

Biographical Encyclopedia of Astronomers

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Shapley, Harlow

Born near Nashville, Missouri, USA, November 2, 1885

Died Boulder, Colorado, USA, October 20, 1972

American observational astronomer Harlow Shapley obtained the data that showed incontrovertibly that the Solar System is not near the center of the Milky Way Galaxy, as virtually all astronomers had thought since the time of William Herschel. His name is remembered in the Shapley concentration of galaxies (a very extensive supercluster) and in the Shapley-Ames catalog of nearby galaxies. Shapley was the son of Willis and Sarah (née Stowell) Shapley. After completing elementary school and a short business course, and before graduating from high school in 1907 (first in a class of three from Carthage Collegiate Institution in Carthage, Missouri), he spent several years as a newspaper reporter, first in Chanute, Kansas, and then in Joplin, Missouri. Shapley then entered the University of Missouri. Finding that the new School of Journalism, which had been his goal, was not yet open, he quickly turned to astronomy, under the influence of Frederick Seares, with whom he worked on light curves of variable stars, mostly eclipsing binaries. Shapley received a BA in 1910 and an AM in 1911, going on that year to Princeton University with a Thaw Fellowship.

Working officially with Henry Norris Russell and also mentored by Raymond Dugan, who was more observationally inclined, Shapley received a Ph.D. in 1913 for the analysis of the light curves of a large number of eclipsing binaries. He was able to measure sufficiently accurate masses and radii for the component stars to conclude that the range of stellar densities is more than 1,000, but that density is not correlated with surface temperature in the way that Russell (with his giant-and-dwarf theory of stellar evolution) was expecting. Seares had by then moved to Mount Wilson Observatory and arranged for Shapley to meet its director, George Hale. After a year in Europe, during which he met many astronomers, Shapley accepted a position at Mount Wilson Observatory.

In 1914, Shapley married fellow Missourian Martha Betz. Trained as a mathematician, Martha Shapley quickly acquired skill in analyzing variable-star light curves to extract binary properties, and published a number of papers alone and with Shapley between 1915 and 1929. Of their five children, Mildred Shapley Matthews became a planetary astronomer, Lloyd a mathematician, Alan a geophysicist, and the others (and some of the grandchildren) scientists, science administrators, and teachers of other sorts.

Before moving west, Shapley had visited Harvard astronomer Solon Bailey, who urged him to use the 60-inch telescope on Mount Wilson (then the largest) to observe variable stars in globular clusters. He did this as soon as the opportunity presented itself. Contemporary astronomers were generally of the opinion that the Cepheid variables (for which a correlation between absolute luminosity and length of period had been discovered earlier by Henrietta Leavitt for stars in the Small Magellanic Cloud) were eclipsing binary pairs Shapley carried

out an analysis demonstrating that this could not possibly be true, for the separation of the stars would have to be smaller than their sizes, putting one star inside the other. In 1914, he advanced an alternative idea that the stars were pulsating radially in size, with corresponding changes in surface temperature and brightness. This proved to be correct. Shapley also tacked on to the faint end of the period-luminosity relation a class of more rapid variables, then called cluster-type (though they also occur outside globular star clusters) and now called RR Lyrae variables. This eventually caused problems.

The pulsation mechanism, however, suggested that the Cepheids could be reliable distance indicators, if only one could calibrate them with a few stars whose real luminosities (or distances) were known in some other way. Ejnar Hertzsprung had attempted such a calibration, using the method of statistical parallaxes invented by Jacobus Kapteyn, and Shapley adapted and improved this. Shapley's calibration was an important advance, but three effects combined to introduce errors into his period-luminosity relation. These were (1) neglect of galactic rotation (not discovered until a decade later by Bertil Lindblad), (2) his own work, which seemed to show that there was no general absorption of starlight in interstellar space (proven wrong in 1930 by Robert Trumpler), and (3) slight bad luck with the statistics of very small motions on the sky for a small number of stars. He was, moreover, mistaken in thinking that the nearby Cepheids (on which the calibration was done), and those in globular clusters, were physically similar. In fact, they differ in mass by a factor of 5–10 and in brightness by factors of 2–10, so that Shapley placed his globular clusters too far away when he started using Cepheids as rulers.

