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NICHOLAS ULRICH MAYALL
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A Biographical Memoir by
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Biographical Memoir

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N. U. Mayall

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May 9, 1906–January 5, 1993

BY DONALD E. OSTERBROCK

NICHOLAS U. MAYALL WAS born in the Midwest near the beginning of the twentieth century and died in Arizona near its end. He was an outstanding observational astronomer of gaseous nebulae, globular clusters, and galaxies. A product of the University of California, he joined the staff of its Lick Observatory even before he completed his Ph.D. and remained a member for more than a quarter of a century, obtaining with its small reflecting telescope excellent data on objects too faint for most astronomers to see. During World War II, he did important weapons development work at Cambridge, Massachusetts, and then at Pasadena, California. He helped launch the Lick Observatory's large, new, postwar telescope and then left the University of California to become the director of the still very young Kitt Peak National Observatory. He built it up into an important research institution, with large telescopes in both hemispheres, the National Optical Astronomy Observatories of today.

LIFE HISTORY

Mayall was born in Moline, Illinois, on May 9, 1906, the first of two sons. His father, Edwin L. Mayall, Sr., was an

engineer who worked for a manufacturing firm in Illinois. His mother, Olive Ulrich Mayall, although she did not go to college, had a visionary understanding of higher education and set high standards for her two sons, Nicholas and Edwin, Jr. The family moved to the central valley of California sometime between 1907, when Edwin, Jr., was born, and 1913, when Nick began first grade at a small rural school near Modesto. By 1917 they had moved to Stockton. Except for one year back in Peoria, Illinois (1918-19), they stayed there through 1924, when Nick graduated from high school. Sometime along the line, probably while Nick was in high school, his parents were divorced.

In his senior year at Stockton High School, Nick arranged for the science club, of which he was secretary, to visit Lick Observatory, atop 4,200-foot-high Mount Hamilton, near San Jose. He was allowed to drive his father's auto and take a car full of boys up the winding mountain road, at that time unsurfaced dirt and gravel. It was his first sight of the observatory where he was to be a student and spend so much of his professional career. The visit inspired him to read all the astronomy books in the high school and local public libraries, but he had never thought of making astronomy his profession.

EDUCATION

In the fall of 1924 Mayall entered the University of California in Berkeley as a freshman in the College of Mining. He lived with his mother in an apartment on Durant Avenue and worked in the stacks at the university library to earn the money they needed to survive. Mayall was a good student, who ultimately was elected to Phi Beta Kappa and Sigma Xi, but by the midterm examinations in the first semester of his sophomore year he was heading for poor marks in mineralogy and chemistry laboratory. The dean

called him in and found that Mayall was color-blind. He could not see the subtle color changes in flame and bead tests, nor in titrations and precipitations. His adviser told Mayall that there was nothing to do but change his major; a mining engineer had to be able to do those tests to graduate.

At this point Mayall decided that maybe astronomy was for him after all. He consulted his mother, who urged him to do what interested him most but, whatever it was, to do it well. First, he investigated carefully, asking several professors in the Berkeley astronomy department if they were happy in their work and making a decent living. Receiving affirmative answers, he transferred to the College of Letters and Science and majored in astronomy. This did not delay his progress, for nearly all his freshman work had been in mathematics and basic physical sciences. He found he liked astronomy very much and decided to go on to graduate work and a career as a research scientist.

In 1928, when Mayall finished his undergraduate work and received his A.B., the University of California had the most outstanding graduate astronomy program in the country. All the courses were taught by the professors in the Berkeley department on the campus, but many of the students did their thesis work on Mount Hamilton, under the tutelage of a Lick astronomer who became a member of their thesis committee. The founder and long-time chairman of the Berkeley department, Armin O. Leuschner, was an expert on celestial mechanics. Most of the other faculty members in the department were his former students, selected much more for their teaching ability than their research qualifications. What research they did do was also in celestial mechanics, except for C. Donald Shane, another Berkeley product who had done his thesis on carbon stars at Lick and who taught all the astrophysics courses in the depart-

ment, undergraduate or graduate. The graduate students were very well trained in the "theoretical astronomy" of that day (celestial mechanics), especially "Leuschner's method" for determining the orbit of a newly discovered comet or asteroid from three observations of its position.

