

Mike Lockwood



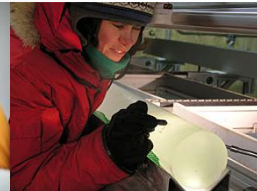
Women in Science: Voices Finding Ways to be Heard

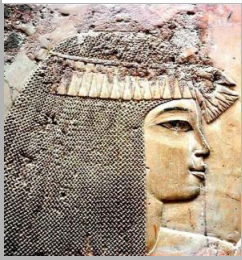
W.I. Meeting, Harwell Village Hall
8th January, 2025



Women in Science

- In the ancient world women often got the chance to develop into great scientists only through the support of fathers or a highly privileged position in society
- In renaissance Europe many women used marriage to a scientist as a means to carry on working in science
- This carried on until the early 20th century when women were employed in science, but were generally treated as “support staff” and their contributions rarely recognised
- In the 20th century some exceptional pioneers began to demonstrate how much talent was being lost by women being under-represented in science
- Equality today is more advanced in some fields than others, but there is more awareness of why women are under-represented and what to do about it





Some Women Scientists in the Ancient World



- **Merit Ptah**, said to be the first female physician mentioned by name in history (c. 2700 BC) - but we know that there were female doctors in Ancient Egypt.
- The first named female scientist appears to be **Aganice** (Athyrta) was an Egyptian princess who worked on astronomy (c. 1900 BCE)
- The first named chemist (c. 1200 BCE) was **Tapputi**, a Belatekallim (a female overseer of a palace) who worked with another researcher (probably also female) to make perfumes. Known from a cuneiform tablet from Babylonian Mesopotamia. She distilled flowers and so operated the first known still.
- **Aglonice** one of the female astronomers known as ‘the witches of Thessaly’ was famous for her ability to predict eclipses. A saying in Greece today is still “Indeed, as the moon obeys Aglaonice” (c. 150 BCE)



Hypatia of Alexandria

(c.355 – 415 CE)



*Hypatia teaching at the Museum of Alexandria.
Fresco c.1430 by Masolino da Panicale, at the
Basilica of San Clemente, Rome* ▶

◀ *Modern Portrait by Maria Kalatzi*

- Daughter of Theon, a mathematician, astronomer, teacher and librarian in Alexandria
- Through Theon's support, reputation and tuition, she and became head of the Neoplatonic School of Philosophy and the greatest teacher of mathematics and astronomy of her day
- Caught up in a struggle for power, as an atheist she became the victim of false accusations in a smear campaign and was flayed alive and beaten to death by Christian fundamentalists
- Her brutal murder is often seen as marking the end of the golden era of Greek science



Portrait by Raphael (1510) ▼



◀ Libbiano, Tuscany, Italy

Medieval Witch Hysteria

- Accusations almost invariably made against poor, single women
- Female health workers and midwives particularly at risk – accused if their treatments worked, accused if they did not work
- **Monna Gostanza** from Libbiano is one of many, many examples
- Born c. 1535, illegitimate daughter of a nobleman and his servant
- Outlived an abusive husband but had to move many times to survive, gained a reputation for skills in herbal medicine and as a midwife
- Accused of witchcraft in 1594 (aged 56), accusations she admitted to in order to end months of physical torture
- Florentine Inquisitor Dionigi di Castrocciaro took an interest and ruled the confessions unsafe & exiled her on condition she ceased working.

