NATIONAL ACADEMY OF SCIENCES

FRANKLIN ASBURY LONG
1910–1999

A Biographical Memoir by

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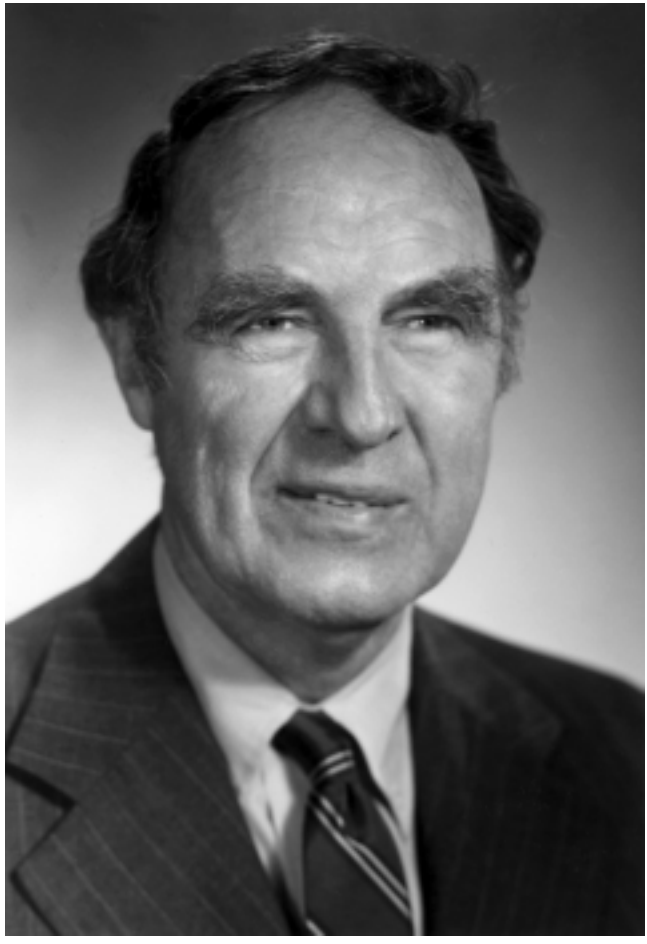
Biographical Memoirs, VOLUME 79

PUBLISHED 2001 BY
THE NATIONAL ACADEMY PRESS
WASHINGTON, D.C.



Frank Lowy

FRANKLIN ASBURY LONG

July 27, 1910–February 8, 1999

BY FRED W. MCLAFFERTY, BARRY K. CARPENTER, AND JERROLD MEINWALD

Frank Long's research made fundamental, unique contributions to a surprising variety of important scientific subjects. He applied his extensive background and deep intuition in physical chemistry, in combination with his creative instrumentation skills and keen awareness of new experimental techniques, to yield important discoveries in other research areas. These included basic reaction mechanisms of organic molecules in solution, unimolecular dissociation of gaseous ions, and diffusion of organic vapors through polymer films.

These broad interests and his outgoing personality also led him into leadership positions in academe, government, industry, and public affairs. The cause of international arms reduction was especially close to his heart. He made friends readily, took on unpopular causes willingly, and fulfilled commitments promptly and with apparent ease. He was department chair, vice-president, and trustee at Cornell, on the President's Science Advisory Committee for Presidents Eisenhower, Kennedy, and Johnson, assistant director of the U.S. Arms Control and Disarmament Agency, co-chair of the U.S. Pugwash Steering Committee, and a director of several large corporations. Probably his most publicized ap-

pointment was the one he did not receive as Director of the National Science Foundation, withdrawn at the last minute when President Nixon learned of Long's criticisms of the antiballistic missile system.

Long was born July 27, 1910, in Great Falls, Montana, and was always proud of his origins in this "frontier state." He grew up in nearby Eureka, where his father was the town doctor, as well as a hopeful inventor (until his automated stump-boring machine found only five customers). His father died when Frank was 13; he and his sister and brother were raised by his widowed mother, who was a schoolteacher and later a school superintendent. Eureka borders a mountainous area where the principal industry was lumbering. Frank worked part time as a surveyor with the U.S. Forest Service, experience that provided a broad perspective for his career, as well as many stories of enjoyable adventures in a pioneer environment.