Mayall received a teaching fellowship (making him equivalent to a teaching assistant of today, worth \$600 a year then) for his first year as a graduate student, 1928-29. He enjoyed the course work, especially in astrophysics, and learned to calculate orbits rapidly and accurately. In the summer of 1928, before beginning as a graduate student, Mayall worked as the grader for an astronomy course taught in the Berkeley summer session by Seth B. Nicholson of the Mount Wilson Observatory staff. He was a Berkeley product himself, who in 1914 at Lick discovered Jupiter IX, a small faint moon of the giant planet. Its orbit became the subject for his 1915 Ph.D. thesis. Nicholson told Mayall that there would be an opening for a computer (a job held by a human being at that time) at the Mount Wilson Observatory offices in Pasadena the following year. By then Mayall was tiring of course work; he applied for the Mount Wilson position and got it. He worked there two years (1929-31), learning research by doing it. His job was to assist Nicholson and several other staff members, including Edwin Hubble, Alfred H. Joy, and Director Walter S. Adams, by measuring and reducing their observational data. When Clyde Tombaugh discovered Pluto at Lowell Observatory in 1930, Mayall, working with Nicholson, demonstrated that Leuschner had taught them well. They used the first preliminary orbit for the new planet, calculated by Ernest Clare Bower and Fred L. Whipple at Berkeley, to search along its early path for a direct photograph in the Mount Wilson collection that would provide an early position of it. They found it, a very faint object in a crowded field, on a plate taken in 1919, mea-

sured it, and quickly calculated and published the first definitive orbit with an eccentricity. It showed that Pluto was certainly a planet whose orbit crossed that of Neptune. But Mayall managed to get to Mount Wilson often himself, working with the staff astronomers on all the telescopes and using most of them on his own as well. He became especially close to Milton L. Humason and was inspired by Edwin Hubble. Mayall decided he wanted to make his career in nebular spectroscopy and research.

When he returned to Berkeley in the fall of 1931 to complete his graduate course work, Mayall had a Martin Kellogg Fellowship (worth \$1,000 per year) and a prospective thesis topic, suggested by Hubble. It was to count the number of galaxies per unit area on the sky, as a function of position, on direct plates taken with the Crossley (36-inch) reflector, on Mount Hamilton, to supplement the counts Hubble himself was making with the 60-inch and 100-inch telescopes at Mount Wilson. Mayall did very well in his courses and went to Lick Observatory in the summer of 1932 to begin the main part of the observational work. He had learned well from his Mount Wilson mentors and was an expert at obtaining first-class direct photographs with the ancient and tricky Crossley telescope. Mayall made the counts on his own plates, after closely inspecting earlier ones taken by his predecessors at the instrument, Heber D. Curtis, Charles D. Perrine, and James E. Keeler, the latter the second director of Lick Observatory, who had put the Crossley into operating condition and with it first discovered (at the turn of the century) the very large number of spiral “nebulae” in the universe.

Mayall finished his thesis and received his Ph.D. degree at the 1934 Berkeley commencement. Hubble praised his work, which was in fact excellent technically. However, the whole program, on which Hubble himself spent years, never

achieved very significant results. It was flawed by the lack of accurate magnitude standards for the faint galaxies at which it was aimed and by the then-unrecognized very strong clustering tendency of galaxies.