'Gostanza da Libbiano', a 2000 film starring Lucia Poli ▶



● Died
c.1604

Bagni dell'Acqua (now Casciana Terme) where she moved to ▶



◀ *after acquittal she was exiled to this stone house in Rivalto*





Maria Clara Eimmart (1676-1707)

- Daughter of Georg Christoph Eimmart the Younger, a painter and engraver who learned his trade from his father and became director of the Nuremberg Academy of Art
- Portraits of the wealthy made her father wealthy and he used his money to build up an impressive astronomical observatory
- Georg Christoph II taught her in art and astronomical observation and she became highly adept and diligent at it
- At the time several female scientists used a carefully-chosen marriage as a way to carry on with their studies
- In 1706 she married a student of her father, Johann Heinrich Muller, whom he was training to take over running the observatory
- Died in childbirth just one year after her marriage





The Eimmart Observatory

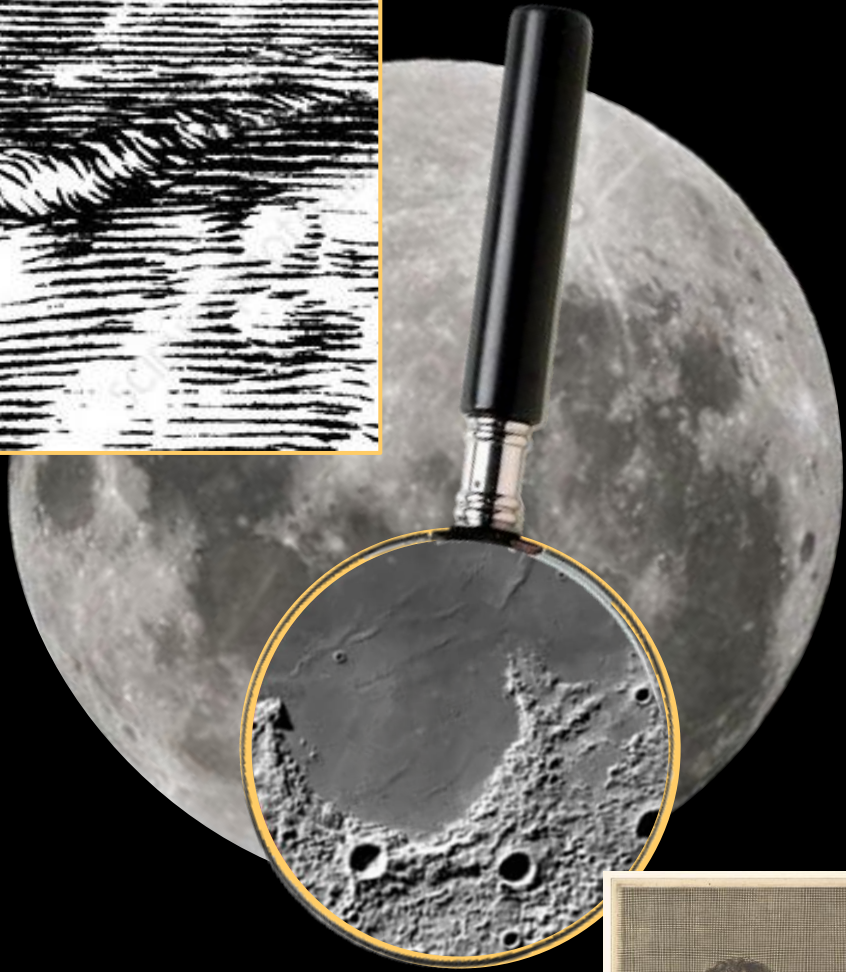
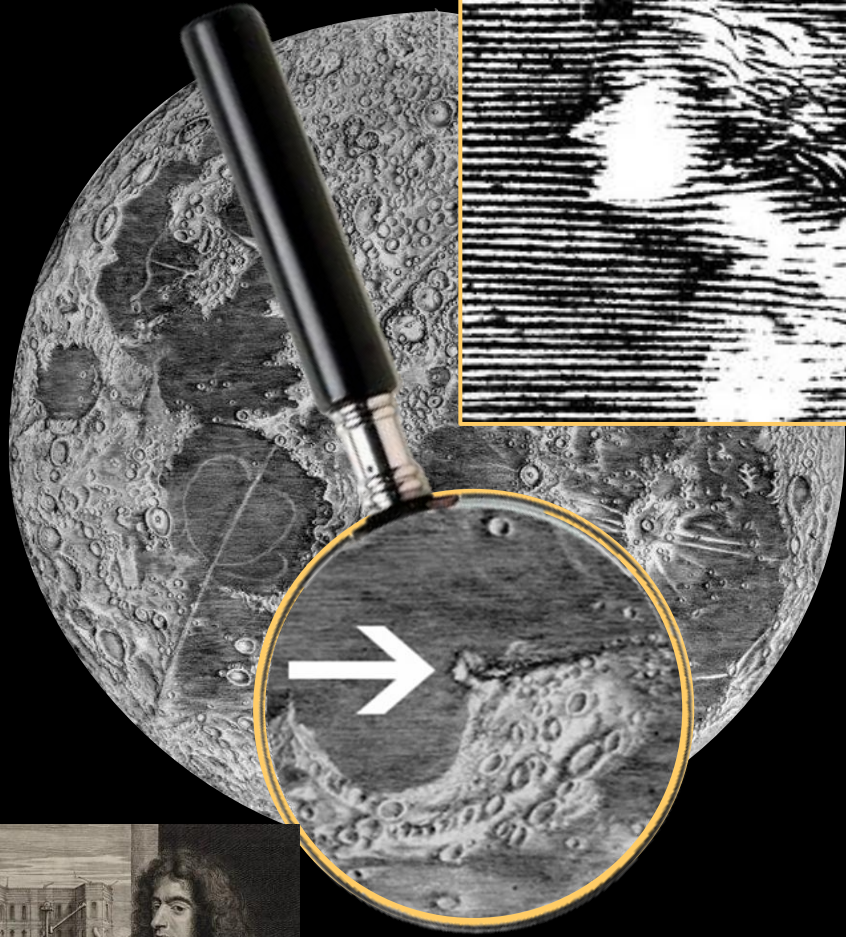
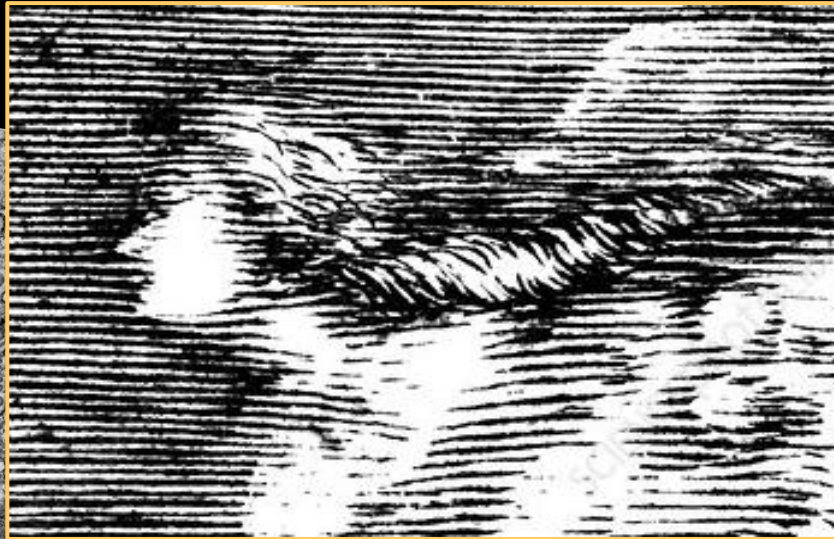
- founded in 1678 on the northern bastion of Nürnberg Castle (Vestnertorbastei)