He received B.A. and M.A. degrees from the University of Montana in 1931 and 1932. He did graduate work in physical chemistry with Axel Olson at the University of California, Berkeley, where he gained his initial experience studying the mechanisms of organic reactions and the use of radioactive isotopes, an area he also pursued with Willard Libby. In commenting on Frank's unusually personable nature, Konrad Krauskopf of Stanford, a roommate at Berkeley, recalled: "One evening he was kind enough to include me on a double date with a couple of damsels from Mills College, and the relationship blossomed so that eventually one of the girls became his wife and the other became mine."

After receiving his Ph.D. in chemistry from the University of California, Berkeley, in 1935, Frank spent a year as an instructor there, and then moved to the University of Chicago the following year as instructor. There he was also a research assistant to W. D. Harkins, whom he accompa-

nied to the Chemistry Department at Cornell for Harkins' semester as Baker lecturer. Long stayed on at Cornell (again as instructor!), but his research efforts were interrupted by the war. He served, initially under George Kistiakowsky, as a research supervisor for the Explosive Research Laboratory of the National Defense Research Committee in Pittsburgh from 1942 until l945. He returned to Cornell as an associate professor and was promoted to full professor in 1946. He was elected to the National Academy of Sciences in 1962 and the American Academy of Arts and Sciences in 1965 (vice-president, 1976-80). He received honorary degrees from the University of Minnesota in 1963 and from Columbia College in 1983.

When Peter Debye stepped down as Chemistry Department chair in 1950, Long took over and served in this position for a record 10 years. He extended and diversified the department's excellence in teaching and research, establishing a unique record in his selfless fostering of the careers of young faculty. He was faculty trustee during 1956-57. He served as vice-president of research and advanced studies at Cornell, 1963–69, and played a key role with Bob Morison in establishing the highly successful Biology Division. In 1969 he began a four-year tenure as director of a new Cornell academic program (Science, Technology, and Society) designed to study the impact of science and technology on the problems facing U.S. society. Between 1969 and 1979 he was Henry R. Luce Professor of Science and Society, and between 1976 and 1979 he was director of the Peace Studies Program. He was a member of the corporate Board of Directors for the Carrier Corporation, United Technologies Corporation, and the Exxon Corporation, for which he was also a member of the Executive Committee.

In 1988 he and his wife, Marion Thomas Long, "retired" away from Ithaca winters to southern California, where he

served as adjunct professor of chemistry and social sciences at the University of California, Irvine, and continued to be active on national and international committees. Marion died in 1992, and Frank died February 8, 1999, in Pomona, California. He is survived by son, Franklin, a chemist of Claremont, California; daughter, Elizabeth, a professor of sociology at Rice University; brother, George, of Portland, Oregon; and a grandson.

Fertile ground for research can often be found at the borders between disciplines. So Frank Long confirmed when he began to bring the language, concepts, and experimental techniques of solution-phase physical chemistry to bear on problems of aqueous organic reactions. He was one of the pioneers who showed organic chemists that they had to think carefully about nonideality, activity coefficients, and ion pairing if they were interested in the mechanisms of such processes. These concepts formed the foundation of the worldwide interest in mechanisms of solvolysis reactions that began in the late 1940s and continued for nearly three decades.

Because many aqueous organic reactions occur in media of high acidity, it soon became clear to mechanistic chemists that a supplement to the pH scale so useful in dilute solutions would be necessary. When Louis Hammett proposed the H_0 acidity function to accomplish this end, Frank immediately saw the power of the approach and put it to good use in his studies of the hydrolyses of lactones, esters, and acetals. He extended the concept to mixed and nonaqueous solvents and proposed alternative acidity functions for use under specialized conditions.

