



Bruce Medalist Profiles

Wallace Campbell: The Twelfth Bruce Medalist

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Readers of this series may recall that in the late nineteenth century Hermann Carl Vogel [*Mercury*, Nov/Dec 1990] obtained the first reliable measurements of radial velocities of stars — their speed toward us or away from us. It was Vogel's laboratory measurements of Doppler shifts on photographs of stellar spectra which allowed him to bring the uncertainties in these velocities down to ± 3 kilometers per second, a factor of ten better than the earlier visual measurements of William Huggins [*Mercury*, Sep/Oct 1990].

When the classic paper by Vogel and Julius Scheiner was published, exactly 100 years ago, Wallace Campbell was 30 years old and in his first year as a regular staff member of the Lick Observatory. Over the next four decades he would come to dominate the field of radial velocity measurement.

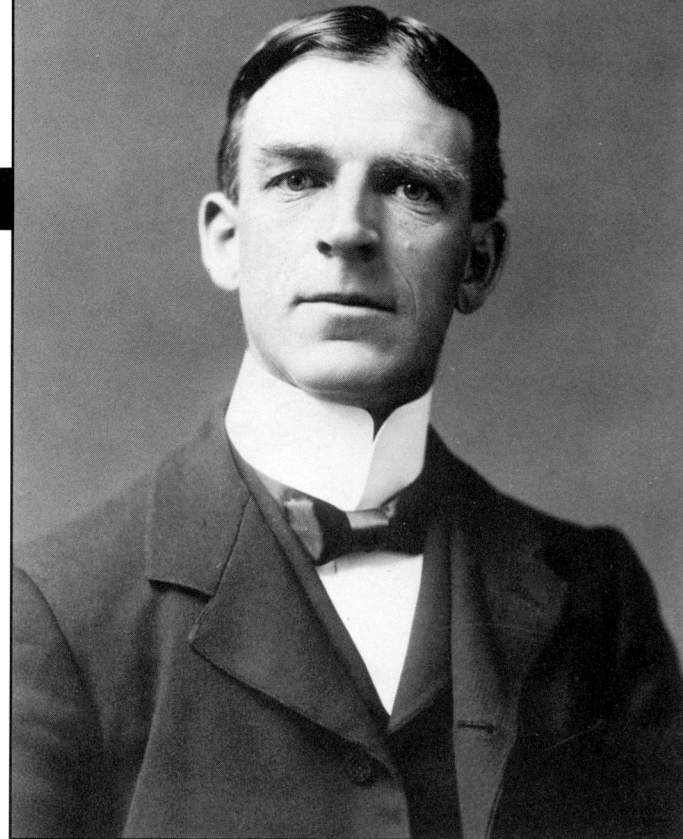
Perhaps we should begin with J. Edward Keeler. A skilled spectroscopist, Keeler began work at the Lick Observatory in 1886, two years before it was completed and turned over to the University of California. It was Keeler who designed and used the first spectroscope¹ on the 36-inch refractor, then the largest telescope in the world. In the summer of 1890 Campbell learned spectroscopy by assisting Keeler as a volunteer observer at Lick.

1. A spectroscope is used visually, a spectrograph photographically.

At the time, Campbell was the astronomy instructor at the University of Michigan. After a childhood of poverty and hard work on an Ohio farm, he had earned enough by teaching school to enter Michigan as a civil engineering student. In his third year he discovered Simon Newcomb's *Popular Astronomy*, and it changed his life. He devoured the book in two days and two nights and decided to become an astronomer. Professor John M. Schaeberle taught him to observe and to calculate comet orbits. After graduation Campbell taught mathematics for two years at the University of Colorado, returning to Michigan to replace his teacher when Schaeberle joined the initial Lick staff in 1888.

Campbell's talent and willingness to work hard (he observed six nights per week and earned his room and board with part-time day work) were noted by Lick director Edward S. Holden, and when Keeler resigned to become director of the Alleghany Observatory in 1891, Campbell became a permanent member of the Lick staff.

