BIOGRAPHICAL MEMOIRS

C. Roger Lynds

July 28, 1928–April 16, 2023
Elected to the NAS, 1974

A Biographical Memoir by Vahé Petrosian

Figure 1 Roger Lynds lying on the floor of the Cassegrain cage at the Kitt Peak Nicholas U. Mayall 4-meter Telescope (1975). The instrument in the cage is a speckle camera, used for high angular resolution work by a clever design that partially compensates for the blurring effect of the atmosphere. *Photo courtesy of NOIRLab/NSF/AURA.*

Clarence Roger Lynds was one of the twentieth century's most innovative and accomplished astronomers. He made lasting contributions in many areas of modern astronomy and astrophysics: observation, data analysis, and theoretical interpretation. His most notable role was in building innovative, state-of-the-art instruments for the National Optical Astronomical Observatory (NOAO) telescopes at Kitt Peak near Tucson, Arizona; the Cerro Tololo telescope in Chile; and the Hubble Space Telescope. Roger was meticulous in every aspect of his research. This extended to his published papers of results, in which he ensured that every word had its proper position and conveyed his ideas clearly and precisely. Somewhat of a maverick, Roger often carved his own path, but he did not shy away from collaboration when a good opportunity arose. As his NOAO colleague Sidney Wolff wrote in a post-tenure review, "Lynds is original. His approach to science ... [is] creative and innovative."

Biography

Roger was born on July 28, 1928, in Kirkwood, Missouri. He was the son of Clarence Wiley and Daisy Deene (Foland) Lynds. As the child of a poor family during the Great Depression, he recalled many tales of helping his family eke out a living. With his father, a school teacher, he worked to refinish school desks during summer recess. Roger would walk the tracks of a nearby railroad, collecting chunks of coal they could use for heating in the winter. And in the summers, his family often obtained their only meal of the day from the fields nearby, where they found fresh ears of corn and vine-ripened watermelons.

When the United States entered World War II, his mother, in the tradition of Rosie the Riveter, moved with Roger to Southern California to do war work. His father later joined them. Roger graduated from Glendale High School in Glendale, California. With his father's encouragement, he joined the United States Navy and served on a destroyer-class ship from 1946 to 1948. He then took advantage of the G.I. Bill

to attend Glendale Community College, earning an associate of arts degree in 1950. He then attended the University of California, Berkeley, graduating with a bachelor of arts degree in 1952**.** He continued in graduate school there, specializing in astronomy. Roger met and married a fellow graduate student Beverly Ann Turner in 1954, and they both received their Ph.D. degrees from Berkeley in 1955. They had one daughter, Susan Elizabeth, born in 1958. They divorced in 1986. In 1990, he married Gina Rita Badami, and they adopted a son, Andrew. They were divorced in 2014. Badami died in 2021.

Roger was a Miller Fellow from 1954 to 1955 and then a research associate at Berkeley from 1955 to 1958. He was a Canadian National Research Council Fellow at the Dominion Astrophysical Observatory, Victoria, British Columbia, from 1958 to 1959. At that time, the National Science Foundation had established a new National Radio Astronomy Observatory (NRAO) in Green Bank, West Virginia. Otto Struve, who had been chair of the Department of Astronomy at Berkeley during Roger's time there, became the director of NRAO and invited Roger to join him on the staff. Roger served as an assistant scientist at NRAO from 1959 to 1961. Roger's primary interest was in optical astronomy and the development of digital detectors for use on optical telescopes. This interest started in his first years of college. A notebook from a physics course at Glendale Community College describes his original work on a dozen experiments on lenses, optical instruments, and spectral and polarization measurements, all of which received high marks. This interest continued during his years at Berkeley. In 1961, he joined Kitt Peak National Observatory in Tucson, Arizona, as an assistant astronomer. He soon began a collaboration with his friend Bill Livingston on optical detectors. Roger was promoted to associate astronomer with tenure in 1967, and to full astronomer the following year. He worked at NOAO until his retirement in 2014 and continued as an emeritus astronomer until his death.

Scientific Achievements

Over his long career, Roger made many important contributions to the field of observational astronomy. The following are brief descriptions of a few of his major contributions. While at NRAO, Roger carried out radio observations of the well-known galaxy Messier 82 (M82). These observations showed that M82 was a strong radio source with a spectrum similar to that of the Crab Nebula. This led him to conclude that the emission from M82 results from the synchrotron mechanism and that the synchrotron continuum extended into the optical region.[1] Later, while a guest investigator at Lick Observatory in Mt. Hamilton, California, Roger and Alan Sandage of Carnegie Observatories (another giant of observational astronomy) in Pasadena, California, followed up these observations with optical ones. The results were reported in their 1963 paper titled, "Evidence for an Explosion in the Center of the Galaxy M82."[2] This source continues to be a laboratory for testing high energy and gravitational astrophysics theories to this day.

