Herschel, John Frederick William | Encyclopedia.com

Complete Dictionary of Scientific Biography COPYRIGHT 2008 Charles Scribner's Sons
23-29 minutes

(*b*. Slough, England, 7 March 1792; *d*. Hawkhurst, Kent, England, 11 May 1871)

astronomy, physics, chemistry.

Herschel was the only child of Sir William Herschel and the former Mary Baldwin Pitt. He was married on 3 March 1829 to Margaret Brodie Stewart. They had twelve children, including Caroline (Hamilton-Gordon), woman of the bedchamber to Queen Victoria; William James Herschel, initiator of the use of fingerprints for purposes of identification; Alexander Stewart Herschel, physicist and astronomer; and Constance (Lubbock), author of *The Herschel Chronicle*. Herschel is buried in Westminster Abbey, next to Newton.

Scions of celebrated families usually enjoy an advantage whatever career they choose. For John Herschel there was a compensating penalty in the eventual choice of his father's profession, for the son was compared with the father, to the former's detriment. William achieved outstanding fame, starting from obscurity and poverty (when he arrived in England his total wealth was one French crown piece). John lived in bourgeois affluence and had a first-class formal education and entrée to all the best-known scientists of Europe. William was a pioneer, "the father of stellar astronomy," who worked in a single field. John worked in many, sometimes within an established framework, and could be accused of dilettantism, except that he achieved distinction in each of several fields. During his life John was immensely celebrated, his name epitomizing science to the public, much as that of Einstein did in the next century. After his death there was a period of obscurity, lifting only now that northern astronomers realize that, for southern hemisphere astronomers, John occupies the same commanding innovative position that William does for those in the north.

An only child in a household devoted to astronomical observation, Herschel may have been saved from becoming a withdrawn solitary by the remarkable relationship with his Aunt Caroline, who, by the sweetness and liveliness of her nature, spanned the gap between herself and the lad forty-two years her junior. The relationship was maintained by correspondence and ended only with her death at the age of ninety-eight, soon after he had proudly sent her the massive *Results of Astronomical Observations Made During the Years 1834–38 at the Cape of Good Hope*.

The careers of many scientists have been determined by wars and other political events, and hardly at all by family circumstances. Herschel's was strongly influenced by his family. Although his early life was full of wars, although as a boy he once met Napoleon and later visited the unmarked tomb on St. Helena, although he mastered many languages, one would never guess from his writings and diaries that the world was anything but peaceful.

After a time at Eton at the age of eight, Herschel went to a private school near his home. At seventeen he entered St. John's College, Cambridge, as a Foundress scholar and read mathematics. There he made friends with George Peacock, later dean of Ely; Charles Babbage, the "irascible genius" whose unsuccessful calculating engine anticipated many modern principles; and William Whewell, the natural and moral philosopher who later became master of Trinity College, Cambridge.

All were mathematicians of great ability; and, while still undergraduates, Herschel, Peacock, and Babbage founded the Analytical Society, devoted to the introduction into the British curriculum of the advanced methods of analysis current on the Continent. A lifelong addict of puns, Herschel described part of their aims as "The replacement of the dot-age of the University by the pure d-ism of the Continent," referring to the change of notation involved. Herschel and Peacock translated Lacroix's *Traité du calcul différentiel et du calcul intégral*, which appeared in 1816; and he and Babbage published two volumes of examples, including much on finite differences, in 1820.

Herschel took the tripos in 1813, when it was still an oral examination, and was, as he wrote in his diary, "Dismissed with a flaming compliment." He was named senior wrangler and first Smith's Prizeman, with Peacock next, Babbage having withdrawn because he could not compete with Herschel. He was elected to a college fellowship in 1813 while still a B.A. and retained this distinction until his marriage. (He was to become an honorary fellow in 1867.) The fifth of a series of mathematical papers, on an application of Cotes's theorem, brought election as a fellow of the Royal Society in 1813, at the age of twenty-one. Herschel was also an expert chemist, and in 1815 he missed election to the chair of chemistry at Cambridge by only one vote. He vacillated in his choice of career. His father favored the church but Herschel first preferred the law, enrolling in 1814 at Lincoln's Inn, where he seems to have used much of his time to further his acquaintance with William

Hyde Wollaston, the natural philosopher who invented the camera lucida and discovered the dark lines in the solar spectrum, and with James South, a wealthy amateur astronomer. Both men exerted strong influences on his later scientific work.

