

= Willard Libby =

Willard Frank Libby (December 17 , 1908 ? September 8 , 1980) was an American physical chemist noted for his role in the 1949 development of radiocarbon dating , a process which revolutionized archaeology and palaeontology . For his contributions to the team that developed this process , Libby was awarded the Nobel Prize in Chemistry in 1960 .

A 1927 chemistry graduate of the University of California at Berkeley , from which he received his doctorate in 1933 , he studied radioactive elements and developed sensitive Geiger counters to measure weak natural and artificial radioactivity . During World War II he worked in the Manhattan Project 's Substitute Alloy Materials (SAM) Laboratories at Columbia University , developing the gaseous diffusion process for uranium enrichment .

After the war , Libby accepted professorship at the University of Chicago 's Institute for Nuclear Studies , where he developed the technique for dating organic compounds using carbon @-@ 14 . He also discovered that tritium similarly could be used for dating water , and therefore wine . In 1950 , he became a member of the General Advisory Committee (GAC) of the Atomic Energy Commission (AEC) . He was appointed a commissioner in 1954 , becoming its sole scientist . He sided with Edward Teller on pursuing a crash program to develop the hydrogen bomb , participated in the Atoms for Peace program , and defended the administration 's atmospheric nuclear testing .

Libby resigned from the AEC in 1959 to become Professor of Chemistry at University of California , Los Angeles (UCLA) , a position he held until his retirement in 1976 . In 1962 , he became the Director of the University of California statewide Institute of Geophysics and Planetary Physics (IGPP) . He started the first Environmental Engineering program at UCLA in 1972 , and as a member of the California Air Resources Board , he worked to develop and improve California 's air pollution standards .

= = Early life and career = =

Willard Frank Libby was born in Grand Valley , Colorado , on December 17 , 1908 , the son of farmers Ora Edward Libby and his wife Eva May (née Rivers) . He had two brothers , Elmer and Raymond , and two sisters , Eva and Evelyn . Libby began his education in a two @-@ room Colorado schoolhouse . When he was five , Libby 's parents moved to Santa Rosa , California . He attended Analy High School , near Sebastopol , from which he graduated in 1926 . Libby , who grew to be 6 feet 2 inches (188 cm) tall , played tackle on the high school football team .

In 1927 he entered the University of California at Berkeley , where he received his B.S. in 1931 , and his Ph.D. in 1933 , writing his doctoral thesis on the " Radioactivity of ordinary elements , especially samarium and neodymium : method of detection " under the supervision of Wendell Mitchell Latimer . Independently of the work of George de Hevesy and Max Pahl , he discovered that the natural long @-@ lived isotopes of samarium primarily decay by emission of alpha particles .

Libby was appointed Instructor in the Department of Chemistry at the University of California , in 1933 . He became an assistant professor of Chemistry there in 1938 . He spent the 1930s building sensitive Geiger counters to measure weak natural and artificial radioactivity . In 1940 , Libby married Leonor Hickey , a physical education teacher . They had twin daughters , Janet Eva and Susan Charlotte , who were born in 1945 . He joined Berkeley 's chapter of Alpha Chi Sigma in 1941 . That year he was awarded a Guggenheim Fellowship , and elected to work at Princeton University .

= = Manhattan Project = =

On December 8 , 1941 , the day after the Japanese attack on Pearl Harbor brought the United States into World War II , Libby volunteered his services to Nobel Prize laureate Harold Urey . Urey arranged for Libby to be given leave from the University of California and to join him at Columbia University to work on the Manhattan Project , the wartime project to develop atomic bombs , at what

became its Substitute Alloy Materials (SAM) Laboratories . During his time in the New York City area , Libby was a resident of Leonia , New Jersey .

