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CHARLES DONALD SHANE

1895—1983

A Biographical Memoir by
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C. DONALD SHANE was born, grew up, and lived all his life in California. He was well known not only for his research, but, especially for his initiative, leadership, and administration of scientific projects and programs. The most prominent period of Shane's professional life was his directorship of Lick Observatory of the University of California from 1945 until 1958. During those thirteen years, he initiated and virtually completed the 120-inch reflector, the largest Lick telescope. It was named after him in 1978. At Lick Observatory he also carried out his monumental program of counting external galaxies and investigating their distribution.

LIFE HISTORY

Shane was born on the Futhey ranch near Auburn, California, on September 6, 1895, the eldest of four children. According to family tradition, an ancestor on his father's side, James McShane, had come from Ireland about 1745 and settled on Long Island. Soon after his arrival in America he dropped the "Mc" from his name. His son, James Shane, migrated west to Pennsylvania. Later he became one of the early settlers of Ohio. Donald Shane's father, Charles Nelson Shane, was born in Adamsville, Ohio, in 1861 and moved to

California in 1886. He settled in Placer County and was appointed teacher in the one-room Lone Star School, about eight miles north of Auburn.

One of Donald Shane's ancestors on his mother's side, Patrick Futhey, escaped from Scotland after taking the losing side in a "civil war" (or rebellion, as the winning side called it) and settled in Ireland. His son Robert I. Futhey came to America about 1730. Robert I. Futhey's son, also named Robert, was reported to have married Isabella Kidd, daughter of Captain Kidd. The family moved westward step by step, and in 1882 Donald Shane's grandfather, Robert Scott Futhey, made the long trip from Kansas to California, where he established a ranch near Auburn. His daughter Annette taught in various one-room schools in Placer County. In 1894, she married Charles N. Shane while he was principal of Auburn Grammar School. He was elected Superintendent of Schools for Placer County and served in this position from 1902 until 1910.

Donald Shane spent his childhood in a semi-rural environment with plentiful opportunities for outdoor recreation. On graduation from the Auburn Grammar School, he entered Placer County High School, which he attended for two years. His parents, concerned with the education of their children, decided to move to the bigger city of Oakland. Consequently, Charles N. Shane and his son went there in July of 1910, six months before the expiration of the father's term as superintendent. Charles N. Shane obtained a position in the Oakland school system and Donald continued his education at Oakland High School. His mother was appointed to fill out the unexpired superintendent's term in Placer County, and then she also moved to Oakland with the rest of the children in 1911. Donald Shane was fortunate in having very good teachers in Auburn as well as in Oakland. He entered the University of California at Berkeley in 1912.

Shane's interest in astronomy had been awakened at the age of ten by his reading and by conversations with his uncle Edgar Futhey, whose interests were wide-ranging despite his limited formal education. Shane's interest was further stimulated by his teachers in Auburn and Oakland. Still, he was not certain that he could make a living in astronomy. He chose to major in this subject only after the University of California advisors assured him that the Berkeley Astronomy Department was outstanding and that he would have no problem finding a good position in this field. It was indeed one of the best astronomy schools in the United States.

At that time the faculty of the Berkeley Astronomy Department consisted of three members: Armin O. Leuschner, its founder and chairman, R. Tracy Crawford, and Sturla Einarsson. They taught orbit theory, celestial mechanics, observational and spherical astronomy, and general astronomy. In addition, Shane took a number of mathematics and physics courses. By taking a heavy load of courses, carrying out a special project, and attending one summer session, he graduated in 1915, after three years instead of the normal four. He was then appointed a teaching fellow in mathematics for the subsequent year, during which he started his graduate work in astronomy, mathematics, and physics. He held the Lick Observatory Fellowship, with residence on Mount Hamilton, in 1916–1917 and again in 1919–1920. Not accepted for military service in World War I because of a minor medical problem, Shane instead taught navigation in Oregon and Washington for the United States Shipping Board from 1917 until 1919.

