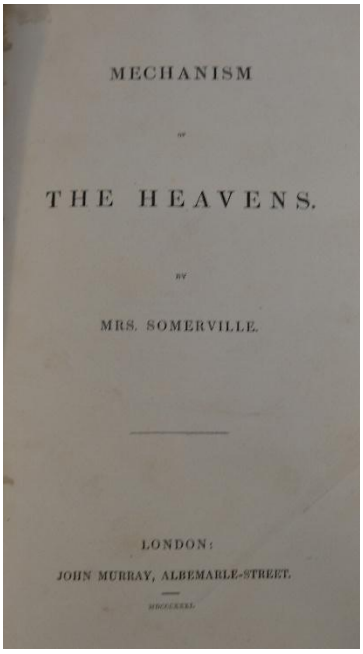
Mary Fairfax Greig Somerville (mathematician, scientist, writer, and polymath)

(December 26, 1780 – November 29,1872)

Mary Somerville was called "Queen of Science" during her lifetime. She wrote five books (four on science and one autobiography) and was acquainted with some of the most famous scientists in history. She was a tutor for Ada Lovelace, was a good friend of Charles Babbage and John Herschel and together with Caroline Herschel was the first woman to be named an honorary member of the Royal Astronomical Society in 1835. Her first book, *The Mechanism of the Heavens* was published in 1831. It was an English translation of *Traité de mécanique céleste* of French mathematician Pierre-Simon Laplace. She wrote this book at the request of the Society for the Diffusion of Useful Knowledge. She was reluctant at first to do this intimidating task since Laplace's work generally was considered to have consolidated and extended Isaac Newton's work in the *Principia*. She agreed to do it in secret. The translation demonstrated her ability to communicate the intricacies of science and complex mathematics to a larger audience. She added full


MECHANISM

OF

THE HEAVENS.

BY

MRS. SOMERVILLE.

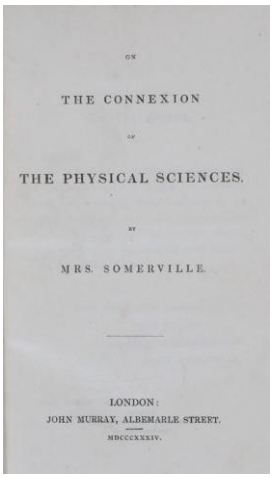
LONDON:

JOHN MURRAY, ALBEMARLE-STREET.

mathematical explanations and diagrams to make it more comprehensible to English readers.

Her second book*, On the Connexion of the Physical Sciences,* was published in 1834 and sold 15,000 copies. This book established her scientific reputation. It ran to 10 editions, was translated into German and Italian and went through several editions in the United States. Her third book, *Physical Geography*, was published in 1848 and earned her the Victoria Gold Medal of the Royal Geographical Society. It was the first English textbook on the subject and remained in use until the early 20th century. Her fourth book and last science book was *On Molecular and Microscopic Scienc*e, published in 1869. The book gave an up-to-date description of the latest discoveries revealed through the microscope and was published in two volumes and three parts. In the first part Mary explained the latest research on atoms and molecules, the second covered plant life, while the third explored animal life. The book included 180 illustrations. After her death in 1872, her daughter published posthumously her last book*, Personal Recollections, from Early Life to Old Age of Mary Somerville*.

It is said that the word "scientist" was coined by English philosopher and historian William Whewell in 1834 to describe Mary Somerville in a review of her book *On the Connexion of the Physical Sciences.* He called Mary a scientist, in part because "man of science" seemed inappropriate for a woman, but more significantly because Mary's work was interdisciplinary. She was not just an astronomer, a physicist, or a chemist, but a visionary thinker who articulated the connections among the various branches of science. The interesting thing about this "scientist" description is that Mary Somerville always considered herself a mathematician at heart and not as good in other sciences. But most people called her a polymath. A polymath is an individual whose knowledge spans many different subjects. Polymaths are known to draw on complex bodies of knowledge to solve specific problems.


ON

THE CONNEXION

OF

THE PHYSICAL SCIENCES.

BY

MRS. SOMERVILLE.

LONDON:

JOHN MURRAY, ALBEMARLE STREET.

