

Why William Herschel Is the Father of Modern Astronomy

Martin Griffiths

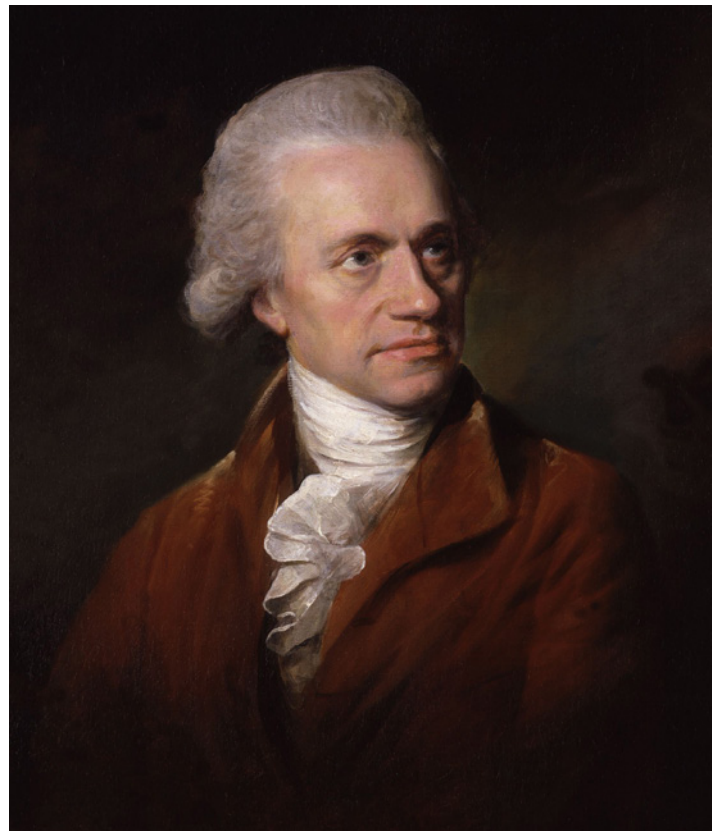
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Editor's Introduction

Readers familiar with the history of astronomical thought will instantly recognize the name William Herschel. But few of us know the full range of his accomplishments and contributions to modern science. We were taken recently with a wonderful piece about Herschel in the British magazine *Popular Astronomy*, by astronomical historian Martin Griffiths, the author of the nontechnical book *Alien Worlds*. We asked if we could adapt the piece for *Astronomy Beat*, and are grateful to the authors and the magazine's editor, Peter Grego, for permission to do so.

The eighteenth century astronomer William Herschel probably contributed more to our knowledge and appreciation of the night sky than any other person before him. Herschel's chief claim to fame amongst the scientific community is the discovery of the planet Uranus; but his renown as an astronomer goes beyond this single element in his career.

As an amateur observer from a young age, it was inevitable that I would encounter the series of objects listed as the "New General Catalogue". As I used a small telescope night after night, the objects first discovered by William and John Herschel in the late 18th and early 19th century beckoned to me and drew me in to the world of the Herschel family. An aspiring composer, William Herschel turned from a lucrative



Portrait of William Herschel (by Lemuel Abbott in 1785; from the British National Portrait Gallery)

career in music to one of astronomy after discovering Uranus in spring 1781.

History records that he rapidly became the foremost observational astronomer of his age and built the world's largest telescopes in a quest to peer further into the heavens than anyone before him. As an observer, I

