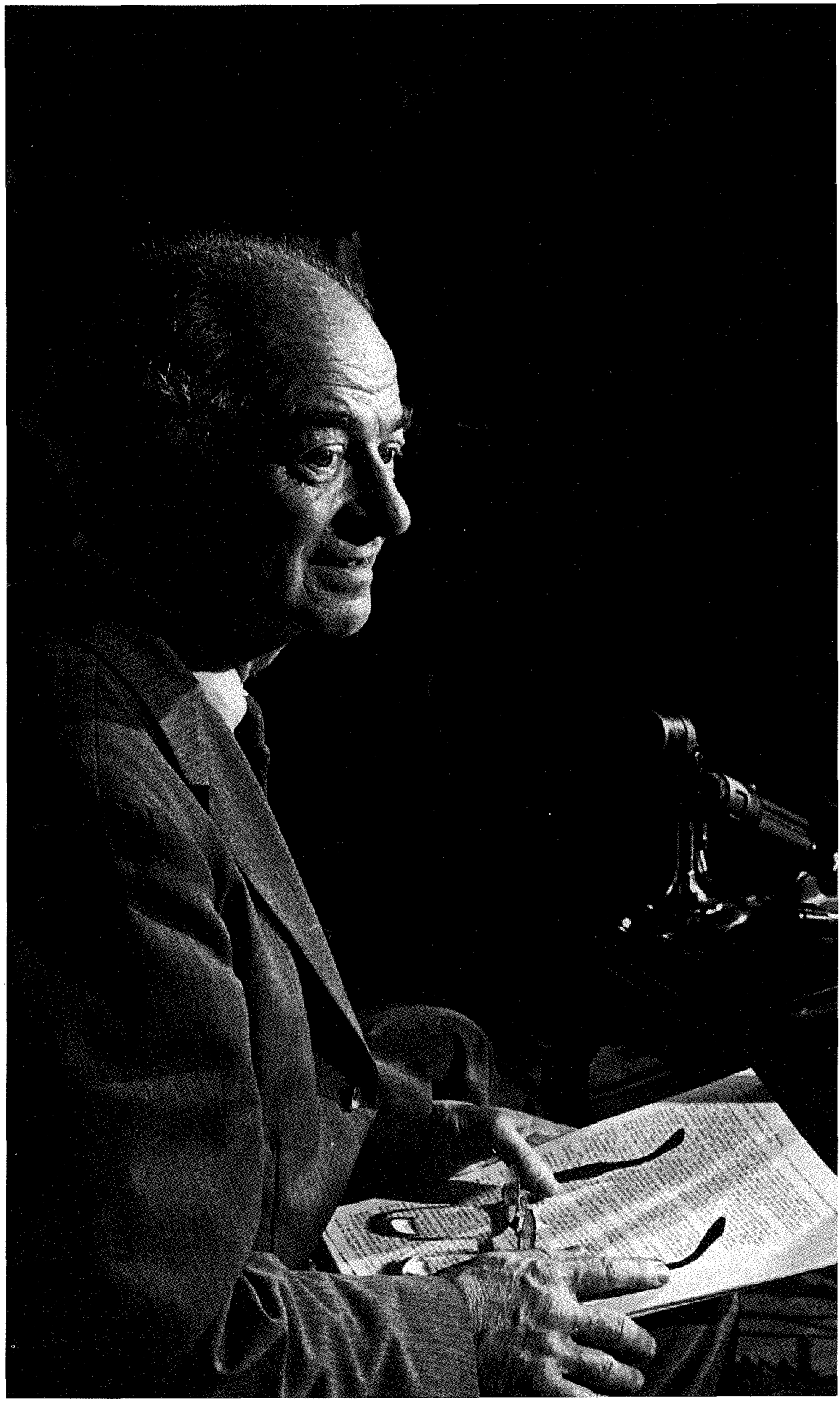


Linus Pauling 1901–1994

He was a genius, a pathfinder, whose scientific courage allowed him fearlessly to cross the boundaries of physics, chemistry, biology, and human medicine.

At a press conference in his Pasadena home on October 18, 1963, Linus Pauling announces his appointment to the Center for Democratic Institutions in Santa Barbara and the end of his 41-year association with Caltech. Eight days earlier he had won the 1962 Nobel Prize for Peace.

Linus Pauling, Nobel Laureate and professor of chemistry, emeritus, died August 19, 1994, at his home in Big Sur. He was 93. He had spent most of his scientific life at Caltech, from his arrival as a graduate student in 1922 to his departure in 1963 after winning his second Nobel Prize, the prize for peace.

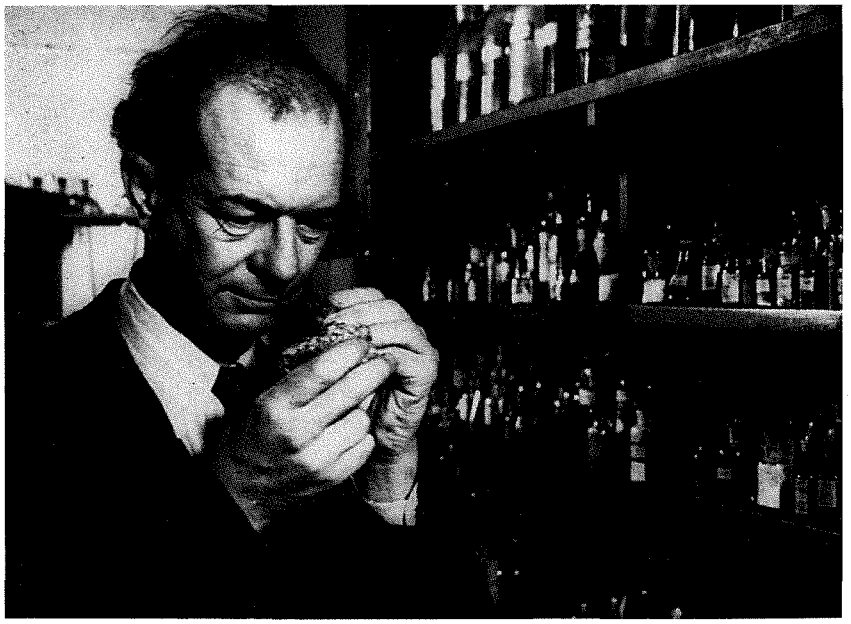
At the campus memorial observance on November 18, Caltech President Thomas E. Everhart welcomed the large crowd that filled Beckman Auditorium to "remember a man some have called the greatest scientist of the 20th century." Peter Dervan, chair of the Division of Chemistry and Chemical Engineering, a post Pauling had held for 21 years, delivered the closing remarks, referring to Pauling as "a genius, a pathfinder, whose scientific courage allowed him fearlessly to cross the boundaries of physics, chemistry, biology, and human medicine." Dervan thanked the speakers "for their eloquent, warm, and very honest remarks about the life and work of Linus Pauling."

