

THE CALIFORNIA-WISCONSIN AXIS IN AMERICAN ASTRONOMY

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INTRODUCTION

Anym astronomers are vaguely aware of a California-Wisconsin axis in American astronomy, but few realize just how many astronomical associations there are between the two states. A very large fraction of American astronomers have made the pilgrimage either eastward or westward between the Badger State and the Other Eden at least once in their careers, if not more often, and quite a few telescopes have made the same journey too, so that it is almost impossible to think of American astronomy without recognizing the connections between the two states.

The reasons for these ties are not hard to find — the two great American observatories founded in the nineteenth century, Lick Observatory of the University of California and Yerkes Observatory of the University of Chicago, located at Williams Bay, Wisconsin, dominated observational astronomy for many years, and each worked as a magnet, attracting astronomers from the other. When the Mount Wilson Observatory was built near Pasadena, in the early years of the twentieth century, it was at first very largely a Yerkes operation, and contributed even more to the traffic in astronomers between Wisconsin and California. The University of Wisconsin was an initially small but growing additional factor in this traffic, and Palomar Observatory, completed just after World War II, eventually became the largest factor of all.

LICK OBSERVATORY

Let us begin at the beginning. Lick Observatory was built as a result of the generosity of James Lick, an eccentric millionaire

whose fortune was based on land speculation in downtown San Francisco at the time of the Gold Rush. Lick, who was born in Pennsylvania but who had spent over twenty years as a cabinet- and piano-maker in Argentina, Chile and Peru, liquidated his South American business and arrived in San Francisco in January, 1848, with \$30,000 in cash. Almost immediately he began buying lots, the first at the corner of Jackson and Montgomery Streets for \$270, and after gold was discovered on the American River he was able to buy more and more land at more and more advantageous prices as everyone else in San Francisco tried to get a stake together and head for the gold fields (1).

Toward the end of his life, Lick decided he wanted to use part of his by then vast fortune to leave a monument to himself. His first idea was to build a pyramid in downtown San Francisco larger than the Great Pyramid in Egypt, but his advisers persuaded him to drop this plan and instead found an observatory with a telescope "superior to and more powerful than any telescope yet made." The observatory was built on Mount Hamilton, near San Jose, a site picked by Lick himself; it was completed in 1888, 12 years after his death, and Lick's body was brought from San Francisco to a tomb in the pier of the telescope, where it remains to this day (2).

The observatory and telescope were built under the dynamic leadership of Captain Richard Floyd, the President of the Board of Trustees of the Lick Trust, and Thomas Fraser, the Superintendent on Mount Hamilton, who had been the foreman of Lick's San Jose property. The 36-inch telescope lens, at that time the largest in the world, was made by Alvan Clark and Sons, the Massachusetts opticians who figured the optics for all the large refractors of those days. As President of the Lick Trustees, Captain Floyd was responsible for staffing the Observatory, and in 1880, long before it had been completed, he wrote to James C. Watson, an outstanding theoretical astronomer who was at that time the first Director of the Washburn Observatory of the University of Wisconsin, and tried to awaken his interest in moving to Lick. Watson was guardedly enthusiastic and replied "Perhaps when the time comes I may enroll my name as one of the candidates for the directorship of your observatory . . . [N]otwithstanding the ties that bind me here, I am for the best scientific opportunity while I live" (3). Alas he did not live, but died less than three months after writing this letter, of pneumonia contracted while observing in the cold Wisconsin night air (4).

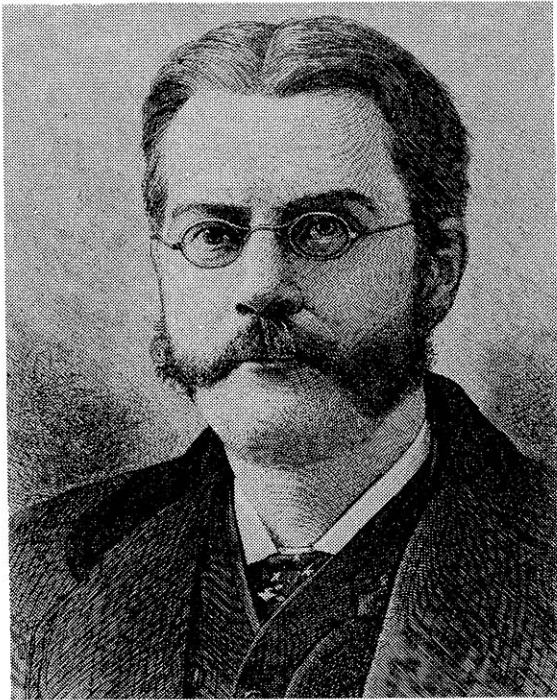


Figure 1. — Edward S. Holden 1846-1914. He was successively Director of the Washburn Observatory of the University of Wisconsin, President of

the University of California, and Director of its Lick Observatory, Mount Hamilton, California. Lick Observatory Archives.

Instead of Watson, the first Director of Lick Observatory was Edward S. Holden, Watson's successor as Director of the Washburn Observatory. Holden was a product of Washington University and of West Point, and the protege of Simon Newcomb, Director of the Nautical Almanac Office and the most distinguished American astronomer of his day (5). Holden was appointed Director at Washburn on Newcomb's recommendation in 1881, while also acting as scientific advisor to the Lick Trust, but after only a few years in Wisconsin he accepted the position of President of the University of California in 1885 to be close to the scene of action until the observatory was completed. First light was seen through the 36-inch telescope on a bitterly cold night in January 1888; in June of that year the observatory was turned over to the University and Holden stepped up from President of the University of California to Director of Lick Observatory (6).

