Biographical Encyclopedia of Astronomers

Herschel, (Friedrich) William [Wilhelm]

Born Hanover, (Germany), 15 November 1738

Died Slough, Berkshire, England, 25 August 1822

As the discoverer of the planet Uranus and the most successful practitioner of the new field of stellar astronomy, Sir William Herschel expanded the scope of the known Solar System and of the Universe beyond it. Herschel was the third of six surviving Georgian P with its Natites.

Children born to Isaac Herschel and Anna Ilse Moritzen. As the son of a Hanoverian Guard bandmaster, William had a musical upbringing. At age 14, he became an oboist in his father's regiment. Around this time, William's practical talent in music brought him to musical theory and, soon after, he inherited his father's fascination with natural philosophy. So it was that William found himself purchasing a copy of John Locke's *Essay Concerning Human Understanding* while visiting England with his regiment in 1756, a visit that historians agree was a milestone in Herschel's early life

After Herschel's regiment came under direct fire from the French in 1757, he immigrated to England. Although he arrived with only a French crownpiece in his pocket, by 1766 he had attained sufficient reputation as a musician to secure a position as organist at Bath's Octagon Chapel, where he worked as a performer, teacher, composer, and concert director. According to some accounts, passersby at times spotted Herschel using the intervals between symphony movements to run in wig, powder, and full concert dress.

from the chapel to his workshop, where he continued the experiments that would eventually produce the most powerful reflecting telescopes of his time. In 1772, William's sister Caroline Herschel joined him in Bath. With Caroline's assistance, William began his astronomical research in earnest. By the 1780s, these efforts would help him emerge as one of the most prominent astronomers of his day

On 8 May 1788, Herschel married Mary Pitt, a wealthy widow, which union brought Herschel both financial security and one son, John Herschel, who himself became an accomplished astronomer and natural philosopher. By the time of his death, William Herschel's achievements earned him membership in the Royal Society and election as the first president of the Astronomical Society of London (later the Royal Astronomical Society). He was also offered memberships in the American Philosophical Society and the Academies of Paris, Dijon, Berlin, Saint Petersburg, and Stockholm. King George III appointed Herschel as his Royal Astronomer, and he was awarded knighthood six years before his death.

Herschel is best described as a "celestial naturalist" whose methodology mixed diligent observation with, at times, daring speculation. Writing in 1785, he gave the clearest explanation of his approach to astronomy:

> If we indulge a fanciful imagination and build worlds of our own, we must not wonder at our going far from the path of truth and nature [whereas] if we add observation to observation, without attempting to draw not only certain conclusions, but also conjectural views from them, we offend against the very end for which only observation ought to be made. I will endeavor to keep a proper medium; but if I should deviate from that, I could wish not to fall into the latter error

In an age when nearly all observational astronomers practiced positional astronomy using refracting telescopes constructed for precision measurement, Herschel built huge reflecting telescopes designed to maximize light-gathering power, resolution, and magnification, and intended to provide answers about the nature of the Milky Way and the existence of extraterrestrial life. These huge reflectors, such as the 12-in.-aperture, 20-ft.-focal-length telescope, which was Herschel's instrument of choice during his early career, enabled him to develop the nascent field of stellar astronomy

In 1779, Herschel commenced a series of "sweeps," observing all stars visible from Bath down to the fourth magnitude. Later "sweeps" included all stars down to the eighth magnitude. These "sweeps" focused special attention on double stars, of which Herschel eventually cataloged 848. His intention was to use the doubles to measure stellar parallax. Although Friedrich Bessel would discover parallax only in 1838, Herschel's own research had immediate consequences. Herschel showed that some doubles, rather than being distant objects near each other in the astronomer's line of sight, are actually gravitationally linked, orbiting their common center of gravity

During one of Herschel's sweeps, on 13 March 1781, he sighted what he judged to be a nebulous star or comet (now known to be the planet Uranus). He observed the object throughout the following weeks, convincing himself that he was watching an approaching comet. England's Astronomer Royal, Nevil Maskelyne, with whom Herschel corresponded after the initial sighting, suggested that the object was in fact an undiscovered planet. This was confirmed by the Saint Petersburg astronomer Anders Lexell, who first calculated Uranus's orbit