At an early age, Mary knew that education was not equal for boys and girls, men and women. She thought of the injustice she suffered because of her sex, the fact that her brothers received a better education than her. Her family and friends disapproved of her reading so many books. They complained that she was depleting the family candle supply by reading Euclid through the night. This reminds us of Sophie Germain hiding the candles so she could read at night. Mary lamented that girls should not have been given a desire for knowledge if they would not be allowed to acquire it.

Mary was an early advocate for girls and women getting the same educational opportunities as boys and men. While living in London, she hired a French nursery maid to take care of her daughters and to teach them French. At an early age she began teaching her daughters geometry and algebra as well as Latin and Greek. Then she got a master teacher in Latin and Greek to teach them so that in her opinion her daughters had a more perfect knowledge of these languages than her. Mary did not like obstacles placed in front of women to get a good education because it ultimately limits what women were able to do with their lives. She herself experienced it! Mary praised the leadership of Cambridge University for their willingness to provide women with greater access to higher education. Girton College at Cambridge University was founded in 1869 as the first women's college in Great Britain. After a decade, the first women's college at the University of Oxford, Somerville Hall (later renamed as Somerville College) was founded in 1879 and named in honor of Mary Somerville.

Mary was also concerned about women's right to vote. In 1868, she was the first person to sign John Stuart Mill's unsuccessful petition for female suffrage.

Her science journey began when Mary Fairfax was born in Jedburg, Scotland at the church manse of her maternal aunt Martha and her husband Rev. Dr. Thomas Somerville. Mary was the daughter of Vice-Admiral Sir William George Fairfax and his wife Margaret Charters whose father Samuel Charters was the Solicitor of the Customs of Scotland. Margaret was related to several prominent Scottish houses. Mary was the second of four surviving children (three siblings had died in infancy). The household's income was low, almost in poverty because naval pay was very low. Margaret supplemented their income by growing vegetables, maintaining an orchard, and keeping cows for milk. Mary did not go to school;

instead, Margaret taught her to read the Bible and Calvinist catechisms. Mary was expected to help with household chores but once they were done, she was allowed to roam freely in the garden.

When she was 10 years old, her father arrived from sea and discovered that his daughter could not read and write or do basic addition and subtraction. Mary was sent to Miss Primrose's boarding school in Musselburgh, Scotland. There she learned writing, French, and English grammar. Later, when she was sent to the village school, she noted that the boys were taught Latin while it was sufficient for the girls to read the Bible. Very few of the girls learned how to write. When she was 13 years old, her mother sent her to a writing school in Edinburgh, where she improved her writing skills and studied arithmetic. Back home in Burntisland she taught herself sufficient Latin to read the books in the home library. Thus, her education has been just as haphazard as that of Sophie Germain, another famous mathematician. Mary felt it unjust that because of her sex, her education was worse than that of her older brother. During her summer vacations she would go back to Burtisland and read elementary books on algebra and geometry at her aunt and uncle's manse in Jedburgh. She also learned to play the piano. She learned Greek so she could read Xenophon and Herodotus in their original versions. Back in Edinburgh, she was allowed to attend the ladies' academy of Alexander Nasmyth, a famous painter and architect. While she was there, Nasmyth advised another student to study Euclid's *Elements* to gain a foundation in perspective, astronomy, and mechanical science. So Mary decided to read the book also. She thought the book would help her understand *Navigations* by John Robertson. On the right is a self-portrait of Mary.

Mary continued her social life in Edinburgh as a daughter of a well-connected family. She was known as the "Rose of Jedburgh". When a young tutor came to teach her younger brother Henry, she asked the tutor to buy books on algebra and geometry for her. He bought her Euclid's *'Elements'* and *A Treatise of Algebra* by John Bonnycastle. Mary would wake up early to play the piano, then paint during the day and stay up late to read these books. Her thirst for knowledge was evident!

MARY'S FIRST MARRIAGE

In 1804 Mary married a distant cousin on the Charters side of the family, Lieutenant Samuel Greig. He was the son of Admiral Samuel Greig. Lieutenant Samuel Grieg was a commissioner of the Russian navy and Russian consul for Britain. They had two children, one of whom, Woronzow Greig, would become a barrister and scientist. The other son, William George, died when he was 8 years old. The family lived in London, but it was not a happy marriage for Mary. Her husband did not believe that women had the same intellectual capacity as men. He was prejudiced against educated women, as was common at that time. He allowed Mary to take French lessons which he thought was more appropriate for women. In 1807, Samuel Grieg died, and Mary returned to Scotland with her two young children.

