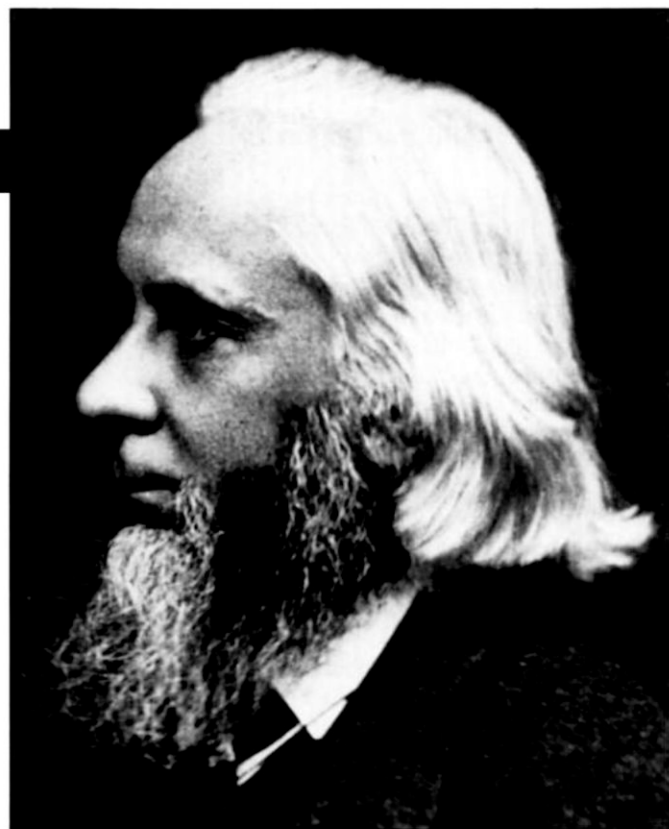




Bruce Medalist Profiles

William Huggins: The Fifth Bruce Medalist



Joseph S. Tenn
Sonoma State University

William Huggins was eighty years old when the Astronomical Society of the Pacific honored him with its Catherine Wolfe Bruce gold medal. He was the president of the Royal Society of London, he had been knighted by Queen Victoria, and he had been one of the first group to be awarded his country's highest honor, the Order of Merit. He had received many other medals, honorary degrees, and awards – all for research by an amateur astronomer who never attended a university.

Born and raised in London, William Huggins was the only child of a cloth merchant. Educated mostly by private tutors, he showed interest in science from an early age. He experimented with chemistry, optics, photography, and electricity before buying his first telescope at age eighteen. At that time his father's health failed, and Huggins decided to forego a university education and take over the family business. So, setting an example that would be followed by David Gill two decades later, he became a businessman by day and an amateur scientist by night.

At first he worked in both microscopy and astronomy, winning membership in the Royal Microscopical Society at twenty-

eight, and in the Royal Astronomical Society at thirty. He gave up the former subject, at least partly because he was too sensitive to cut up animals.

At thirty, Huggins decided to devote the rest of his life to astronomy. He sold the business and moved his family five miles outside smoky London to the clear skies of Upper Tulse Hill, where he soon built "a convenient observatory, opening by a passage from the house, and raised so as to command an uninterrupted view of the sky except on the North side. It consisted of a dome twelve feet in diameter, and a transit room. There was erected in it an equatorially mounted telescope by Dollond of five inches aperture, at that time looked upon as a large rather than a small instrument."¹

In 1858 he replaced it with an eight-inch refractor with a lens by the American optician Alvan Clark. Just as he was getting

1. Quotations are from *An Atlas of Representative Stellar Spectra* by Sir William and Lady Huggins (1899, William Wesley and Son, London) or from *The Nineteenth Century*, 1897, vol. XLI, p. 907.

