NATIONAL ACADEMY OF SCIENCES

WILLIAM AARON NIERENBERG
1919–2000

A Biographical Memoir by

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WALTER MUNK

Biographical Memoirs, VOLUME 85

PUBLISHED 2004 BY
THE NATIONAL ACADEMIES PRESS
WASHINGTON, D.C.

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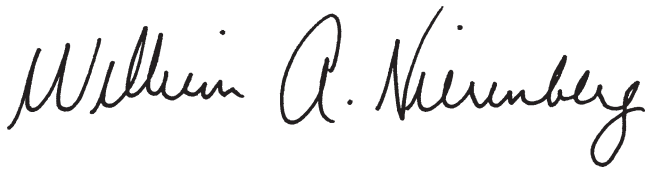

WILLIAM AARON NIERENBERG

February 13, 1919—September 10, 2000

BY CHARLES F. KENNEL, RICHARD S. LINDZEN, AND WALTER MUNK

BILL NIERENBERG EXCELLED in two scientific fields: physics, and oceanography. As a physicist, he worked on the Manhattan Project and contributed to molecular beam research and cascade theory. He helped to shape national policy in oceanography and to develop oceanography into a multidisciplinary, planetary science with a pivotal role to play in climate change research and earth science.

Bill Nierenberg was born February 13, 1919, in Manhattan to a family that lived on Houston Street in the Lower East Side and then moved up to the Bronx. His family was of Austro-Hungarian Jewish ancestry, and his first job was as a "floor boy" in the garment industry. The Bronx was near to his heart and still perceptible in his diction when he died 81 years later in La Jolla, California, after a long and distinguished career as a physicist and oceanographer. Late in his life Bill talked occasionally about how he made the transition from what we now call the South Bronx to California and gave great credit to Townsend Harris High School, where he was admitted by competitive examination in 1933. Townsend Harris was a citywide school for the gifted; it recognized and rewarded his prowess in mathematics, schooled him in physics, paid him small sums for grading papers, and prepared him for the City College of

New York. Bill knew he had a high IQ. Even his boyhood gang called him "the Brain." As a youth he was ambitious, competitive, and excited to be out and in the world; these characteristics stayed with him for life.

Bill had the advantage of growing up in a great city. He spent his free time at the Bronx Botanical Garden and developed an interest in science at the American Museum of Natural History. He went to high school with Herman Wouk and college with Bernard Feld, and he met Richard Feynman at an intercollegiate math contest. Physics was a small world then, and he quickly established himself at CCNY in a set that included Eugene Booth, William Havens, Jr., and teachers like Henry Semat, Mark Zemansky, and Walter Zinn. While CCNY was purely an undergraduate institution, students and faculty there participated in research at Columbia and New York University. Clark Williams took Bill to visit his lab at Columbia, and they became friends. The talk in physics at CCNY was all about the work of Enrico Fermi, I. I. Rabi, and John Dunning at Columbia. Bill first met Rabi in 1939, when he took his course in statistical mechanics.

Bill competed for and won many honors, medals, and prizes. He spent his junior year as the Aaron Naumberg fellow at the University of Paris, where he polished his physics and his French at the Sorbonne. His closest friend was a French classmate, Nicolas Zafiropoulo, who introduced him to new foods, music, and continental viewpoints. France broadened Bill's American outlook and made room for his big personality. France in 1938 was in a foreboding mood, however, and Bill went home expecting a European war.

Even during this period Bill was dismissive of the Left Wing at CCNY in the 1930s, and he was a committed antifascist. He expected to enter military service; naval aviation appealed to him, but his enlistment was delayed when, through Fermi and Dunning, he was offered an opportu-

nity in 1941 for six months of war work in what turned out to be the Manhattan Project. Bill worked with Dunning and Clark Williams and had a role in the project, which he later said was closer to engineering than physics, but it placed him within the *haut monde* of physics and gave him opportunities and responsibilities unusual for a physicist who had just passed the qualifying examination for his doctorate. This work was cited when Bill was nominated for election to membership in the National Academy of Sciences.