Verner Schomaker
Professor of Chemistry, Emeritus
University of Washington
Faculty Associate in Chemistry, Caltech

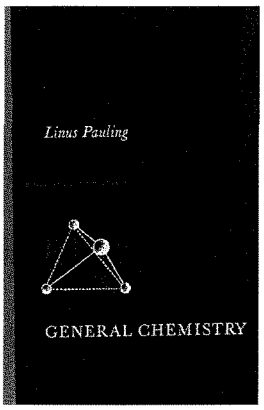
(Verner Schomaker commented on the award established in 1966 by the Oregon and Puget Sound sections of the American Chemical Society, "named after Dr. Linus Pauling, a native of the Pacific Northwest, because of the inspiration of his example. The nominee shall have made outstanding contributions to chemistry of the character that have merited national and international recognition." Schomaker pointed out that in the 29 years between Pauling, the first recipient, and Jim Ibers (BS '51, PhD '54), the latest, nearly half of the recipients of the award had had some connection to Caltech. This says a lot, said Schomaker, about what A. A. Noyes started when he appointed Pauling a graduate fellow in 1922. Schomaker went on to cite Pauling's interest in education in chemistry.)

Some years ago Dr. Pauling mentioned to me that he had given a talk somewhere about why the molecular orbital picture of electronic structure should not be used in elementary chemistry courses, and why he shouldn't be teased so much, ridiculed, and even condemned for sticking with the valence bond language and method. He clearly felt strongly about it, and he promised to send me a reprint, but it never came. This week I found the article in vol. 57, 1980, of the *Journal of Chemical Education*—the talk "Prospects and Retrospects in Chemical Education" given at a symposium in Honolulu in April 1979. In part, he said:

"I think that it is a tragedy that the writers of elementary textbooks decided to discuss the molecular orbital method, because the introduction of such a discussion in the teaching of elementary chemistry has served to confuse students. Only one system for treating valence, valence bonds, and molecular structure should be used for the elementary student in order that he build up a sound picture of molecules and the chemical



Pauling in his Caltech lab, probably in the early forties. His 2-lb. classic textbook (below) was first published in 1947.



bond and not be confused. The valence bond treatment is much simpler than the molecular orbital treatment, and it is also more powerful, so far as elementary non-mathematical discussions are concerned. The molecular orbital method ought to be X-rated, so that only after they had reached a certain age would students be allowed to learn about it.

"The authors of these textbooks discuss ethylene on the basis of the molecular orbital method by stating that in order to apply this method you must first know how the nuclei are arranged. They then say that it is known that in ethylene the nuclei all lie in the same plane, with two hydrogen atoms near each carbon atom, and that therefore we can discuss sigma bonds between carbon and hydrogen, and that therefore we can discuss sigma bonds between the two carbon atoms. There is accordingly a disadvantage right at the start. With the valence bond treatment, planarity follows directly from the concept of the tetrahedral carbon atom, with two bent bonds between the two carbon atoms. It seems to me to be pretty poor that the molecular orbital method does not even permit the derivation of the conclusion that the nuclei in ethylene lie in the same plane. Instead this has to be introduced as an assumption.

"My criticism of the molecular orbital treatment of valence and molecular structure has nothing to do with molecular quantum mechanics. The molecular orbital starting point for quantum mechanical calculations is a very good starting point."

Pauling was also keenly interested in the facts, in descriptive chemistry. For example, Derek A. Davenport, of Purdue, who introduced Pauling at the symposium, reproduces several of Pauling's letters to his Oregon Agricultural College instructor, F. J. Allen. One of them, written October 1924, from Caltech, includes the statement: "The faculty seems to emphasize physics and thermodynamics and statistical mechanics and atomic structure rather than chemistry." He later recalled those impressions: "My idea of chemistry at the time was that one developed a familiarity with chemical substances, and chemical substances to me meant inorganic substances, because all organic substances seemed to be about the same. I remember some 20 years later I met a man who had a PhD in chemistry from Berkeley, and I said to him that I was interested in bonds between metal atoms, that is, inorganic compounds that contain metal-metal bonds. I mentioned that there is, of course, one well known one, the mercurous ion in calomel. It turned out that he, with his PhD in chemistry, did not know that there is a mercury-mercury bond in calomel. I doubt that he knew anything about calomel. I was shocked to find that there could be people with a PhD in chemistry who knew so little about descriptive chemistry."

At the recent Pauling award, Jim Ibers contrasted one of the typical present-day textbooks very unfavorably with Pauling's 1947 edition of *General Chemistry (An Introduction of Descriptive Chemistry and Modern Chemical Theory)*, which he had enjoyed as a freshman here at Caltech. The former weighed 5.7 lbs. versus 2.0 lbs. for Pauling's classic; many dozens of mostly pointless *colored* illustrations versus none; half as much descriptive chemistry; lots of molecular orbitals versus none; physical chemistry, including thermodynamics, versus hardly any; and a triple or quadruple dose of Supplementary Material versus none. Pauling would have been pleased, especially since he didn't like thermodynamics anyhow.

(Schomaker went on to protest statements in some of Pauling's recent obituaries, primarily that Pauling thought he had cured his near-fatal bout with nephritis in 1941 with massive doses of vitamin C, and that the preoccupation with vitamin C that had "spoiled his great reputation as a chemist" in the last 25 years of his life was due to "his greatest failing, vanity." Schomaker noted that Dr. Thomas Addis of Stanford had cured the nephritis with a diet that ran counter to the usual treatment, and that Pauling always credited Irwin Stone with interesting him in vitamin C in 1966. As for his vanity, Schomaker said that in his own private poll, 9 out of 10 respondents agreed with

Before the symposium for his 90th birthday celebration, Pauling is greeted outside Beckman Institute by Walter Schroeder, senior research associate, emeritus.

him that Pauling was "supremely confident, yes, but not a bit afflicted by undeserved self-esteem." Countering an obituary statement about Pauling's lectures—that "he would reel off the top of his head atomic radii with the gusto of an organist playing a Bach fugue; afterward he would look around for applause"—10 out of 10 of Schomaker's respondents agreed that he was "a marvelous showman," but 9 out of 10 thought that he was "never so corny as to look around for applause.")

If Pauling were still living and in reasonable comfort, he would still be enjoying people, minerals, sea lions and otters, birds and flowers. He would still be hoping that physicists would attend his continuing string of papers on nuclear structure; that chemists would pay more attention to his ideas on the metallic bond, and that more physicians would join ever more ordinary people in wholesome interest in good nutrition and orthomolecular amounts of vitamins, especially ascorbic acid. He would be looking for more evidence that quasicrystals are multiple cubic twins after all and he would still be contributing new insightful gems of understanding of chemistry and biology.

I cannot end without reminding myself of the central fact that Linus Pauling was the most original and creative mind in chemistry of the 20th century.

