



Bruce Medalist Profiles

Oskar Backlund: The Eleventh Bruce Medalist

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Jöns Oskar Backlund
28 April 1846 - 29 August 1916
1914 Bruce Medalist

The Pulkovo Observatory, established by Czar Nicholas I in the 1830s, served the needs of the Russian empire just as the Royal Greenwich Observatory, the Paris Observatory, and the U.S. Naval Observatory served their own governments. In the nineteenth century every great power needed astronomers to furnish accurate time, provide precise almanacs for navigators, and help map the Earth.

For the first half century of its existence Pulkovo was directed by Wilhelm and Otto Struve. Wilhelm, famed as one of the first astronomers to measure a stellar parallax (which tells us the distance of a star), was brought from Dorpat (now Tartu, Estonia) to establish the new observatory nineteen kilometers south of the imperial capital of St. Petersburg. A German, he began a tradition, not uncommon in Russia at the time, of importing foreign scientists to staff the institution. They were considered more "modern" than the Russians, who were thought to be relatively backward. His son and successor continued the practice; when Otto W. Struve¹ finally retired just after the observatory's fiftieth anniversary celebration in 1889, there were

only two Russians on the fifteen-man staff of the observatory.

The foreigners were mostly Germans and Swedes; among the latter was Oskar Backlund. Born in poverty, Backlund was sent to work after elementary school, but by self-study he earned admission to the University of Uppsala at age 20. There he studied mathematics and celestial mechanics and earned his Ph.D. in astronomy in 1875. After teaching in a Swedish technical school, investigating motions of a comet and a minor planet at the Stockholm Observatory, and observing for three years at Dorpat, he was hired by Otto W. Struve in 1879.

At first Struve had a high opinion of his new assistant, even writing Simon Newcomb that he saw Backlund as a future successor. He put the newcomer to work on precise measurements of positions of a handful of stars in order to better determine the constant of aberration.²

1. The initial distinguishes Otto W. Struve (1819 - 1905) from his grandson, Otto Struve (1897 - 1963). There were seven astronomers in the Struve family (plus others by marriage), four of them quite prominent.

2. Stellar aberration, an apparent displacement of stars due to the Earth's motion, yields the speed of the Earth in its orbit. From this can be found the length of the Astronomical Unit, the basis for all astronomical distance measurements beyond the Moon.

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

Backlund already had a research problem of his own: the puzzling motion of Encke's Comet. With the shortest known period, just 3.3 years, this comet is always closer to the Sun than Jupiter; at perihelion it passes inside the orbit of Mercury. It is named for Johann Franz Encke, who in the 1820s showed that the comets discovered by Pierre Méchain and Charles Messier in 1786, by Caroline Herschel in 1795, and by Jean Louis Pons in 1805 and 1819 were all the same object. It was the second periodic comet known (after Halley). Encke devoted much of his career to trying to compute orbits which would match the observations. After taking into account the gravitational perturbations of all of the planets, he still could not gain agreement, so Encke proposed that there was a resisting medium near the Sun which slowed the comet.

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Meanwhile the great astronomer Friedrich Wilhelm Bessel suggested that material ejected by sunlight acted as a rocket, providing a thrust which accelerated the comet.

Upon Encke's death the comet was taken up by Friedrich Emil von Asten, who supported the resisting medium hypothesis. When Asten died in 1878 Backlund took over the problem. For the rest of his life Backlund devoted nearly all of his research efforts to the orbit of this one comet!