His family responsibilities expanded at about the same time, when Bill married Edith Meyerson in 1941. Their daughter, Victoria, was born in New York, and their son, Nicolas Clark Eugene, at Berkeley. Nicolas was named in honor of Bill's French classmate, and his friends Clark Williams and Eugene Clark.

After Bill's graduation from CCNY in 1942, he was accepted at Columbia as a graduate student of I. I. Rabi and was received everywhere as a brilliant young physicist, although the acerbic Rabi told him he was too forward and brash. Bill listed Rabi first among those who influenced him, and Bill considered Rabi a great teacher, despite poor skills as a lecturer, because of the personal approach Rabi took with his students.

> He was always available to us in his office, singly or in groups of two or three, to work over some obscure or difficult point. He would spend several hours with us, if necessary. Some of the time, of course, was used to locate some reprint in the famous pile of papers on the table behind his desk.[1]

Rabi had a lifelong influence on Bill, but their relationship remained that of teacher and pupil, not an equal friendship. Rabi drew Bill into science advisory circles. Rabi was involved in the creation of the Hudson Labs at Dobbs Ferry, and Bill directed the labs in 1953-1954, his first contact with oceanography. Rabi introduced Bill to Alan Waterman

and Manny Piore, then at the Office of Naval Research, and to the North Atlantic Treaty Organization science committee. Fred Seitz recommended that Bill succeed him in the position of assistant secretary general for scientific affairs at NATO in Paris from 1960 to 1962. Those years in Paris improved Bill's French accent and deepened his interest in French culture and literature. Bill's special interest in Turkey dates from these years. Rabi and Nierenberg were both interested in music, particularly opera, and Bill even briefly adopted Rabi's recipe for martinis: eight parts gin to three parts vermouth.

Bill also acknowledged the influence of his high school physics teacher, Ivan Hurlinger; the Sorbonne mathematician André Leon Lichnerowicz; and Maurice Biot and Enrico Fermi at Columbia. Bill wrote about Fermi in his unpublished autobiography.

> Fermi . . . was a most extraordinary lecturer on any branch of physics he chose. His most important series was his seminar on advanced nuclear physics that concentrated heavily on slow neutron phenomena. It was in these lectures that he demonstrated the utility of the scattering length and the virtue of his version of the Born approximation in scattering calculations that became known as the Golden Rule after the war among the graduate students. His most appealing feature was the revealing simplifications of what were normally displayed as extremely complex computations in the literature. A good example occurred in his course in geophysics that he had earlier given in Rome and then repeated at Columbia. This was a tremendous simplification of Jeffrey's treatment of the cooling of a spherical earth including the heating due to radioactivity.

Rabi got a National Research Council Fellowship for Bill in 1945, and Bill returned to his doctoral research as soon as the war ended. He reopened Sidney Millman's molecular beam laboratory and worked on an elucidation of the quadrupole broadened alkali resonances in the alkali halides. The committee for his orals included Rabi, Norman

Ramsey, Willis Lamb, and Hendryk Kramers. In 1948 Bill had a new Ph.D. and a letter of recommendation from Rabi.[2]

> Nierenberg belongs to a small group of men who are capable both experimentally and theoretically. He is not a theorist in the sense of Nordsieck, but rather a man who gets a complete grasp of the theory of his field of experimental work and who can carry a problem right through to the end.

Bill received excellent offers from academic departments of physics but none from the place he wanted to go, Berkeley. Therefore, he went to Ann Arbor for two years and arrived in Berkeley during the summer of 1950 as an associate professor of physics. He planned to teach, work on the systematic measurement of the spins and magnetic moments of radioactive nuclei, and live near E. O. Lawrence on Tamalpais Road.

