

Biographical Encyclopedia of Astronomers

© 2007 Springer

Leavitt, Henrietta Swan

Born Lancaster, Massachusetts, USA, July 4, 1868

Died Cambridge, Massachusetts, USA, December 12, 1921

American astronomer Henrietta Leavitt discovered the period-luminosity relation. This is a close correlation between pulsation period and intrinsic brightness in the class of variable stars called Cepheids after their prototype, Cephei & Cephei. The period-luminosity relation is extremely important as a standard candle that permits the determination of the distances of stars in clusters and galaxies too distant to be measured by their parallax.

One of a large number of women employed at Harvard College Observatory by director Edward Pickering, Leavitt was the daughter of Congregational minister Reverend George Roswell and Henrietta S. (*née* Kendrick) Leavitt, who traced their Puritan heritage to settlers at Hingham, Massachusetts in the 1640s. In 1887, Henrietta entered Oberlin College, excelling despite an inexplicable and progressive loss of hearing. She then enrolled at the Society for the Collegiate Instruction of Women, Radcliffe, where her charm and attentiveness made her popular among her classmates, softening the often-traumatic effects of a now-profound deafness. She became immersed in astronomy while taking a course in her senior year at Radcliffe.

In 1872, Henry Draper had taken the first astronomical photographs that showed spectral lines in the ultraviolet as well as the visible portion of the solar spectrum. Then, during the 1880s, Pickering significantly advanced the study of the spectra of stars by employing a large prism in front of a photographic plate to capture an entire field of stars at once. As director of the Harvard College Observatory, he had ambitious plans to map the heavens using this technique. For this, he needed assistance.

Leavitt, who had begun volunteer work for Pickering upon her graduation, had to leave the observatory when a family crisis called her to Wisconsin. After two years, Pickering himself urged Leavitt to return at his expense. He offered to pay her 30 cents per hour (5 cents per hour more than other women working in comparable jobs at Harvard) and told her that if she had to leave the observatory again, she could take with her the materials and data she had collected. Pickering's offer of a raise in 1900 for a woman, no less, was a rarity. Within a short time of her permanent appointment in 1902, Leavitt advanced to head the photometry department.

Almost immediately, Pickering chose Leavitt to execute his grand plan to redetermine star magnitudes using the most up-to-date photographic techniques. The accuracy of such data was crucial to astronomical investigation during this period, and Pickering's staff began with the "north polar sequence" as a standard for the entire sky. In 1904, 46 stars were selected, and 299 photographic plates taken with 13 telescopes were employed to establish this primary sequence. Leavitt and her colleagues then applied this scale to measure the magnitudes of thousands of

stars in the heavens. Leavitt discovered 2,400 variable stars while making these stellar measurements, fully doubling the number of such stars known in her time

Leavitt also observed four novae, various asteroids, and other celestial objects, and published 17 reports of her observations in the *Annals and Circulars of the Harvard College Observatory*. After Leavitt reported 843 new variables in the Small Magellanic Cloud, Charles Young of Princeton (in a letter to Pickering) called Leavitt a "star fiend" and professed himself both amazed and amused that he could not keep up with her

Leavitt's groundbreaking discovery came from her examination of a very large number of images of the Large Magellanic Clouds [LMC] and Small Magellanic Clouds [SMC] (companion galaxies to our Milky Way, visible only from the Southern Hemisphere). These had been taken at the Harvard Southern Station in Arequipa, Peru, starting in 1905. Leavitt eventually found 1,777 Magellanic Cloud variables on these plates and was able to determine regular periods (ranging from less than a day to more than 100 days) for a small subset of them. In 1908, she plotted the average apparent magnitude of the LMC variables (whose light curves had a shape already known for galactic variables called Cepheids) versus the periods with which their brightness changed. Leavitt found a clear correlation, which was published under her own name in 1908

This period-luminosity relation was detectable in the LMC because, although the galaxy's distance was not known, at least all the stars are at the same distance, so that apparent magnitude is a proxy for intrinsic magnitude at that distance. The absolute distances and magnitudes could be established only by measuring Cepheid distances in some other way or by understanding the underlying physics of the variability. Both have now been done, and Cepheid variables are, therefore, an enormously valuable astronomical tool for establishing the distance ladder in the cosmos (although the first calibration, by Harlow Shapley, was considerably in error, making the Milky Way seem larger and other galaxies less distant than they really are).

Leavitt herself was not able to follow up on her discovery until four years later when she confirmed the relationship with a larger number of stars in the LMC and in the SMC. Pickering believed that it was the observatory's responsibility to collect data, and it was up to others to explain them

Leavitt's "record of progress" indicates the large number of projects she was working on simultaneously, including an investigation of Algol variables undertaken by Henry Norris Russell, measurements of the luminosities of stars in Jacobus Kapteyn's selected areas, experiments to determine the colors of faint stars (including hypotheses on the redness of the fainter stars), methods of transforming photographic to visual magnitudes, and, with astronomers at Mount Wilson, determination of the exact photographic magnitudes of the North Polar Sequence of stars.

The information Leavitt supplied on the magnitudes of stars in the North Polar Sequence was adopted by the International Committee on Photographic Magnitudes for the Astrographic Catalogue for the Carte du Ciel map of the sky. By the time of her death, she had completed

work on 108 areas. Astronomers interested in investigating the Milky Way referred to Leavitt's North Polar Sequence data for decades

In 1925, the Swedish mathematician and member of the Swedish Academy, Professor Götha Mittag-Leffler, sent a letter to Leavitt at the Harvard College Observatory. He wished to nominate her for the Nobel Prize in Physics for her discovery of the period-luminosity relationship, which had done so much in advancing the science of astronomy. However, Mittag-Leffler was not aware that Leavitt had died of cancer. A moon crater is named in her honor, and a memorial tablet, honoring her and the period-luminosity relation, hung for many years on the wall at Harvard College Observatory.

Harry G. Lang

Selected References

Bailey, Solon I. (1922). "Henrietta Swan Leavitt." *Popular Astronomy* 30: 197-199.

Gingerich, Owen (1973). "Leavitt, Henrietta Swan." In *Dictionary of Scientific Biography*, edited by Charles Coulston Gillispie. Vol. 8, pp. 105-106. New York: Charles Scribner's Sons

Hoffleit, Dorrit (1971). "Leavitt, Henrietta Swan." In *Notable American Women, 1607–1950: A Biographical Dictionary*, edited by Edward T. James, Janet W. James, and Paul S. Boyer. Vol. 2, pp. 382–383. Cambridge, Massachusetts: Belknap Press.

Kidwell, Peggy Aldrich (1999). "Leavitt, Henrietta Swan." In *American National Biography*, edited by John A. Garraty and Mark C. Carnes. Vol. 13, pp. 337–338. New York: Oxford University Press.

Lang, Harry G. (1994). *Silence of the Spheres: The Deaf Experience in the History of Science*. Westport, Connecticut: Bergin and Garvey

Lang, Harry G. and Bonnie Meath-Lang (1995). *Deaf Persons in the Arts and Sciences: A Biographical Dictionary*. Westport, Connecticut: Greenwood.

Mack, Pamela E. (1990). "Straying from Their Orbits: Women in Astronomy in America." In *Women of Science: Righting the Record*, edited by G. Kass-Simon and Patricia Farnes, pp. 72-116. Bloomington: Indiana University Press