The Yerkes Observatory: Past, Present, and Future

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THE YERKES OBSERVATORY WAS planned and organized by George E. Hale who, at the age of 24, had been appointed professor of astronomy at the new and struggling University of Chicago. Through the generosity of Charles T. Yerkes, traction magnate of Chicago, two 40-inch glass disks were purchased from the firm of Mantois in Paris, and a contract was signed with Alvan G. Clark, of Cambridgeport, Massachusetts, for the work of grinding and polishing. The mounting for the large telescope was made by the Warner and Swasey Company, Cleveland, Ohio, and was exhibited at the Columbian Exposition in Chicago in 1893. The building of the Observatory, on the north shore of Lake Geneva, in Williams Bay, Wisconsin, was started in 1895. On May 19, 1897, the objective for the large telescope arrived in Williams Bay. Two days later, after it had been mounted in the 62-foot tube, astronomical observations were commenced by G. E. Hale, E. E. Barnard, and S. W. Burnham. The quality of the star images was found to be exceedingly fine, and the great light-gathering power of the lens was so remarkable that Barnard remarked that he had never before seen so clearly the faint stars of the cluster in Hercules.

The Observatory was dedicated on October 21, 1897, in the presence of a large gathering of astronomers and guests. Henry Crew, of Northwestern University, one of

Group photographed at the dedication of the Yerkes Observatory, October 20, 1897: E. E. Barnard, C. H. Rockwell, George F. Hull, —— Colton (?), Kurt Laves, Frank W. Very, E. B. Frost, Henry M. Paul, Ernest F. Nichols, F. R. Moulton, Ephraim Miller, Father John Hedrick, John M. Van Vleck, Milton Updegraff, Wm. R. Brooks, F. L. O. Wadsworth, H. C. Lord, F. H. Seares, George W. Hough, W. H. Collins, Caroline E. Furness, Mrs. Pickering, Mrs. Hale, Miss Cunningham, Alva A. Lyon, Carl A. R. Lundin, J. A. Parkhurst, J. A. Brashear, G. W. Ritchey, C. H. McLeod, Father J. G. Hagen, Charles L. Poor, J. K. Rees, Mary W. Whitney, F. P. Leavenworth, Henry S. Pritchett, J. E. Keeler, A. G. Stillhamer, Hugh L. Callendar, George W. Myers, C. L. Doolittle, E. C. Pickering, A. W. Quimby, Asaph Hall, Albert S. Flint, M. B. Snyder, W. W. Payne, Carl Runge, Winslow Upton, George Kathan, G. D. Swezey, George E. Hale, N. E. Bennett, George C. Mors, F. Ellerman, W. J. Humphreys, and Henry Crew.

the few surviving scientists who attended this celebration, has written as follows in a personal letter to the author:

> Hale's sound judgment and capacity for friendship were clearly shown by the first staff which he assembled at Williams Bay and by the group of productive scholars who "assisted" at the dedication of the Observatory. In the picture of this group, taken at the south entrance, one sees E. C. Pickering—long-time friend and adviser—standing in the front row between Keeler and Runge [right, extreme front]; and this in turn reminds one of that interesting remark which Runge made on that same day, in the meeting, when W. J. Humphreys had finished reading his report on the effect of pressure in displacing the lines of the arc-spectrum. Rising in his place, Runge said, "Mr. President, Nature is getting more and more disorderly every day!" and then proceeded to accept Humphreys' surprising results at full value.
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> Returning to the group picture, the man in the front row with the white beard and with his hands in his pockets is that keen and doughty observer, G. W. Hough. At the extreme left, stands E. E. Barnard, at that time, the greatest of all living observers; while at the extreme rear of the picture, standing against one of the columns, wearing a cap and black beard, is F. L. D. Wadsworth—physicist, engineer, and astronomer—a man who helped Michelson and Hale more than the world will ever know.