LICK OBSERVATORY

Mayall's thesis adviser, William H. Wright, a University of California graduate and a Lick Observatory staff member since 1897, was a nebular researcher and spectroscopist himself and a great friend and admirer of Hubble. Mayall wanted to design and build a small fast spectrograph, optimized for nebulae and galaxies, to use at the Crossley to make it competitive for at least some of the spectacular work that Humason and Hubble were then doing with the larger telescopes at Mount Wilson. Wright and Joseph H. Moore, the head of the Lick stellar spectroscopy program, encouraged Mayall to go ahead with the design and then had the spectrograph built in the observatory shop. Though there was no opening on the staff for even the most junior astronomer, they kept Mayall at Lick as an observing assistant after he got his Ph.D. It was the same position he held for the final year of his thesis work and in reality allowed him to devote most of his time to his own research. The job paid very poorly, but the Great Depression was at its height (or in its depth), and there were few available alternatives, none for Mayall, who was committed to a research career with the spectrograph he had designed. He had hoped for a position at Mount Wilson, but there were no openings at all there because of the Depression.

As he began his postdoctoral career at Lick, Mayall married Kathleen (Kay) Boxall of Los Angeles on June 30, 1934. They met during his two years in Pasadena, according to family legend, at a field hockey game, probably at Tournament Park, very near Caltech. Whether it was a mixed game

or Mayall was a spectator was not reported. They moved into a small apartment in the little astronomy village on the summit of Mount Hamilton, where all the astronomers lived.

One year later, on July 1, 1935, Robert G. Aitken, the elderly director of Lick Observatory, retired, and Wright succeeded him in the post. The two of them, and Moore, had managed to keep Mayall and his good friend Arthur B. Wyse, who had also received his Lick Ph.D. in 1934, on the staff, initially as observing assistants. Now as assistant astronomers they replaced Aitken and Robert J. Trumpler, who moved to Berkeley in 1935.

Mayall began using his new nebular spectrograph at the Crossley. Although it was not competitive with Humason's instrument on the much larger 100-inch telescope for stars or elliptical galaxies, with their condensed, relatively bright nuclei, the Lick spectrograph was actually faster for extended, low-surface-brightness gaseous nebulae and irregular galaxies. This was particularly the case in the ultraviolet, for Mayall, with Wright's strong encouragement, used quartz and ultraviolet transmitting optics, in contrast to the Mount Wilson spectrographs with their heavy glass lenses and prisms. With it Mayall got the first really good spectrum of the Crab nebula. From it and the previously published angular rate of expansion of the nebula, he was able to estimate its distance. With this data, Mayall became the first to recognize and prove the Crab nebula to be the remnant of a supernova observed and recorded by Chinese astronomer-astrologers in 1054, rather than an ordinary nova. He also found important new results on emission nebulae in the nearby spiral galaxy M 33 and various irregular galaxies and on the unexpected occurrence of forbidden emission lines of ionized oxygen in the spectra of the nuclei of many galaxies, a sign of the frequent presence of ionized interstellar gas even in the centers of these objects. With Hubble's encour-

agement Mayall measured spectroscopically the rotational velocities of several spiral galaxies. Wyse collaborated with Mayall on several papers on the interpretation of the measured radial velocities of the H II regions in M 31 and M 33 in terms of the rotation of these two especially nearby spiral galaxies, the gravitational field that it implied, and hence the distribution of mass within them. They made a good team, Wyse more theoretically inclined, Mayall an exceptionally skilled observer with the Crossley reflector he knew so well. His color blindness stood him in good stead here, for along with it he apparently had much more acute sensitivity to very low light levels than most mortals. Certainly he could see on the slit and in the periscope eyepiece of his spectrograph objects that were too faint for most other astronomers who observed with him, including myself.

Among the California graduate students who worked with him in those early years at Lick, the closest to Mayall were Daniel M. Popper and Lawrence H. Aller (who finished his Ph.D. at Harvard but came back to Mount Hamilton to observe several times). They both admired him greatly for his observational skills, his dedication to astronomy, and his warm, friendly personality. He was a good adviser to them and a realistic one.

Jan H. Oort, the outstanding Dutch astronomer, collaborated with J. J. L. Duyvendak, an Oriental scholar, in establishing the identity of the Crab nebula with the "new star" recorded by the Chinese a millennium ago. After Holland was overrun by the Nazis early in World War II, Oort, by correspondence, suggested to Mayall further ancient sources, including Semitic records, which might contain information. Mayall helped track them down at Berkeley and published the results in a joint paper with Oort.