Shane received his Ph.D. degree in astronomy in 1920 and was appointed an instructor in mathematics at the University of California at Berkeley. Gradually he transferred his activities into astronomy, becoming assistant professor of astronomy in 1924, working up to professor in 1935, and then

chairman of the astronomy department in 1941. During World War II, Shane served from 1942 to 1945 with the Manhattan Project, first as assistant director for scientific personnel of the Radiation Laboratory in Berkeley and subsequently in the same position at Los Alamos, New Mexico. In 1945 he became director of Lick Observatory. He resigned from the directorship in 1958 but remained an astronomer on the active faculty until 1963, when he retired at the age of sixty-seven.

In 1917, Shane married Ethel L. Haskett, who had been the Lick Observatory secretary while he was there. She died in January 1919, two weeks after their son Charles was born. At the end of 1920 Shane married Mary Lea Heger, and their union continued until the end of his life. Their son, William Whitney, was born in 1928.

RESEARCH

Shane started his research as an undergraduate at Berkeley under Leuschner, whose field was orbit theory and celestial mechanics. Shane's first publications were thus concerned with the elements and ephemerides of comets. He considered writing his doctoral thesis on the orbit of the fifth satellite of Jupiter, which had been discovered by E. E. Barnard at Lick Observatory in 1892. This satellite presented some interesting problems in celestial mechanics because of its proximity to the massive, nonspherical planet. However, when Shane went to Mount Hamilton as a Lick Fellow in 1916, his interest turned to astrophysical problems. For a time he entertained the idea of observing stars at the edges of dark nebulae to find out if he could detect reddening of their light resulting from selective absorption. The outstanding theoretical astronomer Henry Norris Russell discouraged him from undertaking this seemingly hopeless task, though in 1930

Robert J. Trumpler at Lick Observatory did discover the reddening that results from interstellar absorption.

Under the influence of Joseph H. Moore and particularly W. W. Campbell, Shane became interested in spectroscopy. Carbon stars had a special attraction for him and he ultimately did his thesis on their spectra. It resulted in two publications that had considerable influence on subsequent research in this field. Because of the superior spectroscopic equipment then available at Lick Observatory, Shane was able to show that what had previously been supposed to be bright emission lines in the spectra of carbon stars were actually gaps between absorption lines and bands.

While working on his thesis Shane also became interested in *o* Ceti, the well-known long-period variable star, and published several papers on its spectrum and on the spectra of novae and other objects. Later he became fascinated by light interference phenomena and applied a Fabry-Perot interferometer to measure the profiles of solar absorption lines. He spent two summers at Mount Wilson Observatory making spectrographic observations of the sun with the Snow telescope and with the 150-foot solar tower. Subsequently, he had a coelostat and a spectrograph built for solar observations at Berkeley. In collaboration with Frank H. Spedding and Norman S. Grace, Shane did some laboratory research in atomic physics involving heavy hydrogen with this spectrograph. Though Shane was bright, clever, and quick to grasp any new idea up to the time his astronomical career was interrupted by World War II, he had not carried out any long-term research programs nor carved out any field as his own. Only after the war did he carry out his monumental program as director of Lick Observatory.

In 1934, Lick astronomer William H. Wright had obtained funds from the Carnegie Corporation for the design and construction of a powerful 20-inch astrograph to put

into practice his idea of measuring stellar proper motions with reference to distant galaxies. Delays prevented his starting this program before his retirement in 1942. When Shane became the director in 1945, no other Lick astronomer was interested in the program, and he decided to undertake it himself. He felt that the observatory, in accepting the Carnegie gift, had made a commitment to continue the project. The astrograph had been completed and erected under Wright's direction. Shane made the final optical adjustments of the astrograph, then started photographing the sky. Shane and his assistant Carl A. Wirtanen took a total of 1,246 acceptable plates between 1947 and 1954, covering about 70 percent of the sky on 17 × 17-inch photographic plates, each depicting a 6° × 6° area. In order to measure the stellar proper motions, a second set of photographs had to be taken a few decades later. In addition, in response to a request by Dutch astronomer P. J. van Rhijn, Shane and Wirtanen took photographs of 139 Kapteyn Selected Areas, from declination −15° to the North Pole, on 10 × 10-inch plates.