In 1883, with Struve's support, Backlund was elected to the Imperial Russian Academy of Sciences. This allowed him to withdraw from observing and Pulkovo and to take up residence in St. Petersburg to work full-time on the comet's orbit. When the apparition of 1884-85 still left contradictions between theory and observation, he decided to start over. With financial support from the Academy and a philanthropist named M.E. Nobel, he hired a large staff of human computers and directed the recalculation of the gravitational perturba-

tions of the planets on the comet's orbit. A memoir was published describing the effects of each of the planets from Mercury to Saturn. The computations were particularly difficult because the masses of Mercury and Venus had to be determined from their effects on the comet and because the comet sometimes passes within one astronomical unit of massive Jupiter. (Backlund's value for the mass of Mercury, accepted at the time, was in error by more than 50%, partly due to uncertainties in the much larger effect of Jupiter.) Once all of the calculations were completed, they were compared with observations from 1819-91, some 22 orbits and 23 apparitions.

Meanwhile there was growing friction between the aging Struve, who, although born in the Russian empire, still preferred speaking German and hiring Germans and Swedes, and the Russian Academy, dominated by slavophiles. For reasons that are still unclear, Backlund became identified with the Russians, and Struve took an intense dislike to him.

Thwarted in his desire to see his son

Hermann succeed him in 1890, when the academy chose a Russian as Pulkovo's third director, Struve wrote Newcomb, "At least the scoundrel Backlund has not obtained his hoped-for reward."

After five years the new director, Fëdor Bredikhin, who had stayed in distant Moscow throughout his directorship, resigned, and this time the Academy chose Backlund. Hermann Struve promptly left for Prussia. By this time Pulkovo's rank among the world's observatories had declined considerably since the days when it was proclaimed "the astronomical center of the world" by American astronomer Benjamin A. Gould. Struve, and to a lesser extent Bredikhin, had clung to the old astronomy of position at which the observatory had once been the world's best and had given little support to the increasingly important astrophysics. In its glory days Pulkovo had twice built the world's largest telescopes, a 15-inch refractor in 1839 and a 30-inch in 1885, but they had been surpassed by the 36- and 40-inch refractors of Lick and Yerkes, the former at a much better site. Soon George Hale would build 60- and 100-inch reflectors on Mt. Wilson and take a commanding lead in observational astronomy.

According to A. N. Dadeav, a modern chronicler of the Pulkovo Observatory, Backlund's "knowledge, energy and administrative talent promoted the successful development of the observatory's work." He greatly increased both staff and equipment during his 21 years as director.

One of his first innovations was to employ women as computers. Like his contemporary, E.C. Pickering at Harvard, he could not get them official appointments, but he hired graduates of a teacher's training program as temporary workers, paying them by the job. By 1909 he had 14 women working alongside the 18 regular staff members.

Another innovation was to establish branch observatories far to the south of Pulkovo, which is too far north to observe anything beyond declination -10° . Backlund is said to have enjoyed the long train rides to the southern stations as they allowed him to conduct his own research on Comet Encke without being distracted by administrative work. After raising funds and modernizing instruments, Backlund greatly speeded up the production of star

Karl Schwarzschild

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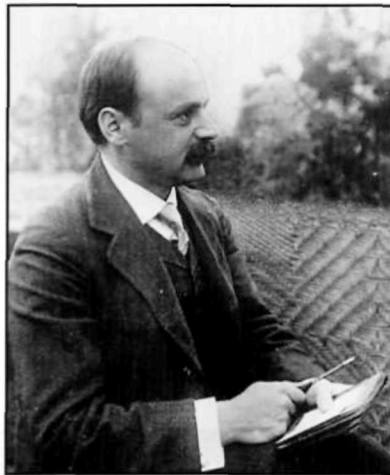
Imagine yourself a member of the A.S.P. Board of Directors in November 1913 examining the records of candidates for the prestigious Bruce Medal. Asked to nominate from one to three astronomers each, the directors of the Berlin, Greenwich, Harvard, Lick, Paris, and Yerkes Observatories have come up with a total of seven names: Karl Küstner, George Hale, Oskar Backlund, Seth Chandler, Karl Schwarzschild, Sherburne Burnham, and Frank Dyson. Which one should be the 1914 Bruce medalist?

We don't know how the deliberations went; we know only that Backlund was selected. By today's standards, though, the list contained two giants who towered above the rest: Hale, who would receive the 1916 medal, and Schwarzschild.

