NATIONAL ACADEMY OF SCIENCES

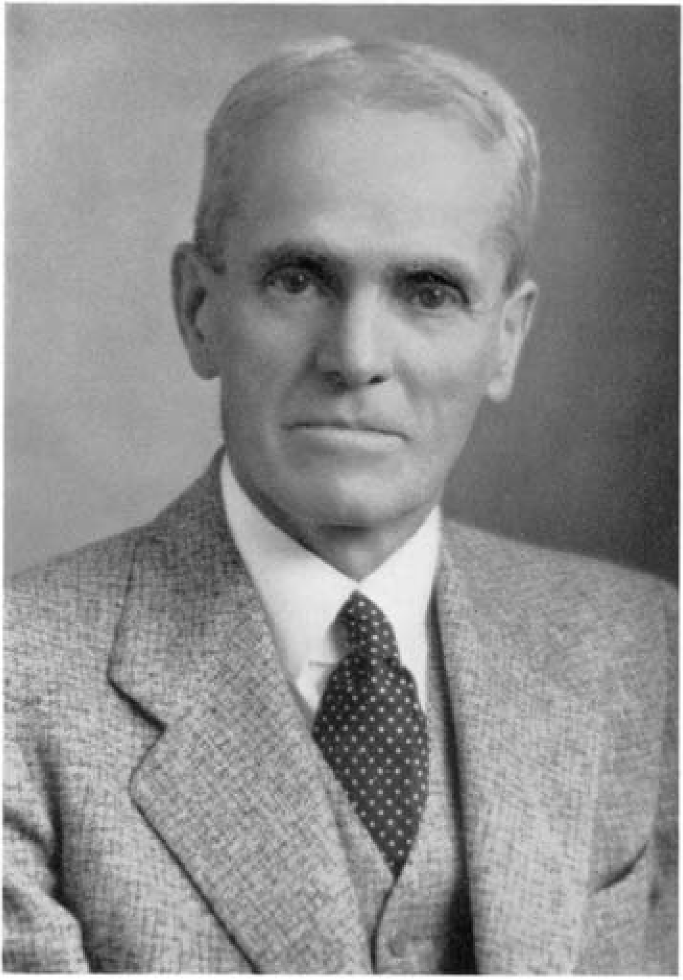
WALTER SYDNEY ADAMS

1876—1956

A Biographical Memoir by

ALFRED H. JOY

Biographical Memoir



Walter S. Adams

WALTER SYDNEY ADAMS

December 20, 1876—May 11, 1956

BY ALFRED H. JOY

NEAR THE BEGINNING of the twentieth century, rapid developments in observational astronomy were made possible by employing more powerful instruments and by applying the methods of the physical laboratory to studies of the distant heavenly bodies. Through the genius of George Ellery Hale, organizations were established to promote this trend, and larger and larger equipment was designed for extending the field of observation to the surface of the sun and to stellar systems.

Walter Sydney Adams, for more than forty years, played a major role in developing and carrying out the extensive program undertaken at the Mount Wilson Observatory under the Carnegie Institution of Washington.

The parents of Walter Adams were of old New England lineage. His father, Lucien Harper Adams, was a native of New Hampshire, a graduate of Dartmouth College (1858) and of Andover Theological Seminary (1861), and an ordained clergyman of the Congregational Church. His mother, Dora Francis Adams, was from Connecticut and a graduate of Mount Holyoke College (1863). Both were missionaries of the American Board of Commissioners for Foreign Missions. Following their marriage, they established a home within the Turkish dominions of North Syria at Kessab on the slopes of Mount Casius near the ancient city of Antioch, ministering mostly to the Armenian population of that mountainous area.

There, on December 20, 1876, Walter Adams was born, the youngest of five children (two of whom died in infancy). Since there were no local schools, the children were fortunate in having in their mother a most competent teacher as long as they remained in Syria. Their father, who had a deep interest in classical languages and history, often took the boys on his trips through the mission field and told them on the spot of the campaigns of Darius, Alexander the Great, the Seleucids, the Romans, the Crusaders, and finally the Turks. Viewed from Mount Casius, the famous and once populous cities of Antioch, Daphne, and Seleucia in the valley of the Orontes River lay at their feet. In the distance, to the west the island of Cyprus was easily visible, to the north were the Taurus Mountains, and to the south the snow-capped peaks of the Lebanon range. At this crossroad of history, massive ruins of ancient castles and cities were visible in all directions. The boys often picked up old Greek and Roman coins in their wanderings and tried to decipher the inscriptions seen in the neighborhood.