Suddenly, Mary became independent financially with the inheritance she received from the death of her husband. No longer controlled by her husband or her parents, she could continue her studies according to her personal convictions. She studied plane and spherical trigonometry and conic sections, and she read *Astronomy* by James Ferguson and *Principia* by Isaac Newton. She started solving mathematical problems in the mathematical journal of the Military College at Marlow. She became famous when she solved a Diophantine problem[1], for which she was awarded a silver medal in 1811

Mary published five solutions in Volumes 3 and 4 of the *Mathematical Repository* under the pseudonym 'A Lady'. Two of her solutions demonstrated her familiarity with differential calculus. This is Mary's contribution to the wide acceptance and visibility of calculus in early 19th century Britain.

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[1] . In mathematics, a Diophantine equation is an equation for which only integer solutions are of interest. Typically, it is a polynomial equation in two or more unknowns with integer coefficients. Diophantine problems have fewer equations than unknowns and involve finding integers that solve simultaneously all equations.

She associated with a “a small society of men” who ran the *Edinburgh Review* and were part of a large intellectual network. She became an integral member of this group. These men included Professor John Playfair who advised her on how to read and master Laplace’s book *Traité de mécanique céleste* and Henry Brougham, who invited her to translate Laplace’s book for the library of the Society for the Diffusion of Useful Knowledge (SDUK). Brougham was the Whig Lord High Chancellor and led an educational reform to make scientific education more available to the working class.

The third member of this group of intellectuals was William Wallace. Mary

corresponded frequently with Wallace, who, at the time, was a mathematics professor at the University of Edinburgh. Wallace was a mathematician and astronomer who invented the eidograph, an improved pantograph. He advised Mary to build a small library of works to provide her with a sound background in mathematics. Wallace suggested that she study the writings of French mathematician Pierre-Simon Laplace which summarized the theory of gravity and collected the mathematical results established in the 50 years since Isaac Newton’s *Principia* was published. Mary said that studying Laplace’s work gave her the confidence to persevere in her mathematical studies. She then moved on to other fields of science, astronomy, chemistry, geography, microscopy, electricity and magnetism. She built a library of scientific books including *Elements of Mechanics* by Louis -Benjamin Francoueur, *Algebra* and *Calculus Treatise* by Sylvestre Francois Lacroix, *Analytical Geometry and Astronomy* by Jean-Baptiste Biot, *Treatise on Mechanics* by Simeon Denis Poisson, *Theory of Analytic Functions* by Joseph-Louis Lagrange, *Elements of Algebra* and *Isoperimetric Problems* by Leonhard Euler, *Figure of the Earth* by Alexis Clairaut, *Application of Analysis to Geometry* by Gaspard Monge, and *Tables Portatives de Logarithmes* by Francois Callet.

MARY'S SECOND MARRIAGE

In 1812, Mary married another cousin, this time her first cousin Dr. William Somerville. Ten years older than Mary, they had not been acquainted with each other, since he had left home to join the army as a hospital assistant in 1795. He and Mary had four children: Margaret, who died in childhood, Thomas who died in infancy, Martha, and Mary Charlotte.

William was a most impressive man with high intellect. He was only 15 years old when he became a hospital assistant in the army. After that, in 1800, he received his medical degree at Aberdeen and was trained as a surgeon. He spent most of his adult life away from England. He had been present when the British captured the Cape of Good Hope, and afterwards he had made at least two trips to the interior of South Africa to negotiate with tribes which were attacking Dutch farmers. He was a widower and had already lived an interesting and adventurous life when he married Mary. He was prepared psychologically and socially to help his wife's scientific career.