Instead of sitting and waiting until the second-epoch observations could be started, Shane decided to carry out the enormous task of counting all the galaxies recorded on the plates. He had two reasons for beginning this program. First, previous knowledge on the distribution of galaxies was based on counts by Edwin Hubble and others in small, discrete areas of the sky. They gave only a general idea of the distribution without any possibility of detecting fine structure within it. Thus there was an important research problem waiting to be carried out. Second, the long-term program, involving much routine counting, could be planned so as not to interfere with his administrative duties as director. He could do part of it himself.

Prior to the counting, Wirtanen had to inspect each plate to judge its acceptability. In this process he discovered a num-

ber of new comets. Then he and Shane counted the galaxies nearly in step with the taking of the photographs. Quite early in the program Shane noticed pronounced clustering in the distribution of galaxies as had been reported earlier by Harlow Shapley. Shane invited Berkeley statisticians Jerzy Neyman and Elizabeth L. Scott to make a statistical investigation of this phenomenon. They suggested extending the proper-motion program southward for statistical purposes, and Shane and Wirtanen photographed an additional 144 fields. Neyman and Scott's analysis, jointly with Shane, showed that not only clusters of galaxies, but also aggregates of clusters exist in the universe. The aggregates were called clouds by Shane, but are presently known as superclusters. With Gerald E. Kron, he carried out photoelectric studies of galaxies. They confirmed Walter Baade's result that the previous photographic photometry by Hubble, based on standards in Selected Areas, was in error by almost one magnitude. Shane and Kron derived new data for the galactic extinction and from their measurements drew refined boundaries of the zone of avoidance of galaxies.

Shane and Wirtanen published counts of the numbers of detected galaxies in each square degree of the sky covered by their photographs. They had done the actual counting in 10′ squares; the total number of one-and-a-half million such squares shows the immensity of work involved and the impracticality of publishing the counts in detail. Later, however, the complete and detailed numbers were transferred to magnetic tapes by P. J. E. Peebles at Princeton. Peebles recognized that the counts were a gold mine for cosmological studies of structure in the universe, being the only existing statistically uniform, comprehensive set of data covering a large fraction of the celestial sphere. The main result to emerge from Peeble's theoretical analysis was that the galaxy clustering shows no characteristic length scales. The covariance function is a

power-law out to very large distances. This suggests that the clustering grew out of a scale-force distribution of small density irregularities produced in the "Big Bang." Peebles derived many interesting new results on the distribution of galaxies from these detailed counts. Thus Shane and Wirtanen's publications inspired other researchers to analyze and discuss their data.

After the whole set of 1,246 photographs had been taken with the 20-inch Carnegie astrograph, Shane decided to photograph the sky again, with a smaller-aperture, wider-field telescope that would not reach objects as faint as those recorded during the proper motion program. Counts of galaxies on these plates would give information on the distribution of galaxies at a brighter magnitude limit. He borrowed a Ross five-inch lens from Mount Wilson Observatory and took all the photographs, but then decided to forego the counting. This set of photographs, however, known as the Lick Sky Atlas, turned out to be quite useful to astronomers as a reference atlas. Many copies have been distributed in the United States and abroad. An extension of this atlas to the Southern Hemisphere was carried out at Mount John Observatory of the University of Canterbury, New Zealand.

ADMINISTRATION

Shane's important contributions to science were by no means limited to his personal research. At Berkeley, Shane lunched regularly at the Faculty Club, the center of the professors' informal activities in the years between the wars. He was personable, intelligent, hard working, and absolutely trustworthy. He became acquainted with faculty members from all over the campus, and many of his friends later became department chairmen, directors, and deans. One friend, Commander Chester W. Nimitz, organized the first Naval Reserve Officers Training Corps unit in the country at

Berkeley in 1926, which he headed for three years before being reassigned to sea duty. Years later, as the victor of the Pacific Sea War, he became Fleet Admiral Nimitz. He was appointed a University of California Regent in 1948 and chairman of the Lick Observatory Committee in 1951.