GEORGE ELLERY HALE

Only two years later, George Ellery Hale, who was to found Yerkes, Mount Wilson and Palomar Observatories, visited Lick Observatory with his bride on their honeymoon trip through the West. Hale, the son of a Chicago elevator magnate, had had a strong scientific interest from childhood, an interest that was encouraged by his father, who bought him the prisms, spectroscopes, gratings and telescopes he needed for his Kenwood Observatory in the backyard of the family mansion on Drexel Boulevard. Hale went to M.I.T., where he was a good student though he was far more interested in the experimental work he did on solar photography for his undergraduate thesis than in the formal courses. Two days after graduation he married his childhood sweetheart, and then began the honeymoon trip which took him two months later to Lick (7).

Hale was tremendously impressed with the telescope and the Observatory; Holden in turn was impressed with Hale and offered him a chance to stay and use the telescope, but he decided instead to go back to Chicago, build up his own observatory, and keep himself available for a faculty position at the then new University of Chicago.

Hale was a unique character in American astronomy. Scion of a wealthy family, he was accustomed from childhood to deal with the rich and powerful as an equal; yet at the same time he was a highly creative scientist who invented the spectroheliograph while still an undergraduate, never had time to complete formal graduate training, pioneered the science of astrophysics, and made many important observational contributions to the study of the sun and its magnetic properties. Above all he was an organizer of science and a builder of observatories.

By 1892 Hale was an Associate Professor at Chicago as part of a package deal in which his father promised to give the University the instruments of the Kenwood Observatory, if the University in its turn would raise the funds for a larger observatory. That same year Hale met Charles T. Yerkes, the tycoon who controlled the Chicago El system, and within a few weeks persuaded him to commit himself to building "the largest and best telescope in the world." Yerkes had been presold on the idea by President William Rainey Harper of the University of Chicago, but Hale had clinched the deal. Luckily the 40-inch glass blanks for the lens were available in the United States. They had been ordered by the University of Southern

California, which hoped to build an observatory on Mount Wilson, but lost all its promised funds when the Southern California land-speculation bubble burst in 1892. Yerkes bought the blanks from USC, Alvan Clark and Sons started grinding them into lenses, and the planning of Yerkes Observatory began (7). Apparently Yerkes himself was only willing to consider locations for his telescope close to Chicago, and the site on Lake Geneva was eventually chosen on the recommendation of Thomas C. Chamberlin, who before coming to Chicago as head of the Geology Department had been successively Instructor at the Normal School at Whitewater, Professor of Geology at Beloit College, Chief Geologist of the Wisconsin Geological Survey, and President of the University of Wisconsin (8). University of Wisconsin (8).

Yerkes, like Lick before him, proved a slippery source of funds, and tried several times to withdraw his support, but in the end the 40-inch telescope was built and first light was seen through it in May 1897. It is still the largest refracting telescope in the world, the Lick 36-inch is the second largest, and both are in regular use as research instruments. The Yerkes Observatory building, designed by Hale, was obviously greatly influenced by his visit to Lick, as the two observatories are very similar in external appearance, and inside too.

One of the first graduate students at Yerkes Observatory was William H. Wright, a native of San Francisco who had done his undergraduate work at the University of California and received his B.S. in Engineering in 1893. He was interested in astronomy and stayed on for two more years at Berkeley studying mathematics, physics and astronomy, and then in his one year at Yerkes got into the new field of astronomical spectroscopy. He returned to California as a member of the Lick staff in 1897, where he remained until he retired in 1944; he was Director from 1935 until 1942. Wright made many pioneering spectroscopic investigations at Lick, particularly of gaseous nebulae and novae or "new stars" (9).

Likewise at Lick Observatory there were graduate students almost from the beginning, although there never was a complete program of courses until the faculty moved to the Santa Cruz campus in 1965. The first group of graduate students at Lick numbered six, of whom two had done their undergraduate work at the University of Wisconsin (10). One of these two, Sidney Townley, who was born in Waukesha, went from Lick to the University of Michigan, where he earned his Sc.D. in 1897, and then a few years

later joined the Stanford faculty where he taught astronomy in the Applied Mathematics Department for many years.

Even before the Yerkes 40-inch was finished, Hale had begun thinking of a larger telescope. He realized that the 40-inch is close to the upper limit of practical size for refractors, and that the new telescope would almost certainly have to be a reflector, in which the light is collected and focused by a large parabolic glass mirror rather than a lens. In 1894 Hale's ever supportive father provided the funds to buy a 60-inch glass blank from France, and to pay to have it figured into a mirror. He agreed to give the mirror to the University of Chicago on condition that the University provide the mounting, dome, auxiliary instruments and necessary operating expenses. Hale wanted to locate the new reflector, when it was built, in a site with more clear weather than southern Wisconsin, and after a trip to California in 1903 he definitely decided on Mount Wilson. Neither Yerkes nor the University of Chicago was able to furnish even the funds necessary to pay the salaries of the astronomers at Yerkes Observatory, but nevertheless in 1904 Hale established a Solar Observatory on Mount Wilson. He was in close touch with Andrew Carnegie and his Carnegie Institution of Washington, which before the year was out, put up the money to found the Mount Wilson Solar Observatory (as it was originally known, for the first instrument was a solar telescope) and mount the 60-inch telescope. Though there was some unpleasantness with the University of Chicago about the ownership of the glass blank for the mirror, eventually it was handed over and by December 1908 the new 60-inch telescope was mounted and in use (7).