In the annals of women's scientific history, Mary's two husbands' extreme views on educating women give us a clear example of how we get a better world when a husband supports his wife's education and scientific career. Mary's first husband did not believe in educating women while her second husband not only believed that women should be educated, but more: he would also encourage Mary every single time an opportunity presented itself. Dr. William Somerville reminds us of Ellen Richards' husband Robert Richards and Marie Curie's husband Pierre Curie. But I think William Somerville's support for his wife was extraordinary! A smart man himself, he could have written books about his exploits in South Africa. But instead, he was content to support his wife's scientific career. He did most of the things that wives of male scientists have done through the years. He offered criticism of her manuscripts, recopied them for her, and searched out the books she needed for her research. It was a labor of love! When their son had a tutor in Greek and Botany, he encouraged Mary to take advantage of this opportunity and study Greek and Botany also. Together, they developed an interest in mineralogy, attended lectures, and started their own mineral collection. By serving as

companion and intermediary for Mary, William Somerville did several things that a "scientific wife" would not have been able to do. Mary's first experiments published in the *Philosophical Transactions of the Royal Society* were communicated through William who had become a fellow of that society in 1817. He was her most important link to the Royal Society and the British Association for the Advancement of Science.

William's liberal outlook on the education and scientific career of women was influenced by his father, the Rev. Dr. Thomas Sommerville, and his mother, Martha Charters Somerville, Mary's aunt. When Mary was 13 years old, she met her uncle and future father-in-law Dr. Sommerville while visiting her aunt in Jedburgh. She told him that she had been learning Latin. Dr. Somerville assured her that in earlier times many women, some of them of the highest rank in England, had been very elegant scholars. He then helped improve her Latin by reading Virgil with her. He was the first person to encourage Mary's studies. William's mother Martha was witty, well read, and a good storyteller. She was a very agreeable, but bold, determined person who was always very kind and sincerely attached to Mary.

After their marriage, William became Head of the Army Medical Department in Scotland so they settled in Edinburgh. In 1819, William was appointed physician at Chelsea Hospital in London and the family moved into a government house at Hanover Square. Mary met Ada Lovelace and became her tutor. Ada's husband, Lord King (later the Earl of Lovelace) was a companion and friend of Mary's son Woronzow Greig in college. Mary and Ada also met Charles Babbage at scientific gatherings. Mary frequently visited Babbage while he was making his "Calculating Machines". Mary also made the acquaintance of John Herschel, Caroline Herschel's famous astronomer nephew. Twelve years younger than Mary, he nevertheless became a lifelong friend of Mary and reviewed her manuscripts for her third book "Physical Geography".

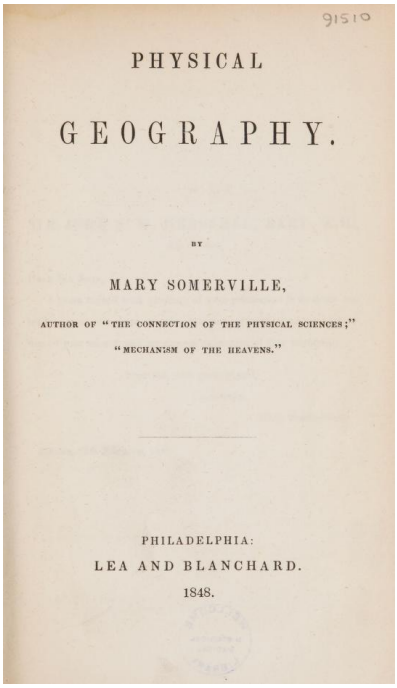
In 1823 Mary's oldest daughter Margaret died after an illness. This is the third child she would lose in her lifetime.

While living in London, Mary and William travelled all over Europe visiting celebrated intellectuals. They also hosted visitors at their house in Chelsea. Mary continued her studies and experiments in science. She conducted experiments to

explore the relationship between light and magnetism. Her first paper, "The magnetic properties of the violet rays of the solar spectrum", was published in the *Proceedings of the Royal Society* in 1826. She also conducted experiments on the blackening effect of sunlight using a sample of silver nitrate. This reaction was used in early experiments in photography. She later developed her technique by using optical prism and vegetable dyes. This technique will be used later by modern scientists to create an optical spectrometer.

The relatively small amount of experimental work she did was complemented by frequent, close contact with researchers who were more heavily engaged in scientific investigations.