Shane's friends quickly became aware of his interest in university affairs, particularly those concerned with academic excellence. In consequence he was appointed to the Committee on Schools, which visited California high schools and evaluated them as sources of students for the University of California. Later he served on the Budget Committee, whose decisions are crucial in faculty promotions, first as a member and later as chairman, and then on the Committee on Courses. He was elected vice-chairman of the Academic Senate and presided whenever the ex-officio chairman, University president Robert G. Sproul, was absent. Sproul and Shane cooperated closely until 1958 when they both retired.

In 1942, Ernest O. Lawrence, recognizing Shane's talent in administration, asked him to take over some of the responsibilities of the wartime work going on in his Radiation Laboratory. Later, at the personal request of General Leslie R. Groves, Shane went to Los Alamos as assistant director for scientific personnel under J. Robert Oppenheimer. Shane's calm manner, impeccable conservative credentials, and wide acquaintance among scientists were important qualifications for both these posts. When he witnessed the first test of the atomic bomb, at the Trinity site near Alamogordo on July 16, 1945, he knew the war would soon be over.

When Wright had retired as director of Lick Observatory in 1942, President Sproul had asked Shane to assume the post. He had declined the offer because of his wartime duties, recommending that Joseph H. Moore, already sixty-four years old, be appointed for the duration of the war. After Hiroshima, Sproul renewed the offer and Shane accepted.

He took up the post late in 1945. One of the first things Shane did as director was to begin holding staff meetings to discuss and seek advice on the future of the Observatory, as well as on current problems. This was a major departure from the previous rather autocratic regimes. Shane's leadership was particularly prominent in the design and construction of the 120-inch telescope, then the second largest in the world. By the time of his retirement from the directorship in 1958, it was nearly ready for regular operation.

From the days of W. W. Campbell, every Lick director had recognized the need for a new large reflecting telescope to put the Observatory back at the frontier of observational research. Campbell, Robert G. Aitken, Wright, and Moore had each in his turn tried to obtain the necessary funds. Shane, during his years in Berkeley, had probably discussed the idea with Sproul. In the early days of World War II, the president included the telescope project in the University of California's huge, ten-year building program planned to begin after the war.

Sproul wanted Shane to take charge of the advance planning for the telescope. The Los Alamos administrator managed to do so by correspondence and in one quick trip to California in March 1945. He headed a committee whose members he himself had recommended to the president. They included Joseph H. Moore; Nicholas U. Mayall, then a young Lick staff member on leave for wartime technical work in Pasadena; Walter S. Adams, director of Mount Wilson Observatory; and Ira S. Bowen of the California Institute of Technology. Shane's basic strategy was to use as much as possible of the Pasadena expertise and experience gained on the 200-inch project and to preserve the California money for building the telescope. John A. Anderson, who had supervised the Palomar telescope project, also met with the committee, and Walter Baade provided copious advice. Mayall

and Gerald E. Kron, another Lick staff member on leave for war work in Southern California, pressed intensively for as large a telescope as the available money would buy. Shane supported them and the decision was quickly reached to go for a 120-inch reflector.

As soon as the two atomic bombs had been dropped and it became clear that Japan would surrender, Shane resigned his Los Alamos post and hurried back to California. From then on much of his time, even before he formally took over the Lick directorship on December 1, 1945, was concerned with making the telescope a reality.

He immediately became involved in defending the telescope budget item before the Legislature, which had first deleted it then, after some politicking between the senators and the governor, restored it and passed the bill. Next Shane had to hire engineers, familiarize them with astronomical requirements, and supervise their work. Prior to the construction of the telescope, he directed the building of its dome, including the optical shop and testing facilities. He had to go back to President Sproul several times for additional funds when costs outran the early plans. Shane hoped to have the telescope operational before his retirement from the directorship but encountered delays. His successor, Albert E. Whitford, headed the telescope's completion.

