



# Frank Schlesinger

## The Twenty-Fourth Bruce Medalist

Joseph S. Tenn

Sonoma State University

"How far away is that star?" The question comes up often at public viewing nights. It has taken an enormous amount of work to answer that question, even for the nearest stars. Look at a nearby object against a distant background from two different positions. It will appear to move through an angle which increases with the separation between the observing positions and decreases with the object's distance. Half this angle is called the parallax of the object, and it is not difficult to show that if the parallax is one second of arc, then the distance to the object is 206,265 times half the separation distance. (The number is the number of arcseconds in a radian.)

In 1543 Nicholas Copernicus claimed that the Earth is orbiting the Sun. Soon afterward astronomers tried to measure the parallactic shifts of stars as seen from opposite sides of the Earth's alleged orbit. Their failure for nearly three centuries implied either that the Earth does not move or that the distances to the stars are much greater than the distance to the Sun (the *astronomical unit*). In 1837-40, Wilhelm Bessel in Germany, Wilhelm Struve, in what is now Estonia, and Thomas Henderson, who had made his observations in South Africa,

finally achieved the first measured parallaxes of stars. The angles they reported were only about one second of arc.

Astronomers usually quote stellar distances in *parsecs*. One parsec is simply the distance at which a star would have a *parallax* of one second of arc. A parallax of 0.5 arcseconds implies a distance of two parsecs, and so on. Now that the astronomical unit is known with precision (due to radar measurements in the 1960s), we can equate the 206,265 astronomical units in a parsec to  $3.08568 \pm 10^{16}$  meters or 3.26156 light years.

There is no star with a parallax as great as one arcsecond. Consequently, parallax measurements are difficult, requiring the measurement of separations between stars to extremely high precision, with great care taken to eliminate such larger effects as instrumental errors, personal differences, atmospheric refraction, and the difficulty of finding the center of a blurry image. Visual observations with the difficult heliometer, used by Bessel, David Gill [May/June 1990 *Mercury*], and a few others, constituted the most successful method at first, but by the last decade of the 19th century it occurred to some

astronomers that the necessary precision might be attainable with photography.

One of these was Frank Schlesinger. As he pointed out in 1899, "no less than sixty years" after the first measured parallaxes, "there [were] not more than twenty-five or thirty stars whose parallaxes, as [then] known, [could] be relied upon within 0.05 arcseconds." A typical stellar parallax at the time might be  $0.10 \pm 0.05$  arcseconds, implying a distance anywhere between 20 and 7 parsecs.

At the time Schlesinger was 28 years old and the lone astronomer at the International Latitude Station in Ukiah, California. It was one of five stations spaced around the world at 39° north latitude to determine the tiny wobble of the Earth's axis of rotation. It was just a year since he had earned a Ph.D. at Columbia University by carefully measuring some old photographic plates of stars. In Ukiah Schlesinger read widely, married and produced a son (who would become a planetarium director), and became active in the ASP. In 1903 he went to Yerkes Observatory, where director George Hale [May/June 1992 *Mercury*] encouraged his experiments with

Frank Schlesinger

11 May 1871 -  
10 July 1943

1929 Bruce Medalist

(photograph c. 1916,  
Yale University, courtesy  
Dorrit Hoffleit)

photography for precision astrometry. As Schlesinger described later:

"I for one had no definite idea what accuracy to expect from such photographs, since up to that time all experience had been confined to plates taken with much smaller instruments, none of these so far as I am aware, having a focal length as great as one-fourth that of the Yerkes telescope. ... I measured on photographs the same stars ... that [Edward E.] Barnard was measuring with the filar micrometer on the same telescope. He entered heartily into this experiment .... It turned out that the measurement of one image on a plate had about one-third the probable error, and therefore about nine times the weight, of a complete micrometer measurement." The photographic method was much simpler—few, if any, visual observers could match Barnard [Sep/Oct 1992 *Mercury*], but almost anyone could learn photography—and, "the time spent at the telescope to secure the same result is at least one hundredfold greater with the micrometer".

After Hale left to build his solar observatory on Mt. Wilson, Schlesinger found a much better position as director of the Allegheny Observatory of the University of Pittsburgh. With much support from local instrument-builder John Brashear, the Allegheny had an almost completed 30-inch reflector and funding to build a 30-inch refractor as well. Using the reflector while waiting for the refractor, Schlesinger became a spectroscopist, and a good one. His work on the eclipsing binary star Delta Librae was the first measurement of the rotation of any star beyond the Sun. As the fainter star covers and then uncovers its bright companion, the light from the system is predominantly from one side of the brighter star and then the other. Schlesinger

measured the difference in radial velocities to obtain the rotation rate of the brighter star.

Meanwhile he kept ace computer Louise Ware busy measuring the plates from his Yerkes days and reducing the data. As the results appeared in 1910-11, the number of stars of measured distance rose rapidly into the hundreds and then the thousands. According to Dirk Brouwer, "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."

Schlesinger made the refracting telescope at Allegheny a photographic one, and as soon as it was ready, he returned to parallax measurements. By 1920, when he was appointed director of the Yale Observatory, he was a renowned leader in the astronomy of position and president of the American Astronomical Society. He placed Yale's new 26-inch refractor in the southern hemisphere, where few stellar distances were known. He erected it in a narrow sliding-roof observatory, as stars would be observed only near the meridian to minimize atmospheric refraction, and opening the entire roof allowed rapid cooling of the air in the building. He left Harold Alden to take the plates in South Africa and send them to Yale for measurement and reduction.

By the time Schlesinger retired in 1941 he and his coworkers had published precise parallaxes of 1323 southern stars, and there were many more to come. According to Brouwer, "In the earlier years the calculation, for every star image on

every plate, ...was done in duplicate with the aid of standard logarithmic tables by a staff of computers under the supervision of Dr. Ida Barney." Later Wallace Eckert adapted the calculations to punch-card machines at the Thomas J. Watson Astronomical Computing Bureau.

Often ahead of his time, Schlesinger had a young Dutch visitor, Jan Oort, using a robotic telescope to make another attempt at measuring variation of latitude in the 1920s. Describing his clock-driven devices, Schlesinger proclaimed, "All that the observer need do is to insert a plate after dark and remove it before dawn."

Schlesinger used wide-angle cameras to photograph fields as large as 10° by 14° on plates 17 by 23 inches. He and his assistants, notably Yale Ph.D. Barney, compiled "zone catalogues" giving precise positions and proper motions of 92,329 stars. These were extended and revised by Barney and by Dorrit Hoffleit, so that 227,000 stars now have proper motions determined at Yale.

*The Bright Star Catalogues*, begun by Schlesinger in 1930, are now under the supervision of Wayne Warren, Jr. at NASA Goddard Space Flight Center. Parallax catalogues begun under Schlesinger continue to improve under the direction of William van Altena at Yale. Today both Allegheny and Yale Observatories remain among the leaders in the astronomy of position, and Schlesinger is known as the "father of modern astrometry."

Acknowledgement: The author is grateful to Dorrit Hoffleit for information and assistance and highly recommends her book, *Astronomy at Yale, 1701-1968* (Connecticut Academy of Arts and Sciences, 1992). ▀