Since the summer of 1897 the 40-inch telescope has been used regularly on all clear nights for the observation of stars, comets, and nebulae, and on many clear days for the observation of the sun. In 1897 it was the largest telescope of any kind then in actual operation, although Lord Rosse, and others, had already constructed and temporarily used reflecting telescopes of greater aperture. After 50 years the 40-inch telescope is still the largest *refractor* in the world. An attempt in France, many years ago, to construct an astronomical objective of more than 50 inches in diameter ended in failure. World War I interfered with the completion of a 41-inch refractor for an observatory in southern Russia, and the project was abandoned.

In certain types of astronomical observations the 40-inch refractor of the Yerkes Observatory still ranks at the top of the long list of telescopes. It is very little affected by changes in temperature, and it is never necessary to disturb it in its cell. In the most precise measurements of relative star positions it is often necessary to compare results obtained on different photographs taken many years apart. Such photographs would be rendered almost useless if the adjustments of the image-forming lens or mirror were changed between exposures. For example, a very slight change in the collimation of the objective can result in a small change of the character of the star's image of a point-source, like a star. This, in turn, would produce a spurious change in the distance between two stars of unequal brightness. Astronomers measure on their photographs displacements of less than 0.001 mm., corresponding to an angular distance of 0.01 second of arc in the focus of the 40-inch objective. Only the lenses of refracting telescopes have the required degree of stability and permanence. The large astronomical mirrors, many of which surpass the 40-inch objective in aperture, are subject to distortions causing astigmatism and to changes in adjustment when they are removed for silvering or aluminizing.

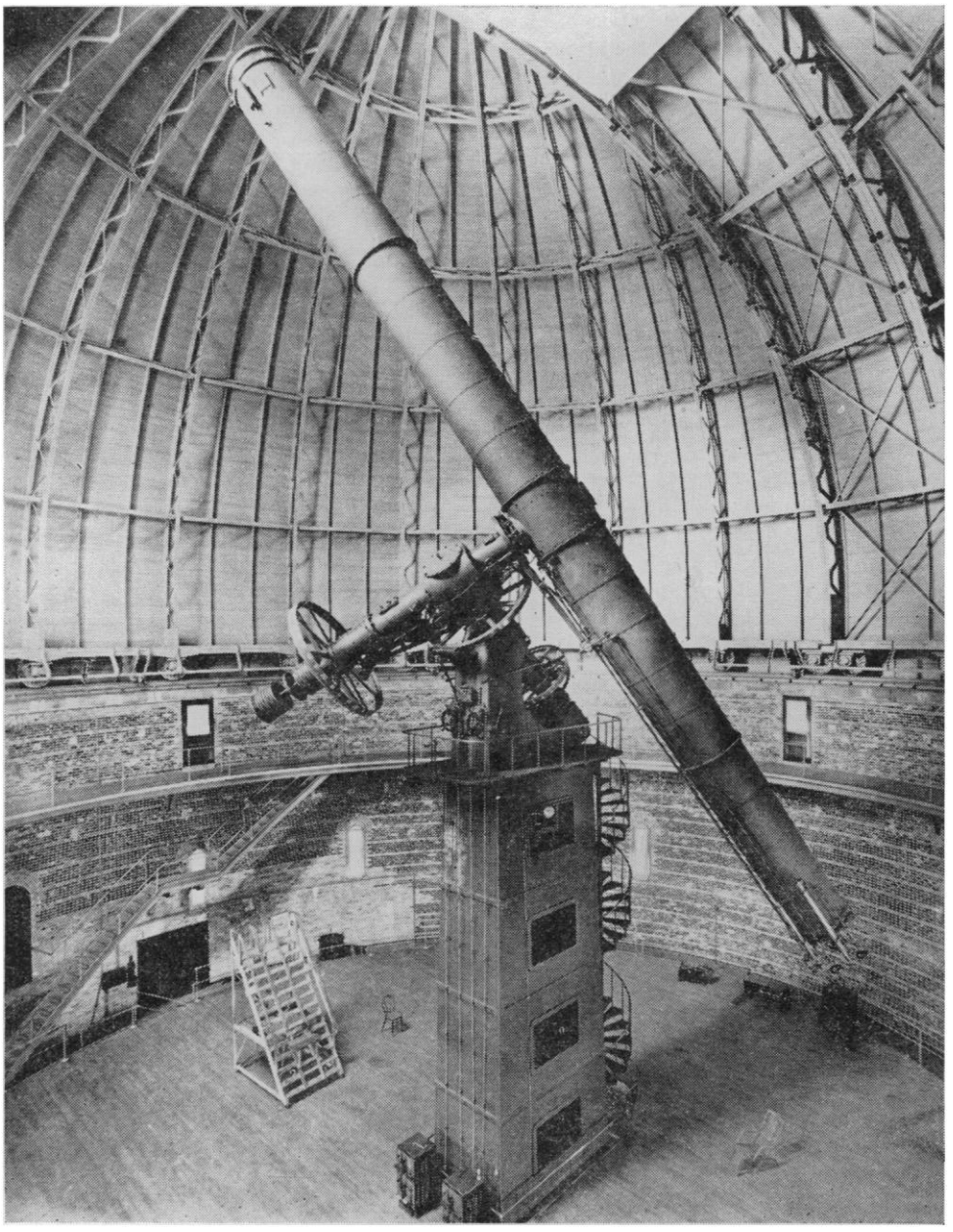
The principal advantage of the 40-inch telescope over all others in existence is in the determination of stellar distances and angular stellar motions. It can also compete with other instruments in the visual and photographic measurement of double stars. But it is surpassed by the large reflectors in most other types of observational work.