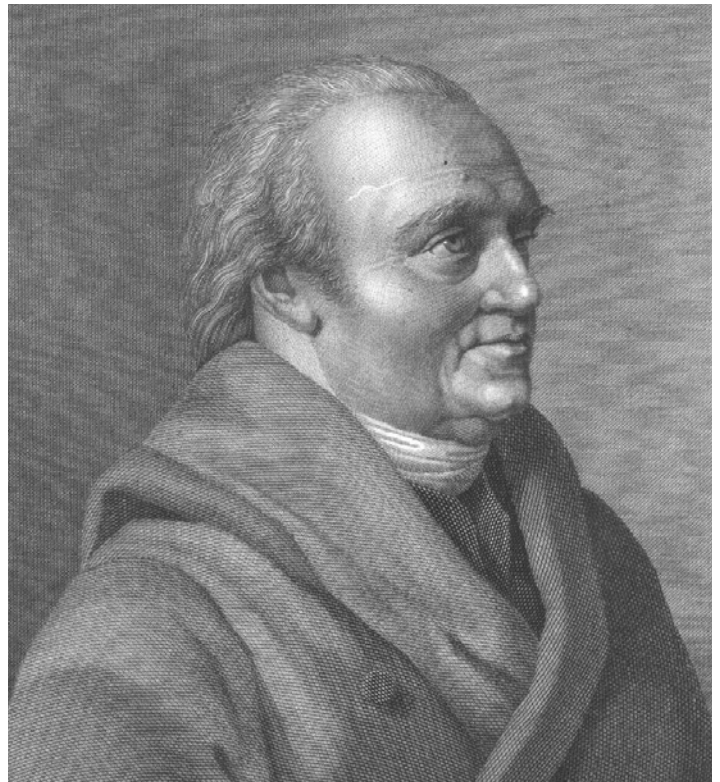
have benefited from his work on binary stars, globular clusters, star clusters, planetary and gaseous nebulae and the plethora of objects we now term galaxies. His theoretical and scientific speculations led him to engage in fields that now occupy me as a professional - his discovery of infra-red radiation and contributions to astrobiology. His fertile mind covered almost every known field of astronomy during his lifetime and set observational astronomy on the path to its great modern achievements.

Background to Greatness

Friedrich Wilhelm Herschel was born in Hanover, Germany in 1738. His father Isaac, a bandsman with the Hanoverian Footguards, was a cultured and intelligent man interested in nature, music and mathematics and his interests rubbed off on many of his 10 children. He encouraged William (I will use his anglicised name throughout) and his brother Jacob to join the band, but when the unit saw bloody action at the battle of Hastenbeck in the Seven Years war, Isaac told his sons to leave the field and return home. William and Jacob did not desert their posts; they had never formally been invested as members of the regiment. Still their home life did not hold much opportunity either. Under their father's guidance they later took a boat to England where they quickly found work as musicians and composers. The family had previously visited Britain in 1755 when the band had been stationed in Oxfordshire and the brothers made good use of their previous contacts there.

William had an outstanding career as a musician. He played cello, oboe, violin, piano, harpsichord and organ and was an excellent craftsman who made his own instruments from time to time. He was also a gifted composer, writing 24 symphonies, several compositions for church and numerous concertos. His musical recitations and skill rapidly established his fame. Initially playing in the Richmond orchestra patronized by the Earl of Darlington, he then travelled to northern England, becoming as a violinist for the Newcastle orchestra before taking a position as organist at St John's church Halifax.

William was eventually offered the post of organist and director of public concerts at the prestigious Octagon chapel in Bath. He moved there in 1767 and encouraged his brothers Dietrich, Alexander and



Engraving of William Herschel Later in Life

Jacob to play with the Bath Orchestra. He completed his sibling ensemble when he brought over his sister Caroline, originally as his housekeeper, but her fine soprano voice made her an excellent addition to concerts. In time she would join William in his astronomical endeavours, becoming the first female professional astronomer. By 1770 William was director of the Bath orchestra and life in this cultured regency town in the age of enlightenment could not have been better.