Norman Davidson
Norman Chandler Professor of Chemical Biology, Emeritus, Caltech

In early 1946, when I was working in New Jersey, I received a letter offering me a job as an instructor at Caltech at the princely salary of $3,600 per year. The letter was in Linus's strong, legible handwriting, characteristically on a laboratory data pad, and written from a hotel in St. Louis. I was probably one of the last of the tenure-track faculty members who entered the system with the now-obsolete title of instructor. My teaching assignment was to assist Linus in Caltech's general chemistry course, for which he was just finishing the book that Verner alluded to. I remember on my first day in September 1946 wandering around sightseeing. I looked into Gates Laboratory—that beautiful room in the Annex with the very high ceiling and bookstacks that you reach by a ladder. And there standing precariously, it seemed to me, at the top of a ladder, with his glasses low on his nose, and balancing a gigantic volume of the *Journal of Physical Chemistry*, was Linus. I knew he was recuperating from a serious illness, and I thought to myself, "There is one of the world's greatest brains balanced on two of the world's frailer legs."

I remember meeting a new graduate student, Harvey Itano, an American born in California of Japanese parents, who, after a period of internment, had gone to medical school in St. Louis during the war. He told me he had come to Caltech after the war to fulfill his prewar ambition to study for a PhD in chemical biology under Linus Pauling. Linus had suggested as a project that he look for a molecular difference between normal hemoglobin and the hemoglobin of people who had the sickle cell disease. I was an ignorant chemist, but I remember thinking to myself that that sounds like a crazy idea. In a few years the team that included Harvey, John Singer, and Bert Wells described sickle cell anemia as the first clear example of a human molecular disease, involving a change in the charge of the hemoglobin molecule (later shown to be a single amino acid change). The point of this story is not that Norman Davidson was not far-seeing, but that Linus Pauling was an audacious, brilliant visionary who created new ideas and new fields.

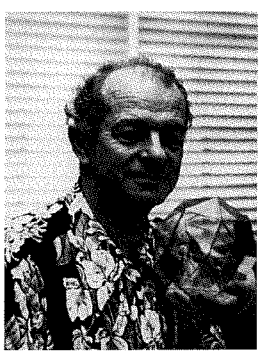
Part of my job as Linus's assistant was to tell him what he was scheduled to lecture about. This was usually at his desk in the chairman's office on the first floor of Crellin, just where it is now. But sometimes, when he had just returned from a trip, I would meet him as he walked into the lecture hall at 11 a.m. in the Gates Annex (the lecture hall now refurbished and renamed the Linus Pauling Lecture Hall) and asked me what it was he was supposed to talk about. He always proceeded to give a very well-organized and, of course, interesting lecture. Few of us can do that.

But on the occasions when I visited him in his

office he would also tell me about his latest ideas—big ones such as the alpha helix structure, and little ones about the unexplained factlets of descriptive inorganic chemistry that fascinated him. Why is HF a weak acid? Why does sulfur form S_8 gas molecules? He told me his ideas about the answers, ideas that came to him, as he said, "with my feet higher than my head for convenience."

Linus was a courageous, compassionate person. There are quite a few cases where he protected and helped relatively powerless victims of McCarthy persecution and hysteria that were then sweeping the country.

Although I'm supposed to limit my remarks to a few of my many personal recollections, I cannot end without reminding myself of the central fact that Linus Pauling was the most original and creative mind in chemistry of the 20th century. From the structure of minerals to the nature of the chemical bond, the structures of complex intermetallic compounds, the structures of proteins, the essential role of complementarity in biological specificity, and molecular medicine, his discoveries opened new vistas and shaped the way we think. To paraphrase another great American, the world will little note nor long remember what we say here today; it will never forget what he did during his life. I was privileged to have worked with him and to have some personal feeling for how that genius was expressed.

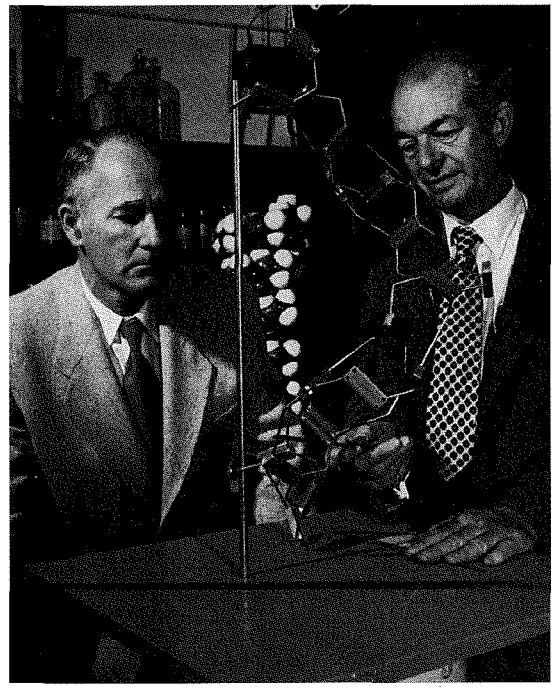


Right: George Beadle, chairman of the Division of Biology and later also a fellow Nobel Laureate, admires Pauling's helical model of protein structure. This photo was probably taken in the early fifties. Below: Pauling was also known for his Hawaiian shirts.

Alexander Rich
Sedgwick Professor of Biophysics
Massachusetts Institute of Technology

My own experience with Linus stems from his invitation to come as a postdoctoral fellow in 1949, a few years after Norman Davidson arrived. I came from the East Coast, having just graduated from Harvard Medical School, and arrived suitably adorned with coat and tie. I walked into Linus's office, and there I saw this man with a flowery Hawaiian shirt and a big smile. I thought to myself, "Gee, this is different." The shirt didn't remain constant, but the warm smile did. And the five years I spent as a postdoctoral fellow was really a great experience.

I became interested in seeing how Linus operated. In his autobiographical sketches, Linus has said that he became interested in chemistry at 13, and by 18 had mastered most of conventional chemistry. Now, that's very important because it means that he already understood the qualitative nature of all these changes that constitute



chemistry, and then was prepared to look more deeply into why things occur. When he went abroad in 1926 as a Guggenheim Fellow, he wrote in his application that he proposed to apply quantum mechanics, which had been discovered only a few months earlier, to the problem of the structure of molecules and the nature of the chemical bond. What remarkable foresight! He accomplished it, too.

He had the ability to see things in a general way, where many people could only see the particulars. This was strikingly illustrated in 1928, when he began looking at the structure of ionic minerals. These are rocks that are made of units that have positive and negative charges. Instead of looking at these three-dimensional structures one at a time, he asked himself why they have the form they have. He formulated a fairly simple set of rules that made it possible to predict all of these structures. In one statement, essentially, he answered the question of why minerals are the way they are, which was an enormous accomplishment.

Linus said he started to learn something about biology in the late twenties, when Thomas Hunt Morgan came to Caltech, bringing with him a number of younger members of the new biology division. In 1931 he had become interested enough to present a seminar describing the crossing over of chromosomes. From this beginning his work began increasingly to move in the direction of biological molecules. Linus began to develop great insight into what was one of the major puzzles of the day, namely the nature of proteins, the complex machinery of the cell. His

Some of the faculty of the Division of Chemistry and Chemical Engineering in 1937, the year after Pauling was named chairman: Pauling is seated in front between Roscoe Dickinson (left) and William Lacey; standing (from left) are Howard Lucas, Arnold Beckman, Bruce Sage, Stuart Bates, James Bell, and Don Yost.

description of proteins, developed in the late thirties and early forties, is essentially the way we see proteins today—that is, long chains of polypeptides held together by a number of weak forces and with some structural motifs on the inside. In 1937 he laid down what he thought was the basic geometry of how the polypeptide chains coil, but it wasn't until 1948 that he discovered (while in bed with a cold and playing with a sheet of paper) what is now known as the alpha helix, the most important element in the structure.

