Caroline Lucretia Herschel (astronomer and comet sweeper)

(March 16, 1750– January 9,1848)

Caroline Lucretia Herschel comes from a family of famous astronomers. Her brother Frederick William Herschel was the Court Astronomer for King George III of England and credited with discovering the planet Uranus. Her nephew John Frederick William Herschel originated the use of the Julian system in Astronomy and named seven moons of Saturn and four moons of Uranus. Caroline herself discovered 8 comets. The brilliance of Caroline in astronomy was overshadowed by her famous brother but in the end, Caroline was able to accomplish many firsts in her life. She was the first woman to receive a salary as a scientist in the field of astronomy and the first woman in England to hold a government position. She was also the first woman to publish scientific findings in the *Philosophical Transactions of the Royal Society*. She was the first woman to be awarded a Gold Medal of the Royal Astronomical Society and together with Mary Somerville was the first woman to be named an honorary member of the Royal Astronomical Society.

Her science journey began when Caroline Lucretia Herschel was born on March 16,1750 in the German city of Hanover, the eighth child of ten children, six of whom survived to adulthood. Her parents were Isaac Herschel and Anna Ilse Moritzen. Isaac's father was a gardener in the fashionable ornamental pleasure gardens in Hohentziatz and his mother was the daughter of a tanner from Loburg.

Isaac was supposed to follow his father's trade as a gardener, but his love of music distracted him from his future career. He taught himself to play the oboe and soon was able to find a job as a professional musician. He joined the Hanoverian Foot Guards band in 1731. In 1732, he met Anna Ilse Moritzen who grew up 3 miles from Hanover. Anna's provincial outlook and lack of education contrasted with her husband who sought to give the best education to his children whether male or female. When Caroline was four years old, she contracted Smallpox which left her with scars on her face. Then at eleven years old, she had typhus which stunted her growth. Her parents thought that it would be impossible for her to get married, so her mother Anna decided to treat her as her unpaid housekeeper. She prevented Caroline from having any interest outside the home. Caroline's older sister Sophia was already married, and Caroline was the only daughter left in the house. She was surrounded by brothers. She attended school only until it was no longer compulsory - her mother did not think she should be educated beyond that. Anna was satisfied that her daughter would serve as her housekeeper. Caroline considered this treatment to be some form of slavery. But Anna had her way because she ruled that household. Anna declared that if Caroline wanted more education, then she could learn something that would contribute to her domestic chores. So Caroline was sent to a seamstress to be taught how to make household linen. Anna was uneducated so could not appreciate the reasons for a girl having more education. But for Caroline, more education meant achievement and independence. After the death of her father Isaac and after William moved to Britain to find employment, Caroline asked her mother to let her learn a new trade-millinery. Anna reluctantly gave her permission and persuaded the lady who ran the classes to accept a lower fee.

MOVE TO BATH, ENGLAND

Caroline's brother William has been living in Bath, England since December 1766. Following in the footsteps of his father Isaac, William established himself as a musician in Bath, becoming the organist at the newly established Octagon Chapel. He was a sought-after music teacher. He has helped his brothers Jacob, Alexander, and Dietrich to find jobs in Bath. Then he decided to help his sister Caroline. Caroline had

become more desperate with no prospects of marrying or escaping her life as a domestic slave for her mother. William went back to Hanover to get his sister and paid his mother for the loss of her unpaid help. William and his brothers paid a small annuity to Anna so she could pay another person to take the place of Caroline.

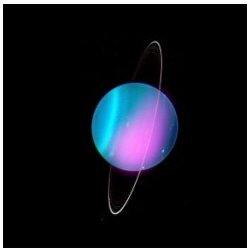
Caroline was happy and grateful that she could join her brothers in Bath. She took regular singing, English, and arithmetic lessons from her brother William and dance lessons from a local teacher. She also learned to play the harpsichord, and eventually became an integral part in William's musical performances at small gatherings. She became the principal singer at his concerts and acquired a fine reputation as a vocalist when she was the first soloist at a performance of Handel's *Messiah* in April 1778. She declined to sing for any conductor but William, and after that performance, her career as a singer declined. William's interest in music declined too as he spent more time on astronomy. Thus, Caroline's career as a solo singer ended.