One of his few pleasures as a bachelor was reading in bed and he consumed several books dealing with scientific matters. Motivated by the connection between mathematics and musical harmony, he progressed from Robert Smith's *Harmonics* to his book *Opticks*, and on to James Fergusons *Astronomy*. In 1771 he began construction of a series of telescopes that would later propel him to fame. In fact, so taken with astronomical observation was he that he reduced the number of musical pupils he had to teach to a level where his time became devoted to his astronomical pursuits. In 1779, he was observing the Moon from the street in front of his house when he was stopped by a gentleman passing by, who inquired if he could have a peep through the scope. The man was Dr William

Watson, and after this meeting, a lifelong friendship sprang up between the two. Watson was a fellow of the Royal Society, and was able to communicate some of Herschel's papers on the height of lunar mountains to its scholars, who were stirred by the astronomers reasoning and observations. William quickly became well regarded by men in scientific circles to such an extent that the Astronomer Royal visited him.

This quiet life of music, astronomy and family was all he wished for. However, in early 1781 a crucial turning point in his career was reached. The musician found a heavenly calling in a literal sense.

The Georgian Star

On the 13th March 1781, Herschel was examining a star field in the constellation of Gemini, when his interest was quickened by the sight of a disc-like object amongst the stars. Over the next few days, Herschel observed this object moving very slowly against the faint background stars, and thought that he had discovered a comet. His positions and observing records were communicated to the Royal Society, and its mathematicians soon discounted the idea of a comet. Instead the most incredible surprise awaited

science. Herschel's object was actually a new planet, the first to be discovered within historical times. When the calculations of Anders Lexell and Pierre Laplace found its orbit, it doubled the size of the solar system overnight. Astronomers all round the world scrambled to their telescopes to observe this newcomer.

Honours rained down upon the little known astronomer. He was granted the Copley medal of the Royal Society and made a Fellow. He was granted an audience with George III and appointed as the "king's astronomer" (there already was a post entitled Astronomer Royal which was held by Neville Maskeleyne). Herschel wished to call the new planet *Georgius Siderius* the "Georgian star" after the king, but wiser heads prevailed and the new planet was eventually called Uranus, after the father of the gods, in keeping with the mythological nomenclature of the planets then in use.

Herschel moved from Bath to Datchet near Windsor castle and enjoyed a royal stipend of £200 per year, freeing him from reliance on musical teaching and allowing him to devote himself to astronomy. William continued to make telescopes, constantly refining his techniques and supplementing the family income with their sales. His customers included the King of Spain, the Emperor of Austria and the Russian court. He also made telescopes for the astronomers Johann Bode, Giuseppe Piazzi and John Pond, who would become Astronomer Royal one day. No instrument maker to the time of Joseph Fraunhofer made such fine instruments or had such commercial success.

Datchet however proved an unsuitable place for astronomical observation due to the mists from the river Thames, and so the family moved to Slough, where William embarked upon a programme of creating the greatest telescopes the world had seen, culminating in a 48-inch diameter, 40-foot focal length monster. This telescope did not work that well due to its rather cumbersome design, but William used a 20-foot focal length forerunner to great advantage, compiling a catalogue of nebulous objects and making copious observations that would later become the *General Catalogue of Nebulae and Star Clusters*. This catalogue was later revised in 1885 by the director of the Armagh observatory, JLE Dreyer, to become the workhorse of amateur and professional observing today — the *New General Catalogue*.