After joining NOAO at Kitt Peak in 1961, Roger joined Bill Livingston in working on the development of modern detectors for astronomical observations. Livingston and Lynds published several papers on their experiments with electronic image intensifiers.[3] Roger continued developing newer and more powerful detectors for NOAO for use by all observers. But he was not content with merely developing better detectors. His main interest was their use for discovering new objects in the Universe and for shedding light on mysteries regarding many known sources. The newly developed detectors on the Kitt Peak 84-inch telescope allowed him to compete with and surpass similar observations made on much larger telescopes that employed traditional photographic detectors. In particular, he was able to apply the new detectors to the study of the spectra of recently discovered quasi-stellar radio sources (QSOs, or quasars).

I met Roger at the 1970 General Assembly of the International Astronomical Union in Brighton, United Kingdom, where he presented a high-resolution spectrum of unprecedented clarity of quasar 4C 05.34, showing numerous absorption lines at the short-wavelength side of the strong Lyman-alpha emission line, a prominent emission signature of high-redshift quasars. He speculated correctly that these features were Lyman-series absorptions by intervening "galaxies" containing atomic hydrogen. In his 1971 letter in the *Astrophysical Journal,*[4] he wrote, "In addition to having the largest redshift (z=2.877) thus far reported, the QSO 4C 05.34 is also important because of the character of its absorption-line spectra"; he named these spectra the "Lyman-alpha forest" in a *Sky and Telescope* article. Investigations of the Lyman-alpha forest continue to this day and have become a basic method for the study of cosmological large-scale structure formations.

Roger's influential work led to his nomination for selection to the National Academy of Sciences by Leo Goldberg, director of NOAO. Several prominent NAS scientists, including Alan Sandage, wrote glowing letters on Roger's behalf. In April 1974, he was elected a member, the first selection of a Kitt Peak astronomer. Roger received congratulatory telegraphs and letters from many renowned scientists throughout the world.

Roger was also interested in other characteristics of quasars, in particular their cosmological distributions and evolution, as described in several papers.[5,6] His collaboration with me led to an enduring friendship and to many subsequent

collaborations. In 1973, I proposed the use of surface brightness variation with redshift as a means of disentangling the evolution of galaxies and the Universe. I approached Roger and Alan Sandage about the possibility of testing this with observations of galaxies. Both agreed and secured time on the Kitt Peak Mayall telescope for deep observations of clusters of galaxies. I joined them in observing all the then-known high-redshift clusters, which took several observing sessions.

I learned a lot from these two giants of observational astronomy, enjoying their cooperation and occasional quibbles. Most observations were carried out using Roger's newly built digital detectors at the Cassegrain focus, but occasionally Alan obtained some data from the prime focus that were later digitized using the NOAO microdensitometer in the basement of the Kitt Peak building. These observations revealed the presence of some elongated, curved, arc-like features in three clusters, one of which was decidedly semicircular. Alan declared that this should be the subject of our first paper on these data, but Roger was concerned about the fuzzy nature of most of the features. As the leader of the project, he suggested that we should wait for the completion of the CCD camera he was in the process of building for the observatory, which would give much clearer images.

During this wait, which took almost a decade, Alan withdrew from the project but continued observations testing the evolution of the surface brightness of galaxies and published several papers on it. I returned to my teaching and research at Stanford University, with three photos of the arcs posted in my office. As promised, Roger did complete the development of the CCD detector and re-observed the three clusters, gaining a much clearer view of the arcs. We submitted a paper[7] to the American Astronomical Society (AAS) meeting at Pasadena held in January 1987, with this abstract (written mostly by Roger):

> We announce the existence of a hitherto unknown type of spatially coherent extragalactic structure having, in two compelling known examples, these common properties: location in clusters of galaxies; narrow arc-like shape; enormous length; and situation of the center of curvature toward both of the cD galaxies and the apparent center of gravity of the cluster. The arcs are in excess of 100 Kpc in length, have luminosities roughly comparable with those of giant E galaxies, and are distinctly bluer than E galaxies—especially in one case. Interpretations of the nature of the arcs are discussed within the framework of available data.