Over the next three years , Libby worked on the gaseous diffusion process for uranium enrichment . An atomic bomb required fissile material , and the fissile uranium @-@ 235 made up only 0 @. @ 7 percent of natural uranium . The SAM Laboratories therefore had to find a way of separating kilograms of it from the more abundant uranium @-@ 238 . Gaseous diffusion worked on the principle that a lighter gas diffuses through a barrier faster than a heavier one at a rate inversely proportional to its molecular weight . But the only known gas containing uranium was the highly corrosive uranium hexafluoride , and a suitable barrier was hard to find .

Through 1942 , Libby and his team studied different barriers and the means to protect them from corrosion from the uranium hexafluoride . The most promising type was a barrier made of powdered nickel developed by Edward O. Norris of the Jelliff Manufacturing Corporation and Edward Adler from the City College of New York , which became known as the " Norris @-@ Adler " barrier by late 1942 .

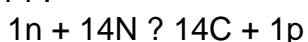
In addition to developing a suitable barrier , the SAM Laboratories also had to assist in the design of a gaseous separation plant , which became known as K @-@ 25 . Libby helped with the engineers from Kellex to produce a workable design for a pilot plant . Libby conducted a series of tests that indicated that the Norris @-@ Adler barrier would work , and he remained confident that with an all @-@ out effort , the remaining problems with it could be solved . Although doubts remained , construction work began on the K @-@ 25 full @-@ scale production plant in September 1943 .

As 1943 gave way to 1944 , many problems remained . Tests began on the machinery at K @-@ 25 in April 1944 without a barrier . Attention turned to a new process developed by Kellex . Finally , in July 1944 , Kellex barriers began to be installed in K @-@ 25 . K @-@ 25 commenced operation in February 1945 , and as cascade after cascade came online , the quality of the product increased . By April 1945 , K @-@ 25 had attained a 1 @. @ 1 % enrichment . Uranium partially enriched in K @-@ 25 was fed into the calutrons at Y @-@ 12 to complete the enrichment process .

Construction of the upper stages of the K @-@ 25 plant was cancelled , and Kellex was directed to instead design and build a 540 @-@ stage side feed unit , which became known as K @-@ 27 . The last of K @-@ 25 's 2 @, @ 892 stages commenced operation in August 1945 . On August 5 , K @-@ 25 starting producing feed enriched to 23 percent uranium @-@ 235 . K @-@ 25 and K @-@ 27 achieved their full potential only in the early postwar period , when they eclipsed the other production plants and became the prototypes for a new generation of plants . Enriched uranium was used in the Little Boy bomb employed in the bombing of Hiroshima on August 6 , 1945 . Libby brought home a stack of newspapers and told his wife , " This is what I 've been doing . "

= = Radiocarbon dating = =

With the war over , Libby accepted an offer from the University of Chicago of a professorship in the Chemistry Department at the new Institute for Nuclear Studies . He returned to his pre @-@ war studies of radioactivity . In 1939 , Serge Korff had discovered that cosmic rays generated neutrons in the upper atmosphere . These interact with nitrogen @-@ 14 in the air to produce carbon @-@ 14 :



The half @-@ life of carbon @-@ 14 is 5 @, @ 730 \pm 40 years . Libby realized that when plants and animals die they cease to ingest fresh carbon @-@ 14 , thereby giving any organic compound a built @-@ in nuclear clock . He published his theory in 1946 , and expanded on it in his monograph Radiocarbon Dating in 1955 . He also developed sensitive radiation detectors that could use the technique . Tests against sequoia with known dates from their tree rings showed radiocarbon dating to be reliable and accurate . The technique revolutionised archaeology , palaeontology and other disciplines that dealt with ancient artefacts . In 1960 , he was awarded the Nobel Prize in Chemistry " for his method to use carbon @-@ 14 for age determination in archaeology , geology , geophysics , and other branches of science " . He also discovered that tritium similarly could be used for dating

water , and therefore wine .