Caroline Herschel

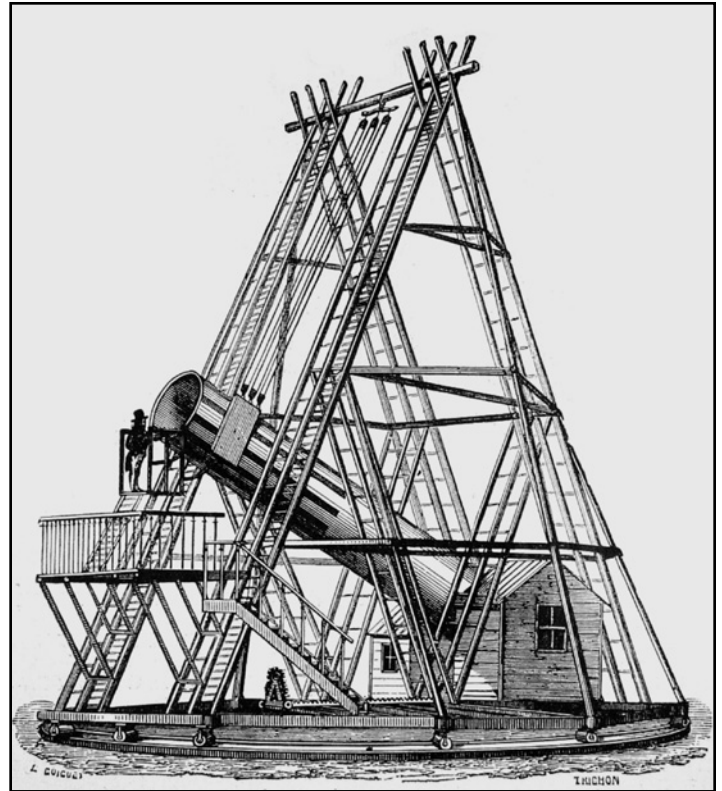
The Lure of Science

A prolific worker and scientific experimenter, Herschel was motivated to follow various avenues of astronomical research, bringing a breath of fresh air and enthusiastic observation to this work. In 1787 after continuing to follow his initial observations of Uranus he discovered its moons Titania and Oberon and notified the Royal Society that his observations revealed the planet to roll like a ball around the sun; its rotational axis was 90 degrees to the plane of its orbit. Two years later, William discovered two previously unknown moons of Saturn: Mimas and Enceladus.

His observations of Mars enabled astronomers to discern its seasons and axial tilt and he became one of the first scientists to write about the polar ice caps of that planet. In the year 1800 his studies of sunlight and temperature enabled him to discern a new form of electromagnetic radiation that Herschel termed “dark heat”, later to be called infra-red. In 1802 he coined the term “asteroid” (little star) to describe the new bodies being found between Mars and Jupiter. He also made some of the first systematic observations of the Sun and made a determined but ultimately doomed effort to connect solar activity with Earth’s weather.

During Herschel’s lifetime, astronomy was generally considered to be merely the study of the solar system and although much speculation abounded with regard to faint nebulous patches scattered throughout the sky, no one knew exactly what such things were. William’s work laid the foundation for accurately mapping the dimensions and positions of such objects and making the first determinations of their nature. This work would lead to the 20th century revelation that the universe was filled with galaxies, and that the universe was a dynamic, expanding construct much larger than any man of the 18th century could imagine.

His studies of the Milky Way revealed the galaxy to be a disc like structure rather like a mill wheel, and his observations of the motions of the stars on the sky determined that the sun and solar system were moving in space towards the constellation of Hercules at a speed of 13 miles per second. William’s examination of double stars proved categorically that these systems were binary stars in gravitational orbit about each other rather than being mere line of sight associations. This observation helped prove the application of Newton’s gravity to the universe at large.



Drawing of Herschel's 40-foot Monster Telescope

William married Mary Pitt in 1788 (Mary was the widow of a brewer, and retained his fortune after his death) and now, financially independent, he became a man who frequented the upper echelons of society; meeting both the emperor Napoleon and the astronomer Charles Messier in Paris and maintaining a correspondence with continental astronomers for many years afterwards. Out of the Herschel’s happy marriage came their only child, John Herschel, who under his father’s influence grew to be one of the great polymaths of his age. John became the co-inventor of the photographic process of negative and positive development, working closely with William Fox Talbot and lending his chemical expertise in experiments. John would continue his father’s astronomical work by mapping the southern hemisphere stars that were not visible from Britain and eventually became President of the Royal Astronomical Society himself. The influence of science in the Herschel household was evident in the nature of studies that John’s children engaged in as they matured, becoming scientists and naturalists, one even inventing the police technology of forensic fingerprinting.