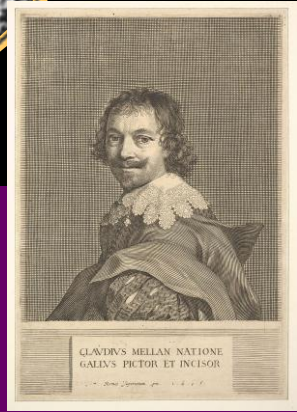
PLENILUNIUM.
pinxit ad Archetypum M.C. Eimmarta Nörimb.



The moon by Maria Clara Eimmart
painted in 1697



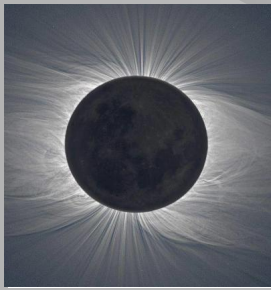
← Giovanni Domenico Cassini
Claude Mellan (1697) →



PLENILUNIUM.
pinxit ad Archetypum M.C.Eimmarta Nörimb.



The moon by Maria Clara Eimmart
painted in 1697



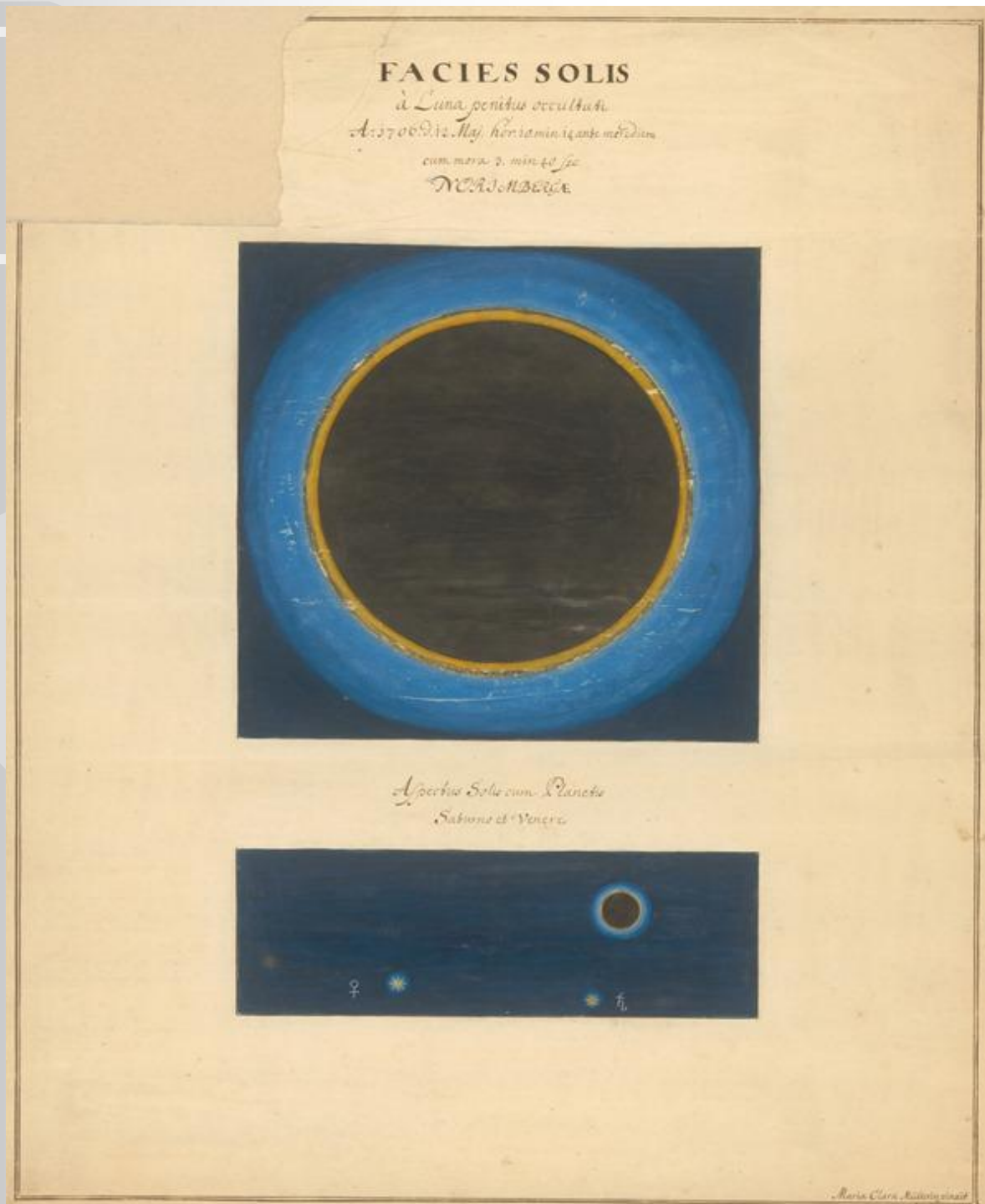
The 12 May 1706 Eclipse

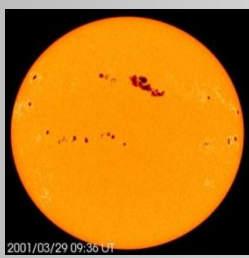
- Observations in Nürnberg
- Text descriptions and diagrams by astronomer Johann Philipp Wurzelbau