We can't criticize those directors now, but with hindsight we might wish they had chosen Schwarzschild. They knew of course of his great contributions to many branches of astronomy, but he was just 40. How could the directors foresee that in less than a year Europe would be at war, and that Schwarzschild, an observatory director and well beyond draft age, would volunteer for the German army? Or that he would contract a fatal disease on the Russian front, depriving astronomy of the man whom no less an authority than S. Chandrasekhar would someday call "one of the towering physical scientists of this century"?

Karl Schwarzschild, born October 9, 1873 into a family of Jewish merchants who had lived in Frankfurt for centuries, was educated at the Universities of Strasbourg and Munich, receiving his Ph.D. at the latter under Hugo von Seeliger at 23. After working briefly at a small observatory in Vienna and directing the observatory at Göttingen for eight years, he was called to the most prestigious post in German astronomy, director of the Astrophysical Observatory at Potsdam.

In his short life Schwarzschild made



Karl Schwarzschild. (Courtesy Yerkes Observatory)

outstanding contributions as theorist, observer, experimentalist, and administrator – in astronomy, physics, and mathematics. He developed instruments and techniques in optics, photography, photometry, and spectroscopy. He modeled the solar atmosphere and the motions of stars. He explored the physics of comet tails and the formation of the solar system. He introduced the concept of color index, the difference between the photographic and visual magnitude of a star, and he made the first measurements of this index, showing its relationship to spectral class. Five years before Einstein, he considered the possibility that the universe might be described by non-Euclidean geometry, and he set observational limits on the radius of curvature. While with the German army in Russia, he calculated the effects of wind and air density on the paths of long range shells, and at the same time he found the first solution to Einstein's just-published equations of general relativity. His solution describes a non-rotating black hole, and today we call the

distance from its center to its event horizon the Schwarzschild radius. He wrote his last paper in a hospital, just before his death 11 May 1916, applying the new quantum theory of Niels Bohr and Arnold Sommerfeld to spectral lines.

Schwarzschild was also an outstanding teacher and writer. Fifty years later, the great physicist Max Born recalled his days at Göttingen: "Schwarzschild was the youngest professor at the university, about thirty years of age; a small man with dark hair and a mustache, sparkling eyes and an unforgettable smile... His was a versatile, all-embracing mind, and astronomy proper only one field of many in which he was interested." Born called Schwarzschild's articles on optical instruments the "backbone" of his great text on optics (English editions with Emil Wolf).

To Hertzprung, who was Schwarzschild's assistant at both Göttingen and Potsdam, "elasticity" was his greatest characteristic: "His mind was always susceptible to new impressions." There is irony in the fact that Karl Schwarzschild was such a German patriot. Two decades after he gave his life for the Fatherland, the Germans would drive his family into exile. His son, who was only four when Karl died, would become a prominent astrophysicist too, but an American one. And in 1965 the A.S.P. would award the Bruce medal to Martin Schwarzschild.

Editor's Note: A poignant short science fiction story which combines impressions of the final period of Schwarzschild's life and his work on black holes is Connie Willis' "Schwarzschild Radius." It can be found in the collection of science fiction entitled *Universe*, edited by Byron Preiss and published by Bantam Books.

catalogs, one of them a contribution to the international *Carte du Ciel* project. He personally participated in an important study of refraction and in the analysis of measurements of the so-called "Chandler wobble" of the Earth's axis.

Active in almost every international

organization, Backlund made some thirty trips abroad, fluently addressing meetings of astronomers in the United States, Britain, South Africa, France, and Germany in the languages of his hosts. Although he never totally solved the problem of what is now called Comet Encke-Backlund in the

Soviet Union (the best model, put forth by Fred Whipple in 1950, combines Bessel's idea of jets with the rotation of the comet), the astronomical societies of Britain and France considered his progress worthy of their gold medals, and so did the Astronomical Society of the Pacific. ■