The Mayalls had two children, Pamela and Bruce, who grew up on the mountain and attended its one-room school.

When they graduated from eighth grade, they had to go away to boarding schools. Mayall took the hour-a-day job as postmaster on Mount Hamilton to help pay the associated costs.

WORLD WAR II

World War II abruptly put Mayall's research career on hold, just as he was getting established. Well before America entered the war both he and Wyse applied for Naval Reserve commissions, to be called to duty as navigation instructors if needed. Mayall was rejected, because his color blindness prevented him from passing the required physical examination. In the fall of 1941 Wyse joined a wartime Navy antisubmarine technical project at San Diego as a civilian scientist. He was killed in sea trials of a proposed new submarine detection system in June 1942 in a collision of two dirigibles over the Atlantic Ocean. He had been Mayall's close friend. Mayall, along with nearly everyone else who knew Wyse, expected that he would someday become director of Lick Observatory.

Even before Wyse's death, Mayall accepted a position at the Radiation Laboratory in Cambridge, Massachusetts, to work on radar development. Gerald E. Kron (who recruited him) and Hamilton M. Jeffers, of the Lick staff, both single men, had begun working there before Pearl Harbor. Mayall worked on testing and calibrating the accuracy of the positions of airplanes provided by the early radar systems, comparing them with optical, visual, and photographic positions. However, the Boston climate, changeable and extreme compared with the California weather to which Mayall was accustomed, caused him and his family many colds and illnesses and aggravated his arthritis and sciatica. He felt he could not make real contributions at the Radiation Laboratory, dominated by electronic and antenna experts.

In mid-1943 Mayall arranged to transfer to the Mount Wilson Observatory offices in Pasadena, where several wartime Office of Scientific Research and Development projects concerned with optics, aerial gunnery, bombing tactics, and aerial photography were under way. There, in the atmosphere of California and astronomy, Mayall's health was restored. In one of the ironies of the war, he ate lunch daily with the two German-born Mount Wilson Observatory staff members—Rudolph Minkowski, a naturalized American citizen who was working with him on the OSRD projects, and Walter Baade, still a German national, who could not participate in or even know of the war work. Presumably, Mayall and Minkowski “buttoned up their lips” (as the wartime posters urged them to do) and did not pass any military secrets to Baade. His enemy alien status meant he was restricted to Los Angeles County, and, as practically the only member of the Mount Wilson staff not doing any war work, Baade had nearly unlimited use of the 100-inch telescope. Under the wartime brownout in Los Angeles, the night skies were unusually dark, and Baade was able to take direct photographs of the nearby Andromeda galaxy, M 31, and its companions, which showed stars to a fainter level than he had been able to reach before. This observation was the final evidence in his great discovery of the “two stellar populations,” young stars and old. Mayall was on the scene in the late summer and fall of 1943 as Baade did this work and discussed it daily with him. Astronomical observations were not military secrets, and the enthusiastic Mayall kept the few elderly Lick astronomers still on the job at Mount Hamilton informed of Baade's epochal results.

Mayall enjoyed the Mount Wilson Observatory atmosphere, especially when he was even allowed to work with the 60-inch telescope for two nights during his Christmas vacation! But he believed that, owing to mismanagement in the

higher levels of the OSRD optical instruments division, he and the Mount Wilson group were not being given a chance to make a really effective contribution to the war effort. Hence, he welcomed an opportunity to transfer in February 1944 to the California Institute of Technology, whose big rocket development project was clearly providing immediately effective weapons. Several other astronomers were working there, including Kron, who had moved there earlier; Horace W. Babcock, who did his Lick Ph.D. thesis under Mayall's supervision; and John B. Irwin, a former Berkeley and Lick graduate student. Mayall, who worked on the Caltech campus and sometimes at the more open testing areas at Inyokern, in the Mojave Desert, soon made himself a highly productive member of the project. He became an expert at high-speed photography, necessary to study and understand rocket trajectories and impacts. After the German surrender in the spring of 1945, Mayall was transferred to an ultrasecret group working on very-high-speed photography for the atomic bomb project, in connection with the plutonium implosion weapon. He made at least two trips to Los Alamos, one at about the time of the Trinity test, but he was not there for the firing. Probably he had briefed the Los Alamos high-speed photography group or discussed some of their results with them. Mayall, a confirmed believer in security to the end of his life, steadfastly declined to discuss this aspect of his wartime career.