Long before this, Hale had turned his attention to building a bigger telescope, and in 1906, two years before the 60-inch was completed, he had managed to persuade John D. Hooker, a Los Angeles iron and oil magnate, to provide the funds for a 100-inch mirror (7). Much more Carnegie money was required before the 100-inch telescope was completed on Mount Wilson in 1917, the third successive largest telescope in the world built under Hale's direction, the first of them in Wisconsin and the other two in California. After his retirement, he also secured the funds for the 200-inch telescope, which is still the largest telescope in the world, though he didn't live to see it completed; it was named the Hale telescope at the time of its dedication in 1948, and the Mount Wilson and Palomar Observatories were renamed the Hale Observatories in 1968, the hundredth anniversary of Hale's birth.

EARLY LICK ASTRONOMERS

When the Lick Trust officially handed over Lick Observatory to the University of California in 1888, the staff included, in addition to Holden, four astronomers, S. W. Burnham, E. E. Barnard, John Schaeberle and James Keeler (11). Burnham was an indefatigable double-star observer, who for many years had been court reporter and later clerk of the Federal Court in Chicago. In the evening he would measure close double stars with his own telescope in his backyard observatory, where the young George Ellery Hale, as a boy of fourteen, met him and first saw a Clark refractor. Burnham had an excellent 6-inch, which he took with him when he went out to Mount Hamilton in 1879 as a consultant to the Lick Trust. He stayed for two months, observed many double stars, and pronounced the atmospheric transparency and seeing excellent (12). It was on the basis of this report that the final decision to build the observatory on the Mount Hamilton site that Lick had chosen was confirmed.

After his return to Chicago, Burnham set up his telescope on the University of Wisconsin campus in Madison, where he went on weekends to take advantage of the clearer and darker Wisconsin skies. This telescope, which Burnham had used in the Mount Hamilton site test, was acquired by the University of Wisconsin (13), and was mounted for many years in a small dome just off Observatory Drive, between the old Washburn Observatory (where the Institute for Research in the Humanities is now located) and the old Director's House (now the Observatory Hill Office Building). The telescope is now in use in one of the domes on the roof of Sterling Hall, while the old dome has been moved to the Madison Astronomical Society's Oscar Mayer Observatory, off Fish Hatchery Road.

Burnham finally went professional when the 36-inch was completed at Lick Observatory, and Holden persuaded him to join the staff. However, it soon turned out that Holden, a West Point graduate, expected to run the observatory as its commanding officer, supervising personally the research of all the astronomers on the staff. Relations became strained at the isolated and underfunded observatory (14), and after only four years at Lick, Burnham returned to the tranquility of Chicago. When Yerkes Observatory was founded a few years later, Hale managed to lure him out of retirement with a position which allowed him to come to Williams Bay on weekends to observe, while keeping his apparently not-too-demanding courtroom job in Chicago (15). Burnham

together with another renegade from the Lick staff, Barnard, was present when the 40-inch Yerkes refractor was first turned on stars, clusters and nebulae in 1897, and Hale quoted the two of them as agreeing that it was "decidedly superior" to the Lick refractor (7).

Barnard was a native of Tennessee, a poor boy who became a self-taught photographer, an amateur astronomer, and eventually a pioneer of celestial photography. He discovered the fifth satellite of Jupiter, the first to be discovered since Galileo's time, with the Lick 36-inch in 1892, as well as several comets, so his name was well known to the public, and it was a severe blow when he left in 1895 to accept a position at Yerkes (16). Before he came to Lick, Barnard wrote that he looked forward to working under Holden, but within a few short years he came to resent him as a petty tyrant, and when he resigned, though he thanked the Regents profusely, he could not bring himself to mention Holden's name (17, 18, 19).

The first of the original Lick staff to go had been Keeler, who became Director of the Allegheny Observatory in Pittsburgh in 1891. Burnham and Barnard were classical astronomers of the old school, but Keeler was a pioneer astrophysicist, applying the new methods of spectroscopy to investigate the nature of the stars and planets. Keeler and Hale were the two American apostles of this new-fangled science, the one specializing in stars and nebulae, the other in the sun. They were personally close, and corresponded often. Keeler was present along with Hale and Burnham when the 40-inch lens was first tested on stars in an improvised mounting at Alvan Clark's optical shop in Massachusetts, and he gave the principal address at the formal dedication of Yerkes Observatory. For several years Hale tried very hard to lure Keeler away from Allegheny to join the Yerkes staff, but he never made the move to Wisconsin, returning instead to Lick in 1898 as Director after Holden had been forced out (20).