Painting of Herschel Telescope in Space (ESA)

Herschel's Legacy

Herschel's influence extended across a range of sciences and his stature induced others to follow him. Such was his impact that he was knighted in 1816 by the prince regent. The formerly obscure yet gifted musician had risen to the top of his field through his sheer love of his subject. Learning the tools of science and marrying them to a careful and systematic observational pattern, Herschel epitomised the ultimate role of the amateur in science. Astronomy was becoming a major discipline, but was overshadowing the work of other fields. To continue and encourage astronomical work and to reflect the increasing specialism in the sciences, the Royal Society split off its astronomical faction and instituted the Royal Astronomical Society, with Herschel becoming its first vice President, then President in 1820.

William Herschel died in 1822 at the age of 83. His scientific observations and shrewd insight into

physical problems had enabled him to make so many contributions that he virtually became the founder of modern observational astronomy. More than one biographer has called him the "Father of Stellar Astronomy". It is not the only tribute to him. William Herschel has a crater on the Moon and a basin on Mars named in his honour; asteroid 2000 is named Herschel as is a giant impact crater on Saturn's moon Mimas. There is also the William Herschel telescope at La Palma and now we have the largest space observatory ever constructed, the Herschel spacecraft, dedicated to investigating the infra-red universe. Amateur astronomers all over the world engage in hunting the beautiful "Herschel 400" the best and brightest of his catalogue discoveries.

Several years after his death, his modest grave, originally at St Laurence's church, Upton, was removed and re-laid alongside that of his son John; close to the gravestone of Sir Isaac Newton in Westminster Abbey. This is a fitting tribute to the gentle genius who singlehandedly did more for astronomy than any other human being before or since.

In a quiet corner of Bath, not far from the bustle of Queen's Square is his only surviving residence at 19 New King Street. It is now a small museum dedicated to the story of this indefatigable observer. The strains of Herschel's beautiful compositions can be discerned as background music as one explores the house. Stepping out into the garden a visitor can contemplate the quiet serenity of a place where long ago on a cold winter's night, William Herschel found the first planet to be discovered with the telescope.

About the Author:

Martin Griffith is senior lecturer in Observational Astronomy at the University of Glamorgan, Wales, UK, where he does research in the history and development of science. He was a founder member of NASA's Astrobiology Science Communication Group, active between 2003–2006 and managed a multi-million pound European Science Foundation program in astrobiology for adult learners across Wales between 2003–2008. For his outreach



work, he became a recipient of the Public Engagement Award of the Astrobiology Society of Britain in 2008. Martin also contributes articles on varied astronomical topics for popular magazines and broadcasts regularly on BBC Wales radio. He has appeared on science programmes for the BBC, Einstein TV, Granada TV and the Discovery Channel.

Resources for Further Information

A Few Books and Articles:

Armitage A. *William Herschel* Nelson Press, London 1962

Buttmann G. *The Shadow of the Telescope* Lutterworth Press London 1974

Hoskin, M. "William Herschel and the Making of Modern Astronomy" in *Scientific American*, Feb. 1986, p. 106.

Jones, B. "William Herschel: Pioneer of the Stars" in *Astronomy*, Nov. 1988, p. 40.

Lemonik M. *The Georgian Star: How William and Caroline Herschel Revolutionized our Understanding of the Cosmos* W. W. Norton Press New York 2009.

Ronan, C. "William Herschel and His Music" in *Sky & Telescope*, Mar. 1981, p. 195.

A Few Web Sites:

Peter Millman's article on William Herschel in the Journal of the Royal Astronomical Society of Canada is available free on the web at:

<http://adsabs.harvard.edu//full/seri/JRASC/0074//0000134.000.html>

Brief biography of Herschel with lots of links to his observing projects and catalogs:

<http://seds.org/messier/xtra/Bios/w Herschel.html>

The Herschel 400 Observing Club:

<http://www.astroleague.org/al/obsclubs/herschel/hers400.html> ♦

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