Since galaxies constituted one of the important research topics at Mount Wilson and Palomar Observatories, Shane was instrumental in arranging regular informal meetings between their astronomers working in this field and those at Lick. The meetings were held for a number of years, alternately at Mount Hamilton and in Pasadena. In these discussions, Hubble encouraged Shane to undertake the counting of galaxies. In 1948 Shane recommended Hubble very strongly for a University of California honorary degree, writing that "no living astronomer has done so much as he to

enlarge and clarify our views of the universe as a whole." The following year the Lick director escorted Hubble to the Berkeley graduation ceremony where the University conferred an honorary doctorate of laws on the great observational cosmologist.

Shortly before his retirement from the Lick directorship, Shane was appointed to the Board of Directors of the Association of Universities for Research in Astronomy (AURA). He served as chairman of its Scientific Committee until 1959, when he became president. He was thus among AURA's leaders during its early years, including the founding of Kitt Peak National Observatory with headquarters in Tucson, Arizona, and the inception of Cerro Tololo Inter-American Observatory in Chile. He was a close friend of Robert R. McMath, the first president and later chairman of the board of AURA. Shane traveled to Chile several times as an advisor in the selection of the site for the planned observatory.

Shane strongly recommended Nicholas U. Mayall for appointment as the second director of Kitt Peak National Observatory, to succeed Aden B. Meinel. Mayall left Lick to accept the position in 1960. In his first years at Kitt Peak, he depended heavily on Shane for advice and counsel. They had frequent telephone discussions, and after Shane left the AURA board in 1962 they corresponded regularly on a personal basis until his death.

Shane was also particularly interested in helping to develop astronomy in New Zealand. While still director, he invited Ivan Thomsen from the Carter Observatory in Wellington to Lick to familiarize himself with research at a major astronomical institution. In subsequent correspondence and personal meetings, especially with Frank M. Bateson, Shane urged a site survey in New Zealand for a possible new observatory. The survey was carried out and ultimately an observatory was established on Mount John, in a cooperative ar-

rangement between the University of Canterbury and the University of Pennsylvania.

ECHELLE SPECTROGRAPH

It is not generally known that Shane first suggested the idea of the astronomical echelle spectrograph, essentially in its present-day form. He did this in 1946, when he and other Lick astronomers were planning the 120-inch reflector. Shane wanted to equip the telescope with a high-dispersion instrument for stellar spectroscopy but hoped to avoid building a coudé focus like that used for this type of work at Mount Wilson and planned for Palomar. Instead he wished to design a high-dispersion spectrograph to be used at the Cassegrain focus, behind the primary mirror. Such an arrangement would save starlight and money and avoid several complications in the design of the telescope. Shane realized that a medium-dispersion spectrograph, the type traditionally placed at the Cassegrain focus, could not simply be scaled up to give the high-dispersion that a coudé spectrograph could provide.

From his experience in solar line-profile work and laboratory spectroscopy, Shane was aware of the "echellettes" that had been developed by Robert W. Wood at Johns Hopkins University. They were essentially coarse reflection gratings, ruled with a blaze that concentrated their light into high spectral orders, giving high angular dispersion. Laboratory spectroscopists used them, as Shane knew, to get very high dispersion and thus resolve the fine structure of individual spectral lines.

He realized that, combined with only a moderate focal-length camera, such an echellette could provide the high dispersion needed by astronomers in a relatively small instrument, which could be mounted at the Cassegrain focus. However, the difficulty was that an echellette, since it worked in a

high spectral order, necessarily produced not a single long spectrum, but rather one composed of many overlapping orders. This was no problem in the laboratory, where a single emission line could be studied with very little danger that another line from a different order would accidentally coincide with it. It would be fatal for stars with continuous spectra.

Shane's solution was to cross the echellette with a small prism, which would provide just the right amount of deviation perpendicular to the main dispersion to separate the different orders. Thus several thousand Ångstrom units of spectrum could be mapped out in many orders onto a single rectangular photographic plate. In this way the best field of the optics would be effectively utilized, and a large spectral range could be photographed in a single exposure with minimum light loss. Previous laboratory spectroscopists had occasionally used cross-dispersion to get rid of unwanted orders but no one had ever mapped out the spectrum in a two-dimensional format like this.