Back at Lick, Keeler applied his personal efforts to using the recently acquired Crossley (36-inch) reflector for celestial photography (21, 22). At about the same time, George Ritchey was using the 24-inch reflector at Yerkes that he himself had made, for a similar program (23, 24). Previously, professional astronomers had thought almost entirely in terms of refracting, or lens telescopes, but Keeler and Ritchey proved that reflecting telescopes had tremendous advantages for photographic work by obtaining pictures of clusters, nebulae, and galaxies revealing details never seen before. A reflecting telescope is achromatic, which means it

brings light of all colors to the same focus, its silvered or aluminized mirror does not absorb blue light, as the lens of a refractor does, and it can be much shorter than a refractor with the same aperture, which makes it both less expensive to build and more effective for photography of faint nebulae and galaxies. Hale had realized even before Keeler's and Richey's results that the big telescopes of the future would be reflectors, not refractors, and had put this conclusion into practice by getting his father to buy the 60-inch glass blank from France. When Hale went west to Mount Wilson, the mirror went along, as did Ritchey, who was put in charge of the optical shop in Pasadena. He finished the 60-inch mirror there after the Carnegie money came through, designed the dome and telescope, and took some of the first photographs with it after it was put into operation on Mount Wilson in December 1908 (25).

In addition to Ritchey, Hale took with him to California Ferdinand Ellerman, Walter Adams, and Francis Pease; and Barnard, though he never joined the Mount Wilson staff, also came as a temporary visitor (7). This was almost the entire Yerkes first team, except for Burnham and Edwin Frost, Hale's successor as Director, and the mass exodus must have caused a certain amount of bitterness among those left behind. Ellerman was originally a photographer, who had been at Kenwood with Hale before going to Yerkes. On Mount Wilson he went western in a big way, sporting a ten-gallon hat, mountain boots, a pistol, cartridge belt, and hunting knife the first time he showed Adams the trail up the mountain (26). Pease was trained as a mechanical engineer, but both these men became highly skilled observers and instrumentalists, who could make complicated equipment work and get results under the primitive conditions on Mount Wilson (27).

Many of Hale's associates had little formal training in astronomy, and he not only directed their scientific work, but also, as a sort of intellectual Prince Charming, widened their horizons with his tales of the books he had read, the travels he had made, and the famous men he had met, in the gatherings on cloudy nights around the fireplace at the Casino, and later the Monastery, the observers' lodgings on Mount Wilson (26). Walter Adams, however, was a trained scientist who eventually succeeded Hale as Director of Mount Wilson Observatory. Son of Congregational missionaries in Syria, Adams did his undergraduate work at Dartmouth, where he came under the spell of Frost, and followed him to Yerkes, where he worked closely with Hale. Adams' combination of scientific

knowledge and ability with observational skill, strong character and physical toughness made it natural that Hale should depend more and more upon him (28).

Hale was a highly neurotic individual, who worked extremely intensely and felt the heavy responsibilities of his position more than most men, perhaps partly because he accomplished more than most men. He suffered a nervous breakdown in 1910, and Adams took over as Acting Director for a year. From that time onward, Hale had progressively more difficulty concentrating, with occasional severe headaches, frequent depression (25), and sometimes even departures from reality (7). He withdrew more and more from active research, spending long periods of time resting or traveling, as Adams became increasingly responsible for the detailed supervision of the observatory, first as Assistant Director in 1913, and then as Director in 1923, when Hale resigned (28). Over the years until he himself retired in 1946, and even after, Adams made many important research contributions, particularly in high-dispersion stellar spectroscopy. He stamped Mount Wilson with his own image of quiet conservative competence, which it retains to this day.

Hale not only brought faculty members from Yerkes Observatory to Mount Wilson, but telescopes as well. In addition to the glass blank for the 60-inch mirror, he wanted badly to take the Snow telescope, a fixed horizontal instrument with a coelostat, especially designed for observations of the sun, to get started at the Mount Wilson Solar Observatory. However, neither Miss Helen Snow of Chicago, donor of the funds with which the telescope had been constructed, nor Frost, the Acting Director at Yerkes, wanted to let it go. Yet within a few months the ever persuasive Hale had convinced them to let him have it, and the Snow telescope was soon transported west and mounted in its own building on Mount Wilson, where it is still in use for special solar observing programs (29).

Hale also managed to persuade Hooker, who later provided the funds for the 100-inch mirror, to put up the necessary money to bring Barnard and the Bruce photographic telescope from Yerkes to Mount Wilson to photograph the southern Milky Way, inaccessible from Wisconsin, but this was planned as a temporary expedition and both instrument and observer soon did in fact return to Yerkes. The Bruce telescope was mounted for many years in a small dome between the Yerkes Observatory main building and Lake Geneva, but it was removed and the building demolished in the 1960s.

Over the years of Hale's directorship several more Yerkes products joined the Mount Wilson staff. Charles St. John was a late bloomer who received his Ph.D. from Harvard in 1896 at the age of 39, and then became Professor of Physics and Astronomy and eventually Dean of the College of Arts and Sciences at Oberlin College in Ohio. His heart was in research, however, and he spent several summers at Yerkes, working on solar observational problems. In 1908, when St. John was 51, an age at which many scientists are shifting into administration, Hale offered him a job at Mount Wilson, and he moved west, where he pursued an active solar research career well beyond his formal retirement (30, 31).