Soon after the war ended, Mayall was released from his post, and by October 1, 1945, he was back in astronomical research at his beloved Mount Hamilton. During his three years with the OSRD, Mayall had made important contributions to the war effort, particularly at Caltech and Inyokern. In addition, he had gotten out of the comfortable little world of astronomy and had greatly broadened his outlook on science, research, and leadership. At the Radiation Labo-

ratory and at Caltech, Mayall saw big science in action, in its wartime version, and he made many contacts with physicists with whom he would interact frequently in his later years as director of Kitt Peak National Observatory.

THE 120-INCH TELESCOPE

During World War II, Mayall played an important role in determining the future of Lick Observatory. From the time he returned to Berkeley and Lick in 1931, after his two years as an assistant at Mount Wilson, he felt acutely the need for a larger telescope at Mount Hamilton. The Lick astronomers prided themselves on getting important results with their small, 36-inch Crossley reflector, which had been dwarfed by the Mount Wilson 60-inch since 1908, the Dominion Astrophysical Observatory 72-inch since 1917, and the Mount Wilson 100-inch since 1919. Mayall became an expert observer with the Crossley, but he realized that it could never really compete with a telescope with three times its diameter, nine times its collecting area. It would be even worse when the Palomar 200-inch came into use. Mayall and the other younger Lick faculty members believed that the older astronomers, Wright and Moore, were too committed to the small telescopes and should have worked harder to get a larger reflector for Mount Hamilton. Wright was proud of what he had accomplished with the Crossley and tended to scoff at the big-telescope mystique, but actually behind the scenes he and Aitken, his predecessor, had tried hard to raise the money for a larger reflector from private sources and also to persuade University of California President Robert G. Sproul to put it in the budget. They failed in each attempt, largely because of the Great Depression. However, unknown to Mayall, Sproul changed his mind in 1942, after his first choice for a director to succeed Wright, Paul W. Merrill of Mount Wilson Observatory, declined to

leave the big telescopes even for the directorship of the University of California's famous research institution. Sproul, shaken by Merrill's refusal, told the regents that they must raise the money somehow after the war ended. At the same time, he either secretly appointed Shane, by then chairman of the Berkeley Astronomical Department, as postwar director of Lick, or promised him the post.

In September 1944 news of the planned big postwar telescope but not of the new director surfaced in the University of California's budget proposals. Moore, by then the interim wartime director, and Wright, seventy-two years old but still very much on the scene as a retired astronomer recalled to service, thought of it as an 85-inch or 90-inch telescope, the largest instrument that they believed could be built for the funds specified in Sproul's budget proposal. Mayall and the other young Lick astronomers and former graduate students now in Pasadena, all of whom longed to return to Mount Hamilton and who discussed frequently everything that happened there, believed that Moore and Wright were out of touch with the real needs of astronomy. Emboldened by the wartime emphasis on youth and on cutting through red tape to get results, Mayall resolved to go straight to the president of the university himself. He wrote Sproul, asking for an appointment to see him on one of his regular monthly visits to the University of California at Los Angeles campus. Kron also signed the letter, in which they said that, "as younger members of the [Lick] staff, who hope to use the instrument," they wished to discuss "what kind of telescope" the University of California should build when the war ended. Sproul welcomed them to his Los Angeles office in December 1944. Mayall did most of the talking. He emphasized the need for a telescope bigger than a 90-inch. In Pasadena he had seen the 120-inch glass disk originally intended for testing the

200-inch Palomar mirror, then nearly finished in the Caltech optical shop. He urged Sproul to make the Lick reflector that large. To Mayall and Kron's surprise, Sproul quickly assented and in turn urged them to keep up the pressure on "the old men."

