Bruce Medalist Profiles

Arthur Auwers: The Second Bruce Medalist

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Arthur Julius Georg Friedrich von Auwers
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1899 Bruce Medalist

(Photograph 1884, courtesy of the Mary Lea Shane Archives of Lick Observatory, University of California, Santa Cruz.)

"Today, Auwers stands at the head of German astronomy. In him is seen the highest type of the scientific investigator of our time, one perhaps better developed in Germany than in any other country." So wrote Simon Newcomb, the A.S.P.'s first Bruce medalist, in his 1903 autobiography. Newcomb continued, "His specialty has been the treatment of all questions concerning the positions and motions of the stars. This work has required accurate observations of position, with elaborate and careful investigations of a kind that offer no feature to attract public attention."

The groundwork for the determination of stellar motions was laid in England. In 1718 Edmond Halley pointed out that a few stars showed measurable *proper motion:* the angles between them and other stars changed by small but measurable amounts over long periods of time. A decade later James Bradley discovered *nutation*, a nodding motion of the Earth that periodically shifts all stellar positions by up to nine seconds of arc, and the *aberration of starlight*, an annual shift of as much as twenty seconds of arc due to the Earth's velocity in its orbit around the Sun. In the 1750s and '60s Bradley, by then Halley's successor as Astronomer Royal, made the first series of measurements of stellar positions precise enough to be of value to future generations.

By the nineteenth century the center of precision measurement in astronomy had shifted to Germany. Friedrich Wilhelm Bessel published the first measurement of stellar parallax[1] in 1838, just after Auwers's birth. Bessel showed that after correcting for the above-mentioned motions, for precession, and for atmospheric refraction, the position of the star 61 Cygni (selected because of its unusually large proper motion) shifted back and forth annually by about a third of a second of arc or 1/600,000 of a radian, implying that the star's distance must be about 600,000 times the radius of the Earth's orbit (the astronomical unit). This was the first measured distance to any star beyond the Sun. During his thirty-two years at the Königsberg observatory, Bessel published elaborate catalogs giving precise positions for tens of thousands of stars, all observed visually and measured with meridian circles. Bessel also made the first reductions of Bradley's observations in order to compare positions and determine proper motions. Bessel died in 1846, but his work was carried on and greatly expanded at Bonn by his protégé, Friedrich Wilhelm Argelander, who published the *Bonner Durchmusterung*, with positions and magnitudes of 324,198 stars, in 1859-62.

By this time young Auwers was assistant astronomer at Königsberg. He had published many observations and determinations of orbits, starting as a teenage student at the University of Göttingen, and he was measuring positions of binary stars. For his 1862 doctoral dissertation he computed the orbits of Procyon and Sirius, showing that an earlier analysis of Bessel's had been right: each had an invisible companion. Sirius B was serendipitously discovered by Alvan Graham Clark in Massachusetts almost immediately after Auwers published its position; Procyon B was not observed until 1896, when it was found with the Lick 36-inch refractor by John Schaeberle.

Tracing the orbits of these stars led Auwers into old star catalogs and the tedious reductions required to eliminate systematic errors and the various motions of the Earth. After assisting Peter Hansen at the Gotha Observatory from 1862-66, Auwers spent nearly fifty years at the Berlin Academy, from 1878 until his death, as its permanent secretary. There he did the work which won him gold medals.

1. When astronomers find the parallax of a star, they are measuring the reflection of the Earth's motion around the Sun in the apparent position of the star in our sky. The farther away the star, the less it will appear to move back and forth as we make our annual swing about the Sun, thus the smaller its paralla. – *Ed.*

For ten years he studied Bradley's century-old observations, working from the Englishman's original manuscripts and re-reducing each observation without reference to later work. He managed to determine the systematic errors in Bradley's work, such as the inaccuracies in the graduation of the Greenwich quadrants. The 3268 stars in the catalog were re-observed at Greenwich, and what became known as the "Auwers-Bradley" proper motions for the 110-year span were found. Published in three volumes in 1882, 1888, and 1903, these data made possible a host of discoveries, including Newcomb's determination of the constant of precession[2] and Jacobus C. Kapteyn's discovery of two star-streams, a precursor to the eventual discovery of galactic rotation.

At the suggestion of Argelander, German astronomers joined together on a gigantic project of measuring magnitudes and precise positions of all stars in the northern sky down to the ninth magnitude. Seventeen observatories, mostly in Germany and Russia, worked on the project, and Auwers took on the difficult task of bringing all observations into the same system. The first catalog, with its extension, contained data on more than 200,000 stars. Auwers, who made many of the observations himself, then suggested that *all* observations of stellar positions be put into consistent form. In 1900 he formally proposed to the Berlin Academy that a "catalog of catalogs" be compiled: more than one million measurements, made from 1750 to 1900, were to be converted to a uniform system. Interrupted by two world wars, the *Geschichte des Fixsternhimmels* was finally completed in the 1960s.

Auwers played a leading role in the German expeditions to observe the 1874 and 1882 transits of Venus in vain attempts to better determine the distance to the Sun. He observed the first from Luxor, Egypt, and the second from Punta Arenas at the tip of South America. He compiled six large volumes of results of these expeditions. In 1889 Auwers traveled to the Cape of Good Hope to help his friend David Gill make observations of the minor planet Victoria in a more successful effort to determine the scale of the solar system. He and Gill were among a handful of astronomers to master the heliometer, a telescope with a split objective used for measuring small displacements.

Auwers was not the only astronomer compiling catalogs and determining fundamental positions of stars in his time; he had competition from the Americans Lewis Boss and Newcomb. Boss criticized Auwers's work and, by using only the more recent observations, achieved greater precision. Yet the German catalogs, among the last made before photographic plates replaced eyeballs behind telescopes, were of considerable utility to astronomers attempting to answer the age-old question, "Where are we?" If only their compilers could see the Space Telescope Science Institute's recently-published *Guide Star Catalog*: positions of nineteen million objects, all measured and reduced automatically by computers, available now on two compact disks! ■

2. The constant of precession is a measure of how much the equinox moves westward along the ecliptic each year. For example, Newcomb's determination that the precession was 50.2619 seconds of arc per year (for 1925) meant that the earth's axis was precessing around the line perpendicular to the plane of the solar system once every 25,784.9 years.