William Huggins
7 Feb 1824 - 12 May 1910
1904 Bruce Medalist

Photograph courtesy of the Mary Lea Shane Archives of Lick Observatory, University of California, Santa Cruz.

bored with the usual observations of the time – clocking transits and sketching planets – Huggins learned that Gustav Kirchhoff and Robert Bunsen at Heidelberg had conclusively solved the mystery of the dark *Fraunhofer lines* in the spectrum of the Sun. Fraunhofer, a German scientist, had shown that each gas when heated emits its own characteristic set of wavelengths. Thus the appearance of dark "lines" in sunlight at the same wavelengths as the bright lines emitted by heated sodium vapor indicates that the atmosphere of the Sun contains sodium. The sodium in the Sun's atmosphere absorbs its characteristic wavelengths from the continuous range of colors coming from the solar interior.

Forty years later Huggins wrote "this news was to me like the coming upon a spring of water in a dry and thirsty land. Here at last presented itself the very order of work for which in an indefinite way I was

looking—namely to extend [Kirchhoff's] novel methods of research upon the Sun to the other heavenly bodies."

Following Kirchhoff's publication, Huggins, Giambattista Donati in Florence, Lewis Rutherford in New York, Father P. Angelo Secchi in Rome, and Astronomer Royal George B. Airy at Greenwich all set out to learn what stars are made of. This research was particularly appealing since philosopher August Comte had cited the composition of the stars as an example of unattainable knowledge just twenty-five years earlier. Huggins was not the first to publish descriptions of stellar spectra, but his work had the greatest impact, and he continued long after the others had died or dropped stellar spectroscopy.

Working first with local chemistry professor William Miller and then for several years alone, Huggins brought chemicals, batteries, and induction coils into the observatory. He arranged prisms so as to disperse both the feeble starlight and the light from glowing tubes of pure gases so that he could visually compare them.

"The observatory became a meeting-place where terrestrial chemistry was brought into direct touch with celestial chemistry. The characteristic light-rays from earthly hydrogen shone side by side with the corresponding radiations from starry hydrogen, or else fell upon the dark lines due to the absorption of hydrogen in Sirius or in Vega. Iron from our mines was line-matched, light for dark, with stellar iron from opposite parts of the celestial sphere."

He found evidence for sodium, magnesium, calcium, iron, and bismuth in the red star Betelgeuse, and for sodium and hydrogen in bluer stars, such as Sirius and Vega. In order to make better comparisons he mapped out the lines in the spectra of pure chemicals which he vaporized in his observatory/laboratory.

Next Huggins turned his spectroscope on the nebulae, those fuzzy objects in the sky that had been the subject of controversy for over a century. As increasingly powerful telescopes had resolved more and more nebulae into stars, some astronomers had proclaimed that all of them must be composed of stars. Others had held that at least some must be clouds of gas. When French comet hunter Charles Messier first published his list of the hundred, or so brightest

nebulae in 1781, William Herschel, possessor of the world's best telescopes, declared that he would resolve all into stars. Eventually Herschel concluded that some, especially the ones he named *planetary nebulae* because they showed disks, were truly gaseous. Yet other astronomers still believed that eventually all would be resolved.

On 29 August 1864 Huggins's spectroscope solved the mystery. "I directed the telescope for the first time to a planetary nebula in Draco . . . I looked into the spectroscope. No spectrum such as I expected! A single bright line only! . . . The riddle of the nebulae was solved. The answer, which had come to us in the light itself, read: Not an aggregation of stars, but a luminous gas."

He found the few bright emission lines characteristic of a gas cloud in the spectra of many nebulae, including the planetaries and the great nebula in Orion. Other nebulae, including the spirals, such as Messier 31 in Andromeda, showed continuous spectra. He correctly concluded that these must be composed of unresolved stars, although it would be many years before dark absorption lines would be detected in their spectra.