Linus was in a very real sense the first molecular biologist—before the term molecular biology was invented.

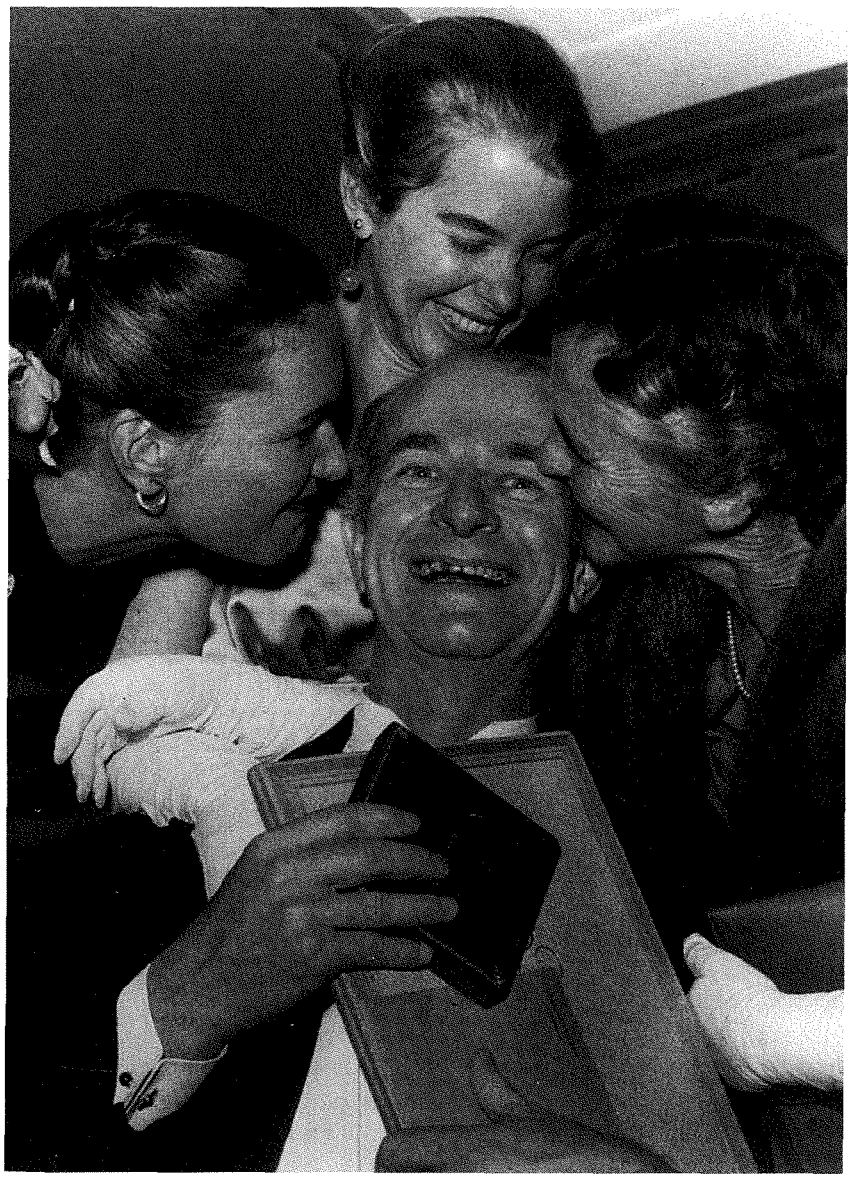
Linus's insights came from many sources, often serendipitous ones. For example, many of us go to committee meetings; they're usually a waste of time. But in 1945 Linus was a member of a committee on medical research, whose report became part of the influential Vannevar Bush report, "Science: The Endless Frontier." One of the members of this group was Dr. William Castle from Harvard Medical School, who described his work on sickle cell anemia; when you remove oxygen from these red blood cells, the hemoglobin within them crystallizes. Linus thought about this and concluded that the molecule has to develop a complementary surface; there must be a change. This led to the suggestion that Harvey Itano try to see if there was a difference. Although today the discovery of a new molecular disease is almost commonplace, then it was revolutionary. This was the first one, and, as such, it laid the pattern for all subsequent work. So Linus was in a very real sense the first molecular biologist—before the term *molecular biology* was invented.

(Rich also described Pauling's method of writing a book on college chemistry—"just dictating it" and then correcting the secretary's mistakes—which illustrated the intuitive depth with which he understood his subject. Rich also defended Pauling's interest in vitamin C and expressed the wish that Pauling could have read a recent paper showing that vitamin C protected animals exposed to cigarette smoke from 90 percent of the damage. "Linus's insight and intuition were very profound. . . . Clearly, he understood something that the rest of us are only beginning to understand.")

I'll end with a quote from Linus. He was working on the question of molecular disease and the evolution of the genetic code. He and Emil Zuckerkandl had developed the concept that there is with time a gradual change in the DNA sequence and likewise a gradual change in the proteins that they encode. He says, "Once more biology will show what it can do without any élan vital. . . . This experience and my other experiences during my last 50 years involving the ever-increasing understanding of the world on the basis of rational principles have led me to reject all dogma and revelations, all authoritarianism. It is possible that the greatest contribution of the new world view that has resulted from the progress of science will be the replacement of dogma, revelation, and authoritarianism by rationality, even greater than the contribution to medicine and to technology." This summarizes what for Linus was a very important thread in the work that he did. He was a man who understood the way nature worked, and from that he learned a great deal about the nature of life itself.

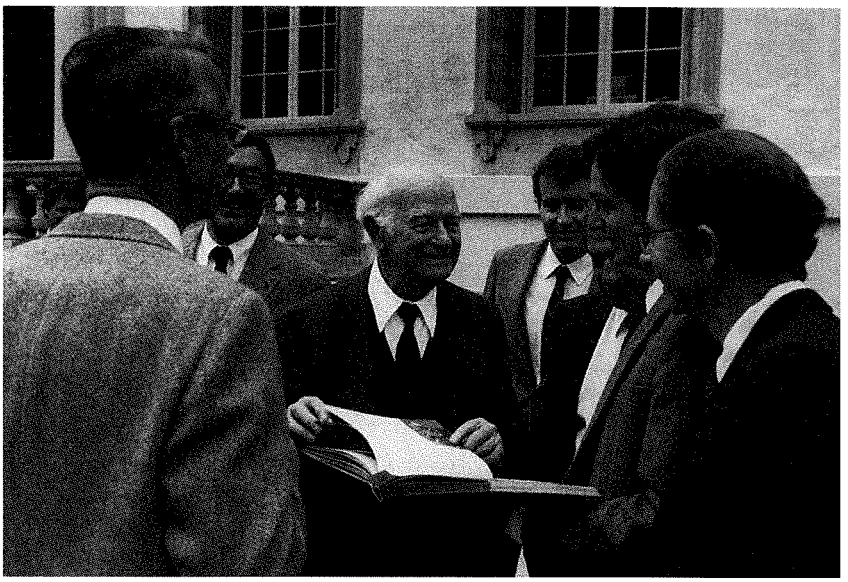
John D. Roberts
Institute Professor of Chemistry, Emeritus, Caltech

After receiving his Nobel Prize in Chemistry in Stockholm in 1954, Pauling is congratulated by, from left, daughter-in-law Anita, daughter Linda, and wife Ava Helen.