The children learned to read at an early age and, in the absence of other material, eagerly perused the books of their father's library, which consisted largely of historical and theological treatises. With their firsthand store of ancient history so vividly in mind, they later looked upon their untutored American schoolmates with much condescension.

For the more advanced education of the children, the family returned to the father's birthplace, Derry, New Hampshire, in 1885. The parents and elder daughter went back to Syria in 1890, hoping that the milder climate there might benefit the mother's health, but she lived only a short time. The father remained four years after her death.

Although Walter was only eight years old when he left Syria, his boyhood days in the Near East had made a deep impression on his life. In later years he took much pleasure in recalling his early experiences and remembered some of the Turkish words of common usage.

After his preparatory schooling at Pinkerton Academy in Derry, St. Johnsbury Academy in Vermont, and Phillips Andover Academy in Massachusetts, and a year on a farm, he entered Dartmouth College, graduating with the highest honors in 1898. In college he enjoyed the courses in mathematics and the exact sciences although, perhaps because of his early impressions, he found Greek and Latin of such great interest that he seriously considered the study of the classical languages for his lifework.

Fortunately for the science of astronomy, his interest in that subject had been aroused by the much-loved teacher, Edwin B. Frost, with whom he had studied. Frost had become widely known through his publication in 1894 of the epoch-making revision of Scheiner's *Astronomical Spectroscopy*. At the invitation of George Ellery Hale, he transferred from Dartmouth to the Yerkes Observatory to take charge of the department of stellar spectroscopy, and he advised Adams to go to the newly established observatory to gain experience in practical astronomy and take his graduate work at the University of Chicago. This prospect was so alluring that Adams cast his lot with pure science and after graduation followed his mentor west.

At the Yerkes Observatory he came in touch for the first time with the magnetic personality of Professor Hale, with whom he continued to work with the highest mutual esteem and complete understanding for forty years.

At the University, Adams studied celestial mechanics with F. R. Moulton and Kurt Laves. In connection with these studies he published in 1899 his first research contribution on "The polar compression of Jupiter." In this study he computed the departure from spherical shape of the planet which would be necessary to account for the advance of the line of apsides of the orbit of the fifth satellite as determined by E. E. Barnard from the observations of its position. His calculated results agreed well with the micrometer measures of the relative polar and equatorial diameters of the planet's disk.

During his second year he gave more of his time to the observational program at the Yerkes Observatory. With the original "universal" stellar spectrograph, he and Professor Frost started a radial velocity program for stars of early spectral type using the 40-inch refractor. Many of the stars were found to be spectroscopic binaries with large ranges in velocity. In addition Adams made a detailed study of the curvature of the spectral lines of the spectroheliograph.

After two years in Chicago and Williams Bay, he concluded that it would be worth-while for him to go to Germany for further study. He chose Munich, where he had the opportunity of working with two great German astronomers, Hugo von Seeliger and Karl Schwarzschild.

In 1901 the new Bruce stellar spectrograph at the Yerkes Observatory was completed, replacing the original Brashear instrument which had been found to be unsatisfactory for the long exposures required for fainter stars. On an invitation from Hale, Adams returned in May, 1901, to continue with the new spectrograph the stellar spectrographic program he had left the year before, and during the next three years he and Frost plunged wholeheartedly into stellar spectroscopic research.

The spectrograms of Nova Persei 1901 which had been photographed by F. Ellerman were measured and the extraordinary changes noted. The spectra of a considerable number of early-type stars were photographed and the motions investigated. Many spectroscopic binaries were discovered from the resulting velocities and the wave lengths of certain stellar lines computed. These years of work in fascinating new fields under the inspiring leadership of Frost and Hale set the pace which Adams kept up with never-failing fervor throughout the succeeding years of his life.

In the spring of 1904 Dr. Hale initiated the astronomical observing station on Mount Wilson in Southern California. At first the undertaking was on an expeditionary basis under the auspices of the Yerkes Observatory. It was supported in part by a small grant from the Carnegie Institution of Washington and by private donors. Hale with Ellerman set up on Mount Wilson a small coelostat with which some excellent photographs of the sun were obtained. A larger appropriation by the Institution in December of the same year made possible an independent installation to be known as the Mount Wilson Solar Observatory.