Keeler, working visually, had already achieved more precise measurements of wavelengths than the aging Huggins (whose wife Margaret did most of the actual observing in this period) or his countryman Norman Lockyer, but it was be-



William Wallace Campbell

11 April 1862 - 14 June 1938

1915 Bruce Medalist

(Photograph 1901, courtesy of the Mary Lea Shane Archives of the Lick Observatory, University of California, Santa Cruz)

coming clear that photography would be the method of the future. Campbell designed a superior spectrograph which would be rigid and temperature-controlled. While Holden persuaded San Francisco financier Darius O. Mills to fund construction of the new instrument, Campbell attached a camera to Keeler's old spectroscope. He quickly became the most successful spectroscopist in the world. Keeler in cloudy Pennsylvania and Huggins, Lockyer, and Vogel in Europe could not compete with the huge telescope and superior skies of Mt. Hamilton. During the 1890s Campbell made important studies of the spectra of nebulae, the very hot Wolf-Rayet stars, comets, and the bright Nova Aurigae. No diplomat, Campbell was quick to point out the errors of others, and he won few friends in London or Potsdam. He vigorously and correctly disputed Huggins's claim that there is a significant amount of water vapor in the atmosphere of Mars.

When Holden was forced to resign in 1898 and Keeler was appointed director,² the latter, who was a diplomat, gave himself a job no one else wanted and left spectroscopy to Campbell. Two years later Keeler died suddenly, and twelve of the world's leading astronomers all recommended that Campbell succeed him. (That same year Simon Newcomb also nominated Campbell for the first Nobel Prize in physics). On the first day of the new century, 1 January 1901, Campbell became the third director of the Lick Observatory. He would retain the position for thirty years.

In their fascinating history of the Lick Observatory, *Eye on the Sky*, Donald Osterbrock, John Gustafson, and Shiloh Unruh call Campbell "the creative scientist who became a factory manager." One of the hardest working and hardest driving scientist-managers of all time, he channeled most of the observatory's resources into his program of measuring radial velocities. According to C. Donald Shane, who greatly admired him, "Campbell brought the measurement of radial velocities to new standards of speed and accuracy." A more detailed account was given by Toronto astronomer C. A. Chant, who visited Lick in 1907:

The most extensive investigation under way at the observatory is that of determining the radial velocities of the brighter stars by means of the Mills spectrograph attached to the 36 inch refractor, in accordance with the programme entered upon by Prof. Campbell in 1896. This programme embraces all of the stars, whose photographic magnitudes are [as bright as] 6.0, lying N[orth] of -25° declination, with the addition of essentially all of the stars brighter than the 5th magnitude between -25° and -30° declination. The number of stars on the list is approximately 750. ... It is of interest to note that the efficient apparatus in use is capable of record-

ing spectra of 6.0 photographic magnitude stars in good strength with an exposure of $2\frac{1}{2}$ h[ours], provided the atmospheric conditions are average.

Since 1896 an average of 3 nights per week have been devoted to the observations. The labor of measuring and reducing a spectrogram is in general 2 or 3 times that of obtaining it.

...the doors of the observatory are never closed, and at almost any hour of the day or night someone can be found busy in observation or investigation. Indeed the energy, enthusiasm, and earnestness of purpose of the Director are reflected throughout the entire institution; and the spirit of investigation seems to saturate the rare air about the summit of the mountain.

By 1914 the survey was almost complete down to stars of the ninth magnitude, 16 times dimmer than the sixth magnitude stars that are the dimmest visible to the unaided eye. Campbell's primary goal was to determine the motion of the solar system with respect to the average of the stars. His program also led to the discovery of a great

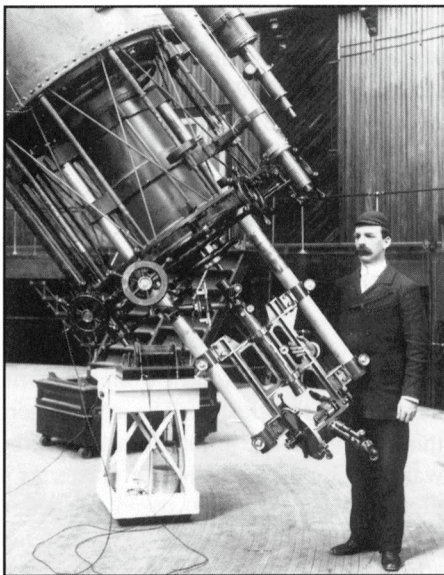
many spectroscopic binary systems, in which the lines of a star move back and forth as it orbits a companion too dim to see. It gradually became clear that multiple star systems are quite common.

In his first year as director Campbell persuaded Mills to donate an additional \$24,000 to obtain radial velocities of southern stars as well. The sum was sufficient to build a 36-inch Cassegrain reflector with a permanently-mounted spectrograph, ship it to Chile, set up an observatory, and pay the two-man staff for two years. Campbell himself was seriously injured when the mounting fell on him during testing, so his assistant, William H. Wright, led the first expedition. The Mills southern station of the Lick Observatory was a great success, and Mills and later his son extended its operation for many more years.