Surprisingly, Herschel accepted a minor teaching post at St. John's and, as sublector from July 1815, endured uncongenial "pupillizing" for a while. Taking his M.A. in 1816, he left Cambridge for good and embarked on a scientific career after earnest conference with his father, who, at seventy-eight, was anxious to see his astronomical work continued but felt his own powers waning. As one of his obituarists was to say, John Herschel took up astronomy out of a sense of "filial devotion."

How this was financially possible is puzzling. William was in desperate straits in 1757. His pay as royal astronomer was £200 per year. Although in his lifetime he made and sold telescopes to the value of £16,000—which must be multiplied by about forty for modern dollar values—only a fraction of it could have been profit. We do not know how wealthy his wife's first husband was, but William's youth contrasts sharply with John's affluent world of Eton and Cambridge. Although John Herschel held no permanent paid post between 1816 and 1850, he brought up a large family in comfort and disbursed large sums on his expedition to Africa. His books, for their kind, had large sales but can hardly have provided a living.

Herschel took over from his father various astronomical and instrumental techniques. The mirrors of reflecting telescopes were then made of an alloy of copper and tin called speculum metal. Herschel himself made the eighteen-inch mirror of his twenty-foot telescope. When the surface of a mirror tarnished, the mirror was replaced by another and the original was repolished and even refigured, usually by the astronomer himself. The observational techniques included the use of star sequences and "sweeping"—fixing the telescope on the meridian at a particular elevation so that, as the earth turned, all the objects at a particular declination were carried through the field of view and could be noted down. The elevation gave the declination; the sidereal time of transit, the right ascension. Used extensively by both Herschels, this technique of discovery was the one by which Uranus was discovered. A sequence of stars, a term still in use, meant a series of stars presumed to be of diverse but known magnitudes, in a given area of sky, into which other stars could be fitted by interpolation and, hence, their magnitudes estimated.

Herschel's choice of research topics was characteristically diverse. After some mathematical papers he turned to physical and geometrical optics. He studied the polarization and birefringence of crystals and worked on rudimentary spectrum analysis and on the interference of light and sound waves. He computed the forms of compound lenses and propounded "Herschel's condition," required for the production of sharp images. In 1819 he discovered that sodium thiosulfate (the photographer's "hypo") dissolved silver salts, an important fact not used practically until some decades later.

In early maturity Herschel made a number of European journeys. Charles Babbage, his companion in 1821, went because of some private affliction; Herschel may have gone because of an unhappy love affair. They went to France and there met Arago, Laplace, Biot, and Humboldt. From France they journeyed to Switzerland and Italy, where they did some very respectable mountaineering. The next year Herschel went with his old friend James Grahame, probably a fellow Johnian, and during this journey received news of his father's death. In 1824 he went again to France and Italy, returning through Germany, meeting Gay-Lussac, Poisson, Fourier, G. B. Amici, Piazzi, Encke, and K. L. Harding. He ended with a visit to his Aunt Caroline in Hannover, whither she had withdrawn to look after her relatives, quixotically renouncing all financial claims on her English family.

On his journeys Herschel made many physical and meteorological experiments and geological and other observations. In particular he used a device he called an actinometer, which consisted of a large-bulbed thermometer containing a dark liquid. He would compare the rate of rise of this liquid in the sun and in the shade and so derive a numerical measure of the solar energy.

A short journey in 1827 took him to Ireland, where he met William Rowan Hamilton, the precocious genius who shared his interests in physical optics and many other fields.

Herschel's first astronomical paper, on the computation of lunar occultations (1822), was published when he was already working in London on systematic observations of double stars with James South, the possessor of two excellent refracting telescopes. It had once been thought that a close pair of stars of differing magnitudes must result from the accidental near alignment of two similar stars at vastly different distances and that any apparent relative motion would be a parallactic effect of the motion of the earth around the sun. The pioneer work of William Herschel had demonstrated orbital motion of binary stars under mutual attraction. John continued the work, reobserving known systems and discovering new ones, with detailed study of several cases, notably Gamma Virginis, and the development of methods (1833) for the determination of orbital elements. For their catalog of 380 double stars (1824) South and Herschel received the Lalande Prize of the French Academy in 1825 and the gold medal of the Astronomical Society (1826).