Alfred Joy, a graduate of Oberlin, was teaching at what is now the American University in Beirut at the time of the Lick Observatory expedition to Egypt to observe the solar eclipse of 1906 at Aswan. Joy joined the expedition and became so interested in astronomy that he returned to the United States for summer volunteer work at Yerkes in 1910 and 1911, and a year's study at Princeton, and then was taken on the Yerkes staff in 1914. After a year at Yerkes, however, he made the move to Mount Wilson, and worked there the rest of his life in stellar spectroscopy. Though he "retired" in 1948 at the age of 65, he continued observing at the telescope until he reached 70, and still came to the Pasadena offices of the Observatory almost daily until his death in 1973 at the age of 91 (32, 33).

Another eventual Mount Wilson Observatory staff member, Edison Pettit, was born and educated at Peru, Nebraska, and then taught astronomy at Washburn College in Kansas for several years. However, in the summer of 1917 he went to Yerkes Observatory, and he liked it so well he returned there as a graduate student for two years until he was offered a job at Mount Wilson, where he remained until his retirement in 1955. He was a dedicated solar and planetary observer, who also pioneered in the measurement of stellar radiation with thermocouples (34).

Surely the Mount Wilson astronomer who had the most impact on the public was Edwin Hubble, who received his Ph.D. degree at Yerkes in 1917. He had been a student at the University of Chicago, where he worked as a laboratory assistant to Robert Millikan, the Nobel prize-winning physicist who later became president of Caltech. When he graduated from Chicago in 1910 Hubble was awarded a Rhodes Scholarship and went to Oxford for three years to study law. He practiced in Kentucky for a year, but then decided astronomy was the only thing that really mattered to him, and he

returned to Chicago and to Yerkes where he did his thesis with the 24-inch reflector, Ritchey's old telescope, photographing faint nebulae (35). Hubble was offered a position at Mount Wilson, but when he had finished his thesis and passed his final oral examination in 1917, he joined the Army and sent a telegram to Hale, "Regret cannot accept your invitation. Am off to war." He was mustered out a Major in 1919, and immediately joined the Mount Wilson staff.

Hubble was technically a rather poor observer, as his old photographic plates in the Mount Wilson files show, but he had tremendous drive and creative insight, and within a few years he was able to distinguish between galactic and extragalactic nebulae and to understand and prove the physical natures of both of these classes of objects. He soon grasped the correlation between the red-shifts and distances of galaxies, and used it to explore observationally "the realm of the galaxies," the modern version of the title of his epoch-making book. Hubble was a more outgoing character than most astronomers, a fine speaker who projected a hearty, soldierly, Rhodes-scholar image, and who had a wide circle of friends outside astronomy and university life (36, 37). He had an excellent sense for public relations, and was constantly called on for radio talks and popular articles. On one occasion in the 1940s the Mount Wilson spectroscopists, concerned that people might think that cosmology was the only problem studied at the observatory, arranged a press conference at which they planned to let the world know of their own contributions. Reporters were invited from the Southern California newspapers and even from the national magazines. Hubble was not notified of the press conference, but of course heard of it from his newspaper friends; he wandered into the library where it was in progress and the reporters, bored with the accounts they had heard of spectroscopy of carbon stars, spectroscopy of M giants, and spectroscopy of cepheid variables, asked if Dr. Hubble had done anything in the line of spectroscopy. He modestly disclaimed any personal involvement, but launched into a gripping explanation of the age and origin of the universe as revealed by Mount Wilson observations, emphasizing the role of spectroscopy as practiced by his collaborator Milton Humason, and this was the story that the newspapers and magazines used (38).

There were tremendous personal contrasts between the transplanted Kentuckian Hubble, and the frugal New Englander Adams, but these two Yerkes products were the outstanding observational astronomers of their generation.

WASHBURN OBSERVATORY

One of their contemporaries, Joel Stebbins, was undoubtedly the greatest astronomer the University of Wisconsin ever had on its faculty, a man who in his career very closely linked California and Wisconsin. Stebbins, a native of Nebraska, attended the state university there as an undergraduate, and then went to the University of Wisconsin for one year as a graduate student, but George Comstock, the one and only Professor of Astronomy at that time, recognized his abilities and advised him to move on to a bigger observatory with more research opportunities. Stebbins nearly decided to go to Yerkes to work with Hale, but instead decided on Lick, where Comstock had spent one summer as a research volunteer. After he earned his Ph.D., Stebbins' first position was at the University of Illinois, where he began to experiment with the photoelectric cells with which he revolutionized astronomy. He returned to the University of Wisconsin in 1922, where he remained as Director of Washburn Observatory and Professor of Astronomy until he retired in 1948. During these years he observed almost every type of astronomical object photoelectrically, with cells and multipliers which, because of their high photon efficiency and linearity, made possible for the first time the accurate quantitative measurement of the brightnesses and colors of stars, clusters and galaxies (39).

Stebbins maintained his contacts in California, and was often invited to bring his photoelectric photometer west to observe with the big California telescopes. He spent 1926-27 at Lick Observatory as Alexander Morrison Fellow, and in 1931 was appointed a Research Associate of Mount Wilson, where he went for several months' observation nearly every year until he retired. Like many another ex-California astronomer, Stebbins keenly felt the cold Wisconsin winters, and he had planned to live in Pasadena after his retirement at the age of 70, but his and all other Research Associateships were terminated in an economy move and he had to abandon this dream (40, 41). Instead he became a Research Associate at Lick Observatory, and moved to Menlo Park, California, making weekly trips to Mount Hamilton for ten more years, participating actively in the research with collaborators on the Lick faculty (42).

