Biographical Encyclopedia of Astronomers

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Payne-Gaposchkin [Payne], Cecilia Helena

Born Wendover, Buckinghamshire, England, 10 May 1900

Died Cambridge, Massachusetts, USA, 5 December 1979

Cecilia Payne (later Payne-Gaposchkin) demonstrated in her 1925 Ph.D. dissertation that nearly all stars have the same chemical composition, with the apparent enormous differences due largely to the wide range of stellar temperatures. She also showed that this composition was dominated largely by hydrogen and helium (which was not immediately accepted) and later became a noted expert on novae and other kinds of variable stars.

Her father was Edward John Payne, a historian, barrister, and scholar at University College, Oxford; her mother, Emma Pertz, a painter and copyist in oils, was a granddaughter of Chevalier G. H. Pertz, Hanoverian scholar and member of Parliament. Cecilia was their oldest child, soon followed by Humfry and Leonora. When her father died, Cecilia was only four, and her mother was left with three small children whom she raised "by a miracle of courage and self-sacrifice" in the environment of Edwardian England. Cecilia Payne married Sergei Gaposchkin in 1934, with whom she had three children: Edward Michael, Katherine Leonora, and Peter John Arthur. All three have had some involvement in astronomy.

After attending elementary school in Wendover, Payne had the opportunity to further her education when the family moved to London. Even at an early age, she had learned much science independently, fascinated, for example, by the chemical elements. With a keen interest in science or possibly the classics, she attended Saint Mary's College, Paddington, London, England, from 1913 to 1917 and Saint Paul's Girls' School, Brook Green, Hammersmith, from 1918 to 1919

Payne was awarded the Mary Eward Scholarship for Natural Sciences and was thus enabled to attend Newnham College, Cambridge University, Cambridge, England (1919–1923). There she first pursued the study of natural sciences with a concentration on botany, but, inspired by a lecture by Arthur Eddington, she changed her course of study to include more astronomy, graduating in 1923. She wrote her first paper in astronomy on the proper motions of stars in the cluster M36 in 1923.

Impressed by a lecture given by Harlow Shapley, then director of the Harvard College Observatory in 1922, Payne traveled to the United States for further study and in pursuit of a research career in astronomy. Payne was the first recipient of the Ph.D. in astronomy from Harvard College Observatory, which she received in 1925, as the first of Shapley's many students

Her thesis, published as *Stellar Atmospheres*, applied Meghnad Saha's theory of ionization to establish the temperatures of the cool giants and the relative abundances of the chemical elements in their atmospheres. The first result, that nearly all stars had essentially the same

abundance ratios, much like the terrestrial ratios for elements heavier than carbon, was immediately incorporated into mainstream astronomical thinking. The second result, that hydrogen and helium were by far the most common elements, was not. Shapley and Henry N. Russell, who had also read the work in advance of publication, recommended that Payne modify this conclusion and speak of "anomaous excitation" and a concentration of light elements on the surfaces of the stars. Nevertheless, the initial conclusion was essentially correct and has led to the thesis being described as "the best Ph.D. thesis in astronomy ever written" and Payne being described as the greatest woman astronomer of all time Additional observations and analysis by Russell, William McCrea, Carl von Weizsäcker, and others led to the accepted fraction of hydrogen and helium in the stars and Sun gradually increasing from one percent or two in 1925, to 10% in 1930, to more than 90% by 1960.

The 1920s were probably the happiest period of Payne's life. During this time, she wrote several papers discussing spectral analysis and application of the Saha equation. Payne's second monograph, *The Stars of High Luminosity* (1930), established the temperature scale and uniform composition for the hotter stars of types 0, B, and A. Her collaborators included Shapley, Leon Campbell, Donald Menzel, Frederick Wright, Fred Whipple, and, from 1934 onward, very often Sergei Gaposchkin. On instruction from Shapley, Payne turned her attention from spectroscopy (which was to be Menzel's bailiwick) to variable stars

Payne-Gaposchkin wrote a textbook, *Introduction to Astronomy* (1954), a monograph on *Variable Stars* (1938) with Gaposchkin, a definitive monograph, *The Galactic Novae* (1964), and an acclaimed popular account of stellar evolution, *Stars in the Making* (1953). The latter was credited by some young astronomers as their inspiration for entering the field. Her last book was *Stars and Clusters*, summarizing much that was known on this topic. She had a deep familiarity with individual stars, and even with specific spectral lines, and discussed them and recalled their characteristics as though they were friends

In addition to her work in astrophysics and spectroscopy, Payne-Gaposchkin spent many years working with variable stars, including those enigmatic objects called novae, and made significant contributions to understanding their nature. She frequently worked with photometric observations made by her husband, and they often published together. In their study of the galaxies, the Large Magellanic Cloud and the Small Magellanic Cloud, the two made roughly a million observations of variables, from which they were able to estimate the distance to these objects

Payne-Gaposchkin was indefatigable in her research endeavors and was highly valued by her colleagues. She received her MA and D.Sc. from Cambridge University, England, in 1952. Payne-Gaposchkin also made occasional forays into history, contributing papers to the *Journal of the History of Science* and writing obituaries of several astronomers. She wrote "The Nashoba Plan for Removing the Evils of Slavery: Letters of Frances and Camilla Wright, 1820–1829," published in the *Harvard Library Bulletin* in 1975, based on a collection of letters passed down in her family.

In addition to her scientific work, Payne-Gaposchkin was an editor of the observatory publications for over a decade and had teaching duties. Unfortunately, she suffered overt

discrimination both at Harvard and in the astronomical community because she was a woman; she was not even considered for certain positions, despite the extraordinary caliber of her scientific work. For example, it was not thought possible for her to make her own observations at remote observatories, as the facilities would not permit a single woman to even visit the site. This excluded her from positions for which less talented men could readily apply.

For many years, Payne-Gaposchkin had no official position at Harvard University and received a very low salary. Eventually, after the retirement of Harvard's president, Lowell, she was named Phillips Professor of Astronomy. After Shapley retired as the observatory director, Payne-Gaposchkin received a professorship at Harvard, the first woman to hold this title. She then became chair of the Department of Astronomy, the first woman to become chair of any department at Harvard University. After her retirement from this institution, she worked for some years at the Smithsonian Astrophysical Observatory, doing research exclusively.

Payne-Gaposchkin was remembered with affection and admiration by her colleagues; she was called "an astronomer's astronomer" and considered a genius. She was an inspiration to her many students and members of the general public as a role model and articulate scientist. Her sense of humor was subtle, and she was addicted to puns

Among the honors received in Payne-Gaposchkin's lifetime were the first Annie Jump Cannon Prize of the American Astronomical Society in 1934; honorary degrees from Smith College and elsewhere; and prizes and lectureships from the American Philosophical Society, the Franklin Institute, and the American Astronomical Society. At the latter, she was the first woman to deliver the Henry Norris Russell Prize (being introduced by the first woman to be president of the Society, E. Margaret Burbidge) in 1976. The minor planet (2039) Payne-Gaposchkin and a feature on Venus were named for her. A number of her own Ph.D. students have made important contributions to astronomy, including Helen Sawyer Hogg, Joseph Ashbrook, Elske Smith van Panhuijs, Frank Drake, Paul Hodge, and Andrew Young.

Katherine Haramundanis

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