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OF

FRANK SCHLESINGER

1871–1943

BY

DIRK BROUWER

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Frank Schlesinger was born in New York City on May 11, 1871. His father, William Joseph Schlesinger (1836-1880), and his mother, Mary Wagner Schlesinger (1832-1892), both natives of the German province of Silesia, had emigrated to the United States. In Silesia they had lived in neighboring villages, but they did not know each other until they met in New York, in 1855, at the home of Mary's cousin. They were married in 1857 and had seven children, all of whom grew to maturity. Frank was the youngest and, after 1939, the last survivor.

His father's death, in 1880, although it brought hardships to the family, was not permitted to interfere with Frank's education. He attended public school in New York City, and eventually entered the College of the City of New York, receiving the degree of Bachelor of Science in 1890. His aptitude for mathematical science, already evident in grammar school, became more marked in the higher stages of his education when he began to show a preference for applied mathematics.

Upon completing his undergraduate work it was not possible for him to continue with graduate studies. He had to support himself, and his health at that time made it desirable for him to engage in outdoor activities. These circumstances caused him to enter the employ of the Title Guarantee and Trust Company of New York as surveyor. In this capacity he was active during two years (1890-1892). Then followed four more years as surveyor for the Department of Street Improvements of New York City (1892-1896).

Some years earlier he had begun to look forward to an astronomical career, and in 1894 he entered Columbia University as a special student in the department of astronomy to the extent that his full-time occupation as surveyor would permit him. For two years this arrangement was continued. By that time he had shown sufficient ability and further promise in his chosen field to be awarded a University Fellowship that enabled him to enter

Columbia University as a full-time graduate student in astronomy (1896-1898).

In the year 1890 the American pioneer in celestial photography, Lewis Morris Rutherfurd (1816-1892), had presented to the observatory of Columbia University his collection of photographic plates and the records of the measurements made by him and his assistants. These plates were of unique value on account of their high quality and their early date. Under the direction of John K. Rees the observatory, now the Rutherfurd Observatory, undertook the study of many of the photographic plates of star fields in Rutherfurd's collection. During the first winter of his graduate work Schlesinger began the measurement of eight plates of the Praesepe group, the discussion of which was the subject for his doctor's thesis (2).* This thesis is a solid contribution to photographic astrometry, in which every important step in the work is presented in full detail.

His first scientific publication (1) appeared shortly before the publication of his doctor's thesis, and deals with the possibility of simplifying the corrections for refraction to rectangular coordinates on a photographic plate by absorbing the principal portions of these corrections in the rotation error and the scale error of the plate. This is an application of an exceedingly important principle in photographic astrometry that permits one to deal with numerous corrections without requiring their laborious calculation and application to individual stars. Some of Schlesinger's most important later contributions are in principle very closely related to the content of his first publication.

During the summer of the year 1898 he was enabled to work at the Yerkes Observatory as research assistant. Schlesinger already had the desire to use a long-focus telescope in an attempt to make photographic determinations of stellar distances. The project appealed to Director George Ellery Hale (1868-1938), but he did not succeed at that time in securing the necessary funds for an assistantship at the Yerkes Observatory that would enable Schlesinger to make such an experiment.

* These numbers refer to the bibliography which follows.

Having returned to Columbia University in the winter of 1898-99, Schlesinger received an offer to become the observer at the International Latitude Station at Ukiah, California, to be established as one of six stations near the same parallel of latitude (39°8′N) for accurate determinations with zenith telescopes of the variation of latitude at each station. This problem had received considerable attention during the preceding decade, due to the discovery by F. Küstner (1856-1936) of the latitude variation and to the analysis of available material by S. C. Chandler (1846-1913). Schlesinger accepted the post, and proceeded to Ukiah to supervise the construction of the pier, the telescope housing, and a little office building. The observing program began in October, 1899, simultaneously with observing at five other latitude stations. The work soon became a steady routine, requiring his almost uninterrupted presence at the observing station, and constant watchfulness that the instrument was kept in proper adjustment to yield the best possible results. The high precision of the observations at Ukiah in the summary for the first two-year period is an indication of the excellence of Schlesinger's work.

On the whole this period was a happy one. Here he met Miss Eva Hirsch whom he married in 1900. At Ukiah also their son and only child, Frank Wagner, was born in 1901.

The observing routine left him a considerable amount of spare time that he began to use for miscellaneous astronomical studies. He had become well acquainted with the astronomers at the Lick Observatory and at Berkeley, and became active in helping Dr. R. G. Aitken on the editorial board of the Publications of the Astronomical Society of the Pacific. He undertook to write frequent notes on the progress of astronomy. The most important consequence of this work was that it gave him a life-long habit of following with interest all significant advances in astronomy.