When Hale was named Director of the more permanent project, he asked W. S. Adams, G. W. Ritchey, and F. Ellerman to make up the staff of the new observatory. They had arrived on the mountain in May, 1904, and F. G. Pease of the Yerkes optical shop joined them a year later. A gift of John D. Hooker of Los Angeles enabled E. E. Barnard to bring the 10-inch Bruce photographic telescope to Mount Wilson and he spent nine months there in 1905 photographing the southern portions of the sky for his *Atlas of the Milky Way.*

Observations with the horizontal Snow reflector, which had been sent out and later purchased from the Yerkes Observatory, were begun early in 1905. With the 6.7-inch image daily direct photographs of the sun and spectroheliograms were begun. For high-dispersion spectrograms of different parts of the sun's disk and of sunspots, an 18-foot grating spectrograph was used, and for spectra of certain of the brightest stars, a 13-foot spectrograph was mounted in a separate chamber with elaborate heat control for the optical parts.

Dr. C. G. Abbot of the Smithsonian Institution was invited to use the large solar image for observations of the sun's radiation with the bolometer and pyrheliometer. Other special problems were taken up by E. F. Nichols and H. G. Gale.

These were busy and happy days for the young astronomers in their great scientific adventure in primitive surroundings. Dr. Hale spent most of his time on the mountain and his eager enthusiasm pervaded the whole enterprise. Improvised living and dining quarters were established at the log cabin called the "Casino," which was used until the spacious "Monastery" was finished in January, 1905. For the small staff long hours and much work were involved, but it was challenging and exciting. Records of weather conditions and tests of night- as well as daytime seeing were continued. Solar observations began at sunrise and ran through most of the day. The different features recorded on the photographs were measured for area and position. Spectrograms required measurement and reduction. Spectra of spots and different parts of the solar disk were compared with each other and with laboratory spectra. At night stellar spectrograms of Arcturus and Betelgeuse were photographed with long exposures. Much time was given to their detailed study and comparison with solar spectrograms. New instruments had to be tested and adjusted. Several important papers were prepared and published.

Transportation to the mountain was by mule or burro over foot trails and often the trip required two days. If supplies were urgently needed or repairs were necessary, a quick round trip on foot to Pasadena with heavily loaded knapsack was routine.

Walter Adams found never-ending delight in this sort of life, for which he was especially conditioned by his earlier days among the rugged hills of Syria and New Hampshire. He loved the mountains and gladly risked the tortures of poison oak, as I well remember from trips with him in later years to the peaks of Mount San Antonio and Mount Whitney, for a chance to hike in the great outdoors and see the wonders of nature. At his home he kept a collection of rocks to remind him of places he had been.

In the development of the observatory, Adams had a large share. He had tested the Snow telescope at Williams Bay and was anxious to find out what it might do under better atmospheric conditions in California. An extensive investigation of the solar rotation from spectrographic velocities was begun with the Snow telescope but later transferred to the 60-foot tower telescope. The lines which were affected in the magnetic field were identified. Working with Hale and Gale, the intercomparison of the spectra of spots, center, and limb of the sun, with added evidence from controlled laboratory spectra of certain elements, quickly led to well-founded conclusions which were mostly new and which became the foundation of much of Adams's later work on stars.

They noted that: 1. Certain lines have very different relative intensities in different sources, depending on temperature, pressure, or density of the source. 2. The enhanced lines, which are strengthened in the hot spark as compared with those of the cooler arc or furnace, are weaker in the higher densities of the spot than in the observable levels of the solar disk. 3. The sunspots have lower temperature than the disk. This is deduced from the fact that the line spectrum of the spot resembles that of the cool star Arcturus; that the molecular bands, which are not dissociated at lower temperatures, occur in spots as well as in Arcturus and Betelgeuse; and that the intensity of the continuum from the spot is comparatively weak in the violet portion of the spectrum as in the cooler sources.

When the stellar spectrograms taken with the 60-inch telescope became available, beginning in 1909, the investigation was extended to include a large variety of stars. A. Kohlschütter joined in the search for lines which differ in stars of various spectral types and absolute magnitudes. The spectral classification was based on the Harvard system and it was found that the greater dispersion of the Mount Wilson spectra permitted much more accurate estimates of the spectral types. At first few absolute magnitudes were available for standards, but as soon as spectrograms of stars having trigonometric parallaxes and of members of moving clusters were examined, it became apparent that certain neutral lines increased in intensity with lower luminosity while enhanced lines were strongest in the high-luminosity stars. This result was of fundamental importance for the progress of physical astronomy because it indicated that certain basic physical characteristics could be determined for all stars for which suitable spectrograms could be obtained. A single spectrogram might reveal equally well the distance, motion, and physical properties of faint as well as bright stars. Thus, the giant and dwarf division of stars, as first described by Hertzsprung and Russell, was definitely confirmed.