Linus Pauling will surely be remembered as the most influential chemist of the 20th century. He showed true genius in transmuting difficult quantum-mechanical principles into a set of simple concepts that could be used to provide a common basis for dealing with the properties of chemical bonds, molecular structures, and reaction mechanisms. Known as Pauling's Theory of Resonance, it fulfilled a need for chemists frustrated by mountains of information on seemingly unrelated chemical phenomena. So they used it. But if you asked if they understood it, that was something else again. Like its underlying quantum-mechanical principles, resonance is not easy to truly understand. But not many cared. The important thing was that it worked. And perhaps I should say here that, even though I wrote the first book popularizing molecular orbital theory for organic chemists, Linus never complained to me about it.

Pauling's genius is also clear from the remarkable breadth of his interests: from his establishment of the basis for protein structures, to studies of amino acids and the ways which they link together as peptides to form helixes and sheets. This work alone would have made him famous, but he went on to study the magnetism of blood, the chemical bases of immunology, sickle cell anemia, the structures of metals and alloys, as well as the structures of atomic nuclei. Pauling's research achievements, along with the wonderful spirit of Caltech, both in the Division of Chemistry and Chemical Engineering and the Institute as a whole, made Caltech compellingly attractive when Linus offered me a professorship in January 1953. Some of my friends suggested that Linus, as chairman of the division, might run over me, but that did not happen. He was generous with startup funds and strongly supportive of what turned out to be a successful initiative to change the Institute's rules to allow admission of a woman who had started graduate work with me at MIT. Further, after some intensive salesmanship in 1954, he agreed to an approach to the Trustees for purchase of a nuclear magnetic resonance spectrometer, an instrument that enabled Caltech to get a head start in applications of this still burgeoning technique to chemistry. We were all excited in 1954 when Pauling received the Nobel Prize in Chemistry. From my perspective, the prize changed Linus's life by enhancing both his credibility and his visibility with nonscientists. This gave him a greater opportunity to be heard on social issues, notably a prodigious



Surrounding Pauling on his return to campus for his 85th birthday are (clockwise from left) John Hopfield, Harry Gray, Terry Collins, Rudy Marcus, Dan Weitekamp, and John Baldeschwieler.

and courageous effort to stop nuclear bomb testing. Some scientists and engineers, including ones at Caltech, were skeptical of or even opposed to Pauling's effort, most because they sincerely believed it might endanger our national security. But the effort was successful and led to the 1962 Nobel Peace Prize.

It was unfortunate that the Institute was not unanimous in its support of Pauling's work on the nuclear test ban. This fact, combined with a major concern in the division about the progress of research programs that Linus had under way to study the action of anesthetic gases and chemical factors in mental health were surely important factors when he resigned his professorship in 1964. We were greatly pleased, however, that he was willing to remain associated with the faculty as a research associate until 1971, and after that as professor of chemistry, emeritus.

Many think of Richard Feynman as THE California genius. Pauling was more than comparable in a different way, perhaps in the way of Leonardo da Vinci.

Linus Pauling was an extraordinary leader in chemistry and molecular biology at Caltech. He had amazing foresight and intuition as to important areas that the Institute should be involved in. He was enormously supportive of and enjoyed participating in undergraduate and graduate teaching. For students, for faculty, he favored doing what is best for the individual situation at hand, rather than following bureaucratic regulations. He both encouraged and personally enlivened our chemical research conferences. Linus set an extraordinary example of broadness of thought and concern for humanity. Many think of Richard Feynman as THE California genius. Pauling was more than comparable in a different way, perhaps in the way of Leonardo da Vinci. Linus was broader, more focused on, more willing to deal with, and more willing to speak out on the impact of science on the world. Linus was a great man. We shall miss him and we shall not forget his genius, nor his contribution to science and our individual lives.

Ahmed Zewail
Linus Pauling Professor of Chemical Physics, Caltech

The last time I spoke with Linus was one week before he passed away. Linda was at home and she was kind enough to let me speak to him on the phone when he was in bed. This was in connection with the publication of his collected work in one volume. With a clear mind and vivid memory he said to me, "Ahmed, my contributions will need more than one volume." Linus was absolutely correct. Indeed, his contributions to chemistry, biology, physics, medicine, and humanity deserve many volumes.

I had the privilege of getting to know him over the past 10 years. I was happy to be part of a celebration to bring him back to campus on the occasions of his 85th and 90th birthdays. I even have a special copy of his book *The Nature of the Chemical Bond*, which I treasure, autographed, "To my friend Ahmed." Throughout my interactions with Linus I observed his unique style, his passion for science, and his brilliant intuition. He had a feeling that he could solve any problem. I noticed on several occasions when we spoke about problems related to my science, he would say, "Well, in 1931 I wrote a paper in the *Journal of the American Chemical Society*, volume so and so, page so and so, that dealt with this problem." What he really was saying to me was that he had solved this problem 60 years ago.

Linus's contributions to chemistry are awesome. He was a pioneer in the application of quantum mechanics to chemistry, a central figure in the use of x-ray and electron diffraction, especially in this country, and the one responsible for introducing chemical-molecular concepts to biology—what we know nowadays as modern molecular biology. Besides his contributions to science, he made contributions to world peace. Essentially all of those contributions, including the writing of the monumental book, *The Nature of the Chemical Bond*, were made here, while Linus was on the faculty of the California Institute of Technology.

Caltech and Pauling were *covalently* bonded. Pauling had an enormous impact on Caltech's chemistry and biology, not only through his science, but also through his leadership. As chair-

man of the Division of Chemistry and Chemical Engineering for 22 years (from 1936 to 1958), he was instrumental in hiring many of the faculty who have continued Caltech's reputation. He was also a superb teacher in the classroom and in guiding the work of Caltech students and postdocs. He inspired a generation of students and postdocs, many of whom are in leading American universities and institutions; a number of them are Nobel laureates. Caltech, on the other hand, offered Linus a unique scientific atmosphere—outstanding students and colleagues and a leadership role.

If Caltech had been a firmly established hide-bound institution, like Harvard or Berkeley, he wouldn't have been able to do the things that he could do in a new institution as this was.