The Carnegie Institution of Washington was founded in 1902. One of the first applications for grants-in-aid was one by George Ellery Hale, supported by Simon Newcomb (1835-1909) and E. C. Pickering (1846-1919), to enable Schlesinger to carry out a series of photographic measurements of stellar parallaxes with the forty-inch refractor of the Yerkes Observatory. The grant was made for an initial period of one year, but with the expectation that further support of the project would be forthcoming. The work at Williams Bay began in May, 1903, and soon the Schlesingers were at home in their new surroundings. Instead of the isolation of Ukiah they now enjoyed the daily companionship of the other astronomers and their families, and friendships were made that were to last for many years.

Perhaps the unhurried reflection during the four years of postponement contributed greatly to the success of Schlesinger's parallax work during the two brief years at the Yerkes Observatory. It is instructive to compare the method finally adopted and described in the series of papers (72, 73) containing the results of the parallax determinations with the Yerkes refractor with his earlier notions expressed in 1899 (7). At that time he expected to avoid the guiding error due to the difference in brightness between the "parallax star" and the "comparison stars" by desensitizing the plate in the center where the parallax star was to be exposed. At the Yerkes Observatory he developed the device of introducing a rotating sector in the center of the plate to produce an intermittent exposure of the brighter star. The superior quality of this device is evidently that it can be controlled to a much higher degree of refinement than the method of desensitization. All plates were taken near the meridian with the telescope at the same side of the pier at all times. The importance of this precaution had been recognized by J. C. Kapteyn (1851-1922). The temptation of an observer was always to permit large hour angles east and west of the meridian in order to secure plates with large parallax factors at the cost of introducing systematic errors due to differences in the colors of the stars of which the images were to be measured. Kapteyn had expressed a preference for taking on each plate exposures approximately six months apart, with the parallax star at the opposite sides of its parallax ellipse. This would have the advantage of making the parallax solution depend upon purely differential measurements. Kapteyn's suggestion was beautiful in principle since it would eliminate a considerable portion of the plate errors. It had, however, such serious practical drawbacks that Schlesinger decided against it. With few exceptions the plates were measured in right ascension only. Since the displacement in declination adds, as a rule, comparatively little weight to the parallax determination, the omission of the measurement in declination resulted in appreciable economy at little or no sacrifice in accuracy.

An important innovation was the introduction of what has become known as the dependence method of reduction. The usual procedure had been to reduce the measurements of all the plates for a region to a common standard by the solution for each plate of a set of plate constants from the measured coordinates of the comparison stars. The residual for the parallax star obtained by the substitution of this solution is the only datum yielded by the plate that is useful in the subsequent solution for parallax and proper motion component. With the dependence method the result is obtained without going through the solution of the plate constants and with a considerable saving in calculation. Instead of a numerical evaluation of the dependences Schlesinger introduced a simple geometrical construction that is particularly advantageous if more than the minimum number of three comparison stars is used.

In 1904 Hale left the Yerkes Observatory to take charge of the establishment of the Mount Wilson Solar Observatory of the Carnegie Institution of Washington. This important event in American astronomy was indirectly the cause of a curtailment of the parallax work then in progress. Arrangements were contemplated by which Schlesinger would join the staff of the Mount Wilson Observatory and the observations and measurements for the parallax series would continue at the Yerkes Observatory.

Into the correspondence on these matters enters the directorship of the Allegheny Observatory of the University of Pittsburgh which was vacant at that time, and which was offered to Schlesinger in March, 1905. His acceptance of this position required new changes in the plans. Both Hale and the new director of the Yerkes Observatory, Edwin B. Frost (1866-

1935), were anxious to see at least a minimum parallax program at the Yerkes Observatory carried to completion. With some further financial support by the Carnegie Institution this was actually accomplished.

The results of Schlesinger's work at the Yerkes Observatory were epoch-making, the accuracy of his determinations of stellar distances far exceeding that of previous measurements by others. His procedure has since been used so universally that it is difficult to realize that it was so completely developed by a young astronomer in such a short time.

The Allegheny Observatory had had a distinguished past under Langley (1834-1906), Keeler (1857-1900), and Wadsworth (1872-1936). During Keeler's directorship plans were formed for a new observatory. These plans included an impressive observatory building in Riverview Park and its equipment with the 30-inch Keeler memorial reflector as well as a large long-focus refractor. John A. Brashear (1840-1920), maker of astrononical instruments, had been the leading spirit in the drive for funds to build, equip, and endow the Allegheny Observatory. He continued to be active as a member of the Observatory Committee until his death.

