

NATIONAL ACADEMY OF SCIENCES

LAWRENCE HUGH ALLER
1913–2003

A Biographical Memoir by
MANUEL PEIMBERT

*Any opinions expressed in this memoir are those of the author
and do not necessarily reflect the views of the
National Academy of Sciences.*

Biographical Memoirs, VOLUME 86

PUBLISHED 2005 BY
THE NATIONAL ACADEMIES PRESS
WASHINGTON, D.C.



Lawrence H Allen

LAWRENCE HUGH ALLER

September 24, 1913–March 16, 2003

BY MANUEL PEIMBERT

LAWRENCE H. ALLER, after finishing his second year at high school, was dragged away by his father to a primitive mining field in northern California, where he worked helping him in an illusory quest for gold. He literally escaped from this situation to become a brilliant astrophysicist, an expert in the study of planetary nebulae, stellar atmospheres, and the chemical composition of stars and nebulae. Aller was elected to the National Academy of Sciences in 1962.

The comparison between the observed abundances and those predicted by the main astrophysical theories—those of stellar evolution, galactic evolution, and the evolution of the Universe as a whole—was one of the main drives in the development of astrophysics in the twentieth century. Aller was one of the first astronomers to advocate that differences in the spectra of stars and nebulae were due not only to physical conditions but also to real differences in their chemical composition. A substantial fraction of Aller's research work was devoted to the determination of the chemical composition of stars of different types and of planetary nebulae, which are objects in transition between red giant stars and white dwarfs.

THE FORMATIVE YEARS

Born on September 24, 1913, in Tacoma, Washington, Aller was the son of Leslie E. Aller and Lena Belle, and the youngest of their six children: Leeon, Jane, Paul, Louis, Lee, and Lawrence. His father and grandfather were involved in printing and mining, and his mother had been a school-teacher before she was married.

His interest in astronomy started early in life. At the age of four he observed the total solar eclipse of 1918, which produced a lasting effect during his life. As a child living in Tacoma, a city by the sea, he was interested in the tides and their causes, and also in world geography. At the age of 10 his mother took him to visit the Lick Observatory, where he bought a small book on astronomy.

During his second year in high school, in Seattle, he borrowed from the public library the book by Russell, Dugan, and Stewart on astrophysics and stellar astronomy. At that time it was not possible to predict that Russell was going to suggest to Aller to write books on astronomy, nor that Aller was going to obtain the Henry Norris Russell award for his life work on astronomy.

In 1929, at the end of his second year in high school, Aller was taken away by his father to a mining camp in northern California, close to the border with Oregon, not far from a little village called Takilma, where he stayed for two and one-half years, never finishing the high school cycle. With the support of his brother Paul he abandoned the mining camp and went to Oakland to live with his sister Jane and her husband.

Before becoming an undergraduate at the University of California, Aller became a member of the Astronomical Society of the Pacific and engaged in fruitful correspondence with many amateur and professional astronomers, among

them Herman Zanstra, Seth B. Nicholson, Adriaan van Maanen, Edison Pettit, and Donald H. Menzel. He read a paper by Menzel on "Hydrogen Abundance and the Constitution of the Giant Planets," which appeared in the August 1930 issue of *Publications of the Astronomical Society of the Pacific*. This paper induced him to write to Menzel, starting a regular correspondence that later on became providential for his astronomical career.

When Aller arrived in Oakland from the mining camp, Menzel was teaching Astronomy I at Berkeley. Aller met Menzel on November 30, 1931, and took the final exam of Astronomy I and obtained excellent results. Based on the interest shown by Aller and his performance in the exam, Menzel convinced Merton Hill, who was the admissions director of the University of California, Berkeley, to admit Aller as a special undergraduate student. Menzel left Berkeley for Lick Observatory in December 1931 and later went to Harvard in 1932.

Aller finished his undergraduate work at Berkeley in 1936. He did not go to graduate school immediately because of illness, and in May 1937 he went up to Lick Observatory as a summer assistant assigned to work with Nick Mayall measuring radial velocities of globular star clusters and galaxies using the Crossley telescope. Aller decided to go to Harvard for his graduate education because he wanted to work with Menzel.

Immediately after Aller's arrival at Harvard, in the fall of 1937, Menzel incorporated him into the group of scientists who pioneered in the study of the physical conditions in gaseous nebulae. From 1938 to 1945 Aller collaborated in 12 of the 18 papers of the series "Physical Processes in Gaseous Nebulae." Aller based his Ph.D. thesis on this work and the observations he had obtained at Lick Observatory. Many years later, Menzel compiled a book on the physical processes

in ionized plasmas,¹ for which he selected 30 papers on the astrophysical interpretation of spectra of gaseous nebulae, including the 18 papers of the “Physical Processes in Gaseous Nebulae” series and 10 other papers by Aller on the subject.