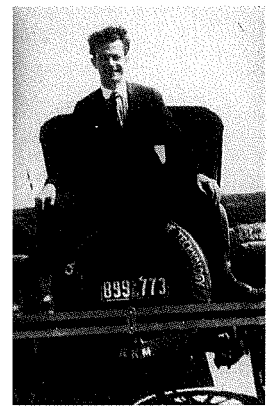
As happens in any family, there were some times of disagreements, but one must integrate these over time and appreciate reasons and changes. When Linus came back to campus on the occasions of his 85th and 90th birthdays, he told me, as he told others, that the best time of his life was spent at the California Institute of Technology. In fact, he said, and I don't know if he was joking or not, that the best thing that had happened to him was that he did not go to Harvard or Berkeley. Likewise, I believe that Caltech is proud of Linus Pauling and his contributions. In his honor, our division and the Institute have established the Linus Pauling Lectureship, the Linus Pauling Lecture Hall, and the Linus Pauling Professorship.

Linus Carl Pauling died at the age of 93. He died, but the contributions of this giant to Caltech, to science, and to the world will never die. Linus is survived by a wonderful family and by generations of chemists and biologists. He is surely one of the greatest scientists of the 20th century.

Linus Pauling, Jr.

When he finished college, Pop applied to Caltech, Harvard, and Berkeley. Harvard offered him a half-time teaching assistantship and the possibility of earning his PhD in five years. At Caltech, A. A. Noyes offered him a full fellowship and the possibility of a PhD in three years. G. N. Lewis at Berkeley didn't reply at all, and Pop found out from Lewis later that his application had gotten lost underneath a pile of journals—unfortunately for Berkeley, but fortunately for Caltech.

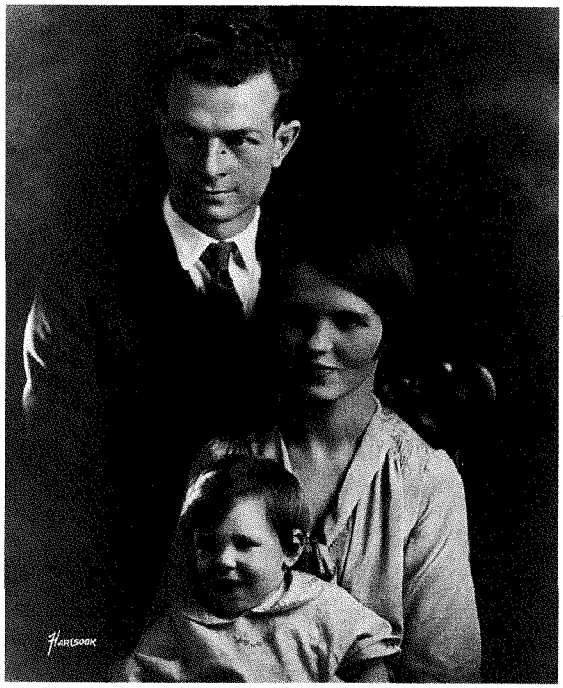
Pop frequently said that he was very thankful that he had come to Caltech. It was a felicitous symbiosis. June next year will be the 70th anniversary of my father's receiving his PhD from Caltech, a ceremony that I was able to watch from my mother's arms. In those days Caltech



was very young. In spite of its 1891 origins as Throop University, the modern Caltech had only started about four years before Pop got here. So it was wet behind the ears too, like Pop. And he was quite wet behind the ears. He was uncultured, coming from the western frontier of Oregon, from a cow college. He often wondered what it was that made Noyes select him, sight unseen, to come here.

Pop and Caltech grew together and were mutually beneficial. He has said to me that if Caltech had been a firmly established hide-bound institution, like Harvard or Berkeley, he wouldn't have been able to do the things that he could do in a new institution as this was. He enjoyed his life here. He worked hard and achieved success. Caltech also achieved success. I think that Pop was an extremely bright star in Caltech's firmament, that he helped make Caltech what it is today.

Pop had another aspect to his personality, and that was a deep sense of ethics, of morality. He felt strongly that scientists who played a role in the development of some of the evils in this world should be responsible for establishing social controls. Following World War II, the evil was radiation. Attitudes were different in those days. The public's attitude, and certainly the government's, was that a little radiation was not bad for you; it might even be good for you, and, in any case, we needed to be willing to suffer this burden in order to keep ahead of the game. Pop wasn't willing to go along with that. Although he wasn't a participant in the development of the atomic bomb, he knew enough about



Pauling as a grad student in 1923 (left); with Ava Helen and Linus Pauling, Jr. in 1926 (right); and at his Caltech graduation in 1925 (below).

it to come to conclusions. So he felt that it was his moral responsibility to campaign for greater understanding of the dangers of radiation. And he set about this, to the displeasure of a great many people, particularly people in the U. S. government.

It's astounding to me that he had the courage to do this, to risk the opprobrium of his government, the people, and his colleagues here. But he went ahead with it, and was, I think, successful in educating the people, not only of the United States but of the world, in the dangers that would come from unrestricted bomb testing. The result was the Nuclear Test Ban Agreement of 1963.

Caltech and its faculty were not much different from the general population. Scientists are people after all, although when I was a kid I thought scientists were gods. When my father saw me out in the audience in my mother's arms, when he got his PhD, he may have thought he was looking at the next generation of scientists. Unfortunately, the gene mix that I got pushed me under the crown of the curve of probability, so I couldn't have followed him even if I'd wanted to. I became a psychiatrist instead. I understand about as much about quantum mechanics as my father did about psychiatry—namely nothing.

But, getting back to scientists as people, when news of his 1962 Nobel Peace Prize came, there was not the spontaneous demonstration of joy on campus that had occurred in 1954. People even crossed the street in order to walk down the other side when they saw Pop coming. It was strange. But it reflected the attitude of the times. He was a very sensitive person, and I believe that he felt really hurt by his Caltech colleagues' abandonment. Some colleagues did celebrate this achievement, of course. He managed to accumulate 11,000 signatures of scientists from around the world to present to the United Nations before the test ban. But Caltech as a campus seemed to feel somewhat ashamed, and a short time later Pop resigned. One could argue that he may have resigned because his laboratory space, office space, and prerogatives were being whittled away, but I suspect that underneath those more logical, public reasons was the hurt he felt at the lack of approval by his colleagues.

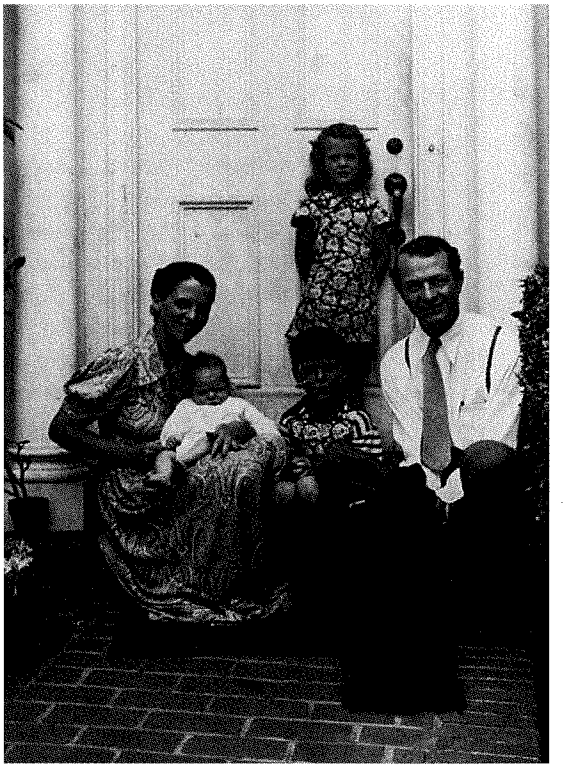
His kindness, sweetness, and sensitivity went deep. I never heard my father say a bad word about his enemies or about Caltech. After that, he became an itinerant scientist, going to the Center for the Study of Democratic Institutions in Santa Barbara, to UC San Diego, to Stanford; he didn't really have a home until he established the Linus Pauling Institute in Palo Alto 21 years ago. But his first love, and the institution to whom he gave credit for his development, was Caltech.