Mary wrote her first book in 1831. It was an English translation of French mathematician Pierre-Simon Laplace *Traité de mécanique céleste*. She wrote this book at the request of the Society for the Diffusion of Useful Knowledge. The reviews of the book were favorable, and she received letters of congratulations from many prominent scientists. She was elected honorary member of the Royal Irish Academy, the Bristol Philosophical Institution, and the Société de Physique et d'Histoire Naturelle de Genève in 1834. The British crown gave her a civil pension of £200 a year in recognition of her eminence in science and literature. Her second book, *On the Connexion of the Physical Sciences*, was published in 1834 and sold 15,000 copies. It was an extended state-of-the-art account of what was known at that time as physical science. She worked with a very distinguished group of consultants. These included prominent scientists of the time such as Herschel, Faraday, Wollaston and Whewell. While she was researching materials for her third book, *Physical Geography*, William became ill and was ordered to go to a warmer climate for the winter. They traveled to several parts of Italy: Rome, Naples, Florence, Bellagio and Lake Como. In 1848, she published *Physical Geography*. The book began with describing the overall structure of planet Earth, along with brief information about the location of the Earth within the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PHYSICAL

GEOGRAPHY.

BY

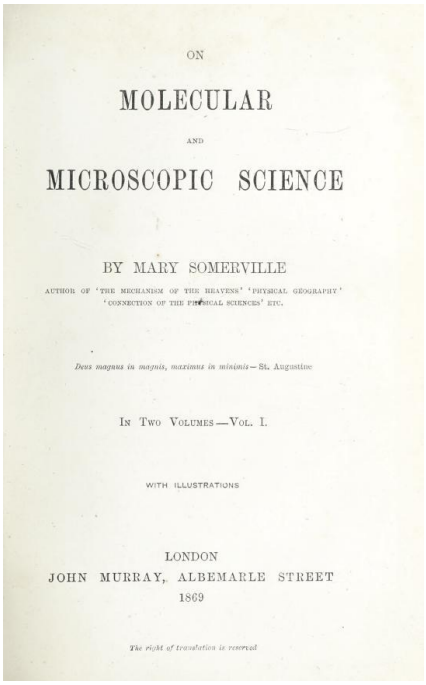
MARY SOMERVILLE,

AUTHOR OF "THE CONNECTION OF THE PHYSICAL SCIENCES;"
"MECHANISM OF THE HEAVENS."

PHILADELPHIA:
LEA AND BLANCHARD.
1848.

solar system. Then the book talks about terrestrial topics, such as the most basic features of land and water, and formations such as mountains, volcanoes, oceans, rivers and lakes. So aside from geography, the book included information on geology and the distribution of animal and vegetable life. On June 26,1860 William died in Florence.

After her husband's death she began writing her fourth book, *Molecular and Microscopic Science*. It took her 10 years to write this book. While it was her least successful scientific book, it was still a remarkable achievement! Her research on *Physical Geography* showed that the new frontiers of science were not in the heavens or the farthest corners of the earth but in the realm of the infinitesimally small--the world of molecules and microbes that were around us. In this book she hoped to provide access to these new frontiers.


ON

MOLECULAR

AND

MICROSCOPIC SCIENCE

BY MARY SOMERVILLE

AUTHOR OF 'THE MECHANISM OF THE HEAVENS' 'PHYSICAL GEOGRAPHY' 'CONNECTION OF THE PHYSICAL SCIENCES' ETC.

Deus magnus in magnis, maximus in minimis—St. Augustine

IN TWO VOLUMES—VOL. I.

WITH ILLUSTRATIONS

LONDON
JOHN MURRAY, ALBEMARLE STREET
1869

The right of translation is reserved

In 1857 she was elected to the American Geographical and Statistical Society and in 1870 to the Italian Geographical Society.

Mary died in her sleep on November 29,1872 in Naples, Italy at the age of 92 years old and was buried in the English cemetery. She was working on the revision and completion of a treatise which she had written years before, on the "Theory of Differences", and on the study of a book on Quaternions. Her daughter published her last book, written in her old age, *Personal Recollections, from Early Life to Old Age of Mary Somerville*, after her death.

HER LEGACY

In 1868, when John Stuart Mill organized a massive petition to Parliament to give women the right to vote, he made sure that the first signature on the petition would be Mary Somerville's.

Somerville College in Oxford, England was named after Mary Somerville. It was founded in 1879 as Somerville Hall, one of the first two women's colleges of the University of Oxford. Among its alumnae are Margaret Thatcher, Indira Gandhi, Iris Murdoch and Dorothy Hodgkin. It began admitting men in 1994.

Somerville House, in Burtisland, Scotland where she lived for a time was named after her; as well as Somerville House in Brisbane, Australia, a high school for girls.