A large program for estimating the spectral type, absolute magnitude, and parallax of most of the brightest stars of late type and many others of special interest was set up by Adams and carried out during a period of nearly thirty years with the collaboration of A. H. Joy and M. L. Humason. For calibration curves of dwarf stars trigonometric parallaxes were used and for giant stars absolute magnitudes were computed by G. Strömberg from proper motions.

Numerical estimates of the relative intensity of sensitive lines as compared with unaffected lines were made in order to give a quantitative value for the absolute magnitude of each star. Such empirical luminosities were determined for some six thousand stars and are known as spectroscopic absolute magnitudes. The method has been extensively used in other observatories with such criteria as could be drawn from the particular spectra used. Plotting these estimates of absolute magnitude against spectral type gives the famous Russell diagram which, in effect, correlates stellar luminosity and temperature.

The same Mount Wilson spectrograms were also used for the determination of the radial velocities of the stars. In this program a number of observers took part and the velocities of more than seven thousand stars were determined with the 60- and 100-inch telescopes. In various investigations the velocities were of basic importance and Adams never lost interest in their determination. He himself made a large percentage of the observations and measurements, especially in the earlier years.

The analysis of these velocities, which had an unexpectedly large dispersion, led to many of the important advances in our knowledge of the behavior of individual stars and the Galaxy. The results had a bearing on the problems of different stellar populations and stellar evolution. Many spectroscopic binaries were detected. The stellar atmospheres were probed and the periodic pulsations of Cepheid variables were investigated. The Einstein relativity displacement was confirmed by means of most difficult measures of the spectrum of Sirius B, whose white-dwarf character Adams had discovered some ten years before in 1915.

The completion of these great programs of stellar velocity and luminosity with the resulting distances of the stars constitutes an enduring memorial to the untiring industry and devotion of Dr. Adams. They were carried on year after year in addition to his heavy responsibilities as Assistant Director from 1913 to 1923 and Director from 1923 to 1946 of a large and progressive research observatory whose methods and objectives were novel and unprecedented in scope.

While the two large and continuing projects for many years took a large part of the time which Adams could spare for research, many other less pretentious spectroscopic investigations were carried on. He took a profound interest in each undertaking and was satisfied only when the best possible results had been attained.

The problem of the novae outbursts was most alluring and when a new one was announced all the great telescopes of the Observatory were trained on it. Adams, jointly with other observers, published twenty-five papers concerning the amazing spectra of thirteen different exploding stars, some of them requiring much difficult observing at the telescope. In RS Ophiuchi, for the first time in stars, the lines of the highly ionized atoms of the solar corona were photographed and identified.

Important early observations by Adams proved that the violet end of the spectrum of giant stars was weakened by absorbing material in space between the stars, and also that the giants were intrinsically redder than the dwarfs. These results led to the use of color estimates for separating the stars according to distance and luminosity.

He recognized the importance of the spectra of variable stars and thought that the peculiarities and sudden changes found there might be the key which would unlock the mysteries of stellar structure and evolution. The spectra of Cepheids and stars with similar spectra were used as standards for stars of the highest luminosity.

For his contribution to knowledge of the planetary atmospheres he made extensive investigations of the spectra of Mars for water vapor and oxygen (with C. E. St. John) and of Venus, which resulted in the identification of carbon dioxide bands (with T. Dunham, Jr.).

In his later researches (some of them after his retirement), Adams undertook a detailed examination and measurement of stellar spectrograms of high dispersion obtained with the coudé spectrograph at the 100-inch telescope. A most interesting and rewarding study

(1949) of the interstellar absorption lines and molecular bands found in the spectra of 300 stars of types O and B revealed the presence of discrete clouds of interstellar gas in the line of sight. Many spectra showed two or more sources with velocity differences great enough to resolve the spectral lines. The velocities, on account of their accuracy, gave good values for the relative motions caused by the rotation of the galaxy, even though the distances to the absorbing clouds were not particularly large.

Other detailed investigations with the aid of high-dispersion spectrograms of giant stars include such physical characteristics as abundance; the displacement of lines depending on ionization, excitation potential, turbulence, or convection currents; and the doubling of lines on account of the presence of outlying shells with outward motion.