Shapley had come to Mount Wilson as a believer in the "island universe," or many galaxies hypothesis, under which the Milky Way and the spiral nebulae were similar kinds of systems. But the map Shapley gradually drew of the locations of the globular clusters eventually persuaded him, first, that the Solar System was very far from the center. (Its center was actually within the grouping of clusters toward Sagittarius, an idea advanced earlier by Swedish astronomer Karl Böhlin.) Second, Shapley was persuaded that the Milky Way extended to at least 50,000 parsecs from that center, making the idea of other galaxies of comparable size most unlikely. He was further misled by his own discoveries of some novae in the Andromeda Nebula that he decided were not as bright as galactic novae (leaving only the 1885 event, now known to have been supernova 1885A, as a distance indicator) and by apparent measurements of the rotation in the plane of the sky of several spiral nebulae, carried out on Mount Wilson plates by Adriaan van Maanen. Knut Lundmark later showed that Van Maanen's measurements were completely erroneous, but Shapley, who regarded van Maanen as a friend, was not convinced.

Against this background, Shapley and Heber Curtis engaged in a discussion of "the distance scale of the universe" before the National Academy of Sciences in Washington, in April 1920. Shapley advocated a very large Milky Way with the Sun far from the center and the spiral nebulae and globular clusters as members of this one, universal system. Curtis advocated a much smaller Milky Way, with the Solar System close to the center, and the spirals as independent, similar systems of stars. The event is frequently called the Great Debate or the Curtis-Shapley debate, though it was not actually organized as a debate. In retrospect, Curtis

was right about other galaxies existing (shown by Edwin Hubble a few years later), and Shapley was right about the noncentral position of the Solar System, which was quickly adopted by the entire community, relegating the smaller Kapteyn universe to the status of a relatively local feature in the galactic disk. The modern distance scale within the Milky Way is about halfway between those of Curtis and Shapley.

The death of Edward Pickering in 1919 left Harvard Observatory directorless. Those charged with naming Pickering's successor attended the debate to evaluate Shapley for the position. It was offered to him, first on a visiting basis, and then permanently in 1921. At Harvard, Shapley carried out investigations in many areas, including studies of the Magellanic Clouds, star clusters, and variable stars. The Shapley-Ames catalog of galaxies, published with Adelaide Ames in 1932, was an important survey of galaxies brighter than the 13th magnitude. That and follow-up surveys, extending to fainter magnitudes, provided early indications that galaxy clustering might be important on large scales. Indeed, Shapley eventually came to the opinion that most galaxies are clustered (the modern view), and he himself recognized several of the large clusters and concentrations

Shapley's view of the clustering of galaxies was another source of disagreement with Hubble, who saw most galaxies as part of a general field. The antipathy felt by both astronomers may have stemmed from their overlap at Mount Wilson Observatory. Shapley remained a civilian during World War I, arriving in 1914, while Hubble volunteered for army service in Europe, arriving at Mount Wilson in 1919 to find that Shapley had initiated some studies that he himself had intended to pursue. That antipathy gradually emerged as full-blown antagonism as their careers diverged, with Hubble garnering fame through the scientific fruits of his work with the most powerful telescope in the world while Shapley administered at the Harvard College Observatory

In 1938, Shapley reported the discovery of the Fornax and Sculptor systems, the first of the dwarf spheroidal galaxies that are satellites of the Milky Way. He completed publication of the Henry Draper Catalogue of Spectral Classifications, a project begun under Pickering, and organized the Henry Draper Extension. Together, these surveys provided spectral classifications for 359,000 stars. Shapley also continued Pickering's support for the American Association of Variable Star Observers, whose members were mainly amateur astronomers. His support for amateurs was evident in other ways, including his founding of the Bond Astronomy Club and support for the Amateur Telescope Makers of Boston

Harvard Observatory, despite its location next to the oldest university in the country, had been a purely research institution. Shapley built it into one of the country's strongest education programs in astronomy. Many of his early students (including Cecilia Payne-Gaposchkin, Helen Sawyer-Hogg, and Dorrit Hoffleit) and his early appointments to the Harvard College Observatory staff (Henrietta Swope, Bart Bok, Donald Menzel, and Fred Whipple) also appear in these pages. He moved the Harvard Southern Station from Arequipa, Peru, to Bloemfontein, South Africa, and hosted at Harvard the headquarters of the American Association of Variable Star Observers and the editorial offices of *Sky & Telescope*, the most important popular astronomy magazine in the United States

Shapley retired from the directorship in 1952 (to be succeeded by Menzel) and from his Harvard professorship in 1956, although he maintained an active interest in astronomical innovation until very late in life, visiting, for instance, the first observatory designed to look for gravitational radiation in 1969.