Bill contrasted American physics before and after World War II by comparing the work done by Rabi at Columbia with that of E. O. Lawrence at Berkeley. He said that Rabi did his great work with grants of a few hundred dollars from foundations and the loan of Navy electric submarine cells for magnet power supplies. This was “small” physics that concentrated on clean, spare problems that did not require complicated apparatus. Lawrence built huge and advanced physics laboratories by convincing the University of California and the federal government that research in physics strengthened the university and the country. Although Bill occasionally lamented the loss of community that resulted from postwar big physics, he agreed with Lawrence’s vision.[3] In 1958 Bill was selected as the first E. O. Lawrence memorial lecturer by the National Academy of Sciences. In the 1980s, when some questioned whether funding for big science projects, like space science and the super accelerator, was justified when society had other pressing needs, Bill said he didn’t understand the question. What he meant was that

the commitment to science made by the United States after World War II was not merely a commitment of funds, it was a decision that American society would be knowledge-based with the expectation that research would build prosperity. Bill was, of course, being coy. He fully understood that the question itself marked a transition from the view that science was an essential part of the solution to society's problems to the view that science was simply another supplicant at the trough.

Bill started work at Berkeley by building a molecular beam apparatus, modeled on the one he had used at Columbia. His research included gaseous diffusion theory and experiment, cascade theory, atomic and molecular beams, the measurement of nuclear spins, magnetic moments, electric quadrupole moments, hyperfine anomalies with particular application to radioactive nuclei, and similar applications to atomic electronic ground states. He hoped to learn more about nuclear structure, and he became a leader in his field. He formed a group to measure spins and magnetic moments of radioactive nuclei, and over the course of his years at Berkeley he published a hundred papers in physics and trained 40 doctoral students. He developed an excellent reputation as a teacher. He established the atomic beam research group at Lawrence Radiation Laboratory. He worked with and admired Edwin McMillan and met Jerry Wiesner during these years. There were lots of parties and social interactions among the physicists in Berkeley. The McMillans introduced the Nierenbergs to Borrego Springs and encouraged them to explore the deserts of California and Mexico. Luiz Alvarez borrowed and played Bill's mandolin at faculty dinners.

When the physics department purchased an IBM 650 computer in the early 1960s, Bill taught himself how to program it with FORTRAN, and then taught FORTRAN to

other members of the department. He was closely involved in the development of the applications of computers to nuclear physics and particle physics at Lawrence Radiation Lab. The short-lived radioactive nuclei were flown into his labs by helicopter for rapid measurement. One of the laboratory doors had a sign that read, "Every nucleus has its moment," and *Physics Today* published a poem on the laboratory wall,

Lament of an Ancient Beamist

There are moments to remember.
There are moments to forget.
There are moments to publish.
There are moments to regret.

Bill was responsible for the determination of more nuclear moments than any other single individual, as he was fond of telling visitors. This work was cited when Bill was elected to the National Academy of Sciences in 1971.

Bill built and flew model airplanes in Berkeley with his son, and Bill quickly moved to full-size aviation. He and his family purchased a vacation home in Borrego and he explored Mexico both from the air and on the ground. He was an avid traveler and a linguist. Bill and his family enjoyed their two years in Paris when Bill was on assignment for NATO. Bill also served as *professeur associé* at the University of Paris and traveled widely in Europe and the Middle East. His French was fluent; he became familiar with several European languages and began seriously studying Turkish.

While at Berkeley, Bill was recruited by Rabi and Piore to work on Project Michael, an Office of Naval Research effort to establish an academic base for use of long-range low-frequency sound in submarine detection. This led to

the creation of the Hudson Labs at Dobbs Ferry, New York, and Nierenberg took a leave from Berkeley in 1953 to direct the lab for a year. While there he was responsible for the introduction of the concept of the vertical hydrophone array for the signal-to-noise improvement possible due to the special distribution of noise in the vertical plane in the deep oceans. He also made some contributions to anti-mine warfare. While in New York, Bill and his wife, Edith, attended the opera and theater and had an opportunity to see Jose Ferrer in the role of Cyrano de Bergerac at the New York City Repertory Theater. Bill adopted the French *physicien* as an alter ego, and researched and lectured on his life. He described his work on Cyrano as an obsession, but it was typical of Bill to pick a subject completely outside his academic interests and become an expert on it.