Meanwhile Campbell ran what Mary Lea Shane called a "benevolent autocracy" on Mt. Hamilton. No detail was sufficiently insignificant to escape his scrutiny, and he wrote lengthy formal letters reprimanding staff members for minor indiscretions. When asked, many years later, if the observatory director might be considered the mayor of Mt. Hamilton, two who had lived there replied in unison, "Oh no. He was the czar."

Campbell became furious when a writer gave credit to one of his staff for what he felt was his work or when a subordinate published results without his approval. As Donald Shane put it:

He was a man of the highest integrity and a strong sense of justice. In that respect he ... was insistent on justice to the other fellow and equally insistent on justice to himself. It was completely even handed. Campbell felt that the radial velocity program was his; he had conceived the program, developed the methods, mostly designed the instruments, raised money to buy them, done much of the observing and generally managed the work. It was therefore just that the bulk of the credit should



Campbell in 1893 next to the Keeler spectroscope mounted on Lick's 36-inch refractor. (Courtesy Mary Lea Shane Archives of Lick Observatory, University of California, Santa Cruz)

2. See Donald Osterbrock's account in *Mercury*, Sep/Oct 1978.

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go to him.³

His own son admitted, "My father was very intolerant on many things. And yet extremely kindly on fundamental things."

Besides radial velocity measurements, Campbell's other great love was solar eclipse expeditions. He traveled to India (1898), Georgia (1900), Spain (1905), Flint Island in the Pacific (1908), Russia (1914), the state of Washington (1918), and Australia (1922). According to Wright, "One was never quite sure whether he enjoyed more the intense concentration during the moments of totality or the excitement of preparation and travel incident to the undertaking, which sometimes occupied the larger part of the year." After observing the eclipse in India, he and his wife continued around the world, a trip of 7½ months. The last eclipse expedition was important, as it confirmed Einstein's prediction that starlight would be deflected by the Sun's gravity. Many scientists had accepted the results of Arthur Stanley Eddington and Frank W. Dyson at the 1919 eclipse, but Robert Trumpler's measurements of the Australia plates made by himself and Campbell three years later had much smaller uncertainties.

On all of the trips Mrs. Campbell was in charge of the commissary. Campbell's one-time student at Colorado, "Bess" was considered a great humanizing influence on a man who was often seen as inflexible and domineering.

When the Campbells returned from Australia, they were met at the dock by a delegation from the University of California regents insisting that he accept the presidency of the University. By this time he was sixty and a world-renowned scientist with five medals. He didn't want the job of president, but he took it when the trustees met his conditions: he would retain the position of director of Lick Observatory, and the regents would promise not to interfere in internal matters of the University. Robert G. Aitken would be associate director and run the day-to-day affairs on Mt. Hamilton, but he would have to consult Campbell on all major decisions, and the

Campbells would keep the director's house (by now a rather palatial one) for occasional visits and entertaining.

His biographers have stated that Campbell was unsure whether he could succeed as president, and he wanted to keep the right to retreat to Mt. Hamilton if things did not work out. With characteristic thoroughness he spent six months studying the history, organization, functions, and problems of the University and consulting with leading members of the faculty before his inauguration in 1923.

As a university regent said when Campbell retired from the presidency and the observatory directorship in 1930, "With a hand always gentle but always firm and never shirking, President Campbell ruled the University wisely and well."

Even faculty members who chafed under his authoritarian style conceded later that he had been the most effective president they had seen. It is certainly appropriate that the building which now houses the astronomy department at Berkeley is named Campbell Hall.

Campbell was also most active in the A.S.P., serving as president of the Society three times, writing articles for the *Publications*, and giving public lectures on new astronomical developments. Even in retirement the Campbells kept the director's house on Mt. Hamilton, but they were soon off to Washington, D.C., where Campbell served as president of the National Academy of Sciences from 1931-35. These years were not happy ones for the septuagenarian astronomer, who was extremely conservative and frequently unhappy with President Franklin D. Roosevelt. Yet he successfully fought to make the government follow its stated policy of consulting the Academy when advice was needed on scientific matters.

Campbell lived his last three years in San Francisco, until, blind in one eye and losing the sight of the other, and unwilling to become a burden to his family, he committed suicide in 1938. Just a few months earlier astronomer Donald Menzel had written, "The epoch of Simon Newcomb and of predominantly fundamental astronomy ended, essentially, with the last century. Campbell, Pickering, and Hale created the newer American astronomy and established firmly by 1910 the American leadership." ■

3. In his 1980 unpublished autobiography, *Life on Mt. Hamilton*, courtesy of the Mary Lea Shane Archives of the Lick Observatory, University of California, Santa Cruz.