The Keeler memorial reflector was completed shortly after Schlesinger took office at the Allegheny Observatory. The telescope soon made excellent contributions in spectrographic studies of eclipsing binaries and other spectroscopic binaries having spectra that can be studied advantageously with low dispersion. The Mellon spectrograph (66), in which a single prism was used, was especially designed for this purpose by Schlesinger and Ralph H. Curtiss (1880-1929), at that time a member of the staff of the Allegheny Observatory. The prime consideration had been to make the exposures as short as possible in view of the faintness of many stars and the lack of transparency of the Pittsburgh skies.

The first three volumes of the Publications of the Allegheny Observatory, a series of publications commenced by Schlesinger, contain about forty spectrographic studies by members of the staff of the Allegheny Observatory. This was a very significant contribution to the store of knowledge in this field. In addition Schlesinger contributed papers on the method of reduction of spectrograms (50) and on a method of deriving the elements of a spectroscopic binary from observations of radial velocities (52). In 1909 he made the important discovery of the rotation effect in the spectra of eclipsing binaries (60).

In 1910 Schlesinger attended the meeting of the Solar Union at Pasadena. He then agreed for the Allegheny Observatory to take part in a cooperative attack on problems connected with the rotation of the sun. For this purpose the mounting of the Keeler memorial telescope was used in conjunction with a coelostat and the Porter spectrograph. The general design of the instrument was due to his predecessor, Wadsworth, but Schlesinger had to superintend its erection and to design the numerous details that require attention before a new instrument is in working condition. The study of the sun's rotation was published in 1914 (93).

The plan for the Thaw telescope, a thirty-inch photographic refractor with focal length 14.1 meters, had been included in the program for the new observatory since its conception in 1897, but its construction was long delayed owing to the difficulty of obtaining suitable disks of glass. When these were finally secured, Mr. James B. McDowell (1861-1923) of the Brashear Company produced a most excellent telescope. The instrument was ready for use at last in September, 1914.

The original plan of the Observatory Committee had been to construct a visual telescope, and in this plan Schlesinger at first concurred. However, the delay opened the possibility of changing to a photographic refractor, a modification that began to appeal to Schlesinger soon after he came to Pittsburgh and, backed by some of the leading astronomers of that day, he succeeded in obtaining the approval of the Observatory Committee. The principal argument in favor of a photographic refractor was that, with the photographic plates then available, the exposure times would be about one-tenth of those required with a visual telescope with the same aperture, with or without a color screen. It is of interest to note that the significant increase in sensitivity of the yellow and red-sensitive plates was much longer delayed than some then expected, and was achieved only during the past ten years. Even now the photographic refractor holds its place.

The method of guiding with an eight-inch visual auxiliary telescope attached to the Thaw refractor turned out to be particularly effective in the principal work of the telescope: parallax observations of the brighter stars. It enabled the observer to guide on the bright star, an advantage not available with a double-slide plate holder used for parallax work with a visual telescope. By the installation of a floating mounting of the lenses of the principal telescope the rolling of these lenses in their cells was prevented.

Beginning with September, 1914, the Allegheny Observatory concentrated heavily upon the parallax work with the new telescope which produced an average of two hundred parallax plates a month. With the limited resources available to the observatory this presented the question whether to limit the work at the telescope or at the measuring engine. Without hesitation the latter course was adopted at some sacrifice in accuracy by the use of a reversing prism in the eye piece of the measuring microscope to avoid reversing the plate and measuring it twice. A comparison between the two methods was carried out later under Schlesinger's direction, and it was found that the use of the reversing prism accounts for an increase of the probable error by twelve per cent, in good agreement with an earlier estimate.

Concentration upon astronomical problems was interrupted by the participation of the United States in the war. In April, 1917, he offered his services to the government, but he remained at Pittsburgh until early in 1918, when he became aeronautical engineer with the United States Signal Corps, in charge of airplane instruments. The following year brought no return to quiet astronomical activity. During the early part of that year he was very active in correspondence and conferences among leading American astronomers in preparation for the first meetings of the International Research Council and the International Astronomical Union in Brussels in July, 1919. He attended these meetings as one of the American delegates. In view of his election to the presidency of the American Astronomical Society his position among the American delegates carried particular responsibility.

Immediately following these important meetings he had to consider the invitation from Yale University to become the director of its astronomical observatory. When he accepted this post he left an active and well-equipped observatory that he had directed for a period of fifteen years to take charge of an observatory that had seen little activity during the preceding ten years and that had no telescopic equipment that could compare with that of the Allegheny Observatory. Perhaps the principal reason for his going to Yale was the prospect of undertaking parallax determinations and other astrometric work in the southern hemisphere for which the University would establish an observing station at a favorable site south of the equator. The need for such an undertaking had been evident for some years, and no one was more strongly aware of it than Schlesinger. In addition to the Allegheny Observatory, five observatories in the United States and the Greenwich Observatory in England were then engaged in determining stellar parallaxes. In this manner the part of the sky well observable from middle northern latitudes was well taken care of, but no work of this kind was in progress at any observatory south of the equator.