Low-energy nuclear physics and atomic beams was an exciting and promising field in physics in 1950, but by 1965, when Bill left the field, its promise was somewhat played out. Bill was interested in highly precise measurements, and these yielded some elegant clarifications, but they didn't produce new ideas. He told friends that he found the huge imbedded bureaucracy of physics objectionable and the process of writing lengthy proposals for research support debilitating. The Free Speech Movement had altered the social ambience of Berkeley, and stimulated Bill to become active politically. He was ready for a change. Ironically, he spent the next 21 years shepherding oceanography through a similar transition from small science to big science.

Bill formally became an oceanographer on July 1, 1965, when he assumed the directorship of the Scripps Institution of Oceanography. He was highly recommended by physicists and science administrators in Washington. Edwin McMillan praised Bill's intelligence and energy. Bob Frosch, who had succeeded Bill as director of the Hudson Labs,

said he would enjoy working with him again. The only negative note came from Edward Teller, who complained that he could never get a word in edgewise in discussions with Bill at NATO.

Bill already knew many of the scientists in La Jolla. He had met Carl Eckart as a physicist in the 1940s. He had worked with John Isaacs on the Mine Warfare Committee. And he had long associations with the first faculty of the University of California, San Diego, including Harold Urey, whom he had first met at Columbia, and Keith Brueckner. Walter Munk and Bill had met as members of JASON, an independent group that advises the Department of Defense on scientific matters related to national security, which Bill chaired for six years.

Nevertheless, journalists often asked what a physicist was doing in oceanography. Bill had to explain that his naval connections dated back to 1947. He had served on the President's Science Advisory Panel on Antisubmarine Warfare from 1958 to 1960. He had conducted research on long-range low-frequency sound in submarine detection under contract to the Office of Naval Research at Berkeley. This gave him some familiarity with the field.

Scripps was one of the best-known centers for oceanography in the United States, and the first to offer a curriculum in the discipline. It had begun as a small private marine biological station, and then became part of the University of California in 1912, but it didn't become prominent until World War II, when researchers in La Jolla made very significant contributions to the war effort in the area of underwater sound, antisubmarine warfare, the development of methods of surf forecasting, and other research in support of amphibious and naval operations. During and immediately following the war it was virtually a Navy laboratory, but it gradually broadened its research interests and fund-

ing sources to emerge in the 1960s as a major center for geophysical research with a stellar faculty of biologists, geophysicists, and chemists. Its work contributed to the earth sciences revolution of plate tectonics, and its faculty had done some trailblazing work in geochemistry and atmospheric science. In particular, Walter Munk and Harry Hess had suggested a core-drilling program dubbed "Mohole" to answer key questions about the composition of the earth's mantle and the geological history of the planet. At Roger Revelle's initiative Charles David Keeling initiated measurements of atmospheric carbon dioxide in 1956 during the International Geophysical Year. These showed that carbon dioxide was building. Scientists began to speculate about possible environmental consequences. So Scripps was a famous and successful laboratory in 1965, but it was not a cohesive community.

There were a number of reasons for this. Bill arrived at La Jolla at a difficult moment. He succeeded a great and very popular oceanographer, Roger Revelle, who resigned when he was not named chancellor for the campus that he virtually founded, the University of California, San Diego. The Scripps faculty was disappointed by Revelle's departure, exhausted by the effort of parenting a new general campus, fearful of being absorbed by UCSD, and divided into camps along disciplinary lines.

The student activism that Bill had already experienced at Berkeley was also evident at UCSD, and there was friction between the conservative La Jolla residents and the liberal academic community. The UCSD faculty was liberal, while Bill and Scripps were more conservative. Harold Urey had been a science advisor to the John F. Kennedy campaign, while Nierenberg supported Lyndon Johnson, because he considered Barry Goldwater reckless. Bill later supported and advised presidents Richard Nixon and Ronald Reagan. The 1960s were a difficult time in La Jolla. When student

activists approached the Scripps campus to protest military-sponsored research, Bill had the campus police turn them away. The faculty at Scripps wanted a little peace and quiet, but Bill wanted action.