Hale intended, from the very beginning, to construct for the Yerkes Observatory a large reflector. His father donated a 60-inch glass disk, and G. W. Ritchey undertook the work of grinding and polishing in the optical shop of the Observatory. The gift of the mirror was conditional upon the University supplying the necessary funds for the mounting and dome. Unfortunately, the University was unable to meet these requirements, and when Hale left the Yerkes Observatory in 1904, he arranged for the transfer of the 60-inch reflector to the Mount Wilson Observatory. With him also went the large horizontal Snow telescope for solar research, as well as several members of the Yerkes staff, including Adams, Pease, Ellerman, and Ritchey.

Before his departure Ritchey completed for the Yerkes Observatory a smaller reflector—one with a 24-inch aperture. This instrument has been used to good advantage for photometric studies of stellar brightnesses by J. A. Parkhurst, for the photography of nebulae, clusters, and other interesting objects by Ritchey, and for the determination of the spherical coordinates of comets and minor planets by Van Biesbroeck.

Soon after Hale's departure for Pasadena, Edwin B. Frost was appointed director. The staff then consisted of S. W. Burnham and E. E. Barnard as senior astronomers, P. Fox as solar physicist, F. Schlesinger as holder of a Carnegie Institution grant for the measurement of stellar distances, J. A. Parkhurst as photometric observer, and S. B. Barrett as secretary and librarian. The principal observing programs during the next 25 years consisted of photography of the sun with Hale's spectroheliograph; determination of stellar distances from photographs with the 40-inch; visual measurements of double stars with the micrometer; determination of positions of comets and other moving objects in the solar system; discovery and measurement of stars of large proper motions across the line of sight; measurement of radial velocities of stars; and determination of the apparent brightnesses of the stars.

Many distinguished astronomers took an active part in this work. S. A. Mitchell, who later became the director of the University of Virginia's McCormick Observatory, and his successor in Virginia, H. L. Alden, were both at



The 40-Inch Telescope of the Yerkes Observatory

one time or another connected with the Yerkes Observatory. F. Slocum, later director of the Van Vleck Observatory, Wesleyan University, and O. J. Lee, later director of the Dearborn Observatory, Northwestern University, were at different times in charge of the solar and parallax observations. After the retirement of Prof. Burnham the work on visual double stars was continued by G. Van Biesbroeck. Prof. Barnard's place was taken by F. E. Ross after the former's death in 1923.