Aller’s graduate preparation on theoretical astrophysics and basic physics was obtained at Harvard, while his observational preparation continued at Lick Observatory, where he went to work in 1938 and 1939 with Nick Mayall. They worked on the rotation curve of the M33 galaxy, and Aller obtained the necessary plates on planetary nebulae for his Ph.D. thesis. For this they used the slitless spectrograph at the Crossley reflector.

Up to 1939 Aller lived on a very tight budget, which along with his relatively humble origins gave him the feeling that he was in the Harvard community but not a part of it. This feeling changed when he was accepted into the Harvard Society of Fellows in 1939. According to Aller, the Society of Fellows was enormously important in his life; thereafter his economic situation improved spectacularly, banishing the severe poverty under which he had lived for so many years. Moreover, he considered that the Monday evening meetings of the fellows and the lunch gatherings on Tuesdays and Fridays at Eliot House, during his three years in the society, did more for his general education than any three years before or since. He was nominated to become a member of this society by Menzel with the support of Harlow Shapley, Bart J. Bok, and John H. van Vleck.

Aller was an instructor of physics at Harvard in the 1942-1943 period. Together with Leo Goldberg, his classmate, he published the first edition of the book *Atoms, Stars, and Nebulae* in 1943; afterwards, in 1971 and 1991, Aller alone produced the second and third editions. This book was the precursor of many more written by Aller.

Aller obtained his M.A. in 1938 and his Ph.D. in 1943, both at Harvard University. The title of his doctoral thesis was "A Spectroscopic Analysis of the Planetary Nebulae."

THE ACADEMIC JOURNEY

From 1943 to 1945 Aller participated in the war effort at the University of California Radiation Laboratory, where he was hired as a physicist to work on the electromagnetic separation of the 235 and 238 uranium isotopes. The director of the laboratory was Ernest O. Lawrence, and Aller was assigned to the group under the direction of Harrie S. W. Massey. During this period he managed to observe at Lick Observatory three days in a row every three weeks. As the war was ending, in June 1945, he was one of the first to be dismissed. Fortunately, he already had a job offer from Indiana University.

Aller worked as an assistant professor at Indiana from 1945 to 1948. During his stay at Indiana he wrote the first draft of the books, *The Atmospheres of the Sun and the Stars* and *Nuclear Transformations, Stellar Interiors, and Nebulae*. These books were written at the suggestion of Henry Norris Russell. At Indiana there were no observing facilities suited to the spectroscopic work needed by Aller. But the university obtained telescope time from the McDonald Observatory in Texas through an agreement between the universities of Chicago and Texas and Indiana University. Frank Edmondson showed Aller how to use the 82-inch reflector and the spectrographic equipment at McDonald Observatory.

Aller received an invitation in 1948 from Leo Goldberg to accept a position at the University of Michigan as an associate professor. There were two main reasons why he accepted the position at Michigan; his Indiana colleagues Edmondson and James Cuffey worked in quite different fields from those of Aller and, on the other hand, at Michigan

there were a number of people with interests and background much closer to Aller's. Besides Goldberg, there were Keith Pierce, Helen Dodson, Orren Mohler, and Robert McMath in the solar research field, and Dean B. McLaughlin, the stellar spectroscopist. In 1954 the University of Michigan promoted him to professor.

During the 1948-1962 period Aller consolidated his reputation as a scientist and helped develop the Michigan graduate program. One of his main activities was the production of books for the popularization and teaching of astronomy. *The Atmospheres of the Sun and the Stars* appeared in 1953 and was revised a decade later. *Nuclear Transformations, Stellar Interiors, and Nebulae* appeared in 1954. In 1956 he published *Gaseous Nebulae*, and in 1961 he published the last of the Michigan books, *The Abundance of the Elements*.

The lack of adequate observing facilities at Indiana and afterward at Michigan led Aller to participate actively as a guest investigator at the Mount Wilson Observatory in the 1945-1982 period. According to Aller, in those days the Mount Wilson Observatory played the role of a de facto national observatory; he also thought that an essential contribution to his success in astronomy was due to the guest investigator program offered by the Mount Wilson Observatory. Most of his research work during his Michigan years was associated with Mount Wilson and a good fraction was done in collaboration with Olin C. Wilson, Rudolph Minkowski, Ira S. Bowen, and Jesse L. Greenstein, all of them staff members at the Mount Wilson and Palomar observatories.

His 1951 paper with Joseph Chamberlain on the atmospheres of A-type subdwarfs was chosen as one of the twentieth century's most influential papers in astronomy. In the words of George Wallerstein, "The Chamberlain and Aller paper opened a huge field of research on the composition of

metal-poor stars and the nucleosynthesis of the species found in such stars.”² This paper provided definitive evidence of chemical abundance differences among stars.