In early 1945 Sproul appointed a committee, chaired by Shane, then on leave at Los Alamos as assistant director for scientific personnel, to plan the postwar Lick telescope. He also appointed Moore and Mayall to the committee, as well as Mount Wilson Observatory Director Walter S. Adams and Caltech physicist Ira S. Bowen, who would succeed Adams and become the first director of Mount Wilson and Palomar Observatories at the war's end. The committee worked mostly by correspondence, and Mayall's first letter helped to persuade Shane that it was reasonable to hope for a 120-inch rather than settle for a 90-inch, as he had earlier thought. Mayall, on the scene in Pasadena, was invaluable in providing liaison between the strong telescope group there and Shane, whose expertise was much more in teaching and university administration than in instrument design. Adams and John A. Anderson, executive officer of the 200-inch project, made their drawings, plans, and experience freely available to the California astronomers. Mayall was present at the one actual meeting of the committee, in Pasadena on March 6, 1945, when Shane could get away from Los Alamos briefly. On that day the committee made all the basic decisions for what eventually became the Lick 120-inch reflector. Shane and Mayall went on to Mount Hamilton the next day and there, with Moore (who had not been able to get to Pasadena) and Wright, picked out the spot where the telescope would be erected.

After the war Shane guided the 120-inch project through the university and helped Sproul sell it to the legislators and the governor. Caltech made its disk available at cost,

which bypassed the delay that ordering a new one would have caused. Mayall, as the most experienced big telescope user on the Lick faculty, who often went to Mount Wilson and later even to Palomar to observe with Baade, Minkowski, and Humason, made many suggestions that were incorporated into the Lick reflector. It was safe, sound, conservative, and productive—his style exactly.

POSTWAR LICK RESEARCH

The 120-inch telescope was years in the building. Meanwhile, Mayall worked actively on research with the Crossley reflector. He began obtaining the integrated spectra of globular clusters with his fast spectrograph well before the war. Now he finished this work and published the results—the radial velocities of the first fifty clusters. The result was important in proving that the system of globular clusters shares only slightly in the galactic rotation exhibited by the flattened system of young stars and interstellar matter in the Milky Way. This work, like all of Mayall's, was very well suited to his small telescope and fast spectrograph, optimized for extended, low-surface-brightness nebulae, galaxies, and clusters.

Much of Mayall's best work was done in collaboration with or at the suggestion of his friends and mentors at Mount Wilson Observatory. Although he still idolized Hubble, who had been on leave as director of the Army's Ballistics Research Laboratory at Aberdeen, Maryland, for the duration of the war, by the time the 200-inch telescope went into operation in 1948 the great observational cosmologist was tired and ill. He suffered a heart attack in 1949, never fully recovered, and died in 1953. Baade had become Mayall's chief source of inspiration during World War II. He wrote frequently to his younger friend at Mount Hamilton, and they had long discussions at the informal Lick-Mount Wil-

son and Palomar nebular research conferences that Shane and Bowen arranged. With Baade's continued encouragement and advice, Mayall carried out a long, important program of spectroscopy of the H II regions in the spiral arms of M 31, to better define its rotation curve.

One very important paper Mayall published in observational cosmology, with Humason and the young Allan Sandage as coauthors, was a catalog of the Lick, Mount Wilson, and Palomar redshifts of galaxies. It contained the redshifts of more than 800 galaxies observed over the years from 1935 to 1955. Humason provided the data on the ellipticals and distant spirals for which the 100-inch and 200-inch telescopes and their spectrographs were so well suited, Mayall for the irregulars and nearer spirals, and Sandage provided most of the magnitudes. He was also chiefly responsible for the discussion in terms of the velocity-distance relationship. This paper enormously strengthened the observational evidence for a linear velocity-distance relationship. The value they determined for the Hubble constant, 180 km/sec/Mpc was a step along the way from the outstanding observational cosmologist's early value of 530 km/sec/Mpc to the currently accepted values of 50 to 100 km/sec/Mpc.