ASTRONOMY

In 1774, William found a new hobby, astronomy. He became less interested in music and was putting more energy into astronomy. But his new obsession required a telescope. He found a small telescope which he used for a while but then he realized he needed a larger instrument if he was going to do serious research in astronomy. A large telescope was too expensive to pay out of his salary as an organist. He decided to make his own telescope, 18 -20 feet long. He experimented to find which metallic alloys reflect light with the greatest intensity, the best means of giving parabolic shape to the mirrors, how best to polish the mirrors, and other practical details. Caroline became his assistant - helping her brother with household chores and sometimes feeding him while he polished the mirrors. She copied catalogs, tables, etc. for him. She also helped him wherever else was needed, such as with measurements made using the lamp-micrometer William had invented[1]. William erected a stand for his twenty-foot telescope in his garden. On March 13, 1781, his efforts were rewarded with the discovery of a new planet! This

[1] C.f. https://royalsocietypublishing.org/doi/10.1098/rstl.1782.0015

was the first planet to be discovered for thousands of years. He called it Giorgium Sidus in honor of King George III; later, the planet would be renamed Uranus.



William became famous worldwide as an astronomer. King George III made him a Court Astronomer and paid him an annual pension of three hundred pounds[2]. William also received the Royal Society's Copley Medal for his discovery. The award was founded in 1731 and named after Sir Geoffrey Copley.

Caroline became the official assistant to William because their brother Alexander did not have the patience and perseverance needed to become an astronomer. Caroline showed more commitment to the work of an astronomer. In 1782, William and Caroline would appear on stage for the last time. Distracted by his astronomical studies, William conducted a poor performance of *Messiah* in Bristol. Caroline was not keen on pursuing astronomy, but she followed her brother and respected his decision to leave his music career and work as a full-time astronomer. But William had formerly earned four hundred pounds a year as a musician, so he saw a big decrease in salary - science was not a lucrative profession.

After the family moved to Datchet in August 1782, Caroline started using a telescope to observe the skies. She received more training as "an assistant Astronomer". William decided that his sister could provide him with the best and unpaid assistance he could find. She dutifully recorded her observations in her notebook. She was not consulted about this new role but nevertheless she did her duty efficiently. Slowly, Caroline began to enjoy her new duty of sweeping for comets. Her first telescope was a simple tube with two glasses which pivoted about a vertical axis, making it suitable for horizontal sweep. She began to ask questions of her brother, and she recorded his answers in her "Common place Book". This contained examples of how to take equal altitudes, how to convert sidereal time into mean time, how to find the logarithm of a given number, how to calculate oblique plain triangles and right-angled spherical triangles, and theorems for making tables of motion. Formerly a confused novice who could not tell one celestial object from another without consulting her brother, by now Caroline had

[2] At the time, a skilled tradesman would need about seven years to earn that much. C.f. https://www.nationalarchives.gov.uk/currency-converter/

found fourteen nebulae as of the end of 1783. She recorded a catalog of these findings. During this time the term "nebula" was used to describe any diffused astronomical object including galaxies beyond the Milky Way. After a year, Caroline had increased the number of known nebulae by 5 percent. Caroline was now a practicing astronomer in her own right with scientific discoveries to her name.

