Edwin M. McMillan

duties. A group headed by Glenn Seaborg carried forward the chemical identification of element 94. The discovery of plutonium was recorded in a publication by Seaborg, McMillan, Joseph W. Kennedy and Arthur C. Wahl dated January 1941 but withheld until 1946. In 1951 McMillan and Seaborg were awarded the Nobel Prize in Chemistry for "their discoveries in the chemistry of the transuranium elements."

In November 1940 McMillan left Berkeley for the MIT Radiation Laboratory, where he worked on the development and testing of airborne microwave radar. A year later he was drafted to help in the development of sonar devices at the newly organized Navy Radio and Sound Laboratory in San Diego. When Robert Oppenheimer was designated in November 1942 to head what was to become the Los Alamos National Laboratory, he called on McMillan to help find a location for the new laboratory and to help organize it. At Los Alamos McMillan had major responsibilities for development and testing of the gun assembly method used in the uranium bomb and for the implosion assembly used in the plutonium bomb.

As the end of the war neared, McMillan's thoughts returned to accelerators, particularly the central problem of the energy limit imposed on cyclotrons by the relativistic increase in the mass of the circulating ions as they gain energy. McMillan conceived a solution that was startling in its simplicity and that would prove to be far-reaching in practice: In 1945 he showed that under certain conditions ions in cyclotron orbits collect in stable, zero-energy-gain bunches. One may then slowly alter the frequency of the accelerating field or the strength of the magnetic field to increase the energy of the stable bunches without limit. This principle of phase stability, together with strong focusing, provides the basis for the design of all the great high-energy accelerators today. (The principle of phase stability had been anticipated by Vladimir Veksler in the Soviet Union, but due to the complete breakdown in communications during the war, this was unknown in the West.)

On returning to Berkeley's Radiation Laboratory when the war ended, McMillan had a leading role in formulating and carrying out the laboratory's broad research program based on new high-energy accelerators. Three of these accelerators, the 184-inch cyclotron, the Bevatron and the 330-MeV synchrotron, depended upon phase stability. The construction of the synchrotron was McMillan's special responsibility. He also carried out an extensive experimental program on the 184-inch cyclotron that included measurements of cross sections, excitation functions and the angular distribution of neutrons from targets. When the synchrotron became operational in 1949, he led the successful program of experiments on the photoproduction of mesons.

At Lawrence's death, McMillan was appointed director of the newly renamed Ernest O. Lawrence Radiation Laboratory. This was a very difficult position, because the competition for running time on the then-unrivaled accelerators and other facilities of the laboratory was fierce, and because the need to redirect scientific resources in response to societal needs was becoming increasingly apparent. Although McMillan was much more the scholar than the administrator, his wide knowledge of the sciences and his innate fairness, approachability and modesty enabled him to lead the laboratory successfully until his retirement in 1973.

In retirement he actively participated in the running and analysis of the $g-2$ experiment at CERN, which measured the magnetic moment of the muon. He wrote several papers on topics in the history of accelerators and kept up an active interest in physics and the laboratory until he suffered a debilitating stroke in 1984.

Edwin McMillan was an unassuming person with a quiet sense of humor. He had a great sense of curiosity about all of nature and a rare fund of knowledge that made "natural scientist" an apt description of him. He served his country, the university and the science community well. The many persons who have been enriched by contact with him, whether as teacher, colleague or friend, will deeply feel the loss at his passing.

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Roger Revelle

Roger Randall Dougan Revelle, a research oceanographer at the Scripps Institution of Oceanography, died 15 July 1991 in La Jolla, California, of complications following a heart attack. He was 82.

Roger had many achievements in his long and productive career. Though a geologist, he had an important influence on physics, chemistry and biology as well. Roger was a geology major as an undergraduate at Pomona College, from which he graduated in 1929. In his graduate work he switched to oceanography, which he studied at the Scripps Institution of Oceanography. He earned his PhD in 1936 from the University of California, Berkeley, since the oceanographic campus was overseen by the university's senate at the time. After 1931 he was a research oceanographer at the Institution.

He was a naval reserve officer during World War II and rose eventually to the rank of commander, stationed in Washington, DC. There, as officer in charge of the oceanographic section of the Bureau of Ships, he helped to establish the Office of Naval Research. Roger had a special role in assuring a place for the Earth sciences in the scheme of things at ONR. Unlike the situation for physics, there were very few other lines of support available to them at the time.

Roger was chief of the geophysics branch of ONR in 1946–47. In that position he was responsible for studies of the oceanographic aspects of the Bikini tests of the hydrogen bomb.

Roger became director of the Scripps Institution in 1951, though not without some strong opposition—already an indication of his fierce drive for accomplishment and his insensibility to the diplomatic niceties of bureaucrats.