The great expert on spectral classification of stars, William W. Morgan, worked with Mayall and his collection of galaxy spectra during a visit to Lick. They published a joint paper on the results, a spectral classification of galaxies that showed many of the population and heavy-element abundance differences between spiral and elliptical galaxies, much later made quantitative by detailed CCD spectrophotometry. Mayall and Kron, again with the very active encouragement of Baade, collaborated on measuring the colors of globular clusters in our own Galaxy and in M 31 and its companions, for information on interstellar extinction and the stellar populations of these clusters.

From the end of World War II, Mayall was the editor of all the Lick Observatory scientific publications and hence a member of the editorial board of the *Astrophysical Journal*. He devoted considerable effort to this task and greatly improved the clarity and accuracy of presentation of several of his colleagues' papers.

As the 120-inch telescope approached completion on Mount Hamilton, Mayall was responsible for taking the test exposures that showed how close the primary mirror was to the correct form and what additional figuring was necessary to bring it to the final ideal paraboloid. On this project he worked with Stanislavs Vasilevskis, who measured the plates and reduced the numerical results to quantify the form of the mirror.

In 1958 with the telescope still not completed, Shane stepped down as director. Albert E. Whitford, his successor, was brought from the University of Wisconsin to finish the task and put the 120-inch into operation. The opticians finally figured the mirror correctly, as the test plate Mayall took on June 17, 1959, confirmed. Then the mirror could be aluminized and the auxiliary instruments installed. By early 1960 the 120-inch was in regular operation. Mayall began taking direct exposures of nebulae and galaxies at the prime focus, but only a few months later, in September 1960, he left Lick Observatory and Mount Hamilton.

KITT PEAK NATIONAL OBSERVATORY

Mayall left the University of California, where over a span of more than a quarter of a century he had been undergraduate, graduate student, and assistant and held every rank from assistant astronomer to astronomer, to become the second director of Kitt Peak National Observatory. The national observatory concept had only become a reality a few years before. Under the financial sponsorship of the

National Science Foundation, a group of universities organized a consortium, Associated Universities for Research in Astronomy, to build and operate a research observatory for all American astronomers to use. The first director, Aden B. Meinel, located the site, Kitt Peak, a 7,000-foot mountain near Tucson, Arizona. He selected and recruited the first staff members and built the first telescopes. But in the spring of 1960, as the Kitt Peak 84-inch reflector was completed and dedicated, the AURA Board of Directors decided that Meinel was not the person to manage it. He resigned, and the board named Mayall to succeed him. Shane, who represented the University of California on the AURA board and was its president at that time, played the major role in persuading him to take the job.

Mayall had never had any previous administrative experience, but he was an excellent choice for the post. Then fifty-four years old, he was ready for a change, and, after only a brief hesitation, he accepted the proffered appointment. He gave Kitt Peak instant credibility, in a way that Meinel, a postwar Ph.D., and the few young staff members he had assembled could not do. Several of the Lick, Mount Wilson, and Palomar astronomers, comfortable with the idea of an elite few having the largest telescopes in the world at their disposal, had scoffed at the concept of an observatory for everyone (although Bowen, Shane, and Whitford all supported the project strongly). But no one could scoff at Mayall, one of the most respected research astronomers in America. A member of the National Academy of Sciences since 1949 and chairman of its astronomy section, former president of the Astronomical Society of the Pacific, and president of the International Astronomical Union Commission on Extragalactic Nebulae, he clearly belonged. He could recruit new staff members who would come firm in

the knowledge that he would be there for years and that the national observatory was there to stay.

In his early years Mayall received frequent advice from Shane, but he quickly picked up the skills needed to direct Kitt Peak National Observatory. He was particularly effective in handling its external relations, with NSF administrators, university vice-presidents and business managers, and Arizona and government officials. The 1960s were the post-sputnik era in American science. The country was prosperous and eager to support research. Mayall saw to it that Kitt Peak got its share of the available funding. He knew well all the astronomers who represented their various universities on the AURA board and could work effectively with them.