Linda Pauling Kamb

I want to say a bit about what it was like growing up with Linus Pauling as my father. In recent interviews my father said that he had pretty much ignored his children as they were growing up. I guess that is partly true, since he was working so much of the time, either at Caltech, at home, or traveling. But there are numerous wonderful times with him to remember. And I'll tell you some of these.

For instance, he used to read the Sunday comics to us, the newspaper spread out on the living room floor, and with Peter, Crelly, and me sitting around. Linus was too old for that. My father had such a wonderful sense of humor. He loved the *New Yorker* cartoons, although much later in life he complained that the modern ones weren't funny anymore. We loved it when he entertained us with some of his tricks, such as wiggling his big ears. He could also wiggle his nostrils. None of us could do that. And he could flip a dime laid on his wrist by turning his hand in a certain way from one side to the other and closing his fingers at the same time, causing a tendon to pop and flipping the dime. I remember we kept trying and trying to do that. I could get a slight wiggle of the dime but never a full flip.

Occasionally we went camping at Painted



In 1937 the Pauling family had grown to include Peter, Linda, and baby Crellin, in addition to Linus, Jr., not pictured here.

Canyon in the desert near Indio, continuing a tradition that was introduced to my parents by Arthur Amos Noyes, who would take the chemistry graduate students out for camping trips in his legendary touring car. I remember with great pleasure the times we had camping. We children had our own sleeping bags and cots and we would make our own fire pits with rocks. My father taught us how to shoot, using his .22 rifle with tin cans as targets (remember this in light of his antiwar activities). This helped me once later, when I was able to shoot from the open living room window a gopher that was decimating my ajuga plants. That was using Barclay's .22. Actually I had to call Barclay to get directions over the telephone for loading it.

We loved it when he entertained us with some of his tricks, such as wiggling his big ears. He could also wiggle his nostrils.

When my father was ill with nephritis and had to spend most of his time in bed resting, he took up dictating his letters at home into a dictaphone, rather than to his secretary. I believe that secretary was Judy Rook, now Mrs. Verner Schomaker. You could hear him in there doing his correspondence. I also need to explain that my father was known for his insistence on correct grammar and punctuation, and he did not leave anything up to the discretion of his secretary. Thus, when dictating a letter he would start, for example: "Dear Dr. Jones comma." Once my mother asked Crellin, my younger brother, who was four at the time, where Daddy was; Crelly answered, "Oh, he's in there talking to Comma again."

Recently my father spoke again of his getting ill with nephritis, as Verner has described to you, when he was visiting Princeton in the winter of 1941. His hands and feet were very swollen. He went on to an engagement at the Rockefeller Institute in New York City, and there they told him not to go on to the Mayo Clinic as scheduled but to cancel that; go directly home and call up Dr. Thomas Addis, a kidney specialist at the Stanford Medical School. This my father did, and Dr. Addis, with my father's input also, put him on a salt-free, meatless diet, with only 37 grams of protein a day. My mother weighed all the food and calculated the number of grams of protein in everything he ate. And, unable to get salt-free bread at that time, during the war, she started baking her own. That was something we all loved, her wonderful bread, salt-free or not. This was not the conventional treatment for kidney disease, which was to give lots of meat and restrict the water intake. Most if not all such patients died, and my father was not expected to live either. He told us recently that Dr. Addis had said to him later that if he had gone as planned to the Mayo Clinic they would have given him something to get rid of the swelling, which would have worked, but he would have been dead within six months. The treatment of putting as little stress on the kidneys as possible is what allowed him to recover completely.

It will be three months tomorrow since my father died. During this time I have received many beautiful letters and cards. I'm grateful to everyone for their love.

Barclay James Kamb

My grandfather came to Caltech 40 years before I was born, so I really missed a lot of his achievements. My first recollection of him is as a white-haired icon, powerful and strong, sharp, witty. He was the center of the family, he and Ava Helen, and brought my brothers, my cousins, my mother, and my uncles along in a family tradition that I will always thank him for. We continue to share something that you can't have without having someone as warm and caring as he was.

What I first noticed as a kid, when I started to pay attention to something more than what was within six inches of my nose, was just how incredibly sharp and insightful he was. My appreciation of how his mind worked grew over the years. Once, he and Ava Helen invited me to spend the summer with them, the summer of 1980. He had offered me a job to help out with some quantum mechanics—as if I were really in a position to help him. I think he thought this would give me a good opportunity to learn that

Pauling at his home in Big Sur in 1983.

chemistry was a good grounding for doing biology. Once we were spending the evening, as we often would, catching up on some news on the television. He would recline on this huge recliner, the size of a double bed, in the shape of a sine curve and covered in fur (I've never seen anything like it, before or since). He would lie on this thing with his feet up—he did like to think with his feet up. I'd sit on a chair and we'd watch the news on TV. Like most people, I'd watch the news and think about the news. But in the middle of some broadcast, he turned to me and said, "Have you solved that problem I gave you yesterday?" I said, "Well, I'm watching the news." This moment was inspirational for me. He really could think about many things at once. I've tried to do that without success, but unfortunately, if I want to learn what's happening on the TV news, I have to pay attention to it.

He probably said many times that he didn't think that he was blessed with an ability to divine the truth. What he thought he could do was come up with many ideas and just throw out the bad ones. I suppose we all ought to just relax our minds and try to think as many thoughts as we can.

At the age of 90 he stayed very current and engaged with people. About four summers ago I suggested bringing some of my 30-something friends around for cocktails at his Big Sur home; my grandfather liked to have a little vodka in the evening, and I thought this would be a good opportunity for me to spend some time with him. He, of course, thought that was a great idea. So we sat on the porch of his house overlooking the Pacific and drank cocktails out of little 100-ml or 250-ml beakers that he had around. He immediately dominated the conversation, which was wonderful for my friends. He could entertain anybody, be it a 20-year-old or a 70-year-old. This is what was charming and what I loved about him—he was so interesting and warm and engaging. But this occasion struck me in particular. He went on about a *Saturday Night Live* program he'd seen the night before, a very funny sketch about the *Time-Life* books—"48 hours in Grenada." And he proceeded to tell the story funnier, I suspect, than the *Saturday Night Live* cast had done it, and he kept us all in stitches. That someone 90 years old could be interested in *Saturday Night Live*, watch it and understand it, and then retell it better than the original—this was a part of him, aside from his science, that we can all cherish and remember.