Many of the mechanistic descriptions that we teach our undergraduates can be traced back to Long's work. When an ester or lactone undergoes hydrolysis, does the O-acyl or the O-alkyl bond break, and how can one find out? Which

end of an unsymmetrical epoxide opens under hydrolytic conditions, and is the answer the same under all conditions? Long and Lewis Friedman pioneered the use of stable isotopic labeling with degradation and analysis in the mass spectrometer to tackle these problems. Early isotope labeling studies relied on the use of radioactive tracers, with chemical degradation of reaction products being used to locate the labels. In contrast, their new mass spectrometric technique made it possible to acquire the same information faster and without the use of radioactivity or chemical degradation.

Not only did Long use stable isotopic labels for tracer purposes, he studied the change in kinetics that could accompany the introduction of such isotopes either into the molecule of interest or into the solvent in which the reaction occurred. His work on H_2O/D_2O solvent isotope effects showed the way to generations of researchers studying the mechanisms of biologically relevant reactions. The important proton inventory techniques that have elucidated some key enzymatic mechanisms can trace a good part of their ancestry to Long's work.

Mass spectrometry had previously been used largely for the determination of accurate atomic weights and isotopic abundances, and for the quantitative analysis of hydrocarbons. Long and Friedman were pioneers in characterizing reaction products by vaporizing them into the mass spectrometer to form gaseous organic ions; they were among the first to study the unimolecular decompositions of these ions, particularly for alkanes, lactones, alcohols, and esters. In a first for mass spectrometry, they used this chemistry in 1953 to confirm the molecular structure of ketene dimer, a highly publicized controversy of the time. Long's pioneering physical chemistry studies of gaseous ions included appearance potentials, heats of formation, and the statistical

theory of their dissociations. Notable was his classical example of the nonergodic dissociation of ionized fluoroethylenes that occurs before the input energy can be statistically randomized.

Long contributed to early work in polymer chemistry at Cornell with definitive studies of the diffusion of organic vapors into polymer films that demonstrated dramatic effects of polymer crystallinity. Such research provided a critical part of the scientific basis for the now extensive food wrap and packaging industry.

Reviews citing Long's work invariably refer to it as "thorough," "careful," or "detailed." These qualities are obviously necessary if the data being reported are to be considered reliable, but Frank had the rare ability to combine a painstaking approach to his experimental work with a real penchant for innovation. This unusual combination ensured that his contributions to the mechanisms of solution-phase reactions would remain classic studies in the field of physical organic chemistry, as indeed they have.

Long's ability to be effective simultaneously in research and public service is illustrated by a story from Zafra Lerman:

> As a postdoc with Frank, one day in his office we began to discuss the entropy of activation in a proton transfer reaction. As Frank began his sentence with "This entropy must be negative," his secretary told him that both George Kistiakowsky and Jerry Wiesner were on the phone to discuss a *New York Times* article on antiballistic missiles. In the ensuing conversation I felt as if I were transported to another world in the company of people who were running the planet. I lost all track of time and my surroundings. When Frank finally hung up, he looked at me and said, "I'm sure it's negative." I had no idea what he was talking about and asked, "What is negative?" He responded, "The entropy of activation."

Frank Long's interest in arms control and other public issues began early, aroused initially by his military research during World War II, for which he was awarded the U.S.

Certificate of Merit in 1948. He was chair of the Advisory Committee for Chemistry, Office of Naval Research, 1949-52; trustee of Associated Universities, 1947-1993; consultant, Ballistics Research Laboratory, Department of the Army, Aberdeen, Md., 1953-59; member, Science Advisory Board, Department of the Air Force, 1956-60; member, Ballistic Missiles Advisory Committee, Office of the Secretary of Defense, 1957-60; chair, Chemistry Advisory Committee, Air Force Office of Scientific Research, 1959-63; and member of the President's Science Advisory Committee under Presidents Eisenhower, Kennedy, and Johnson.

When the U.S. Arms Control and Disarmament Agency was formed in 1962, he was its first assistant director for science and technology, serving also as consultant, 1963-73 and 1977-79. As a member of the U.S. group that went with Averell Harriman to the Soviet Union in 1963, Long took a leading role in the effort of the United States, the United Kingdom, and the Soviet Union to negotiate a comprehensive nuclear test ban treaty. Intense negotiations over an extended period resulted in agreements on almost everything except the number of on-site inspections; the Soviets insisted on three per year versus the U.S. demand of seven. The historical compromise, the Limited Test Ban Treaty, prohibited testing in the atmosphere, the oceans, and in space, but permitted underground testing. He was a director of the Arms Control Association, 1971-77, and co-chair of the U.S. Pugwash Steering Committee, 1974-79 (the Pugwash Conferences received the Nobel Peace Prize in 1995). He was a member of the Board of Directors of the Albert Einstein Peace Prize Foundation and a member of the Board of Trustees of the Fund for Peace.