After obtaining spectra of the arcs, in the abstract of our 1989 paper in the *Astrophysical Journal,* we presented the conclusion, "The weight of evidence seems to favor the interpretation that these features are images of more distant objects produced by the gravitational field of the intervening clusters."[8]

Initially, Roger was slightly disappointed with this result because gravitational lensing had been predicted and discussed since the early twentieth century, notably by Albert Einstein and Fritz Zwicky. But he came around and soon was proud of this discovery, seeing the wide use and the great success of gravitational lensing in many areas of modern cosmology that continues to this day.

When plans were being made for the Hubble Space Telescope, Jim Westphal was named principal investigator of the project to design and construct the Wide Field and Planetary Camera, which became Hubble's workhorse camera. He invited Roger to join his team. When built, this camera recorded images through a selection of forty-eight color filters covering a spectral range from far-ultraviolet to visible and near-infrared wavelengths. Roger was an active member of the team. As a footnote to this history, he was the first to recognize that Hubble's primary mirror suffered from a spherical aberration. He raised his concerns at a meeting on May 20, 1990, but the assembled group was not disposed to look into Roger's claim. Roger stood and delivered a strongly jarring and discordant response. A month later, after an air-tight demonstration of the spherical aberration, the devastating discovery was announced to the world. Roger's assessment had been correct.

Throughout his career, Roger was always in search of new phenomena and mysterious astronomical sources. He had a drawerful of such objects. For example, he had images of galactic size sources that looked like a smoke ring or a bird and others, most of which were not published. Another example of his unpublished work was Roger's pioneering experiment using the well-known ~4000 Angstrom break of galaxies for obtaining their redshifts. He had obtained narrow-band images around this break for galaxies with known redshifts and showed that the observed wavelength in which the flux underwent a step wise drop can be used to determine the redshift. Using such features of galactic spectra to estimate redshift, known as photometric redshift, is a common practice nowadays. This tendency of not publishing or delaying publication until a more reliable data could be obtained or a better understanding was achieved sometimes did not sit well with directors, who believed that data obtained by publicly supported instruments should be disseminated broadly. Roger remained true to his core principles.

Other Interests

Roger's interests and passions extended beyond science. As in his research, Roger was thorough in all his many activities and hobbies. He was an enthusiastic hiker and enjoyed many

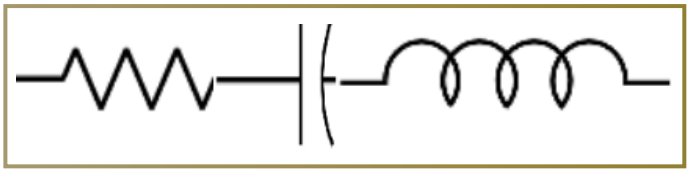

Figure 2 Sometimes, whimsically, Roger would sign his letters and emails by the symbol of a resistor, capacitor and inductor in place of Roger C. Lynds.

trips to the Sierra Nevada Mountains with friends and excursions with companions into Arizona's Catalina Foothills, where he once almost lost his life in a fall over a waterfall. During these hikes he took photos of the scenery and worked them into beautiful panoramic views that he posted outside his office. When he developed interests in table tennis and volleyball, he worked hard to become an accomplished player in both. Later, he became a proficient alpine skier. He skied often in Santa Fe, New Mexico, and taught skiing for several years at the Wolf Creek Ski Area in Colorado.

Roger's artistic abilities were most strongly exhibited by his superb calligraphy. As a master craftsman of this art, he was active in the Calligraphic Society of Arizona. He once suggested to the editors of the *Astrophysical Journal* that they publish a paper of his on his own calligraphy. This was politely refused. Roger also enjoyed classical music and played Johann Sebastian Bach enthusiastically first on a harpsichord he built and later on a more sophisticated one he purchased. He also was an avid fan of science fiction. He recorded a complete set of all *Star Trek* episodes on VHS, and he saw the Star Wars franchise movies many times over. He kept several statues of Chewbacca the Wookiee on his desk. Roger died on Sunday, April 16, 2023, in Tucson, Arizona, at the age of 94.

Final Thoughts

Roger's contributions to astronomical research are many, highly regarded, often quoted, and continue to be in the forefront of astronomical research in the areas of quasars, gravitational lensing, and the Hubble Space Telescope. His productivity, measured by the number of publications in astronomical journals, was not high. But this is not a true measure of the importance of his contributions. Roger devoted considerable time to building state-of-the-art instruments specifically for the National Observatory at Kitt Peak and for the Hubble Space Telescope. Roger immersed himself in every aspect of a research project, from hardware development to theoretical modeling. His highly meticulous approach to research meant that he rarely published a paper on an incomplete project. A good example of this is his insistence on waiting until he could provide clearer images of the arc, which was probably key to their discovery becoming national news.

References

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