Almost at once correspondence and examination of meteorological records was begun to determine where in the southern hemisphere the telescope should be located. The final decision was to establish the telescope in Johannesburg, South Africa. This site offered superb observing conditions, and had much to recommend itself in other respects.

The construction of the optical parts of the new 26-inch photographic refractor proceeded most auspiciously. As with the Thaw refractor, Mr. McDowell of the Brashear Company figured the lenses from computations by Dr. C. S. Hastings (1848-1932). The objective was completed in September, 1923, two months before Mr. McDowell's death.

The mechanical parts of the telescope and its mounting were constructed in the workshop of Yale Observatory, and had been designed by Schlesinger. This plan was not altogether a matter of choice, but was adopted when it was found that the estimates submitted by leading telescope builders were far above the amount originally budgeted, a consequence of the uncertain industrial conditions and the high level of wages and prices of materials in the early nineteen-twenties.

The completed parts were shipped to South Africa, where Schlesinger had gone to locate the site, make all arrangements to provide for the housing of the telescope, and supervise its erection. The University of the Witwatersrand made available a suitable site on its grounds and, moreover, very generously built living quarters and a small office for the astronomer in charge. The telescope was housed in a narrow building with a sliding roof. This arrangement permits observations within a small range of hour angles near the meridian only. The cost of such a structure is very low compared with a dome; for the principal work for which the instrument was intended it was entirely satisfactory and even had some advantages. For other projects for which the telescope was later used the limitations introduced by this type of housing were, however, felt as a disadvantage.

Remarkably much had been accomplished during a stay of only five months in South Africa. Dr. Harold L. Alden, who had received his training as an observer mainly at the University of Virginia, arrived in Johannesburg a month before Schlesinger's departure, and remained in charge of the telescope. The observing program got under way in September, 1925, and since that date the telescope has compiled a most excellent record in the field of photographic astrometry.

The parallax program undertaken at Johannesburg was intended to be an extension to the southern skies of the work at the Allegheny Observatory. The only important respect in which a deviation from the Allegheny practice was introduced was that the plates were measured twice, "direct and reversed," instead of with a reversing prism. Altogether the program comprised 2240 stars. Of these 1323 had been completely observed, measured and published (227, 262) at the time of Schlesinger's retirement in 1941; the work on the remaining stars being in various stages of completion.

The enormous progress that had been made in this field of astronomical investigation was brought into full light by the publication of the General Catalogue of Parallaxes. The second edition, 1935, compiled by Schlesinger with the collaboration of Miss Louise F. Jenkins, listed over 9000 stars for which parallaxes had been determined, all reduced to a uniform system. This number included about 4000 stars with trigonometric parallaxes. The field had been well explored for the brighter stars, both in the northern and the southern hemisphere. Among the important goals achieved was the establishment of a solid foundation for methods of measuring distances of more distant stars to which the direct trigonometric method is not applicable. It was the result of the joint efforts of a number of astronomers who had for years patiently made determinations of stellar distances. The number of determinations for which Schlesinger was directly responsible was impressive, but more important had been the leadership that he had provided by the development of the method and by his choice of program.

During the last ten years of his directorship of the Yale Observatory a different project replaced the parallax work as Schlesinger's first interest. This concerned the determination of star positions by photography with wide-angle cameras.

His first work in this field began in 1913 at the Allegheny Observatory. Experimental measurements on plates taken at the Harvard Observatory were sufficiently encouraging to warrant the construction of a camera specially designed for the purpose. This camera was a doublet built by the Brashear Company, the optical design by Dr. Hastings. Its focal length was 163 cm. Special efforts had been made to guard against flexure of the telescope tube, and practical methods were devised for adjusting the cell and the plane of the plate holder. The necessity for these precautions was prescribed by the large angular distances from the axis of star images near the edge of the field. From the beginning the position work with wide-angle cameras was done on photographic plates made of heavy plate glass. Later on, sheets of plate glass selected for flatness were used.

With this camera an equatorial zone was first photographed on plates with a field 4° by 6° (155, 169), and later two zones on plates 5° by 5° between declinations +50° and +60° (170, 184). The plates were reduced with the aid of selected comparison star positions obtained by meridian circle observations at the Lick Observatory for two zones, and at the Leiden Observatory for one zone.

The principal purpose of the zone catalogues was to provide accurate proper motions for numerous stars. Unfortunately star positions determined with meridian circles before 1900 are affected by a systematic error in right ascension depending upon the magnitude. If a proper motion is obtained by comparing a recent position with an earlier position, its right ascension component will evidently be affected by the magnitude error in the earlier position. No method exists by which this effect can be completely eliminated. Schlesinger boldly applied systematic corrections so determined that for each magnitude the proper motions in right ascension would average zero. This procedure is not entirely rigorous, but it has proved remarkably effective.

