

Biographical Encyclopedia of Astronomers

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Bessel, Friedrich Wilhelm

Born Minden, (North Rhine-Westphalia, Germany), 22 July 1784

Died Königsberg (Kaliningrad, Russia), 17 March 1846

Friedrich Bessel, one of the most skilled astronomical observers of his time, made the first published determination of stellar parallax and distance, produced numerous volumes of his own observations, reduced observations of others, and contributed to advanced mathematics and celestial mechanics. Bessel was one of three sons and six daughters born to Carl Friedrich Bessel, a government secretary, and Friederike Ernestine (née Schrader), daughter of a pastor. In 1812, he married Johanna Hagen (1794–1885); they had one son (Wilhelm, 1814–1840) and three daughters (Marie, 1816–1902; Elisabeth, 1820–1913; and Johanna).

In January 1799, Bessel went to Bremen to contract with the Kulenkamp mercantile firm for a seven-year apprenticeship. In addition to rapidly developing his accounting skills, he trained himself in geography, navigation, mathematics, and astronomy. In 1804, he contacted Wilhelm Olbers concerning his determination of the orbit of comet 1P/Halley using data from observations made by Thomas Harriot in 1607. Olbers's encouragement, and recognition of Bessel's mathematical abilities, led to the publication of this work and to Bessel's career shift to astronomy when, in 1806, Olbers successfully recommended Bessel for a post as an assistant at a private observatory in Lilienthal (near Bremen) owned by Johann Schröter. There, Bessel observed comets and planets, studied atmospheric refraction, and began to reinvestigate the astrometric observations of James Bradley

In 1809, Bessel took two positions that he would keep for the rest of his life: director of King Frederick William III of Prussia's new Königsberg Observatory, and professor of astronomy at Albertus University in Königsberg. Bessel arrived in May 1810 and started lectures that summer. The observatory was completed in 1813, with its first instrumentation purchased from the estate of amateur astronomer Friedrich von Hahn. Later additions included a Reichenbach meridian circle (1819), a Fraunhofer heliometer (1829) suitable for very accurate position measurements, and a Repsold meridian circle (1841).

During his 36 years at Königsberg, Bessel taught many students, including Friedrich Argelander, Carl Steinheil, and Heinrich Schlüter. Bessel contributed significantly to mathematics and physics, developing the Bessel or cylinder functions beyond the work done earlier by Daniel Bernoulli and Leonhard Euler

Bessel was ordered to undertake a geodetic survey of East Prussia, performed together with Johan Bayer in 1831/1832 and published in 1838. From the differences between geodetic and astronomical coordinates, Bessel derived the figure of Earth as an oblate spheroid with ellipticity $1/299.15$. In 1839, his physical studies led to the introduction of a new Prussian measurement system.

Bessel's first major work in Königsberg was a reduction of Bradley's astrometric observations to a fixed date (1755). Published in 1818, it contained the reduced positions of 3,222 stars, together with a complete theory of spherical astronomy and data reduction. From these observations, supplemented by his own and those of Giuseppe Piazzi, Bessel extracted a list of 71 stars with notable proper motion

As Bessel became particularly interested in factors impacting the accuracy of measurements, he studied precession, nutation, aberration, and refraction, and developed a theory of errors. His results, summarized in his *Tabulae Regiomontanae*, also contain the positions of two pole stars (A and 8 in Ursa Minor) and Nevil Maskelyne's 36 "fundamental stars" from 1750 to 1850. These tables laid the groundwork for precision measurements and theories concerning solar, lunar, planetary, and stellar motions. In 1821, Bessel put forth the notion of the "Personal Equation," the effect of the observer's personality and circumstances on astrometrical measurements (especially the timing of transits) and evidence for suspected variations of the obliquity of the ecliptic. Bessel was also concerned with the quality of his instruments and the effects of instrumental errors on observations, which he thought could be eliminated by expanded data reduction; according to Rudolph Engelmann, Bessel produced at least 23 articles on his investigations of astronomical instruments for angular measurements.