Stebbins returned to Madison to give the principal address at the dedication of the then new Pine Bluff Observatory in the Town of

Cross Plains in July 1958, and an oil portrait of him, presented to the University at that time, is on display in the foyer there.

Stebbins' student and the first Ph.D. in Astronomy at the University of Wisconsin, was C. M. Huffer, who previously had gotten his master's degree at Illinois in 1917 and then spent five years in Chile with the D. O. Mills Expedition of the Lick Observatory. This was an observing station with a 36-inch reflector, maintained for several years at Cerro San Cristobal, in the outskirts of Santiago, in order to make radial-velocity measurements of stars in the southern skies inaccessible from Mount Hamilton. On his return to the States in 1922 Huffer went to Wisconsin, where he received his Ph.D. in 1926, joined the faculty, taught and did photoelectric research, initially with Stebbins, until he retired in 1961. He then began a new career at the California State University in San Diego, teaching astronomy to numerous students until he retired again in 1969, and he now lives in Alpine, California, near San Diego.

Another Wisconsin product, Albert Whitford, was an undergraduate at Milton College, and then did his graduate work in Physics at the University of Wisconsin. After receiving his Ph.D. in 1932, Whitford went to Mount Wilson Observatory and Caltech for two years on a post-doctoral fellowship, and then returned to Wisconsin, where he collaborated closely with Stebbins, particularly in photoelectric measurements of interstellar reddening, of globular clusters, and of galaxies. Much of the observing was done at Mount Wilson, where Whitford continued to go as a guest investigator after he had succeeded Stebbins as Director of Washburn Observatory. In 1958 Whitford left Wisconsin to become the eighth Director of Lick Observatory, and was responsible for the completion of its 120-inch reflector, which had been begun under his predecessor, Donald Shane. Whitford gave up the directorship at Lick in 1968, and retired from the faculty in 1973, though he continues to live in Santa Cruz and spends much of his time on astronomical research.

Two other of Stebbins' students who went on to become members of the Lick staff were Gerald Kron and Olin Eggen. Kron, a native of Milwaukee, did his undergraduate work at Madison and worked as an assistant to Stebbins, making several observing trips to California with him (42). He did his graduate work at Lick Observatory, and then worked there on the faculty from 1938 until 1965. Eggen, who was born in Orfordville, (Whitford used to refer to

him as the other member of the Rock County Astronomical Society), was a graduate student at Wisconsin, where he received the second Ph.D. ever granted in Astronomy. In 1948 he became a member of the Lick faculty, where he stayed until 1956, afterwards going to the Royal Observatory in England, to Caltech, to the Australian National University, and most recently to the Cerro Tololo Interamerican Observatory in Chile. Both Kron and Eggen are experts in photoelectric photometry, which they had first learned at Wisconsin, and then applied at Lick, particularly to research on globular clusters and on color-magnitude diagrams, respectively.

YERKES OBSERVATORY

Stebbins was not the only Wisconsin astronomer to retire to California. One of his predecessors was Frank Ross, who had been a member of the Yerkes faculty for fifteen years until he retired in 1939 and moved to Altadena. Ross was born in San Francisco, and did his undergraduate and graduate work at Berkeley where, in 1901, he received one of the first two Mathematics Ph.D. degrees given by the University of California. His training was in celestial mechanics, and he worked at the Carnegie Institution for several years on orbital computations of planets and satellites, but then went to Eastman Kodak as a research physicist, specializing in lenses and photographic techniques. He was invited to join the Yerkes faculty as a photographic expert in 1924, and his main contribution there was a photographic survey of the sky that went beyond Barnard's earlier work and revealed many new features of the interstellar matter in our Galaxy. As the outstanding astronomical photographer of his day, Ross was invited to Mount Wilson to use the 60- and 100-inch telescopes to study Mars and Venus in the late 1920s and many of his photographs taken then were very widely used and reproduced for years afterward. After his retirement Ross had an office in the Mount Wilson Observatory, where he worked as an optical consultant until his death in 1960. He designed the Ross corrector lens that is used for almost all direct photographs of nebulae and galaxies taken with the 200-inch telescope, as well as the 20-inch Ross astrograph lens used for the fundamental proper-motion program at Lick Observatory (43, 44).

Just a year before Stebbins moved from Illinois to Madison, Otto Struve emigrated from Russia, by way of Turkey, to Williams Bay. Struve was born in Kharkov, where his father was Professor of

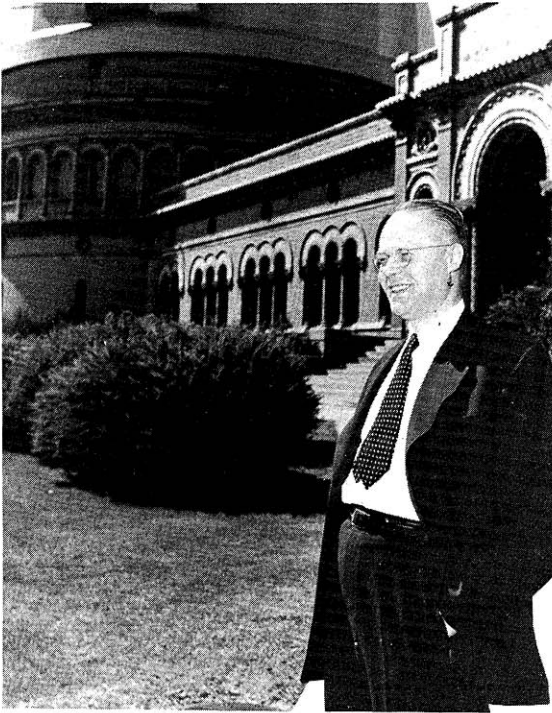


Figure 2. — Otto Struve 1897-1963. He was successively Director of the Yerkes Observatory of the University of Chicago, Williams Bay, Wisconsin, and Chairman of the Berkeley

Astronomy Department of the University of California. Here he is shown standing outside Yerkes Observatory. Yerkes Observatory Photograph.