With a view to the statistical use of the proper motions the generous cooperation of the Harvard Observatory in supplying the spectra of stars not contained in the Henry Draper Catalogue was of great importance. Of equal importance were the accurate photographic magnitudes for the zones north of declination +20°. These were the result of a large research project undertaken by Dr. Jan Schilt who was on the Yale Observatory staff for five years, and who continued this work at Columbia University after 1931.

As early as 1915 Schlesinger began to think of reobserving by photography the stars in the Astronomische Gesellschaft catalogues for the entire northern hemisphere. The zones observed with the Hastings doublet were the experimental beginning of the execution of this plan. Later, at Yale Observatory, he modified the project to the reobservation of the stars in the Astronomische Gesellschaft and Cordoba catalogues between declinations $+30^\circ$ and -30°. This change was in part due to the fact that the Astronomische Gesellschaft had independently begun the photographic reobservation of the stars in the northern hemisphere, in part to the fact that there was a particular need for star positions in a belt in the sky that contained the zodiac and for positions of stars in the southern hemisphere.

At Yale Observatory a new wide-angle camera designed by Dr. Frank E. Ross was introduced. The focal length was chosen to be 206 cm, corresponding to a scale of 100″ to the millimeter. The angular distance from the axis for which the Ross camera still gave excellently measurable star images was much greater than was the case with the camera previously used. Hence a larger field could be measured on one plate. The first application was made to the ten-degree zone between declinations $+20^\circ$ and $+30^\circ$ (199, 206). On plates measuring 19 by 23 inches a field of 10° by 15° was measured. Stars in the corners of these plates were 9° from the axis, yet had images of excellent quality.

The introduction of the very large plates required much new experimental work as well as a new measuring engine, large enough to accommodate plates of this size. This was built by the Gaertner Company. Its general design was the same as that of the first long-screw measuring engine designed by Schlesinger in 1906, but, on account of its size, important modifications in detail were necessary.

After the experience gained with these very large plates a uniform procedure for the remaining zones was adopted. Plates measuring 17 by 17 inches, covering an area of 11° by 11°, were used. With new Ross cameras both at the Yale Observatory in New Haven and at Johannesburg, and with very sturdy plate holders constructed from cast aluminum, the plates for the remaining zones of the project, i.e., between declinations $+20^\circ$ and -30°, were obtained. Catalogues covering the zones -10° to -30° appeared between the years 1939 and 1943 (246, 250, 251, 259, 260, 261). They represent the best in position work on large photographic plates that has been produced; the exceptionally high accuracy of the comparison star positions, furnished by the United States Naval Observatory and by the

Observatory at the Cape of Good Hope added to the value of the catalogues.

The increase in accuracy, from a probable error of 0."16 in each coordinate for the first zones photographed with the Hastings camera to a probable error of 0."11 for the latest zones, is most significant. The excellent quality of the later Ross cameras is an important contributing factor; equally important is the circumstance that the plate solutions for the larger plates, in which terms of higher order are included, give a closer representation of the system of the comparison stars than could be achieved with plates covering a smaller area. A further advantage is that fewer comparison stars are required for a given area; hence it has become more feasible for the meridian circle observers to furnish the positions of the necessary comparison stars.

It is likely that Schlesinger's enthusiasm led him to underestimate the extent of the undertaking when he wrote, in 1914, that "the repetition of all the northern (Astronomische Gesellschaft) zones, if carried out photographically by means of a doublet, would be a task well within the powers of a single observatory". This was before the reductions for any complete zone had been made, and without this actual experience no one could make even an approximate estimate of the very large amount of work involved. In the earlier years the calculation, for every star image on every plate, of the rectangular coordinates from the right ascension and declination was done in duplicate with the aid of standard logarithmic tables by a staff of computers under the supervision of Dr. Ida Barney. For the catalogues between declinations +30° and −30° the burden upon the Observatory staff was diminished by the use of the punched card machines of the Thomas J. Watson Astronomical Computing Bureau. The adaptation of the calculations to the use of these machines was made by Dr. Wallace J. Eckert. It is perhaps justifiable to say that without the use of the punched card machines the project would have been too large for the Observatory.

When it became clear that the project could not be completed before his retirement he made every effort to reduce the task remaining for the Observatory by seeing to it that all the plates were measured. It was a great satisfaction for him to know that the work on the catalogues would continue to rank first among the programs of the Observatory. A further happy circumstance was that the work was continued with Dr. Ida Barney in full charge. She had been co-author of all the catalogue volumes published under Schlesinger's direction, and had taken an important part in every phase of the work. At the time of his death there remained about 58,000 stars on the program. When completed the Yale zone catalogues will have furnished accurate positions and proper motions of approximately 150,000 stars. The value of this material for the study of the structure of the star system is very great indeed.