The solar composition has generally been taken as the basic yardstick for chemical composition comparisons and for the study of the chemical evolution of our Galaxy and other galaxies. The 1960 paper with Goldberg and Edith Muller and the 1976 paper with John Ross were standard references for solar chemical composition from the 1960s to the 1980s.

Aller spent three sabbatical years in Australia as a visiting professor: in 1960-1961 at the Australian National Observatory, in 1968-1969 at Sydney University and the University of Tasmania, and in 1977-1978 at the University of Queensland. In 1960 Donald J. Faulkner, then a graduate student from the University of Queensland, was assigned to work with him. Most of their effort was devoted to the study of planetary nebulae in our Galaxy and of nebulae embedded in regions of recent star formation in our Galaxy and the Magellanic Clouds, the closest galaxies to our own. The observations were obtained at Mount Stromlo Observatory, which was under the direction of Bart Bok. Aller often mentioned that observing the treasures of the southern sky was one of the most thrilling episodes in his life. During the 1970s, in a cooperative program with Douglas Milne, Aller observed planetary nebulae with the Mills Cross at Molonglo and with the 64-meter dish at Parkes.

At the end of the summer of 1961 Daniel Popper convinced the University of California to accept the establishment of a new Ph.D. program in astronomy at the Los Angeles campus. Shortly afterward, Popper offered Aller a position as professor, which he immediately accepted, arriving at UCLA in 1962. Aller finally had come back to the University of California and to Lick Observatory. He had for the first time in his life direct access to first-class instrumentation.

In the 1963-1968 period he chaired the UCLA astronomy department and was instrumental in the consolidation of the Ph.D. program.

He was named professor emeritus in 1984, but this distinction did not imply the end of his academic career. He published his book *Physics of Thermal Gaseous Nebulae* in 1984, continued to teach into the mid-1990s, and kept doing research until the end of his life. A prolific writer and researcher, Aller produced 346 research papers during seven decades; his first one was published in 1935, and his last one in 2004. In addition to his productivity in research, Aller published a substantial number of advanced textbooks and monographs on fundamental astrophysical topics. These have had a vital influence on the academic development of young astronomers, both in the United States and abroad.

COLLABORATORS AND HONORS

The number of his collaborators was very large and included colleagues, students, and former students. A selected list of his main collaborators follows: D. H. Menzel, R. Minkowski, L. Goldberg, J. L. Greenstein, I. S. Bowen, O. C. Wilson, Jun Jugaku, E. A. Muller, Merle F. Walker, William Liller, D. J. Faulkner, Lindsey F. Smith, Jim B. Kaler, J. E. Ross, Stanley J. Czyzak, Charles D. Keyes, Karen B. Kwitter, Ben Zuckerman, Walter A. Feibelman, Francis P. Keenan, and Siek Hyung.

I first met Aller in 1964, and over the years we attended many of the same international astronomical meetings. Over four decades, I had the privilege to discuss matters of gaseous nebulae, astronomy in general, and global problems. He was always a sincere and passionate interlocutor. He was a man with strong views on social and political issues. He wanted a peaceful world where most of the resources would go into finding universal employment and education for all.

He was a visiting professor or a guest professor at a large number of institutions in the United States and abroad. He was elected to the American Academy of Arts and Sciences in 1961. He was a director of the Astronomical Society of the Pacific (1974-1977). He received the prestigious Henry Norris Russell Lectureship (1992) of the American Astronomical Society, awarded annually to commemorate a lifetime of preeminence in astronomical research. He received the Russell Prize for his research in the astrophysical study of gaseous nebulae, the chemical analysis of stars, and the analysis of the solar photosphere.

Since 1967 there have been eight international symposiums on planetary nebulae at five-year intervals. Aller participated in the first seven, giving invited reviews in all of them and sending his invited contribution to the eighth one. During the fourth meeting, which took place at University College London in 1982, I had the pleasure to give on behalf of the scientific organizing committee two academic medals, one to Michael Seaton, and the other to Lawrence Aller for their lifelong contributions to the study of planetary nebulae. The proceedings of the eighth symposium on planetary nebulae, which was sponsored by the International Astronomical Union, were dedicated to Aller's memory.³

Aller kept his initial love for planetary nebulae during his entire life. Most of his papers were dedicated to the study of the physical conditions in planetary nebulae and in particular to their chemical composition. His passion for astronomy was maintained during his whole life, and regardless of severe physical handicaps he kept working in astronomy until the end of his life.

In 1941 he married Rosalind Duncan Hall, who survives him. They had three children: Hugh, an astronomer; Raymond, a physician; and Gwendolyn Foster. One of his four grandchildren, Monique Aller, is a graduate student in astronomy.