The anonymity that Herschel knew when he first arrived in England quickly faded after the discovery of Uranus. The Royal Society awarded him the Copley Medal for his discovery in 1781, the same year that he was elected to the society. Herschel's suggested name for the new planet, "Georgium Sidus" (George's Star), earned him the attention of its namesake, King George III, who awarded Herschel a £200 annual pension and the title Royal Astronomer. Since the newly created position required that Herschel live nearer Windsor Castle, William and Caroline moved from Bath to Datchet in 1782; in 1786, they settled in Slough. In 1787, King George III gave further support to the Herschels' work by granting Caroline a pension of £50 per year. Herschel also enhanced his income by selling reflecting telescopes to buyers in Britain and on the Continent. Historians agree that few of the telescopes Herschel's sales contributed significantly to the advance of astronomy. The 48-in.-aperture, 40-ft.-focal-length reflector that Herschel completed for himself with the king's support in 1788 remained the largest telescope in existence for decades, although Herschel achieved his greatest successes with more

manageable, smaller reflecting telescopes, especially his 18.7-in.-aperture, 20-ft.-focal-length instrument.

Besides his discovery of Uranus, Herschel made other contributions to the astronomy of the Solar System. He presented evidence against claims made by Johann Schröter about extra-atmospheric mountains on Venus. He observed and suggested the name "asteroid" for the small bodies that his contemporaries had begun to discover orbiting the Sun between Mars and Jupiter. His studies of Jupiter's four known satellites revealed that, like our Moon, each rotates on its axis once per revolution Between 1787 and 1789, he discovered Mimas and Enceladus, Saturn's sixth and seventh satellites. In 1787, he discovered the first two satellites of Uranus, Oberon and Titania. Herschel claimed to have discovered four additional satellites orbiting Uranus, but this claim has proven to be spurious. He developed a widely accepted model for the Sun and sunspots, one feature of which was his claim that the Sun is "probably... inhabited, like the rest of the planets." Herschel's early notebooks show that for a period he believed he had observed lunar forests and other evidence of life on the Moon.

The Universe beyond the Solar System gave Herschel's keen eye and active imagination ample room to operate. Herschel set both to work in his investigations of the size, shape, and composition of the Milky Way. In his 1783 work "On the Proper Motion of the Sun and the Solar System," Herschel analyzed proper-motion data to suggest that the Sun and its planets are traveling in the direction of Hercules. His later papers on the subject calculated the velocity of this movement.

Although Herschel's estimated velocities are incorrect, his estimates of the direction of the Sun's motion are quite close to modern values

In his 1784 paper on the "Construction of the Heavens," Herschel suggested that the Milky Way is a forked slab of stars, in which the Sun lies slightly off-center. Herschel based this claim on his technique of "star gauging." Making the hypothesis that all stars have the same intrinsic brightness, he argued that the dimmest stars are most distant and the brightest are nearest. As a consequence, the overall concentration of stars and the proportion of bright stars to dim stars in any direction approximates the density and depth of space in that direction. As his improved telescopes penetrated deeper into space and revealed stars not seen in earlier gauges, Herschel departed from the forked-slab model. But both his model and his method were improvements over the primarily conjectural disk theories of the Milky Way that Herschel's generation inherited from Thomas Wright, Immanuel Kant, and Johann Lambert

Some of Herschel's most innovative research regarded the "nebulae"—a general term at that time for what are today recognized as reflection nebulae, HII regions, planetary nebulae, open and globular clusters, and galaxies. Although only a hundred such objects were known when Herschel began to observe them, he discovered and cataloged over 2,400 more and brought them to a central position in his cosmology. Initially, Herschel believed that most nebulae are resolvable into individual stars; in fact, during the mid-1780s, he concluded that most are, in effect, comparable in nature and size to our Milky Way system. A 1785 paper corroborated this claim by suggesting that Newtonian gravitational theory is sufficient to explain the

conglomeration of individual stars into clusters. Herschel backed away from his stance on the resolvability

of nebulae and the existence of island universes in his 1791 paper "On the Nebulous Stars, Properly So-Called." Here, Herschel discussed his observations of a planetary nebula, arguing that, rather than being resolvable into individual stars, it must consist of a central star surrounded by a "shining fluid." This "shining fluid" entered the heart of his cosmology and cosmogony in an 1811 publication, "Astronomical Observations Relating to the Construction of the Heavens." In this study, Herschel suggested that most nebulae, rather than being composed of thousands of stars, consist of clouds of "shining fluid" gradually condensing into individual stars

Although by 1811 Herschel had backed away from his earlier (and correct) belief that some nebulous objects are island universes independent of the Milky Way, his exhaustive observations, extensive catalogs, and careful speculations regarding the stars and nebulae were enough to lay firm foundations for cosmology and stellar astronomy. The latter field, although it scarcely existed before Herschel made it central to his research, eventually emerged as the dominant discipline of modern astronomy.

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