From an early date Schlesinger resisted the temptation, always present, to scatter his research on a great variety of subjects. He wished to contribute a maximum effort to a limited field which, in his case, meant concentration on photographic astrometry. This explains the termination of the work at Allegheny on spectroscopic binaries as soon as the Thaw refractor became available. Even in his experimental work this concentration is strikingly present. At the Allegheny Observatory he began studies on the nature of the errors in the measurement of star images on photographic plates, which included a study of refraction anomalies (57, 84). His efforts to introduce improvements in the design of measuring engines cover a long period of years. Beyond the introduction of the long-screw engine and the design of the measuring engine for very large plates his principal contribution was the development of the projection method in collaboration with Dr. Arthur L. Bennett (198). A simple optical system was introduced by which the star image and the cross wires are projected on a white surface placed at the same distance from the eye as the circle and the record sheet. The merit of the projection method is that it eliminates the principal cause of fatigue of the measurer. At no sacrifice in accuracy it became possible to have a measurer double the number of hours a day at the measuring engine.

In connection with the zone-catalogue work he began at the

Allegheny Observatory an experiment with the view of obtaining absolute positions of stars by photography. Much later the attempt was resumed at Yale Observatory by a graduate student working under his supervision, but no conclusive results were obtained. This is one of several experiments in astrometry that were taken up at various times, and that were permitted to be crowded out by the larger projects. Among these were attempts to devise a method that would permit the accurate measurement of the moon's position by photography as well as experiments with a photographic zenith telescope.

Perhaps the fact that some of these projects were left incompletely developed accounts for Schlesinger's occasional expression of regret that so much of his own energy and of the resources of the observatories that he directed was expended on projects that involved so much routine work that there was less opportunity left for experimental work than he would have desired. Such expressions were of course entirely sincere, but they fail to state the great amount of satisfaction that he derived from the efficient execution of the large programs. He took justifiable pride in the successful employment of a staff of assistants who had no knowledge of astronomy but who had learned to make measurements and computations of a routine character. That this arrangement worked so satisfactorily was due to the fact that he could rely upon competent professional collaborators for supervision. He succeeded in keeping in close touch with the work by taking upon himself some of the operations, and he enjoyed doing this as an interesting interruption of his administrative work.

Soon after the parallax work at the Allegheny Observatory began, Schlesinger felt the need for a catalogue that contained all the important information concerning the brighter stars. Work on such a catalogue was begun in 1916, but its appearance in print (183) was delayed until 1930. The Catalogue of Bright Stars was at once recognized as an indispensable reference work of astronomers; a second edition (253) in which the material was brought up to date was published in 1940.

Every subject that he had ever taken up seriously had his lifelong interest. Examples are the variation of latitude, observation of the sun, Algol, the Pleiades, and many others. On the Pleiades he began the compilation of a general catalogue in 1898. The work progressed slowly, and little more than a beginning had been made when, at the meeting of the Astronomische Gesellschaft in Hamburg in 1913, he met Dr. R. H. Trumpler who spoke to him about a plan for an investigation of the same general nature. This led Schlesinger to invite Dr. Trumpler to a position as assistant at the Allegheny Observatory, where the latter began his important investigations on this star cluster.

Notable also was his interest in the history of astronomy, and more particularly in the astronomers of previous generations. With deep personal devotion he could speak about the great astronomers of the recent past whom he had known when they were the leaders of the science. Examples of this reverence were his placing of a bronze plaque on the house in Nyack where George William Hill (1838-1914) was born and had worked, as well as his calls on Küstner and Max Wolf (1863-1932) when he was in Germany in 1928 to attend the Heidelberg meeting of the Astronomische Gesellschaft.

It was inevitable that Schlesinger should play an important rôle in the American Astronomical Society of which he became a member in 1905. He served successively as a member of the council, vice president and president. To the highest office in the Society he was elected in 1919 at the age of 48, succeeding E. C. Pickering, and was the youngest president in the history of the Society. It was at the meetings of the American Astronomical Society that he became well acquainted with Ernest W. Brown (1866-1938), who was mainly responsible for his coming to Yale. Though the two men worked in totally different fields of astronomy, they had many scientific interests in common. Brown was a member of the department of mathematics at Yale, but he made the Observatory his headquarters, at Schlesinger's suggestion. There are probably few other examples of an informal association of this kind that worked out so well with never an incident to mar the friendship.

On an international scale Schlesinger's rôle in astronomy became equally distinguished through his activities in the International Astronomical Union. From the founding in 1919 on he was an influential member whose wisdom in committee and council meetings was thoroughly appreciated. This culminated in his election to the presidency for the three-year term 1932-35, at the conclusion of which he presided at the meeting of the Union in Paris. At the next meeting, in 1938, the first that he did not attend, his absence was felt intensely.