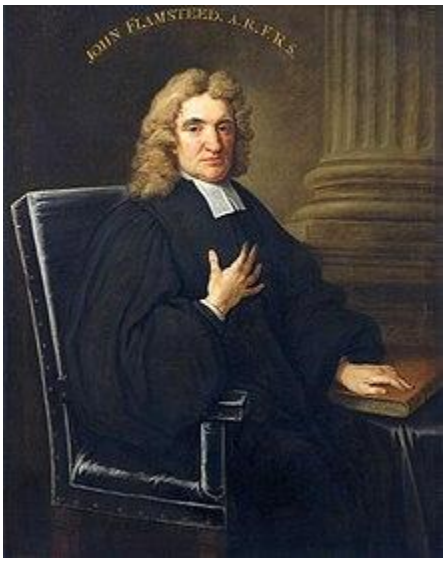
As a reward, William replaced Caroline's telescope with a more powerful instrument. The new Newtonian reflecting telescope was larger than her first telescope with a focal length just over two feet. William adapted it to have only one mirror instead of two, thus allowing the incident light to be reflected from the speculum mirror directly into the eyepiece without further loss of brightness. But before she could fully use her new instrument, she was asked to help record the observations her brother William had made with his latest telescope, the large, twenty-foot telescope with 18-inch mirrors and an additional chair. So, her comet sweeping was interrupted. But later, when her brother left for Germany, she resumed her comet sweeping project. Caroline discovered her first comet on August 1, 1786. The scientific community was delighted to hear about this discovery! Caroline was visited by notable scientists including the President of the Royal Society, Sir Joseph Banks. Before the eighteenth century, comets were found only by accident.

Caroline's achievement was a triumph for British astronomy! In August 1787, King George III granted another £2000 to William for the continuing construction of the 40-feet reflector and added a provision that his sister Caroline be paid a salary of £50 per year as an assistant astronomer. Thus, Caroline became the first woman in the history of science to be paid for her services to astronomy. On the left is a picture of William and Caroline polishing a mirror.

MARRIAGE OF WILLIAM TO MARY PITT

On May 8, 1788, William married a rich widow, Mary Pitt (née Baldwin). William's marriage affected his sister dramatically. With the arrival of William's wife, Caroline lost her managerial and social responsibilities in the household and accompanying status. She also moved from the house to other lodgings, returning daily to work with her brother. She no longer held the keys to the observatory and workroom, where she had done much of her own work. Left on her own, Caroline discovered her second comet on December 21,1788. She then found her succeeding comets on January 7 and April 17, 1790, December 15, 1791, October 7, 1793, November 7, 1795, and August 14, 1797, for a total of 8 comets. Five of her comets were published in the *Philosophical Transactions of the Royal Society*. The French astronomer Joseph Jerome de Lalande was so impressed he named his daughter Caroline - the ultimate compliment. This pleased Caroline as she knew that Lalande's son was named Isaac after Isaac Newton. Her achievements were also lauded in the popular press of the day.

William's marriage did not stop the sibling's partnership. They continued their astronomy undertakings. It did create some problems. For one there were two households, Upton where William and his wife lived, and Slough where Caroline lived. The sisters-in-law did not like each other at first, and William's wife didn't understand what he and his sister were doing in astronomy. But in later years Caroline and Mary would become good friends and correspondents.



In 1797 William noticed many discrepancies in the star catalog published by John Flamsteed. John Flamsteed was the first Royal Astronomer for the United Kingdom. The catalog was difficult to use because it had been published as two volumes, the catalog proper and a volume of original observations. The catalog also contained many errors. William realized that he needed a proper cross-index to properly explore these differences but did not want to devote time to it at the expense of his more interesting astronomical activities. He therefore recommended that his sister Caroline

undertake the task of publishing a more accurate and complete catalog. The task was a formidable one and took 20 months. The *Catalogue of Stars, Taken from Mr. Flamsteed's Observations Contained in the Second Volume of the* Historia Coelestis, *and Not Inserted in the British Catalogue* was published by the Royal Society in 1798 and contained an index of every observation of every star made by Flamsteed, a list of errata, and a list of more than 560 stars that had not been included. In 1825, Caroline donated the works of Flamsteed to the Royal Academy of Gottingen.

As William's health deteriorated in late 1810, he encouraged his son John, a brilliant mathematician, to abandon his academic career and learn the family trade of astronomy. Caroline, at the age of 71, acted as John's assistant and he recorded his first sweeps in June 1821. Caroline was exceptionally fond of her nephew who was frequently mistaken for her son.