Shane wrote Wood in April of 1946 outlining these ideas and providing a specific numerical example of the design. He asked for the laboratory spectroscopist's comments and inquired whether he could provide a suitable echellette. Shane followed up his letter with a visit to Wood's laboratory in Baltimore in May. That summer Wood set up a trial version of the system in the barn of his vacation retreat on Long Island and tested it visually with sunlight. The whole solar spectrum from the violet to the red was mapped out between the twelfth and seventeenth orders and despite "a rather poor echellette," wrote Wood, "[i]t looks like an awfully good idea to me." He later recorded the solar spectrum photographically with this system.

He presented a paper on this "new method of employing echellettes" at the meeting of the Optical Society of America

in New York that fall. In both his oral presentation and his later written version of the paper Wood credited Shane with the original idea.[1] Spectroscopist George R. Harrison, who was presiding at the session at which Wood presented this paper and who, according to the latter, "said that he considered this the greatest advance in spectroscopy since the invention by Rowland of the concave grating!", took up the idea and pushed it further. Harrison, at his Massachusetts Institute of Technology spectroscopy laboratory, was developing very similar "echelles," and he discussed in detail the design considerations for using them most effectively to obtain a large spectral range at high dispersion. In his published papers he also generously credited Shane with the original suggestion.[2] Among other items, Harrison stated that a prism (which Shane had originally suggested) is more effective as the cross-dispersing element than a grating (which Wood had used).

The novelty of Shane's idea illustrates his wide range of knowledge and quick mind. In 1946 it was ahead of its time, however, for neither echellettes nor echelles could be obtained that were large enough and suitably blazed. Shane was not able to build a Cassegrain echelle spectrograph for the 120-inch reflector. Instead, a very good coudé spectrograph was constructed, under the supervision of George H. Herbig, to provide high dispersion. More recently, however, echelle spectrographs have been put into use on many astronomical

[1] R. W. Wood, "Concave Replica Gratings, and a New Method of Employing Echellettes," *Journal of the Optical Society of America,* 36(1946):715; "The Use of Echellette Gratings in High Orders," *Journal of the Optical Society of America,* 37(1947): 733–37.

[2] G. R. Harrison, *Physical Review,* "The Production of Diffraction Gratings. II. The Design of Echelle Gratings and Spectrographs," 39(1949):522–28; G. R. Harrison, J. E. Archer and J. Camus, "A Fixed-focus Broad-range Echelle Spectrograph of High Speed and Resolving Power," *Journal of the Optical Society of America,* 42(1952): 706–12.

telescopes, including the Shane 120-inch, usually for moderate dispersion rather than for high.

OTHER ASPECTS

During Shane's many years on the Berkeley faculty, he spent more time on teaching than on research or administration. He taught considerably more than would normally have been expected of him, and he considered it the most important and rewarding part of his work. He was a good teacher, and as the University of California was one of the leading centers of graduate work in astronomy in the world, in his astrophysics classes he taught many students who later became outstanding researchers. Among them were, as undergraduates, Olin C. Wilson and Lawrence H. Aller, and as graduate students, Louis Berman, Fred L. Whipple, Nicholas U. Mayall, Daniel M. Popper, Horace W. Babcock, and Gerald E. Kron. Shane was also pleased to have attracted many of the best physics students—some of whom later became quite famous—to his astrophysics course. One, who remained his lifelong friend, was Edward U. Condon.

Shane had many interests outside astronomy and science. He was a longtime member of the Chit-Chat Club in San Francisco, a group of men interested in the arts, science, and current affairs. He was deeply interested in all things Icelandic, especially Icelandic literature and more particularly the sagas. Shane made two long visits to Iceland in 1967 and 1968, traveling around much of the island. He had several discussions of ancient Icelandic history with Kristian Elojarn, the director of the National Museum in Reykjavik in 1967, who had become president of the country by the following year.

Shane was an avid reader. He had a deep interest in biographies of world leaders and in both world history and the history of California—especially of the Auburn, San Fran-

cisco, Mount Hamilton, and Santa Cruz regions where he had lived. He was a raconteur of the first order, with an apt story for every occasion.