Through his membership in the American Philosophical Society, since 1912, and the National Academy of Sciences, since 1916, he became associated with many eminent scientists in other fields. He had a keen appreciation of significant contributions to science, even very remote from his own field of specialization. This broadness of his interests must have come as a surprise to many who knew of the strict limitation in his choice of research subjects. It was also demonstrated by the success with which he presided at neighbors' meetings, informal gatherings of astronomers in the eastern part of the United States. They began at Schlesinger's initiative, soon after he came to Yale. Most meetings, usually three a year, were held at the Yale Observatory.

He did not lecture a great deal, but when he did, he preferred to speak about a subject close to his own special fields of interest, and succeeded in lifting his audience to an appreciation of the objectives of astronomical research. He was at his best when he was called upon to speak without much preparation. In such circumstances he exhibited an admirable command of the English language, and stated his views with order and clarity. In debates he would stand his ground firmly, and never seemed to have any difficulty in choosing the appropriate tactful words.

It may be regretted that a scientist who can expound his subject so clearly has so few students. Schlesinger's activity as a teacher of undergraduate students was always very limited. For graduate students he offered a number of subjects, with astronomical photography and the theory of errors as his favorite topics. Always teaching to a small group, his lectures were not particularly formal, but his work was conscientious and he succeeded in stimulating the initiative of his students. Especially when they were engaged in independent research, for the doctor's degree or otherwise, he would always be ready to drop his own work and concentrate with them on finding the best approach to the solution of a problem that had arisen.

This is not the place for more than a brief account of his family life. His first wife shared with him his introduction into the astronomical world. She frequently accompanied him to astronomical meetings, and made many friends there. Her interest in others was expressed in community work, and in her relation to the observatory staff and their families. This first marriage ended with her death in January, 1928. Their son, Frank Wagner Schlesinger, received his college training at Yale University, and followed his father in interest and ability in engineering. Astronomy was for him a hobby until, after some years of practical work in engineering, he became a member of the staff of the Adler Planetarium in Chicago of which Dr. Philip Fox (1878-1944) was then director. He eventually became director of the Fels Planetarium in Philadelphia and, in 1945, director of the Adler Planetarium.

In 1929 Schlesinger married the former Mrs. Philip Wakeman Wilcox of Atlanta, Georgia, and New York City. In a very short time she had made a place for herself in the community. The meeting of the International Union at Cambridge, Mass., in 1932, brought many foreign astronomers to this country, and during that year a good percentage of them were entertained as guests at the Observatory house. Perhaps no other astronomer's wife ever was introduced so rapidly into such a large circle.

During the last five years of Schlesinger's life his failing health permitted him on ever fewer occasions to enjoy the full activity to which he had been accustomed. Wishing to conserve his strength for his research and administrative work, he became more and more retiring. The summers were quietly spent at their country house at Lyme, Connecticut, which was their home after 1941. Without any apparent effort Mrs.

Schlesinger made it her first duty to provide comfort for her distinguished husband whose health was precarious during most of the two years of his retirement from academic work. He died at Lyme, Connecticut, on July 10, 1943, after a long illness, in his seventy-third year.

On November 19, 1943, Memorial Exercises in his honor were held in Strathcona Hall, Yale University, with President Charles Seymour of Yale University presiding, and President-emeritus James Rowland Angell of Yale University and Professor Henry Norris Russell of Princeton University as the principal speakers. The following characterization of Schlesinger's scientific work is quoted from Dr. Russell's address:

"His special field, the astronomy of position, is as much an art as a science. Its main problems—where the heavenly bodies appear to be, where they are, and how they are moving—may be solved in principle by simple geometrical means. Its methods have gradually been perfected until they are accurate to one part in a million or better; but the quest for such precision unveils many unsuspected errors. To distinguish between those arising from the inevitable, but accidental, imperfections of observations and those which can be got rid of only by improving the conditions of observation requires skill in applied mathematics and statistics; to find the causes of the latter demands a thorough study of every detail of the apparatus, including the psychology of the observer; to devise ways of avoiding or correcting them needs also inventive skill; and to organize a program of research so that results of the highest precision can be obtained efficiently and at a minimum cost of labor and money is a matter of engineering and economic management. In all four of these capacities Schlesinger was a master."