Herschel's scientific life was closely bound up with two royal societies. A fellow of the Royal Society in 1813, he won its Copley Medal in 1821 and 1847, and its Royal Medal in 1833, 1836, and 1840; he served as secretary from 1824 to 1827. In 1830 a reform group within the Royal Society nominated Herschel as president. He lost by eight votes to the duke of Sussex, a son of George III. The following year the British Association for the Advancement of Science was founded; Herschel was elected its president in 1845. (A full account of the controversy is L. Pearce Williams, "The Royal Society and the Founding of the B.A.A.S.," in *Notes and Records of the Royal Society*, **16** [1961], 221–233.)

The Astronomical Society (Royal after 1831) began with a dinner attended by fourteen gentlemen, including Herschel, on 12 January 1820. Initial hostility from the senior Royal Society was placated and the new society formally established. Herschel was foreign secretary from 1820 to 1827 and in 1846–1847. He was president three times (1827–1829, 1839–1841, 1847–1849), gold medalist in 1826 and 1836, and one recipient of the series of testimonials awarded in lieu of medals in 1848 during the row over the credit for priority in discovery of the planet Neptune.

In July 1825, working with the geodesist Edward Sabine and aided by large parties of troops, Herschel collaborated with a group of French scientists to determine the longitude difference between the Greenwich and Paris observatories.

James South left England and Herschel continued astronomical observations at Slough, following his father's lead in observation of nebulae, clusters, and double stars. A monumental catalog of 2,307 nebulae and clusters, 525 being new, was issued in 1833. By 1836 he had published six catalogs of double stars, comprising 3,346 systems.

Herschel's long list of research papers includes other astronomical contributions and optical, chemical, and geological studies. Somehow he also found time to contribute long articles on a variety of topics to several encyclopedias then being published. For David Brewster's *Edinburgh Encyclopaedia* (1830) he wrote "Isoperimetrical Problems" and "Mathematics." For the *Encyclopaedia metropolitana* he produced "Light" (1827) and "Sound" (1830). In 1830 he published *A Preliminary Discourse on the Study of Natural Philosophy* as the first volume of Dionysius Lardner's *Cabinet Cyclopaedia*. In 1833, also for Lardner, appeared *A Treatise on Astronomy*, which became his most celebrated work, *Outlines of Astronomy*.

Herschel was now nearing forty and had earned almost every possible distinction in his field. He might well have remained a solitary bachelor but for his friend James Grahame, who decided he would be better off married and even picked out the girl: Margaret Brodie Stewart, daughter of Dr. Alexander Stewart, a Presbyterian divine and Gaelic scholar, who by his two wives had had a large family. Maggie, as Herschel was to call her, was good-looking, eighteen years younger than Herschel, and possessed an extremely strong character. Grahame threw the couple together; they married in 1829, were supremely happy, and had twelve children. Maggie followed Herschel everywhere, even to the wilds of Africa, and managed all his complex affairs, even to the extent of running a household of seldom less than twenty people when she was still in her early twenties.

Herschel now conceived the idea of an astronomical expedition to the southern hemisphere, possibly delaying its execution until after his mother's death in 1832. The only possible choices of site were South America, Australia, and the Cape of Good Hope. The Cape Colony had come under British rule in 1806 as a consequence of the Napoleonic Wars. Cape Town had existed as a town since 1652 and was important as a way station for many ships en route to India. The British had established an observatory there for the "improvement of astronomy and navigation" in 1820. As the result of the work of Lacaille in 1751–1753 it had an astronomical tradition and also enjoyed the technical advantage of being in the same longitude as eastern Europe, so that cooperative observations in the same meridian were possible.

On 13 November 1833 the *Mountstuart Elphinstone* sailed from Portsmouth with the Herschel party—John, Maggie, three children, a mechanic named John Stone, and a nurse—on board. They had a twenty-foot telescope and a seven-foot equatorially mounted refractor. They landed at Cape Town on 16 January 1834, Herschel having happily beguiled the voyage with all kinds of astronomical, oceanographical, and meteorological investigations while everyone else was prostrated with seasickness. Ten days before they landed, the newly appointed director of the Cape Observatory (H.M. astronomer at the Cape), Thomas Maclear, had arrived with his family and servant; the two were to enjoy four years of happy collaboration.