Prof. Frost retired from the directorship in 1932 and was succeeded by the writer of this article. It became more and more evident that the 40-inch telescope was no longer adequate to provide astrophysical material in those branches of the science which employ spectrographs of high dispersion or photometers of very high precision. In 1933 an agreement was completed with the University of Texas providing for the joint operation of a large reflecting telescope, to be constructed from the W. J. McDonald bequest to the University of Texas. The outcome of this cooperative project was the completion, in 1939,

of an 82-inch reflecting telescope on top of Mount Locke, near Fort Davis, Texas. The high elevation of almost 7,000 feet, the remarkable clearness of the air at night, the large percentage of cloudless sky, and the absence of all disturbing terrestrial lights have combined to make this an exceedingly important observing station. Until the completion of the 200-inch telescope on Mount Palomar the McDonald reflector ranked as the second largest telescope in the world.

The idea of cooperation between universities in the utilization of an expensive astronomical telescope has been entirely successful. Both universities have derived fame from the research work of the staff. Separately, neither university could have accomplished even a small fraction of the results which have accumulated during the past 8 years. In order to serve astronomical departments at other universities which have previously been deprived of the use of a large telescope, the cooperative arrangement was extended to include Indiana University and the University of Minnesota. F. K. Edmondson, of the former university, has for several years been using 100 hours of observing annually, and his institution has taken a corresponding share of the operating expenses. Similarly, W. J. Luyten, of Minnesota, makes use of 50 hours per year.

The Yerkes Observatory has had a notable record in the training of astronomers. Among its former students or research assistants were E. Hubble, E. Pettit, A. H. Joy, A. van Maanen, and Horace Babcock at the Mount Wilson Observatory; W. H. Wright at the Lick Observatory; N. T. Bobrovnikoff, P. C. Keenan, and A. J. Deutsch at the Perkins Observatory; J. A. Hynek at the McMillin Observatory, Ohio State University; G. Münch at the Tacubaya Observatory of Mexico; and many others.

The research program of the Observatory during the past 50 years followed closely the path laid out by Prof. Hale in 1897. He wanted to make the Yerkes Observatory primarily an astrophysical institution where astronomy would be coordinated with physics and chemistry. With an important exception—research in the physics of the sun—his hopes and aspirations have been fully realized. After Hale's departure for Mount Wilson the routine work with the spectroheliograph was continued for a number of years, but the results were less important than could have been hoped for. The principal reason for this decline in Hale's own field of study consisted in inability to secure the services of a competent solar physicist.

As a result of scientific developments during the war there has been an enormous increase in the scope of astronomy during the past five years. Fifty years ago the observable part of the spectrum extended from about H and K of ionized calcium to about H_α. The violet limit was set by the transmission of the 40-inch objective and of the dense flint-glass prisms of the stellar spectrograph. The red limit could be reached only with very long exposures by the use of specially sensitized photographic plates. In 1947 the violet limit was extended to about λ 2,000 by the use of spectrographs mounted inside V-2 rockets, and the red limit was extended through the use of micro-wave and radio-wave techniques. Electronics has become an important tool in many astronomical investigations. These and other developments have made it necessary to redirect the work of the Yerkes Observatory and to spend time and energy in the preparation of a new plan of research.

In connection with this need for long-range planning it has been decided to reorganize the structure of the astronomical institutions of the University of Chicago and the University of Texas. The Department of Astronomy will henceforth consist of four units: the two observatories, Yerkes and McDonald, under the directorship of G. P. Kuiper; a section of theoretical astrophysics, which will also be responsible for maintaining the advanced teaching at Yerkes, under S. Chandrasekhar; the *Astrophysical Journal*, with W. W. Morgan as the managing editor; and the teaching section on the campus in Chicago. All four sections will be coordinated by the present writer as chairman of the Department and as honorary director of the two observatories. Under the new arrangement the writer will devote most of his time to research, as well as to the broader policies of the Department; G. P. Kuiper will have charge of the administration of the two observatories; and W. A. Hiltner will continue to serve as assistant director.