Mayall delegated almost all the responsibility for designing new instruments and operating the telescopes to the younger staff astronomers. Some met the challenge; others did not. As the staff grew, Mayall brought in some first-rate scientists who were willing to give their time and effort to make it possible for short-term visitors from all over the country to get important scientific results. Everyone who worked under Mayall at Kitt Peak considered him kind and gentle, and some thought that he was a little too gentle—with others. One administrator, not a scientist, was a continual source of problems, but he was useful, too, and Mayall never got rid of him.

As director, Mayall presided over the building of the 4-meter reflector, Kitt Peak's largest telescope. It was a huge team-engineering project that had been planned even before he came on board. Some of his former Lick colleagues and students were surprised and somewhat disappointed that he never began a research program of his own with the big Kitt Peak reflector, but he felt that he had too many other responsibilities that had to come first.

Mayall was much more personally involved in the expan-

sion of the national observatory to the southern hemisphere, in the Chile project that eventually became Cerro Tololo Interamerican Observatory. He and Shane went to Chile two months after he accepted the directorship and scouted the prospective sites. Mayall reported that he favored the one that was subsequently chosen, on Cerro Tololo. He strongly believed in the southern hemisphere observatory, as he demonstrated by his frequent trips to Chile and almost daily radio and telex contacts with the CTIO director, Victor Blanco. Mayall helped it grow, and its 4-meter reflector was well under way when he retired in 1971, at the age of sixty-five.

Mayall's retirement was marked by a scientific symposium, held in Tucson, at which Morgan, Minkowski, Sandage, and Margaret Burbidge were the invited speakers. He and his wife remained in Tucson, and, when the Kitt Peak 4-meter reflector was completed and dedicated in 1973, it was named the Mayall telescope for him. He was present for its "first light" on February 27 of that year. The telescope was in full operation by 1974, as was the Cerro Tololo 4-meter telescope the following year. Mayall had lived to see his work bear fruit. In retirement he corresponded frequently with Shane and Frank K. Edmondson, the long-time AURA representative of Indiana University who was one of the strongest early proponents of the cooperative or national observatory concept. Mayall kept in touch with the observatory and his many friends on its staff. He had suffered from diabetes for thirty years and died at his home in Tucson on January 5, 1993.

In summary, Mayall was an outstanding observational astronomer. At Lick Observatory he made many contributions to our knowledge of gaseous nebulae, supernovae, the motions within spiral galaxies, and the redshifts of the galaxies in the universe. In eleven years as director of Kitt

Peak National Observatory, he built it and Cerro Tololo Interamerican Observatory into first-rate research observatories, with world-class telescopes. Throughout his career he remained a kind, considerate person who was respected and admired by all who worked for him.

THIS BIOGRAPHICAL MEMOIR IS based largely on the written record of Mayall's research, given in his published scientific work, and of his other accomplishments and his life, drawn from hundreds of letters to, from, and about him in the Mary Lea Shane Archives of the Lick Observatory, going back to the 1924 letter that he wrote as secretary of the Stockton High School science club. These include a great many letters from his own personal scientific correspondence, which he presented to the archives. Some of the material on his student days is from his autobiographical chapter in a University of California centennial volume.¹ I knew Mayall personally since 1957, had many conversations with him in his later years about his scientific life, and interviewed him extensively in 1987, just before the Lick Observatory centennial. In addition, I received letters and messages from many of Mayall's former colleagues at Lick, Kitt Peak, and the wartime Caltech project, giving their reminiscences of him. I am greatly indebted to all of them, as I am to Kay and Bruce Mayall, who kindly provided additional information, particularly on this great astronomer's early life.

NOTE

1. Nicholas U. Mayall. In *There Was Light, Autobiography of a University: Berkeley: 1868-1968*, ed. I. Stone, pp. 107-19. Garden City: Doubleday & Co., 1970.

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