Herschel leased at £225 per annum (and subsequently purchased for £3000) an eighteen-room house called "The Grove," which he named "Feld-hausen" by a German approximation to its Dutch name, in the suburb of Claremont, south of Cape Town. Within six weeks he and John Stone had the reflector erected on a spot now marked by a memorial obelisk. By 1838 he had swept the whole of the southern sky, cataloged 1,707 nebulae and clusters, and listed 2,102 pairs of binary stars. He carried out star counts, on William Herschel's plan, of 68,948 stars in 3,000 sky areas. Herschel made micrometer measures for separation and position angle of many pairs. He produced detailed sketches and maps of several objects, including the Orion region, the Eta Carinae nebula, and the Magellanic Clouds, and extremely accurate drawings of many extragalactic and planetary nebulae. He observed lunar eclipses, and when Eta Carinae, an object whose nature is still not understood, underwent a dramatic brightening in December 1837, he recorded its behavior in detail. Herschel invented a device called an astrometer, which enabled him to compare the brightness of stars with an image of the full moon of which he could control the apparent brightness, and thus introduced numerical measurements into stellar photometry. Maclear provided him with accurate star positions, and he assisted Maclear in geodetic and tidal observations. He observed Encke's and Halley's comets and experimented with the actinometer and with cooking by solar heat.

Herschel and Maggie and some of the children made several trips into the nearer parts of the western Cape Colony. He helped promote exploring expeditions and galvanized the Cape Philosophical Society. His correspondence was enormous, and virtually everyone of note visited him. He drew pictures of scenery and flowers with the camera lucida, and Maggie colored some of the pictures. He did enough botany to get his name in the list of species and established systematic meteorology in the area. With several local worthies Herschel devised a new educational system for the Cape Colony, traces of which persist; and, having written memoranda from the Cape, lobbied for their acceptance when he reached home. He refused official financial aid for the expedition and was able to offer financial aid to several of his numerous brothers-in-law. On 11 March 1838 the expedition embarked on the *Windsor*, with Herschel conducting experiments throughout the voyage, and landed at London on 15 May 1838.

The newly created baronet rushed off to Hannover to see his Aunt Caroline, as well as Gauss, Olbers, and H. C. Schumacher. He produced numerous papers on topics ranging from iron meteors to variable stars to the structure of the eye of the shark. Many of these derived from his African experiences, particularly his plan for the reform of the nomenclature and boundaries of the constellations, which was ready by 1841. Herschel served on committees and commissions, including the Royal Commission on Standards (1838–1843), and as lord rector of Marischal College, Aberdeen, in 1842. He helped to organize worldwide meteorological and magnetic observations, as well as the geomagnetic expedition of James Clark Ross to the Antarctic.

From Herschel's return from Africa until the mid-1840's two special scientific preoccupations stand out: the reduction of the African results and their preparation for publication, which led to numerous relatively short papers; and the researches in photography. So expert a chemist was Herschel that he was readily able to duplicate work reported by others and to improve on it, often in a matter of days. He made the first photograph on glass (of the decrepit forty-foot telescope, destined to be dismantled and mourned in a curious ceremony on 1 January 1840) in 1839. He introduced the terms "positive" and "negative," In eleven papers on photographic topics, Herschel tested an extraordinary variety of chemicals and processes. In 1839 he reproduced a solar spectrum in its natural colors. He extended his researches into both the ultraviolet and the infrared, and discovered the "Herschel effect": the quenching effect of light of a longer wavelength on a photosensitive surface afterward exposed to a shorter wavelength. Because his interests were mainly scientific and academic, he has been deprived of credit that is now accorded to others in the practical development of photography.

In 1840 the family moved from Slough to "Colingwood," a house at Hawkhurst, Kent. Herschel was then forty-eight years old and beginning to slow down. Still to come were the remaining photographic papers, a great deal of committee work, miscellaneous astronomical papers, some investigations of the phenomena of fluorescence, and thoughts on such diverse topics as meteorology, metrology (including that of the Great Pyramid), and color blindness. The *Results* from Africa appeared in 1847. *Outlines of Astronomy* was issued in 1849, as was a *Manual of Scientific Inquiry* for the Royal Navy. Herschel found time to translate into English hexameters some of the works of Schiller, Dante's *Inferno*, and, at the end of his life, the *Iliad*.