A brilliant public speaker, Shapley enjoyed popularizing science, especially astronomy. He arranged an extended series of radio talks on astronomy when that medium was still comparatively young. Later, with Bok, he initiated the Harvard Books on Astronomy, popular volumes that filled a growing demand for informative books on what was happening in astronomical research. These were written by some of the leading astronomers of the time. Some books in the Harvard Books series went through four editions before the series was cancelled.

Shapley had always been an outward-looking, publicly oriented scientist, serving, for instance, as one of the first presidents of the Commission on Galaxies of the International Astronomical Union in the 1920s. In the late 1930s, he became increasingly concerned about what was happening to German, and later European, scientists and spent a great deal of time helping to resettle refugees before, during, and after World War II. Shapley was actively involved in the processes that led to the establishment of the National Science Foundation, Science Service Inc. (the publishers of *Science News* and coordinators of the science talent search, of which he was president), and UNESCO, where he was a strong advocate for the inclusion of the "S" (science) component. He served as president of the American Astronomical Society, the American Association for the Advancement of Science, and Sigma Xi (the scientific research society), as well as giving numerous public lectures and serving as a board member of the Belgian-American Education Foundation, the Worcester Foundation for Experimental Biology, and many others. Shapley was a strong opponent of "fringe science," helping to coordinate opposition to the ideas of Immanuel Velikovsky and the flying saucerites. At some point, this stance was perceived as threatening to United States security, and he was summoned before the House Un-American Activities Committee for alleged (and completely untrue) Communist connections and sympathies.

His own scientific colleagues recognized and rewarded Shapley's work in many ways. He held 16 honorary degrees (ten from within the USA and six others), was elected to the United States National Academy of Sciences and to science academies in nine other countries, and received medals and awards from the American Astronomical Society, the Royal Astronomical Society, the French Astronomical Society, and others.

Horace A. Smith and Virginia Trimble

Selected References

Belkora, Leila (2003). "Harlow Shapley: Champion of the Big Galaxy." In *Minding the Heavens*, pp. 245-292. Bristol: Institute of Physics.

Bok, Bart J. (1978). "Harlow Shapley. Biographical Memoirs," *National Academy of Sciences* 49: 241-291

Bryant, Katherine L. (1992). "The Great Communicator: Harlow Shapley and the Media, 1920-1940." AB thesis, Harvard University.

De Vorkin, David H. (2000). *Henry Norris Russell: Dean of American Astronomers*. Princeton, New Jersey: Princeton University Press

Fernie, J. D. (1969). "The Period-Luminosity Relation: A Historical Review." *Publications of the Astronomical Society of the Pacific*, 81: 707-731.

Gingerich, Owen (1988). "How Shapley Came to Harvard or, Snatching the Prize from the Jaws of Debate." *Journal for the History of Astronomy* 19: 201-207.

—— (1990). "Through Rugged Ways to the Galaxies." *Journal for the History of Astronomy* 21: 77-88.

Palmeri, Joann (2000). "An Astronomer beyond the Observatory: Harlow Shapley as Prophet of Science." Ph.D. diss., University of Oklahoma.

Shapley, Harlow (1914). "On the Nature and Cause of Cepheid Variation." *Astrophysical Journal* 40: 448-465

(—— 1915). "A Study of Orbits of Eclipsing Binaries." *Contributions from the Princeton University Observatory*, no. 3.

"On the Determination of the Distances of Globular Clusters." *Astrophysical Journal* 48 (1918): 89-124. (Sixth paper in the series "Studies Based on Colors and Magnitudes in Stellar Clusters." Additional papers include "The Distances, Distribution in Space, and Dimensions of 69 Globular Clusters." *Astrophysical Journal* 48 [1918]: 154-181 and "Remarks on the Arrangement of the Sidereal Universe." *Astrophysical Journal* 49 [1919]: 311-336.)

—— (1969). *Through Rugged Ways to the Stars*. New York: Charles Scribner's Sons, 1969

Shapley, Harlow and Adelaide Ames (1932). "A Survey of the External Galaxies Brighter than the Thirteenth Magnitude." *Annals of the Astronomical Observatory of Harvard College* 88, no. 2: 41-75.

Smith, Horace (2000). "Bailey, Shapley, and Variable Stars in Globular Clusters." *Journal for the History of Astronomy* 31: 185-201.

Smith, Robert W. (1982). *The Expanding Universe: Astronomy's 'Great Debate, 1900-1931*. Cambridge: Cambridge University Press.