His aggressiveness in arms control efforts is best illustrated in his opposition to the antiballistic missile project, as delineated in a 1968 publication stating that ABM mis-

sile development would create "strong pressure toward acceleration of the arms race." In 1969 he was nominated by a board of scientists to be director of the National Science Foundation, and he went to Washington D.C., one morning presumably to receive the appointment from President Nixon in the White House Rose Garden that afternoon. Upon arrival, however, presidential science advisor Lee DuBridge told Long that the situation had changed—that the ceremony was cancelled. International publicity produced an immediate outcry from a wide variety of concerned citizens, including many prominent scientists. In a letter to *The New York Times*, S. E. Luria and Victor Weisskopf stated, "the implication is that the government desires scientific advice only from men who agree with the policies of the government. Science deals with truths, often unpleasant truths. In a world where the destinies of men and nations are forged by science and technology, a nation that puts only yes-men in its science councils might well court intellectual decay, technological paralysis and ultimate catastrophe." Later the White House relented, but Long then declined the President's offer.

Long contributed to two important studies on defense issues carried out under the auspices of the American Academy of Arts and Sciences. In the 1970s he and George Rathjens edited a volume on *Defense, Defense Policy, and Arms Control* (1976), and in the 1980s he led a study of President Reagan's program for ballistic weapon defense (Star Wars) that resulted in the edited volume *Weapons in Space* (1986). From 1983 to 1988 he served as chair of the American Academy of Arts and Science's Committee on International Security Studies.

Long served from 1947 until 1993 on the Board of Trustees of Associated Universities, Inc., a consortium of nine private universities founded to establish and operate

Brookhaven National Laboratory (BNL) and the National Radio Astronomy Observatory. He contributed uniquely to the unusual success of BNL. In addition to his unparalleled board activities, Long was also extensively involved in BNL research activities, especially with scientists Jacob Bigeleisen, Max Wolfsberg, Lewis Friedman, and Gerhart Friedlander. Long arranged for Jake and Max to spend semesters at Cornell, and he spent a semester at BNL in active research collaborations.

Long also played a major role in science and technology transfer to underdeveloped nations, including India, South Korea, Latin America, Malaysia, and Indonesia, in part as a member of the National Academy of Sciences' Board on Science and Technology for International Development. He was U.S. co-chair for the Indo-U.S. Sub-Commission on Education and Culture; a member of the U.S. Overview Committee for Indo-U.S. Science and Technology Initiative of the National Research Council started in 1983 by Prime Minister Indira Gandhi and President Ronald Reagan; a member of the Council on Foreign Relations, 1964-89; and co-chair of the Joint U.S.-Korea Advisory Committee for Science of the National Academy of Sciences, 1972-76. In 1975 he received the Order of Civil Merit and Dongbaeg Medal from the President of the Republic of Korea for contributions to the development of science and technology in Korea.

Only a few prizes are available to scientists for outstanding public service. Two of the most prestigious of these are the Charles Lathrop Parsons Award from the American Chemical Society, which Long received in 1985, and the Philip Haug Abelson Prize of the American Association for the Advancement of Science, which he received in 1990.