- Two paintings by Maria Clara Eimmart
- The paintings were thought lost until they were re-discovered in 2012 by Markus Heinz of the Staatsbibliothek zu Berlin (Gaab, 2016).
- Hence, they were not known to previous modern authors discussing the MM eclipses - in particular, Jack Eddy.



The 12 May 1706 Eclipse

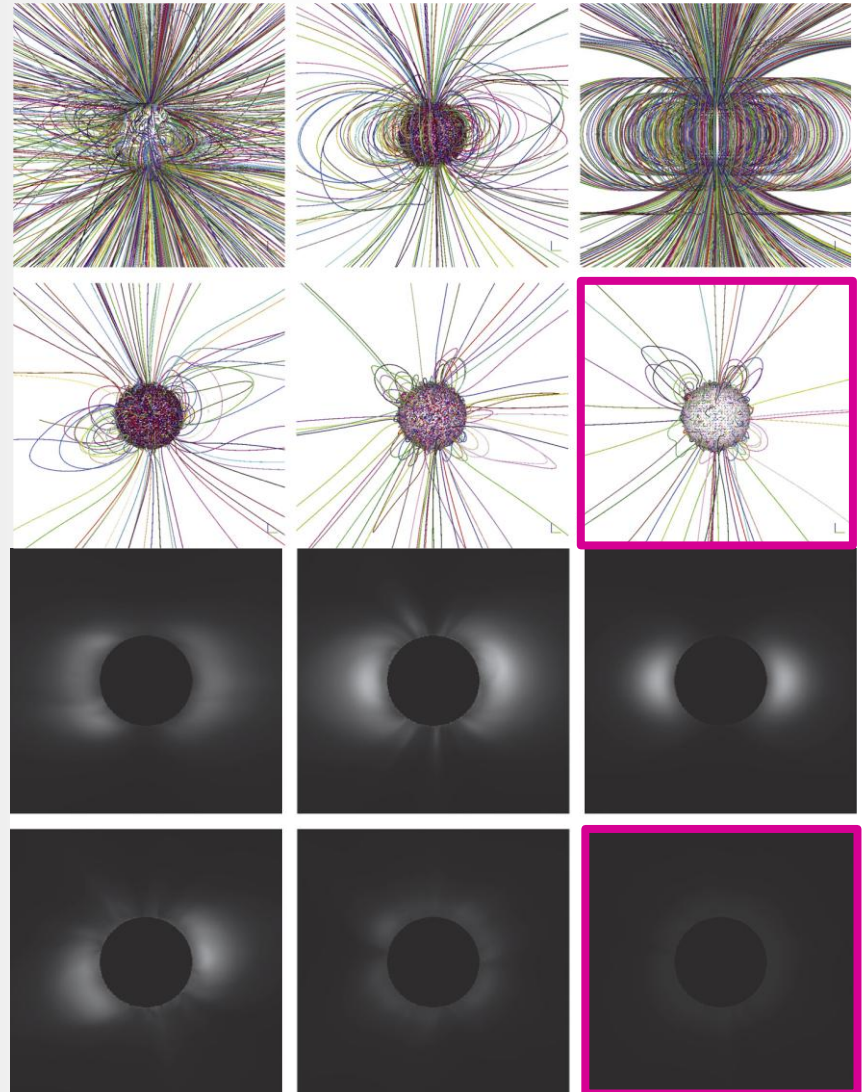
- The eclipse painting by Maria Clara Eimmart
- Shows a chromosphere and a fainter and completely unstructured corona all around the Sun
- A good depiction of an dominant F corona