As director of Scripps, Bill planned a new initiative every year, but he started by trying to repair what he saw as shortcomings at the institution. His appointment as director included the rank of dean and vice-chancellor for marine sciences at UCSD, which helped to define the muddled relationship between Scripps and the general campus. Bill was amazed to find that computers were almost unknown on campus. A few pioneers had their own small computers at the Institute of Geophysics and Planetary Physics, but bathythermograph and other large datasets were still kept on computers at the University of California, Los Angeles. There was no central computer facility on the UCSD campus, and data was still recorded on Scripps ships, using paper and audiotape systems. Bill loaded IBM 1800's on the institution's largest ships, acquired a Prime computer for the Scripps campus, modernized the shore-based datacenters, and supported the creation of a supercomputer facility at UCSD. He streamlined the administrative and financial structure of Scripps, for the institution was expanding rapidly with the creation of the Deep Sea Drilling Project.

The Deep Sea Drilling Project rose like a phoenix from the idealistic but politically moribund Mohole Project. Scripps managed and housed the project from 1966 until 1986, under contract with the National Science Foundation for some $20 million. Bill negotiated the prime contract and oversaw the building of the drilling vessel *Glomar Challenger,* with its unique dynamic positioning technology. He fostered a strong science advisory structure and built the team that made the project operational. In doing so he pioneered a new type of scientific organization and guided

the project from a national and institution-based effort to the first multi-institutional, international collaboration in science, a model for later projects from GEOSECS to ITER (international thermonuclear experimental reactor). The DSDP lived up to its objectives and fostered some of the major scientific advances of the twentieth century. Before DSDP most scientists thought hydrocarbons did not exist in the deep ocean basins, but they were found at the very first drilling site in the Gulf of Mexico. The Mediterranean was thought to be an ancient sea, but the DSDP found that it had been a closed basin and even a dry seabed in the past. The project verified that the present ocean basins were young and confirmed aspects of seafloor spreading and plate tectonics. The project greatly enhanced the prestige of the institution.

Bill knew how to capitalize on success, and he served as director during a fertile period. Plate tectonics and the environment took center stage in science in the 1960s and 1970s, and oceanography entered the mainstream of American science. Bill moved Scripps toward work in air-sea interaction and climate studies and established the remote sensing facility at Scripps, the first such facility at an oceanographic institution. Scripps acquired a DC-3 airplane for observations from above the sea, an acquisition that coincided with Bill's growing enthusiasm for flying his own plane. The climate program capitalized on Scripps's growing reputation in atmospheric science, which was based on the CO_2 work that had been done for years at Scripps by Charles David Keeling and others. The precise measurements done by Keeling were something that Nierenberg understood, and he relished the growing debate within the scientific and political worlds about the possible consequences of increasing atmospheric carbon dioxide and what, if anything, should be done. Nierenberg and Keeling held differing views about

climate change, but they agreed about the necessity for continuous measurements. Keeling recalled with admiration the political skill Bill employed to ensure continued funding of the program at Scripps by the Department of Energy in 1981.[4]

Bill was director of Scripps for 21 years, the longest sitting director of the institution to date. During his tenure five vessels joined the research fleet and the institution's budget increased fivefold. Scripps scientists discovered the deep-sea hydrothermal vents. Bill worked to strengthen both the teaching and research programs at Scripps. He fostered international cooperation. For instance, with Saul Alvarez Borrego, Bill strengthened the relationship between Scripps and science institutions in Mexico, particularly with the two Baja marine institutions, the Escuela Superior de Ciencias Marinas of the Universidad Autonoma de Baja California, and the Centro de Investigaciones Cientifica y Educacion Superior de Ensenada. The interaction among these institutions strengthened them all, and Bill particularly enjoyed the soccer game that was a feature of the annual exchange visits. Bill retired from Scripps in 1986 but strongly continued his science advisory activities. When Charlie Kennel became director of Scripps in 1998, Bill initiated monthly lunch discussions with Charlie; Bill's purpose was to help his successor once removed to be scientifically rigorous in all his public interactions. These continued to within weeks of Bill's death and were much appreciated.