During his directorship from 1951 to 1964, oceanography grew to be a major discipline in the US, which became the world leader in the field. Roger was partly responsible for this accomplishment, along with the other three giants of the field, Columbus Iselin of the Woods Hole Oceanogra-

phic Institution, Harry Hess of Princeton University and Maurice Ewing of Columbia University. In marked contrast to the earlier period of research in local waters, this was a time of oceanographic activity over all the world's oceans.

Roger's stewardship of the Scripps Institution provided a productive environment for the extraordinary collection of researchers there who were principals in the development of the theories of sea-floor spreading and plate tectonics: Russell Raitt, Victor Vaquier, Albert Engel and H. W. Menard. Almost all of this work was supported by ONR via the Marine Physical Laboratory, a major unit of Scripps devoted mostly to antisubmarine warfare.

Roger's interests beyond marine geology were many and varied. He is most famous to the public for his investigating and stimulating interest in global warming due to the anthropogenic emission of carbon dioxide. He did this research at Scripps with Hans Suess and Charles D. Keeling, and the work is notable for a famous example of his incisive epigrams: "Thus human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor reproduced in the future." This statement parallels his other famous aphorism, "We know less about the ocean's bottom than about the Moon's back side."

Revelle is perhaps best known to physicists as the builder of one of the country's best physics departments, at the University of California, San Diego. He built up this department in an incredibly short time from 1958 to 1961, fulfilling his goal of creating a great technical research and teaching institution using Scripps as a base. California needed to develop new campuses of the university to satisfy the needs of a growing population. Revelle had the very good sense to identify some of the best, most active physicists in the country, and through his charisma and force of persuasion he rapidly convinced several of them to come to San Diego. This amazing collection formed the nucleus about which crystallized today's department. Roger did equally well with the biology and chemistry departments.

When the search for a chancellor for the new campus at San Diego opened in 1960, the resistance that developed when Roger was named director of Scripps resurfaced. It was perhaps his bitterest disappointment not to be chosen. (The position went to Herbert York.) Roger then went to the University of California, Berkeley, for a very short period to fill a university research deanship that had originally been designed by the university regents for Ernest O. Lawrence. The position did not occupy him adequately, nor did it permit him to concentrate on the kind of problems that interested him the most—those of a global nature that impacted society in a vital way—and so he left the university in the fall of 1964.

He spent the next ten years at Harvard University as head of the Harvard Center for Population Studies. His interest in population issues was stimulated during his stint as science adviser to Secretary of the Interior Stewart L. Udall during President Kennedy's Administration in 1961–63. He also headed a special committee to investigate agricultural practices in Pakistan at that time.

Roger returned to the University of California, San Diego, as a professor of science and public policy in the department of political science, where he taught and continued his research in scientific and policy areas. He was active in the American Association for the Advancement of Science and served as its president in 1974. Roger was president of the First International Oceanographic Congress of the United Nations, was the first chairman of the US national committee for the International Biological Program and was chairman of the US delegation to the Intergovernmental Oceanographic Commission. He was deeply involved in many aspects of UNESCO, having been a member of the US delegation to the UN Atoms for Peace Conference in August 1955 and to the UN Conferences on Science and Technology in 1962 and 1979. He was a Pugwash attendee for 23 years.

Roger received many honors. The honor he cherished the most, however, was his last, the National Medal of Science in 1990.

Roger R. D. Revelle

Roger Revelle was a big man, both in his physical stature and in his accomplishments. In an uncharacteristic bit of modesty he once characterized himself as someone who started things but never saw them through. At least that once Roger missed the point: The challenges he undertook were the important ones, and they can be classified as insoluble in the sense that they are never ending. What Roger Revelle did was to improve our understanding of them and our ability to deal with them to the greatest extent possible in our times.

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Res Jost

Res Jost died on 3 October 1990 in Zurich, Switzerland, at the age of 72, after a long illness. Jost was an influential figure in the development of theoretical physics after World War II.

Jost was born in Bern, Switzerland, and received his elementary and secondary education there. He attended lectures at the University in Bern, and in Zurich at the University and at the ETH. He wrote his thesis under the guidance of Gregor Wentzel on the charge dependence of nuclear forces.

The first work to bring Jost international attention was on the so-called false zeros of the S matrix. During the Second World War, Werner Heisenberg had put forward his S-matrix program, which proposed that quantum field theory as it then existed be abandoned and that the theory of elementary particles be expressed entirely in terms of S matrices. It was regarded as essential, if this program was to work, that the location of the bound states of the theory be obtainable from the S matrix. Hendrik Kramers and Heisenberg had proposed that the zeros of the scattering matrix elements on the negative imaginary energy axis should give the bound states. It was natural to test this proposition in the simplest possible case: Schrödinger potential scattering. However, Shih-Tsun Ma had found examples of potentials having "false" zeros—zeros that do not correspond to bound states. Jost clarified the situation by showing that in the scattering by a central potential the S matrix in a state of given angular momentum is always given by a ratio, $S(k) = \mathrm{f}(k)/\mathrm{f}(-k)$, where k is the asymptotic momentum and f is what is now called the Jost function. Any bound states are given by the zeros of