= = Atomic Energy Commission = =

Atomic Energy Commission (AEC) Chairman Gordon Dean appointed Libby to its influential General Advisory Committee (GAC) in 1950 . In 1954 , he was appointed an AEC commissioner by President Dwight D. Eisenhower on the recommendation of Dean 's successor , Lewis Strauss . Libby and his family moved from Chicago to Washington , D.C. He brought with him a truckload of scientific equipment , which he used to establish a laboratory at the Carnegie Institution there to continue his studies of amino acids . Staunchly conservative politically , he was one of the few scientists who sided with Edward Teller rather than Robert Oppenheimer during the debate on whether it was wise to pursue a crash program to develop the hydrogen bomb . As a commissioner , Libby played an important role in promoting Eisenhower 's Atoms for Peace program , and was part of the United States delegation at the Geneva Conferences on Peaceful Uses of Atomic Energy in 1955 and 1958 .

As the only scientist among the five AEC commissioners , it fell to Libby to defend the Eisenhower administration 's stance on atmospheric nuclear testing . He argued that the dangers of radiation from nuclear tests were less than that from chest X @-@ rays , and therefore less important than the risk of having an inadequate nuclear arsenal , but his arguments failed to convince the scientific community or reassure the public . In January 1956 , he publicly revealed the existence of Project Sunshine , a series of research studies to ascertain the impact of radioactive fallout on the world 's population that he had initiated in 1953 while serving on the GAC . By 1958 , even Libby and Teller were supporting limits on atmospheric nuclear testing .

= = UCLA = =

Libby resigned from the AEC in 1959 , he became Professor of Chemistry at University of California , Los Angeles (UCLA) , a position he held until his retirement in 1976 . He taught honors freshman chemistry . In 1962 , he became the Director of the University of California statewide Institute of Geophysics and Planetary Physics (IGPP) , a position he also held until 1976 . His time as director encompassed the Apollo space program and the lunar landings . In 1966 he divorced Leonor and married Leona Woods Marshall , a distinguished nuclear physicist who was one of the original builders of Chicago Pile @-@ 1 , the world 's first nuclear reactor . She joined him at UCLA as a professor of environmental engineering in 1973 . Through this second marriage he acquired two stepsons , the children of her first marriage . He started the first Environmental Engineering program at UCLA in 1972 . As a member of the California Air Resources Board , he worked to develop and improve California 's air pollution standards . He established a research program to investigate heterogeneous catalysis with the idea of reducing emissions from motor vehicles through more complete fuel combustion . The election of Richard Nixon as president in 1968 generated speculation that Libby might be appointed as Presidential Science Advisor . There was a storm of protest from scientists who felt that Libby was too conservative , and the offer was not made .

Although Libby retired and became a professor emeritus in 1976 , he remained professionally active as a member of the National Academy of Sciences , American Academy of Arts and Sciences , and the American Philosophical Society , until his death in 1980 . In addition to the Nobel Prize , he received numerous honours and awards , including Columbia University 's Chandler Medal in 1954 , the Remsen Memorial Lecture Award in 1955 , the Bicentennial Lecture Award from the City College of New York and the Nuclear Applications in Chemistry Award in 1956 , the Franklin Institute 's Elliott Cresson Medal in 1957 , the American Chemical Society 's Willard Gibbs Award in 1958 , the Priestley Medal from Dickinson College and the Albert Einstein Medal in 1959 , the Geological Society of America 's Arthur L. Day Medal in 1961 , the Gold Medal of the American Institute of Chemists in 1970 , and the Lehman Award from the New York Academy of Sciences in 1971 . He was elected a member of the National Academy of Sciences in 1950 . Analy High School library has a mural of Libby , and a Sebastopol city park and a nearby highway are named in his honor .

Libby died at the UCLA Medical Center in Los Angeles on September 8 , 1980 , from a blood clot in his lung complicated by pneumonia . His papers are in the Charles E. Young Research Library at the UCLA . Seven volumes of his papers were edited by Leona and Rainer Berger and published in 1981 .