The extent and character of Adams's contributions to astronomy may be estimated by reference to his papers, 270 of which are listed in the appended bibliography. A considerable number of them were published under joint authorship with other members of his staff. This was his method of encouraging other investigators. He usually did more than his share of the work, but in his innate modesty he liked to have the added moral support of one of his colleagues. The papers are highly condensed as compared with the usual style of scientific reports but give a remarkably clear summary of the methods used and the results obtained. He had such a distinct mental picture of the ideas he wished to include that he could write a whole article without the necessity for any later changes.

In the spirit of a true scientist, Dr. Adams found much satisfaction in his astronomical investigations. No routine was too dull or too prolonged if there was any hope that it might lead to new and useful results. He was an indefatigable measurer of spectrograms, using a small measuring machine in his office, and he loved spectrographic observing of the sun, planets, or stars on Mount Wilson. As an observer he was unexcelled among the members of the staff. His observations made the best use of the many factors involved to produce a useful spectrogram—the instrumental equipment, the "seeing" conditions, alert guiding, the exposure time, and the photographic process.

Although he had little natural inclination for mechanical things, his desire for perfect observational results was so strong that, through the years, he developed a profound understanding of the design of optical instruments and great personal skill in adjusting and using them. These talents were continually called upon during his career, beginning with his tests of the Snow telescope at the Yerkes Observatory in 1903. On Mount Wilson he set up the high-dispersion stellar spectrograph at the Snow telescope and later the spectrograph of the 60-inch reflector. He had a large part in the design of the 100-inch telescope and made the Hartmann tests of the mirror which made possible its completion with a figure of the highest perfection. From its inception he played a leading role in the 200-inch telescope project and served on the various committees which had to do with its design and construction.

In addition, his advice was sought for many outside projects. The outstanding success attained with the equipment for which he had responsibility indicates that his judgment in such matters was remarkably sound.

As director of one of the large departments of the Carnegie Institution of Washington, Dr. Adams served under two presidents, J. C. Merriam (1923–1938) and Vannevar Bush (1939–1945). He was always careful to cooperate with the policies of the Institution in all its branches. As head of the Mount Wilson Observatory, he followed the methods introduced by Dr. George E. Hale with whom he had worked as Assistant Director for many years. Much freedom in the choice of research fields was given the investigators but telescope-time was strictly apportioned by the Director. Hale stirred the interest and loyalty of the observers by his own enthusiasm. Adams accomplished the same result by his continued concern for the success of the projects undertaken by each member of the staff. He believed that in the long run the greatest progress could be made only through the harmonious efforts of the whole staff and this spirit of cooperation has been maintained at a high level throughout the history of the Observatory. His warm appreciation of the work of the staff members is recorded in detail in the Annual Reports of the Director which are published in the *Yearbooks* of the Carnegie Institution of Washington. These reports are models of concise scientific writing. In his administration of the Observatory he was progressive but preferred to improve upon old methods step by step rather than by instituting new and untried procedure. To him administrative work was a chore which had to be done, but he took no pleasure in it. Small difficulties were often a source of much worry. From his associates he expected loyalty and serious endeavor, but he was always tolerant and helpful. Behind his New England reserve was a spirit of comradeship in adventure which made it a pleasure to work with him.

Adams followed the politics of the day with great interest. Although he considered himself a liberal, he scorned any approach to socialistic philosophy. In his community he was much interested in the schools and served for forty years on the Library Board of the City of Pasadena.

In astronomical and scientific societies Dr. Adams took an active and unselfish part. When chosen for office or particular responsibilities, he cheerfully responded to the best of his ability and endeavored to cooperate with other officers of the society.

His scientific achievements and services were widely recognized by universities and learned societies, as is indicated by the honors listed in the chronology following this account.

Social affairs were, in general, avoided by Adams, but he appreciated the associations with friends and colleagues. A detective story was a source of recreation for him, and he delighted in a game of bridge, golf, or tennis. As in the more serious occupations of life, he played to win. He did not enjoy half-hearted efforts, or people who were satisfied with frivolities.

Throughout his life he had a remarkably strong physique which enabled him to carry a heavy burden of responsibility in the management of the Mount Wilson Observatory for thirty-five years. During the war he was requested by the Trustees of the Carnegie Institution to postpone his retirement in order to fulfill some Government contracts. He retired in 1946, but continued his research with great pleasure until the spring of 1956. He suffered a stroke in April and his strength failed gradually until May 11, when he died at his home, seven months before his eightieth birthday.