Astronomy; his grandfather and great-grandfather both had been Directors of Pulkovo Observatory, and his uncle was a famous astronomer in Germany. Struve as a very young man served as an officer in the Russian army in World War I, and then after a short interval as a student, in the White army fighting the Bolsheviks. After the collapse of the Whites, he managed to flee to Turkey, and eventually was brought to Yerkes Observatory by Frost in 1921. Struve completed his graduate work and received his Ph.D. in 1923, and continued on the Yerkes faculty until 1950, when he left to become Chairman of the Berkeley Astronomy Department of the University of California. Struve was an outstanding stellar spectroscopist, who in his observational efforts applied the new results of quantum mechanics, particularly on ionization and excitation, to trying to understand stellar atmospheres and the

physics of stellar evolution. He worked single-mindedly at astrophysical research and produced a prodigious number of papers, particularly on stellar rotation, binary stars and peculiar stars of all kinds. Struve was appointed Director of Yerkes Observatory when Frost retired in 1932, and he picked and led the brilliant staff that made it famous in the 1940s and 1950s (45). They included Gerard Kuiper, a Dutch astronomer who was at Lick Observatory for two years as a post-doctoral fellow before joining the Yerkes staff in 1936, and W. W. Morgan, a 1931 Yerkes graduate who remained on the faculty there, and in fact was elected President of the Village Board of Williams Bay for two terms in the 1940s. Morgan was a Morrison Fellow at Lick in 1955, a Visiting Professor at Caltech in 1957, and over the years made several extended visits to the Mount Wilson and Palomar Observatories for research work with the collection of photographs of galaxies there.

CALIFORNIA

During Struve's years there was a constant traffic of astronomers back and forth between California and Wisconsin. Two Californians who did observational theses at Lick and received their Ph.D.s at Berkeley, and then joined the Yerkes staff in 1939 were Daniel Popper and Horace Babcock. At Yerkes they broadened their experience and skills in stellar spectroscopy, and after a few years returned to California, where Popper is now a senior professor at UCLA, while Babcock has recently retired as Director of Hale Observatories. His father, Harold Babcock, who was born in Edgerton but moved to California at an early age, was a member of the Mount Wilson staff before him. A gentle, sensitive soul, Harold Babcock idolized Hale; his long poem "In 1903" describing Hale's first visit to Mount Wilson ends with the stanza (46)

"How fortunate that little group of men
Whom in those next swift years he chose to be
His friends and colleagues in the appointed task
Of realizing what he had foreseen!
We cannot speak the things we wish to say,
But bright and clear within our inner hearts
Devotion's timeless flame burns on."

Fifteen years after these lines were written, Harold and Horace Babcock, working at the Hale Solar Laboratory in Pasadena,

proved the existence of the general magnetic field of the sun, an observation Hale tried very hard to make himself, and would have applauded if he had still been alive (47).

During the 1930s two German astronomers, Walter Baade and Rudolph Minkowski, emigrated to America from Hamburg and joined the Mount Wilson staff. Baade, the first to come, originally had a *Wanderjahr* (1926-27) in the United States on a Rockefeller Fellowship, in the course of which he spent several months at Yerkes, at Lick and at Mount Wilson (48). He loved to tell stories about his summer in Williams Bay; it was during the days of Prohibition and the landlady of the boarding house in which he stayed was a strict Teetotaler, while her two sons, approximately Baade's age, were not, at least whenever they could get out from under Mother's eyes. It was a situation that appealed to him and he could never forget their escapades, in which he himself was fully involved, hiding cases of beer in a tent in the back yard, in the woods around the house, or under his bed (49). Baade's great contribution to astronomy, the recognition of the two stellar populations, young stars and old, was the result in part of the fact that he, technically an enemy alien, was one of the very few astronomers not involved in military research in World War II. As a result he had a large amount of observing time with the 100-inch telescope, in skies made dark by the Southern California wartime dim-out, and was able to photograph extremely faint stars in neighboring galaxies.

Minkowski, who came to Mount Wilson in 1935, four years after Baade, was responsible with him for the identification and interpretation of the newly discovered radio sources in the 1950s. After his retirement from the Mount Wilson and Palomar Observatories, Minkowski was a Visiting Professor at Madison in 1960-61, and then moved to Berkeley, where he was a Research Associate for several years until his death in 1976.