THIS MEMOIR is based mainly on the scientific research papers and textbooks by Lawrence Aller, personal recollections, the autobiographical essay written by Aller,⁴ the interview by David DeVorkin,⁵ the obituary written by Jim Kaler,⁶ and valuable information provided by Donald Osterbrock, Jim Kaler, Susan Grodin, and Benjamin Zuckerman.

NOTES

1. D. H. Menzel, ed. *Selected Papers on Physical Processes in Ionized Plasmas*. New York: Dover, 1962.
2. G. Wallerstein. Chamberlain and Aller's subdwarf abundances. *Astrophys. J.* 525 (Part 3, Centennial Issue) (1999):447-449.
3. International Astronomical Union Symposium No. 209. *Planetary Nebulae: Their Evolution and Role in the Universe*, eds. S. Kwok, M. Dopita, and R. Sutherland. San Francisco: Astronomical Society of the Pacific, 2003.
4. L. H. Aller. An astronomical rescue. *Annu. Rev. Astron. Astrophys.* 33(1995):1-17.
5. Aller's edited version of the interview conducted by David DeVorkin in August of 1979. Malibu, California, June 1980, unpublished.
6. J. Kaler. *Bull. Am. Astron. Soc.* 35(2003):1453-1454.

SELECTED BIBLIOGRAPHY

1942

The spectra of emission nebulosities in Messier 33. *Astrophys. J.* 95:52-57.

1945

With D. H. Menzel. Physical processes in gaseous nebulae. XVIII. The chemical composition of the planetary nebulae. *Astrophys. J.* 102:239-263.

1951

Spectrophotometry of representative planetary nebulae. *Astrophys. J.* 113:125-140.

With J. W. Chamberlain. The atmospheres of A-type subdwarfs and 95 Leonis. *Astrophys. J.* 114:52-72.

1954

Astrophysics: Nuclear Transformations, Stellar Interiors, and Nebulae. New York: Ronald Press.

1956

Gaseous Nebulae. New York-London: Chapman & Hall, Wiley.

1957

With G. Elste and J. Jugaku. The atmospheres of the B stars. III. The composition of Tau Scorpi. *Astrophys. J.* 3(suppl.):1-35.

1960

With L. Goldberg and E. A. Muller. The abundance of the elements in the solar atmosphere. *Astrophys. J.* 5(suppl.):1-138.

With J. L. Greenstein. The abundances of the elements in G-type subdwarfs. *Astrophys. J.* 5(suppl.):139-186.

With S. Chapman. Diffusion in the sun. *Astrophys. J.* 132:461-472.

1961

The Abundance of the Elements. New York: Interscience.

1963

Astrophysics: The Atmospheres of the Sun and Stars. New York: Ronald Press.

1969

With L. F. Smith. On the classification of emission-line spectra of planetary nebula nuclei. *Astrophys. J.* 157:1245-1254.

1970

With M. F. Walker. The spectra of thirty-three gaseous nebulae in the yellow-green region obtained with an electronic camera. *Astrophys. J.* 161:917-945.

1975

With D. K. Milne. Radio observations at 5 GHz of southern planetary nebulae. *Astron. Astrophys.* 38:183-196.

1976

With J. E. Ross. The chemical composition of the sun. *Science* 191:1223-1229.

With J. B. Kaler, H. W. Epps, and S. J. Czyzak. The spectrum of NGC 7027. *Astrophys. J.* 31(suppl.):163-186.

1979

With S. J. Czyzak. A spectroscopic study of moderately bright planetary nebulae. *Astrophys. Space Sci.* 62:397-437.

1981

With G. A. Shields, C. D. Keyes, and S. J. Czyzak. The optical and ultraviolet spectrum of the planetary nebula NGC 2440. *Astrophys. J.* 248:569-583.

With K. B. Kwitter. Chemical composition of H II regions in the Triangulum spiral, M33. *Mon. Not. R. Astron. Soc.* 195:939-957.

1983

Chemical compositions of planetary nebulae. *Astrophys. J.* 51(suppl.): 211-248.

1984

Physics of Thermal Gaseous Nebulae. Dordrecht: Reidel.

1986

With B. Zuckerman. Origin of planetary nebulae: Morphology, carbon-to-oxygen abundance ratios, and central star multiplicity. *Astrophys. J.* 301:772-789.

1987

With C. D. Keyes. A spectroscopic survey of 51 planetary nebulae. *Astrophys. J.* 65(suppl.):405-428.

1994

With S. Hyung and W. A. Feibelman. The spectrum of the variable planetary nebula IC 4997. *Astrophys. J.* 93(suppl.):465-483.