While fisheries had been a subject of great interest to the government of the United States since its founding, oceanography was rarely discussed in Congress before World War II. That changed beginning with the International Geophysical Year in 1956, and by 1969 the Stratton Commission recommended the creation of a new agency, the National Oceanic and Atmospheric Administration, and a new presi-

dential advisory committee, the National Advisory Committee on Oceans and Atmosphere to oversee a national program in oceanography. Bill chaired NACOA from 1972 to 1977 and spoke forcefully in support of NOAA. This put him in close contact with legislators, and drew him into related matters of interest to Congress, including law of the sea and the earth observing system being promoted by the National Aeronautics and Space Administration. Bill served the White House during 1975-1976 as a member of the PSAC and during 1976-1978 as a member of the Office of Science and Technology Policy. He served on the NASA Advisory Council and was its first chairman from 1978 to 1982. However, he may be best remembered for influential reports he prepared on the Santa Barbara oil spill, acid rain,[5] and climate change.[6]

Bill delved seriously into scientific issues as the author of these reports, and never was this truer than his involvement with the climate change issue. His 1983 report *Changing Climate* was the first to introduce into public debate the concept of the "fingerprint" for detecting human-induced climate change, the possible release of methane hydrates because of warming, and carbon taxes. The *New York Times* covered the report on its front page, and Bill was proud that the newspaper published verbatim the report's executive summary, every word of which he had worried over.

For the remainder of his life Bill actively battled what he felt was exaggerated concern over the role of CO_2 in climate change. As the issue became politicized, Bill became identified with the political right, but Bill was always more idealistic than partisan. His priorities were the nation (he was patriotic to the core), science in both its methodology and institutions, and honesty and fairness. Given these priorities, he was often allied with conservatives, but his children—Victoria (who is liberal) and Nicolas (who is con-

servative)—both feel that Bill was supportive of their views. He was particularly proud of Victoria's contributions as an environmental consultant to the National Research Council report *The Policy Implications of Greenhouse Warming*. While working on the climate change report in 1983, Bill supported the participation of George Woodwell, a strong environmental advocate and activist, because George was concerned with the role of land processes in the CO_2 budget, a matter Bill felt was being underestimated by the marine geochemists. One of Bill's last e-mail messages to one of us (R.S.L.) was a reminder that a proper representation of climate feedback should also automatically eliminate climate drift in coupled models. This is a far deeper and subtler comment than one usually finds associated with this issue. The same e-mail message sought advice on purchasing a flat in Paris, something Bill had his heart set on.

Bill Nierenberg died of cancer at his home in La Jolla, California, on September 10, 2000. At the time of his death Bill was assembling a panel for the Marshall Institute in order to prepare a summary of the IPCC Third Assessment Report that would be more representative of the text itself. James Schlesinger eventually succeeded him in this effort, and the report was completed in 2001.[7]

Bill's family created the Nierenberg Prize for Science in the Public Interest in his honor. The Nierenberg Prize recognizes those who promote science in the public interest and reflects the mission of Scripps: to seek, teach, and communicate scientific understanding of the oceans, atmosphere, Earth, and other planets for the benefit of society and the environment. Bill would have enjoyed knowing that his prize was given to people of international reputation, like E. O. Wilson, Walter Cronkite, Jane Lubchenco, and Jane Goodall, who were also known to the layperson. The world of science will miss Bill's critical, perceptive, and supportive voice.

WE WOULD LIKE to thank Scripps Archivist Deborah Day for her critical and dedicated assistance with this memoir. Bill's correspondence and personal papers, including a brief autobiography completed shortly before his death, are at the Scripps Archives. These were invaluable in the preparation of this memoir. We would like to thank Jesse Ausubel, Edith Nierenberg, and Ken Watson for their comments and suggestions.

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