In 1866 Huggins presented a lengthy discourse, "On the Results of Spectrum Analysis Applied to the Heavenly Bodies," before the British Association. He displayed careful drawings of the spectra of the Moon and planets (essentially the same as that of the Sun, with a few extra lines formed in the atmospheres of Mars, Jupiter, and Saturn), of stars of several different colors, of variable stars (showing that their spectra varied along with their magnitudes), of novae, of nebulae both gaseous and stellar, and of a comet. That year the Royal Astronomical Society awarded him his first medal.

In 1868 Huggins attempted to determine the radial velocity (motion toward us or away from us) of a star by measuring the Doppler shift in its spectral lines. His result, that Sirius was receding from the solar system at 47 kilometers per second, was not close to later values obtained by photographic methods (Sirius is actually approaching at about 8 km/s), but it was the first attempt.

Huggins had tried to photograph stellar spectra as early as 1863, but the wet collo-

Catalogue of the
Rare Astronomical Books
in the Ernst Zinner Collection
San Diego State University Library

Annotations by Louis A. Kenney
Introduction by Owen Gingerich
336 pages 322 illustrations, 16 in color;
handsomely bound and in matching slipcase.
"A Collector's Item"



Leopold of Austria, 1520

Includes rare editions of Copernicus, Galileo, Apianus, Kepler, Newton, Sacro Bosco, Ptolemy, Hevelius, Flamsteed, Tycho Brahe, and many more

Order Now from
Friends of the Library, San Diego State University
San Diego, CA 92182

\$125 + 4.50 shipping US/Canada (8.50 foreign)
(Calif. add \$9.06 tax)

Bibliophiles and students of the History of Astronomy will treasure this never-to-be-duplicated Limited edition!

dion process in use then was too slow and the tracking clock too imprecise for the images to reveal any lines in the spectra. It was Henry Draper, in New York, who obtained the first stellar spectrogram in 1872, using a 28-inch reflector and an excellent home-made clock.

Huggins's mother died in 1868. For the next few years his only companion was a dog named Kepler. Then the Royal Society decided to use a substantial bequest to build a major new telescope for spectroscopy and to give it to the man considered the leading British spectroscopist. Huggins agreed to accept it only on loan and only for as long as he could make good use of it. He made a number of trips to Dublin to visit telescope maker Howard Grubb and also an enthusiastic young amateur astronomer there named Margaret Lindsay Murray. They were married in 1875; from then on there were two in the observatory.

With the new double telescope (a 15-inch refractor and an 18-inch Cassegrain reflector on one mount) and with the "fast" new gelatine dry plates which they pio-

continued on page 153

neered, the two began to photograph stellar spectra in earnest. As William aged (he did not give up astronomy and the telescopes until he was 84), Margaret, 24 years younger, did more and more of the actual observing. William would turn the ladder on which she perched. "Astronomers need universal joints and vertebrae of india rubber," she noted. The publications from Upper Tulse Hill Observatory now bore the names of both Hugginses. After his knighthood, their papers and the magnificent volume, *An Atlas of Representative Stellar Spectra* (London, 1899) came out under the names of "Sir William and Lady Huggins."

A cherubic-looking man with a long white beard, Huggins was recalled by many as kindly and helpful. He had a stern side though, vigorously defending his priorities and results. In his later years he found it difficult to accept the fact that younger researchers with newer methods were obtaining wavelengths more precise than his. Yet he was the pioneer, and according to J. B. Hearnshaw's *The Analysis of Starlight* (an excellent recent history of spectroscopy), "For most astrophysicists Sir William Huggins is regarded as the founder of stellar spectroscopy." ■

Errata

In the Bruce Medalist Profile article by Joseph S. Tenn on William Huggins (Sep/Oct 1990 *Mercury*), we included the sentence, "Fraunhofer, a German scientist, had shown that each gas when heated emits its own characteristic set of wavelengths." This was an editorial error; Fraunhofer never knew what physical process created the spectral lines. He had been dead for 34 years before Bunsen and Kirchoff determined that each hot gas emitted and absorbed light at its own characteristic set of wavelengths. We apologize to Professor Tenn and our readers for the inaccuracy. —
Ed.