CURRICULUM VITAE AND HONORS

Certificate of Proficiency in Descriptive Geometry, Freshman Year, College of the City of New York, 1887.
B.S., College of the City of New York, 1890.
Surveyor for the Title Guarantee and Trust Company, New York, 1890-92.
Surveyor for the Department of Street Improvements of New York City, 1892-96.
M.A., Columbia College, 1897.
Ph.D., Columbia College, 1898.
Research Assistant at the Yerkes Observatory, summer of 1898.
Observer-in-charge, International Latitude Observatory at Ukiah, California, 1899-1903.
Astronomer at the Yerkes Observatory under the auspices of the Carnegie Institution of Washington, 1903-05.
Director, Allegheny Observatory, University of Pittsburgh, 1905-20.
Member, American Philosophical Society, 1912-43.
Vice-President, American Astronomical Society, 1912-19.
Vice-President, American Association for the Advancement of Science, and Chairman, Section A, 1913.
Collaborating Editor, Astrophysical Journal, 1913-41.
Associate, Royal Astronomical Society, 1914-43.
Member, Washington Academy of Sciences, 1915-43.
Member, National Academy of Sciences, 1916-43.
Honorary Fellow, Royal Astronomical Society of Canada, 1916-43.
Aeronautical Engineer, In charge of Airplane Instruments, United States Signal Corps, 1918.
Foreign Member, Societa degli Spettroscopisti Italiani, 1918-43.
Honorary Member, Astronomical Society of Mexico, 1918-43.
President, American Astronomical Society, 1919-22.
D.Sc., University of Pittsburgh, 1920.
Director, Yale University Observatory, 1920-41.
A.M., Yale University, 1920.
Fellow, American Academy of Arts and Sciences, 1921-43.
Vice-President, International Astronomical Union, 1925-32.
Sc.D., Cambridge University, 1925.
Valz Medal, French Academy of Sciences, 1926.
Member, Editorial Board, National Academy of Sciences, 1926-36.
Gold Medal, Royal Astronomical Society, 1927.
(First) George Darwin Lecturer, Royal Astronomical Society, 1927.
Bruce Medal, Astronomical Society of the Pacific, 1929.
Corresponding Member, French Academy of Sciences, 1932-43.
President, International Astronomical Union, 1932-35.

(First) Honorary Member, Rittenhouse Astronomical Society, 1933-43.
Townsend Harris Medal, College of the City of New York, 1935.
Officer, Légion d'Honneur, 1935-43.
Associate Fellow, Jonathan Edwards College, Yale University, 1937-43.
Correspondent, Bureau des Longitudes, 1938-43.
Ordinary Associate, Royal Academy of Sciences, Upsala, 1938-43.
Member, Board of Directors of the Gould Fund, National Academy of Sciences, 1938-43.
Professor of Astronomy and Director of the Observatory, Emeritus, Yale University, 1941-43.

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The abbreviations used are those of the World List of Scientific Periodicals, second edition.

KEY TO ABBREVIATIONS USED IN BIBLIOGRAPHY

Amer. Astr. Soc. Publ. = Publications, American Astronomical Society
Amer. J. Sci. = American Journal of Science
Amer. Phil. Soc. Yearb. = American Philosophical Society Yearbook
Ann. N. Y. Acad. Sci. = Annals, New York Academy of Sciences
Astr. J. = Astronomical Journal
Astr. Nachr. = Astronomische Nachrichten
Astrophys. J. = Astrophysical Journal
Biogr. Mem. Nat. Acad. Sci. = Biographical Memoirs, National Academy of Sciences
Bull. Amer. Math. Soc. = Bulletin, American Mathematical Society
Bull. Nat. Res. Coun. = Bulletin, National Research Council
City Coll. Quart. = City College Quarterly
Contr. Columbia Univ. Obs. = Contributions, Columbia University Observatory
J. R. Astr. Soc. Can. = Journal, Royal Astronomical Society of Canada
Mem. Nat. Acad. Sci. = Memoirs, National Academy of Sciences
Misc. Sci. Pap. Allegheny Obs. = Miscellaneous Scientific Papers, Allegheny Observatory
Mon. Not. R. Astro. Soc. = Monthly Notices, Royal Astronomical Society
Pop. Astr. = Popular Astronomy
Proc. Amer. Acad. Arts Sci. = Proceedings, American Academy of Arts and Sciences
Proc. Amer. Phil. Soc. = Proceedings, American Philosophical Society
Proc. Nat. Acad. Sci. = Proceedings, National Academy of Sciences
Publ. Allegheny Obs. = Publications, Allegheny Observatory
Publ. Astr. Soc. Pacif. = Publications, Astronomical Society of the Pacific
Publ. Astr. Astrophys. Soc. Amer. = Publications, Astronomical and Astrophysical Society of America
Rep. Smithson. Instn. = Report, Smithsonian Institution
Sci. Mon. = Scientific Monthly
Trans. Int. Astr. Un. = Transactions, International Astronomical Union
Trans. Yale Astr. Obs. = Transactions, Yale Astronomical Observatory
Yearb. Carneg. Instn. = Yearbook, Carnegie Institution

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1899

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1900

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1902

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1912

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1915

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1916

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1917

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