On August 22,1822, William died at the age of 83. Caroline was grief-stricken after her brother's death and moved back to Hanover, Germany, continuing her astronomical studies to verify and confirm William's findings and producing a catalog of nebulae to help her nephew John in his work. Throughout the remainder of her life, Caroline was physically active and healthy and regularly socialized with other scientific luminaries. She never married and devoted her life to astronomy. She spent her last years writing her memoirs and lamenting her body's limitations, which kept her from making any more original discoveries. Caroline Herschel died peacefully in Hanover on January 9, 1848. She is buried at 35 Marienstrasse in Hanover at the cemetery of the Gartengemeinde, next to her parents and with a lock of William's hair. Her tombstone inscription reads, "The eyes of her who is glorified here below turned to the starry heavens." With her brother, she discovered over 2,400 astronomical objects over twenty years.

HER LEGACY

Caroline Herschel is the first woman to receive a salary as a scientist in the field of astronomy and the first woman in England to hold a government position. She received the gold medal from the Royal Astronomical Society in 1828 for her "reduction", i.e. cataloging, of the 2500 Nebulae discovered by her brother William. She completed this after her brother's death and her move to Hanover.

The Royal Astronomical Society elected her as an honorary member together with Mary Somerville in 1835. They were the first female members. She was also elected as an honorary member of the Royal Irish Academy in Dublin in 1838.

In 1846, she was awarded a Gold Medal for Science by the King of Prussia in recognition of her valuable services to Astronomy.

The asteroid 281 Lucretia which was discovered in 1888 was named after her second given name. The crater C. Herschel on the moon is named after her.

The open clusters NGC 2360 (Caroline's Cluster) and NGC 7789 (Caroline's Rose) are unofficially nicknamed in her honor. On November 6, 2020, a satellite named after her (NuSat10 or "Caroline", COSPAR 2020-079B) was launched into space.

The 1968 poem "Planetarium" written by Adrienne Rich celebrates Caroline's life and scientific achievements. The 1969 artwork *The Dinner Party* by Judy Chicago which celebrates historical women who have made extraordinary contributions features a place setting for Caroline Herschel.

On March 16, 2016 Google honored her with a doodle on her 266th birthday.

In 2023, the handwritten pages of her diary - all 57 of them - were put on display in the music room of the Herschel Museum of Astronomy in Bath, the same place

where Caroline used to live. The documents cost the museum £108,000, the museum's most expensive acquisition. The diary documented her life in the years 1755-1775, from her childhood in Hanover to her first years of living in Bath.

In 2024, British musician and singer-songwriter Jay Anderson released the son "Moving", a song dedicated to the life and times of Caroline Herschel. He also filmed a live acoustic version of the song at the Herschel Museum in Bath, in the old music room where Caroline and her brother William used to rehearse for local concerts.

HER SCIENCE JOURNEY

1750 - Caroline Lucretia Herschel was born in Hanover, Germany

1766 - Moved to Bath, England to be a soloist in her brother William's concerts

1781 - William discovered Uranus and Caroline became an assistant astronomer

1782 - Appeared for the last time on stage as a soloist and moved to Datchet where she started using a telescope

1783 - found 14 nebulae

1786 - Discovered her first comet

1787 - Received a salary of £50 per year which made her the first woman in history to receive a salary as an astronomer

1788 - William married Mary Pitt and Caroline discovered her second comet

1790 - Discovered third and 4th comets

1791 - Discovered 5th comet

1793 - Discovered 6th comet

1795 - Discovered 7th comet

1797 - Discovered 8th comet

1798 - The *Catalogue of Stars, Taken from Mr. Flamsteed's Observations Contained in the Second Volume of the* Historia Coelestis, *and Not Inserted in the British Catalogue* was published by the Royal Society

1810 - William's health deteriorated and John Herschel joined the family trade-astronomy

1821 - With the help of his Aunt Caroline Herschel, John made his first sweep

1822 - William Herschel died and left Caroline grief-stricken

1825 - Donated the works of John Flamsteed to the Royal Academy of Gottingen.

1848 - Caroline died peacefully in Hanover at the age of 98 years

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The photos and some of the information were taken from the following websites:

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