With the new Reichenbach meridian circle, Bessel (together with Argelander) started a project in August 1821 to determine accurate positions for all stars down to the 9th magnitude with declinations between $+15^\circ$ and -15° . In 1825, the range was extended to $+45^\circ$, and concluded in 1835 with a catalog of 75,011 stars, organized into 536 zones. Later, Argelander continued this work to create the *Bonner Durchmusterung* (Bonn Survey). Also in 1825, Bessel initiated the endeavor to create an accurate atlas, the *Akademische Sternkarten* (Academic Star Maps), which was recorded at various observatories and finished only in 1859.

From Bessel's first efforts relating to Halley's comet, he expressed his interest in comets both by observing and by calculating their orbits, improving orbit calculation methods. Following his observations of the return of Halley's comet in 1835, Bessel published a physical theory of comets (1836), stating that comets consist mainly of volatile matter. In 1839, he proposed methods to calculate meteoroid orbits from meteor observations.

Bessel's continued interest in planetary astronomy led him to observe the orbits of Jupiter's and Saturn's satellites (and, in particular, Saturn's satellite Titan) using the Fraunhofer heliometer, resulting in accurate determinations of the masses of the two planets. In 1837, he investigated the theory of Uranus and supported the hypothesis of another planet further from the Sun. That planet, Neptune, was finally found in the year of Bessel's death.

Bessel's ability to make very precise measurements led to his greatest discovery. After determining with unprecedented precision the position of the vernal equinox and proper motions of nearby stars, Bessel published in 1833 a catalog of 38 double stars, measured with the Fraunhofer heliometer. With that instrument, Bessel became the first to measure and publish (in *Astronomische Nachrichten*, 1838) a stellar parallax and calculate the distance to a star (the double star 61 Cygni) from observations made over 18 months in 1837 and 1838. His parallax value of $0.314''$, corresponding to a distance of 3.18 parsecs or 10.4 light-years, is very close to the modern value of $0.292''$, corresponding to 3.42 parsecs (11.2 light-years). He had chosen 61 Cygni because it had the largest known proper motion. Concerned with the accuracy of his parallax, Bessel, together with Schlüter, redetermined the parallax of 61 Cygni in 1840, yielding a somewhat less accurate value of $0.348''$, corresponding to 2.87 parsecs (9.4 light years). Concurrently, Thomas Henderson published a parallax for Centauri in 1839, derived from observations made in 1832/1833 at the Cape of Good Hope, and in 1840, Friedrich Struve of Dorpat presented his (less accurate) parallax for Vega from observations made during 1835-1837.

In 1841, Bessel announced his conclusion, based on variations in their proper motion, that Sirius and Procyon each had an invisible companion. An orbit for Sirius's companion, Sirius B, was calculated 10 years later; the star was eventually found by Alvan Clark in 1862 while

testing the 18.5-inch objective of a new telescope commissioned for the University of Mississippi. Procyon B was not discovered until 1896 by John Schaeberle with the 36-inch telescope at Lick Observatory. Both companions were later revealed to be white dwarfs.

Bessel's scientific publications total at least 400 items addressing most of contemporary astronomy; his particular expertise was precision measurements. Bessel's early works in Lilienthal include observations of comets, asteroids, planets, occultations, eclipses, and atmospheric effects, as well as instrumental studies; most of them were published in Johann Bode's *Berliner Astronomisches Jahrbuch*

Bessel was honored during his lifetime by academy memberships (Berlin, Palermo, Saint Petersburg, and Stockholm), by memberships in scientific societies (Edinburgh, Göttingen, Copenhagen, and London), and by memberships in the British Royal Astronomical and Royal Meteorological Societies. Later, he was honored by the astronomical community by the naming of a lunar crater for him (21.8 N, 17.9 E; 15.0 km in diameter) in 1935. Minor planet (1552) Bessel was discovered on 24 February 1938 at Turku by Yrjö Väisälä.

Hartmut Frommert

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