One of my most powerful early memories of him was not of him directly, but of a photograph. I spent a lot of time as a child thumbing through books in the house where I grew up (which my grandfather had built). I particularly liked books with photographs. In one of these I discovered a picture of him and grandmother at a dinner party honoring Nobel laureates, given by President and Mrs. Kennedy at the White House back in the early sixties. It was a lovely, grainy, black-and-white photograph of Linus and Ava Helen dancing alone on this beautiful parquet floor. What was more stunning to me, however, was that right next to it was a picture of my grandfather taken earlier in the day: he was out on a sidewalk holding a big placard that read, "We

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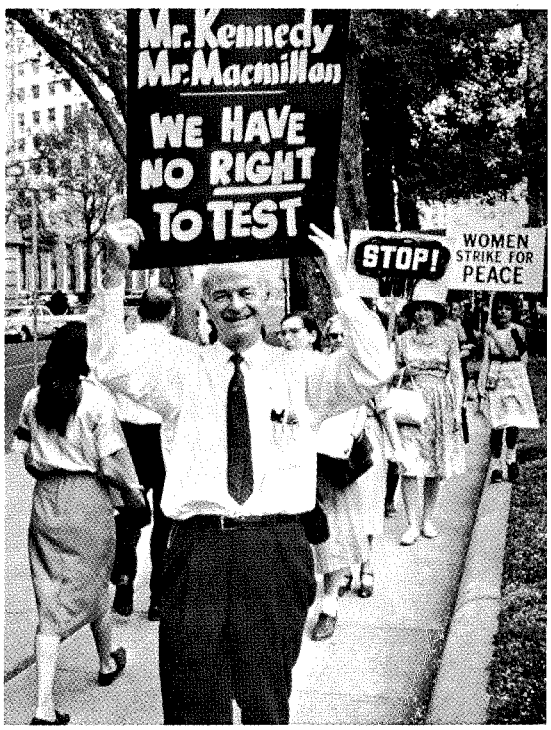
Dancing inside the White House and demonstrating outside in 1962.



Perhaps I didn't understand it consciously at the time, although the two pictures together certainly struck me. I think what it brings home to me now is that you can do a lot of things with your life if you care about it.

have no right to test." Perhaps I didn't understand it consciously at the time, although the two pictures together certainly struck me. I think what it brings home to me now is that you can do a lot of things with your life if you care about it. There are a lot of different things to enjoy about this world, and he certainly did many, many things. I hope this has inspired us all to chase down what it is we like and to not let anything get in the way of pursuing what we want to do.

Alexander (Sasha) Kamb

I once asked my grandfather which Nobel Prize most pleased him, his chemistry prize or his peace prize. He answered, surprising to me, that he was happiest about the peace prize, because with chemistry he was doing exactly what he always wanted to do and what he did naturally. It was never any strain at all. He had to be goaded into the peace effort by his wife, and it was a struggle for him, at least initially. But he took it up, as we all know, with tremendous vigor, and was in the end as successful at that as he was at everything else that he tried to do. I really don't know much about his activism. I've seen some old film footage of his being harassed by various congressional committees and by the press, and his charisma, personal power, and integrity came across very clearly. But what struck me most was his great courage, and I marvel at a man with so much confidence and courage that he could take on these people with impunity, with tremendous will and energy, and with no fear at all.

I've wondered why he got interested in nutrition. It seems a somewhat fuzzy discipline to those trained in physical science, but this interest was typical of him. He did things partly based on his own experiences, and also based on very sound, logical, simple principles. I think the role of dietary restrictions in his recovery from nephritis might have served as the basis for his developing interests in nutrition and health, and also led him to speculate that very simple compounds like salt and protein could change a person's health in dramatic ways. I've been sort of wounded over the years by some of the attacks on him; I'm sure he was somewhat wounded himself. His critics gave the impression that maybe Linus Pauling didn't really have it any more as a scientist. Nothing could be further from the truth. Up to the very end of his life he was extremely sharp, and the arguments he made in favor of vitamin C, for example, were compelling, lucid, clear, and very smart. I think the

I want to remember him like his crystals—as a man who was very solid and deep himself, very lustrous and, if not perfect, about as close to being perfect as a man can be.

On his 93rd birthday Pauling celebrated with two (and possibly three) more Caltech generations of his family: his son-in-law Barclay Kamb, BS '52, PhD '56, the Rawn Professor of Geology; grandson Alexander (Sasha) Kamb, PhD '88; and great-grandson Alexander Kamb.

mainstream of scientists now are coming around to the idea that intake of this type of nutrient—vitamin C, vitamin E— is very beneficial, at least in terms of its protective effects against disease.

I'm proud to be a relative of Linus Pauling, and it pleases me to think that I share a quarter of his genes and that perhaps some of the great traits he had might, although somewhat diluted, have been passed on to my son. But I think everyone here can appreciate that being Linus Pauling's grandson has been a little difficult as well. By going into the field that I've gone into, I didn't discourage the inevitable comparisons. But it seems odd to me that he never understood that this made me uncomfortable.

To give you an example, in the last couple of years we started to correspond. One of the letters he wrote began, "Dear Sasha, I've been thinking a lot about you lately"; and I thought, "Gee, I didn't know he thought much at all about me, and that's really nice." But then it went on: "I've been thinking about why you haven't reached your potential (you were a smart kid), and I think I know why. It's because you never took your work seriously enough. And the evidence I have for that is a conversation we had seven years ago where I told you that I'd gotten my PhD in three and a half years, and I asked you why you hadn't gotten yours yet. And you said, 'Well, the average PhD at Caltech takes six years, so I'm even ahead of schedule.'" He went on for another paragraph in this vein.

I was distressed by this letter. By that point I'd gotten used to these kinds of things, but I was hurt that he would be unhappy about me and perhaps about other members of his family as he was reaching the end of his life. I wanted to set him straight about that, and I was also annoyed that he didn't understand. So I went up to see him in Big Sur about a year ago, and I said to him, "Grandpa, I'm pretty unhappy about that letter. I've been trying for a good part of my life not to compare myself to you, and I really don't appreciate your undermining my efforts to do that." He just set his jaw and looked off into the distance, which is something he did when he thought there was nothing to be done—the equivalent of throwing up his hands.

But though he had a somewhat harsh way of treating his family at times, that's not the way I'm going to remember him. The way I will remember him is as the generous and gentlemanly host to me and my friends, other young scientists, when I was living in San Francisco during the last couple of years of his life. My friends would be awestruck—actually dumbstruck. He wasn't a great one at making small talk, but nevertheless he would make an effort to fill the awkward silences. He would lead these young scientists around and show them things in his house that he enjoyed. One of the things he liked to show people was his little collection of crystals, really beautiful ones. And I can see him now, holding a crystal of amethyst, or a big, lovely cubic crystal of pyrite—heavy and solid and lustrous and perfect—and pointing out its various features. I want to remember him like his crystals—as a man who was very solid and deep himself, very lustrous and, if not perfect, about as close to being perfect as a man can be. □