FAMILY LIFE

Donald and Mary Shane were an exceptionally close and cooperative married couple, and Mary had an important role in Donald's personal and professional life. As Mary Lea Heger she graduated from the University of California in 1919, and she received her Ph.D. degree in astronomy in 1924. In her thesis work at Lick Observatory she detected the presence of sodium atoms in interstellar space, a major discovery. She did not pursue an astronomical career, however, being fully occupied first with raising two small children, then later as the director's wife, with the duties of being the hostess at Lick Observatory. On remote Mount Hamilton there were many important scientific visitors from the United States and abroad. Throughout her experiences with them she retained her strong interest in astronomy and a particular attachment to Lick Observatory.

When Donald Shane was chairman of the Local Organizing Committee for the General Assembly of the International Astronomical Union, held at Berkeley in 1961, Mary carried a heavy load. She planned, organized the office work, and made arrangements for entertaining more than seven hundred participating astronomers—a total of about a thousand guests including spouses. An official record of thanks to Donald and Mary Shane can be found in the *Transactions of the International Astronomical Union,* which quotes Dr. Alena G. Massevitch, speaking for the visitors from abroad: "No words of mine can convey adequate thanks to them for their arduous efforts over many months; the success of these efforts is clear from the perfection of the organization, and our appreciation is unlimited."

Mary Shane also demonstrated her organizational talent and devotion in establishing the Lick Observatory Archives, renamed the Mary Lea Shane Archives in 1982. She conceived the idea of converting the old Lick Observatory files, dating from 1876, into an organized source of historical information. She began the project on Mount Hamilton. It reached its full fruition when the Lick headquarters were moved to the new Santa Cruz campus of the University of California in 1966. Mary Shane persuaded Chancellor Dean E. McHenry and University Librarian Donald T. Clark to provide space for the Lick Archives in the University Library. Under her leadership and with her active participation, a group of dedicated volunteers identified, classified, and catalogued thousands of letters, clippings, and photographs. Letters from almost every notable American astronomer since Simon Newcomb, as well as from many European scientists, can be found in the Shane Archives.

RETIREMENT YEARS

After retirement Donald and Mary Shane lived at their home in the redwoods at Scotts Valley, near Santa Cruz. Their American and foreign friends, mostly astronomers and their families, frequently visited them. The Shanes had a swimming pool and a separate guest house for their visitors. In the years 1962 through 1965, the University of California, Santa Cruz, campus physical plan was being formulated, and Chancellor McHenry frequently sought Shane's advice. As an emeritus faculty member, Shane served on the Campus Planning Committee for two of those early years. He was a regular participant in informal meetings of the Santa Cruz faculty emeriti group. Its members enjoyed listening to Shane's reminiscences, drawn from his exceptional memory and flavored with his characteristic wit and humor. He recollected many

events and noted personalities from his seven decades of association with the University of California.

Leukemia finally slowed him down, and he died at the age of eighty-seven on March 19, 1983. His wife Mary died of a heart attack on July 13, 1983, her eighty-sixth birthday. They are survived by their sons Charles Nelson Shane, presently associate dean at the Fletcher School of Law and Diplomacy of Tufts University, Massachusetts, and William Whitney Shane, a professor and radio astronomer at the University of Nijmegen in the Netherlands, as well as by six grandchildren and three great-grandchildren.

Honors were bestowed upon Donald Shane for his many achievements. He was elected to the American Philosophical Society in 1955 and to the National Academy of Sciences in 1961. He was awarded an honorary LL.D. degree by the University of California in 1965, and the 120-inch telescope that he initiated was named after him in 1978. Shane was an Associate of the Royal Astronomical Society and of the Royal Astronomical Society of New Zealand. The minor planet 1961 TE, discovered at Goethe Link Observatory, Indiana University, was named (1994) Shane in his honor in 1981.

WE ARE GRATEFUL to archivists at the Niels Bohr Library of the American Institute of Physics and at the Mary Lea Shane Archives of Lick Observatory for making available their rich stores of information for this biography. Transcripts of several interviews Donald Shane gave to historians were especially useful, as were his own handwritten autobiographical notes, composed in the last years of his life. His published scientific papers and our personal recollections provided supplementary sources.

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