After World War II, when the Caltech administration decided to build up an astrophysics department to match the 200-inch telescope, the first new faculty member to be brought in was Jesse Greenstein, who came from the Yerkes faculty in 1948, followed in succession by Guido Münch, a Yerkes Ph.D. who had stayed on the Yerkes faculty, myself, a Yerkes Ph. D., and Arthur Code, a Yerkes Ph.D. who had joined the University of Wisconsin faculty. Only after these four appointments was the magic Wisconsin circle broken, and the next new faculty member came from Princeton. In those same years several other Yerkes students and faculty

members were moving west to the big observatories in California. Louis Henyey, a Yerkes Ph.D. and faculty member until 1947 went to Berkeley a few years before Struve; John Phillips, a Yerkes Ph.D. who stayed on there as a lecturer for two years, went with Struve; and Su-shu Huang, another Yerkes Ph.D. and lecturer, went a year after Struve. Armin Deutsch, a Yerkes Ph.D., joined the Mount Wilson and Palomar Observatories in 1951, while William Bidelman, another Yerkes Ph.D., joined the Lick Observatory faculty in 1953 after three years on the Yerkes faculty. Basically, all these men were carrying the Yerkes spectroscopy tradition to California. A counter movement brought Harold Johnson from Berkeley, where he earned his Ph.D., to the Wisconsin faculty in 1949 and then to Yerkes in 1950, and Aden Meinel from Berkeley to Yerkes in 1949. A few years later, Helmut Abt, who earned his Ph.D. at Caltech in 1952 and then spent one year at Lick as a post-doctoral research fellow, joined the Yerkes staff.

RECENT PAST

In the more recent past, when the University of Wisconsin administration decided to expand to a full-fledged graduate program in astronomy, it brought Arthur Code and myself from Caltech in 1958, and within a few years we were joined by John Mathis, who had received his Ph.D. at Caltech in 1956, and later by Robert Parker and Christopher Anderson, both Caltech Ph.D.s, and by Jack Forbes, a Berkeley Ph.D. When Forbes left Wisconsin, he was replaced by Kenneth Nordsieck, a University of California-San Diego and Lick Observatory product. Half the present University of Wisconsin astronomy faculty members are linked by graduate training or previous faculty experience in California.

Likewise, at Yerkes the present Director, Lewis Hobbs, is a University of Wisconsin Ph.D. who had a post-doctoral research position at Lick Observatory before returning to Yerkes, and his two immediate predecessors were also closely associated with California. William Van Altena, the Director before Hobbs, is a Berkeley Ph.D. who did his thesis at Lick, while C. Robert O'Dell, the Director before Van Altena, is a Wisconsin Ph.D. who was a post-doctoral fellow at Mount Wilson and Palomar Observatories and then a faculty member at Berkeley before returning to Williams Bay. The two newest faculty members at Yerkes, Kyle Cudworth and Richard Kron, are recent University of California Ph.D.'s from Lick and Berkeley respectively.

At Lick Observatory at present nearly all the senior professors have Wisconsin connections. George Herbig, Merle Walker and Robert Kraft are all Berkeley Ph.D.s who spent some time at Yerkes, Herbig as a post-doctoral fellow in 1950-51, Walker as research associate in 1954-55, and Kraft as an assistant professor in 1961-63. I am a Yerkes, Ph.D. and the third director of Lick to come from the University of Wisconsin faculty. Joseph Wampler did his graduate work at Yerkes and received his Ph.D. in 1963 before coming to Lick, first as a post-doctoral fellow, and then joining the faculty in 1965. Among the associate professors, Joseph Miller was a UCLA undergraduate, then did his graduate work at Madison and received his Ph.D. in 1967, and then came to Lick, while William Mathews spent one year as a graduate student at Yerkes before transferring to Berkeley. George Blumenthal did his undergraduate work at the University of Wisconsin-Milwaukee before getting his Ph.D. at San Diego in 1970, and then coming to Santa Cruz as an assistant professor two years later.

At the present time the only ex-Wisconsinite on the Hale Observatories staff besides Greenstein is Jerome Kristian, who grew up in Milwaukee, did his graduate work at Yerkes, and was a faculty member at Madison from 1964 until 1968 before going to California. And at Berkeley there are no astronomical immigrants from Wisconsin except Phillips and Harold Weaver, a Berkeley Ph.D. who was a post-doctoral fellow at Yerkes in 1942-43 before returning to the University of California in 1945. However, the other University of California campuses are full of them. At San Diego, Geoffrey and Margaret Burbidge did post-doctoral research work at Yerkes in 1951-53 when they first came over from England, then after a year back at Cambridge went to Caltech for three years where they were very active in opening up the field of stellar nucleogenesis. From Caltech they returned to Yerkes, where Geoffrey Burbidge was on the faculty and Margaret Burbidge was initially a research associate and later a faculty member during the years 1957-1962 and then they went to UCSD, where they both are faculty members. At UCLA two of the eight present astronomy faculty members are Wisconsin Ph.D.s — Harland Epps and Holland Ford. In addition, in the California State University system there are three more astronomy faculty members who did their graduate work at the University of Wisconsin, Burt Nelson and C. T. Daub at San Diego, and Joseph Boone at San Luis Obispo. Boone at San Luis Obispo.

Over the years, from Holden and Hale's days down to our own, about half the Wisconsin astronomers have had strong California ties, and vice versa. No other pair of states are so intimately linked astronomically. Probably in future years there will be more California-Arizona connections, because of the growth of the Kitt Peak — University of Arizona complex in Tucson, but there is little sign that the California-Wisconsin ties have slackened yet.

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