In December 1850 Herschel took a step that is almost inexplicable unless he was motivated by either financial stringency or the example of Newton. He accepted the post of master of the mint, where he tightened up the administration and advocated decimal coinage. He sat on a royal commission investigating the curricula at Oxford and Cambridge and on a committee choosing scientific instruments for the Great Exhibition of 1851. He wrote articles on meteorology, physical geography, and the telescope for the eighth edition of the *Encyclopaedia Britannica*. It was all too much for him. He was often away from his family; he was ill with gout and depression; and he suffered a breakdown. He retired from the mint at the beginning of 1856 but still had the verve to produce a consolidated catalog of 5,079 nebulae and clusters for the *Philosophical Transactions* of 1864 and to do much of the work for the posthumous catalog of 10,300 double stars. Herschel could even write about meteors and meteorology, and on musical scales. But in Julia Margaret Cameron's photographs of him, he seems old and feeble, with all the energetic good looks of the African time quite gone. When he died in 1871, he was mourned by the whole nation, not merely as a public figure and great scientist but also as one of the last of the universalists.

BIBLIOGRAPHY

I. Original Works. Books by Herschel are *A Collection of Examples of the Application of the Calculus of Finite Differences* (Cambridge, 1820); *Preliminary Discourse on the Study of Natural Philosophy* (London, 1830); *A Treatise on Astronomy* (London, 1830); *Results of Astronomical Observations Made... at the Cape of Good Hope, Being a Completion of a Telescopic Survey of the Whole Surface of the Visible Heavens, Commenced in 1825* (London, 1847); *Outlines of Astronomy* (London, 1849); *Essays From the Edinburgh and Quarterly Reviews, With Addresses and Other Pieces* (London, 1857); and *Familiar Lectures on Scientific Subjects* (London, 1868).

Contributions to encyclopedias include David Brewster, ed., *The Edinburgh Encyclopaedia* (Edinburgh, 1830): "Isoperimetrical Problems" (not signed), XII, pt. 1, 320–328; and "Mathematics," XIII, pt 1, 359–383; Edward Smedley, ed., *Encyclopaedia metropolitana* (London, 1845): "Physical Astronomy," III, 647–729; "Light" (dated Slough, 12 Dec. 1827), IV, 341–586; "Sound" (dated Slough, 3 Feb. 1830), IV, 763–824; and T. S. Traills, ed., *Encyclopaedia Britannica*, 8th ed.: "Meteorology," XIV (1857), 636–690; "Physical Geography," XVII (1849), 569–647; and "Telescope," XXI (1860). "l 17–145.

Books translated or edited by Herschel are S. F. Lacroix, *An Elementary Treatise on the Differential and Integral Calculus*, translation (pt. 2 by G. Peacock and J. F. W. Herschel) with an appendix by Herschel and notes by Peacock and Herschel (Cambridge, 1816); *A Manual of Scientific Inquiry; Prepared for the Use of Her Majesty's Navy; and Adapted for Travellers in General*, edited by Herschel (London, 1849); and *The Iliad of Homer TranslatedInto English Accentuated Hexameters by Sir J. F W. Herschel* (London, 1866).

For a list of Herschel's papers see Royal Society *Catalogue of Scientific Papers*, III (1869), 322–328: VII (1877), 965; and *Mathematical Monthly*, **3** . 220 f.

Principal repositories of Herschel documents are the Royal Astronomical Society and the Royal Society, London; St. John's College, Cambridge; the University of Texas at Austin; and the South African Public Library and the South African Archives, Cape Town.

II. Secondary Literature. See Günther Buttmann, *The Shadow of the Telescope*, translated by Bernard Pagel, edited and with an intro. by David S. Evans (New York, 1970); Agnes M. Clerke, "Sir J. F. W. Herschel," in *Dictionary of National Biography*, IX (Oxford, 1921), 714; David S. Evans, Terence J. Deeming, Betty Hall Evans, and Stephen Goldfarb, eds., *Herschel at the Cape* (Austin, Tex.-London, 1969); and *Sir John Herschel at the Cape, 1834–1838*, special issue of *Quarterly Bulletin of the South African Library*, **12** , no. 3 (Dec. 1957), which contains an intro. by D. H. Varley; "Sir John Herschel, 1792–1871." by R. H. Stoy: "The Astronomical Work of Sir John Herschel at the Cape," by David S. Evans; and "Sir John Herschel's Contribution to Educational Developments at the Cape of Good Hope," by E. G. Pells.

David S. Evans