Frank Long will be remembered in science for his public service as well as his research accomplishments. His early

fundamental contributions to the mechanisms of solvolytic reactions that utilized key concepts of physical chemistry provided a firm scientific basis for this important field. He was also a pioneer in understanding the physical principles and mechanisms of the reactions of gaseous organic ions, applying these in the mass spectrometer with stable isotopic labeling for the structural characterization of organic molecules and their basic reactions. Long was unusually effective and dedicated in public service, especially in his long-term efforts for arms control among the world's nuclear powers. His outstanding leadership and advisory board service greatly enhanced the research productivity at Cornell, Brookhaven National Laboratory, the President's Science Advisory Committee, other federal research agencies, and third world countries. At a Cornell University symposium in memory of Franklin Long on October 1-2, 1999, funded by a grant from the John D. and Catherine T. MacArthur Foundation, these contributions were remembered in talks by Dale Corson, Robert Hughes, George Rathjens, John Harvey, George Lewis, Jeremiah Sullivan, David Wright, Richard Garwin, Matthew Evangelista, Lisbeth Gronlund, Anne Cahn, Nikolai Sokov, Tom Christenson, Sarah Mendelson, and Judith Reppy.

WE THANK Jacob Bigeleisen, Konrad Krauskopf, Zafra Lerman, Elizabeth Long, Daniel Luten, Leo Mandelkern, Judith Reppy, Harold Scheraga, and Gerald Tape for particularly useful information.

SELECTED BIBLIOGRAPHY

1934

With A. R. Olson. The mechanism of substitution reactions. *J. Am. Chem. Soc.* 56:1294.

1936

With A. R. Olson, W. F. Libby, and R. S. Halford. An improvement on the quantitative determination of radioactivity. *J. Am. Chem. Soc.* 58:1313.

1939

A study of the interchange between chromioxalate ion and oxalate ion, using radio-carbon. *J. Am. Chem. Soc.* 61:570.

1950

With L. Friedman. Determination of the mechanism of γ-lactone hydrolysis by a mass spectrometric method. *J. Am. Chem. Soc.* 72:3692.

1951

With L. Mandelkern. Rate of sorption of organic vapors by films of cellulose acetate. *J. Polym. Sci.* 51:457.

With W. F. McDevit and F. B. Dunkle. Salt effects on the acid-catalyzed hydrolysis of γ-butyrolactone. I. Chemical activity and equilibrium. II. kinetics and the reaction mechanism. *J. Phys. Colloid Chem.* 55:813, 829.

1952

With R. J. Kokes and J. L. Hoard. Diffusion of acetone into polyvinyl acetate above and below the second-order transition. *J. Chem. Phys.* 20:1711.

1953

With L. Friedman. Mass spectra and appearance potentials of ketene monomer and dimer: Relation to structure of dimer. *J. Am. Chem. Soc.* 75:2837.

1954

Kinetics of reactions in solution. *Annu. Rev. Phys. Chem.* 5:219.

1956

With J. G. Pritchard. Hydrolysis of substituted ethylene oxides in $H_2{}^{18}O$ solution. *J. Am. Chem. Soc.* 77:2663.

1957

With L. Friedman and M. Wolfsberg. Ionization efficiency curves and the statistical theory of mass spectra. *J. Chem. Phys.* 26:714.

With M. A. Paul. H_0 and related indicator acidity functions. *Chem. Rev.* 57:935.

1959

With J. Bigeleisen. Correlations of relative rates in the solvents D_2O and H_2O with mechanisms of acid and base catalysis. *Trans. Faraday Soc.* 55:444.

1961

With E. A. Halevi and M. A. Paul. Acid-base equilibria in solvent mixtures of deuterium oxide and water. *J. Am. Chem. Soc.* 83:305.

1964

With P. Salomaa and L. L. Schaleger. Solvent deuterium isotope effects on acid-base equilibria. *J. Am. Chem. Soc.* 86:1.

1965

With C. Lifshitz. Appearance potentials and mass spectra of fluorinated ethylenes. III. Calculations based on the statistical theory of mass spectra. *J. Phys. Chem.* 69:3737.

1968

Strategic balance and the ABM. *Bull. At. Sci.* 24:2.

1969

Support of scientific research and education in our universities. *Science* 163:1037-40.

1976

Arms control from the perspective of the nineteen-seventies. In *Arms, Defense Policy and Arms Control*, eds. F. A. Long and G. W. Rathjens, pp. 1-222. New York: Norton

1980

With A. Oleson, eds. *Appropriate Technology and Social Values. A Critical Appraisal.* Cambridge, Mass.: Ballinger.

1986

With D. Hafner and J. Boutwell, eds. *Weapons in Space*. New York: Norton.