In 1819, Somerville Island, a small island in Barrow Strait, Nunavut, was named after her by Sir William Edward Parry.

In 1835, the vessel *Mary Somerville* was launched in Liverpool. The ship traded with India for Taylor Potter & Co. and sank in late 1852 with the loss of all people aboard.

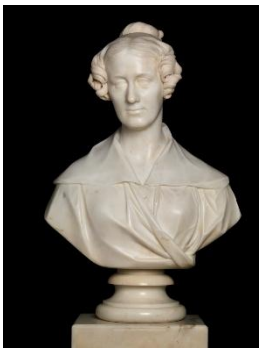
5771 Somerville, a main-belt asteroid that was discovered on September 21, 1987 by E. Bowell at the Lowell Observatory in Flagstaff, Arizona was named after her.

Somerville Crater is a small lunar crater named after Mary Somerville. It lies to the east of the prominent crater Langrenus. It is one of a handful of lunar craters named after women.

In February 2016 Mary Somerville was shortlisted, along with Scottish physicist James Clerk Maxwell and civil engineer Thomas Telford, in a public competition run by the Royal Bank of Scotland to decide whose face should appear on the bank's new £10 notes, to be issued in 2017. Later that month RBS announced that she had won the public vote, held on Facebook. The banknotes, bearing her image, were issued in the second half of 2017.

In February 2,2020, Google honored her with a Google Doodle.

On April1,2022, a satellite named after Mary Somerville (ÑuSat 26, COSPAR 2022–033) was launched into space as part of the Satellogic Aleph-1 satellite constellation.



The Royal Society has a marble bust of Mary Somerville. The bust shows her wearing a dress with a wide collar, accentuated by a medallion or brooch. Her hair is meticulously styled, pulled up, and fashioned into ringlets on both sides. The Royal Society wanted to portray her as the perfect example of how a woman can perform the traditional duties of a domestic life and still perform scientific and mathematical research. The combination of femininity and intellect harmonized in one person! The bust was commissioned by the Royal Society in 1832 after the publication of Mary Somerville's first book.

HER SCIENCE JOURNEY

1780- Mary Fairfax was born in Jedburg, Scotland

1790-Attended Miss Primrose's boarding school in Musselburgh, Scotland to learn writing, French, and the English grammar

1793-Went to a writing school in Edinburgh, Scotland to improve her writing skills and learn arithmetic

1794- Attended the ladies' academy of Alexander Nasmyth and learned how to paint

1804 -Married her first husband Samuel Grieg

1807- Samuel Grieg died and she became a widow with two small children

1811- Awarded the silver medal for solving a Diophantine problem

1812-Married her second husband Dr. William Somerville

1819-Willam appointed physician at Chelsea Hospital in London and the family moved to Hanover Square. Somerville Island, a small island in Barrow Strait, Nunavut, was named after her by Sir William Edward Parry.

1823-Oldest daughter Marguerite died after an illness

1826- First paper "The magnetic properties of the violet rays of the solar spectrum" published in the *Proceedings of the Royal Society*

1831-Published her first book, *The Mechanism of the Heavens*, an English translation of *Traité de mécanique céleste* of French mathematician Pierre-Simon Laplace.

1832-Marble bust of Mary Somerville commissioned by the Royal Society

1834-Wrote and published her second book *On the Connexion of the Physical Sciences,* moved to Italy

1835- Together with Caroline Herschel became the first woman to be named an honorary member of the Royal Astronomical Society. The vessel *Mary Somerville* was launched in Liverpool and was named after her

1838-Moved to Italy to help William recover from his illness

1848- Wrote and published her third book *Physical Geography*

1860- William died in Florence, Italy

1868-She was the first person to sign John Stuart Mill's unsuccessful petition for female suffrage

1869-Published her fourth scientific book, *On Molecular and Microscopic Scienc*e

1872-Died in Naples, Italy, her fifth book, *Personal Recollections, from Early Life to Old Age of Mary Somerville* was published posthumously

1879-Somerville Hall (later Somerville College) was founded as the first women's college of the University of Oxford

2017- Her image appeared on the bank notes of the Royal Bank of Scotland

2020-Google honored her with a doodle

2022- A satellite named after Mary Somerville (ÑuSat 26, COSPAR 2022–033) was launched into space as part of the Satellogic Aleph-1 satellite constellation.

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