In 1910 he was married to Lillian Wickham, who died ten years later. In 1922 he married Adeline L. Miller, who survives him together with their two sons, Edmund M. and John, and two grandchildren.

In the years to come, many of the researches of Dr. Adams, especially his extensive radial-velocity results and the methods which he developed for determining spectral class, luminosity, and distance of stars from slit spectrograms, will be of fundamental value to astronomers everywhere. To his friends and associates his kindliness, good cheer, and devotion to duty will be a happy memory and a continual source of inspiration.

To the fascinating pursuit of knowledge Walter S. Adams gave his life with zealous abandon and made unequaled contributions in the realm of stellar motion, luminosity, and astronomical spectroscopy. The magnitude of his own accomplishments was greatly enlarged through his personal and official encouragement to many others working in astronomical and allied fields.

CHRONOLOGY

1876	Born December 20 in Kessab, North Syria
1885	Arrived in Derry, New Hampshire
1887–1889	Pinkerton Academy, Derry
1889–1892	St. Johnsbury Academy, Vermont
1890	Father and mother returned to Syria
1891	Mother died in Syria
1893–1894	Phillips Academy, Andover, Massachusetts
1894–1898	Dartmouth College
1898–1900	University of Chicago and Yerkes Observatory
1899	Charter member, American Astronomical Society
1900–1901	University of Munich, Germany
1901–1904	Assistant, Yerkes Observatory
1904–1946	Staff, Mount Wilson Observatory of the Carnegie Institution of Washington
1910	Married Lillian M. Wickham, who died in 1920
1910–1911	Acting Director, Mount Wilson Observatory
1913–1923	Assistant Director, Mount Wilson Observatory
1913	Sc.D., Dartmouth College
1914	Associate, Royal Astronomical Society
1915	Member, American Philosophical Society
1917	Gold Medal, Royal Astronomical Society
1917	Member, National Academy of Sciences
1918	Draper Medal, National Academy of Sciences
1922	Married Adeline L. Miller
1922	Member, Royal Academy of Science, Upsala
1923	Valz Prize, Academy of Sciences, Paris
1923	President, Astronomical Society of the Pacific
1923–1946	Director, Mount Wilson Observatory
1926	Janssen Prize, Société Astronomique de France
1926	Sc.D., Columbia University
1926	L.L.D., Pomona College
1926–1929	Chairman Astronomy Section, National Academy of Sciences
1928	Bruce Medal, Astronomical Society of the Pacific
1929	President, Pacific Division, American Association for the Advancement of Science
1930	Sc.D., University of Southern California
1931–1934	President, American Astronomical Society
1934	Janssen Medal, Academy of Sciences, Paris
1935–1948	Vice President, International Astronomical Union
1935	Foreign Associate, Royal Swedish Academy of Science
1940–1945	Acting Secretary, International Astronomical Union
1945	Sc.D., University of Michoacan, Mexico

1945	Sc.D., University of Chicago
1945	Foreign Associate, Academy of Sciences, Paris
1945	Foreign Associate, Academy of Sciences, U.S.S.R.
1946–1950	Research Associate, Carnegie Institution of Washington
1947	Sc.D., Princeton University
1950	Foreign Member, Royal Society of London
1956	Died at his Pasadena home

KEY TO ABBREVIATIONS

A. J. = Astronomical Journal
Ap. J. = Astrophysical Journal
A. S. P. Leaflet = Astronomical Society of the Pacific Leaflet
Biog. Mem. Nat. Acad. Sci. = Biographical Memoirs of the National Academy of Sciences
Carnegie Inst. Wash. = Carnegie Institution of Washington
Jour. R. A. S. Can. = Journal of the Royal Astronomical Society of Canada
M. N. = Monthly Notices of the Royal Astronomical Society
Mt. W. Contr. = Contributions of the Mount Wilson Observatory
Pop. Astr. = Popular Astronomy
Proc. Nat. Acad. Sci. = Proceedings of the National Academy of Sciences
Pub. A. A. S. = Publications of the American Astronomical Society
Pub. A. S. P. = Publications of the Astronomical Society of the Pacific
Pub. Yerkes Obs. = Publications of the Yerkes Observatory
Trans. Internat. Astr. Un. = Transactions of the International Astronomical Union

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