The Maunder-Minimum Solar Corona

- Riley et al. (2015) simulations of the solar corona based on sunspot observations. For the 1760 eclipse, (bottom right) the “F” corona dominates over the “K” (magnetic) corona in the Maunder minimum
- Eddy (1976) concluded that the corona during the MM was structureless and limited, but this was based on only text descriptions
- Eimmart gives us the only known graphical depiction that shows this

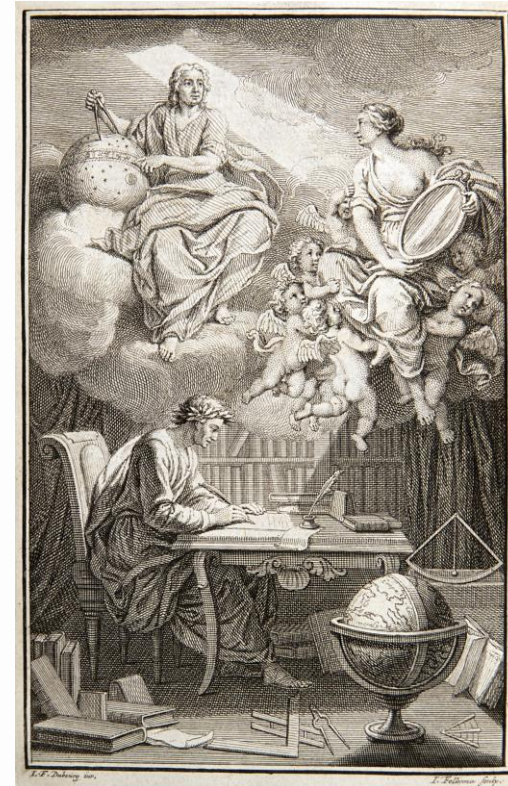




Émilie du Châtelet (1706-1749)

M^{me}. La marquise du Châtelet

- Born in Paris into a “lesser nobility” family
- Agreed to an arranged marriage to a Marquis to avoid being sent to a convent: the couple seem to have agreed on a very open marriage
- A brilliant mathematician, she did all the maths for her lover, Voltaire, who dedicated their book on Newton to her but fails to mention she dictated most of it for him to write down
- She correctly reasoned that light must be massless long before that became accepted and she laid the seeds for the modern concepts of energy and momentum
- She worked to ‘internationalise’ science, writing “About a book of physics, one must ask if it is good, not if the author is English, German or French”
- as Voltaire noted “In the kingdom of Madame du Châtelet there is absolute freedom of conscience”
- She died age 42 in childbirth

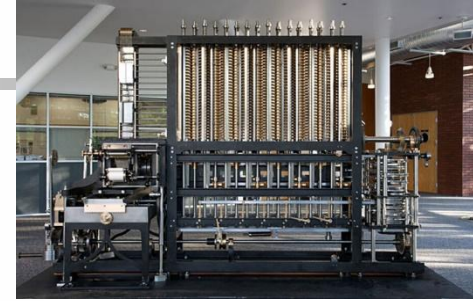
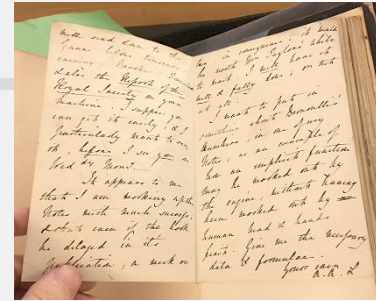




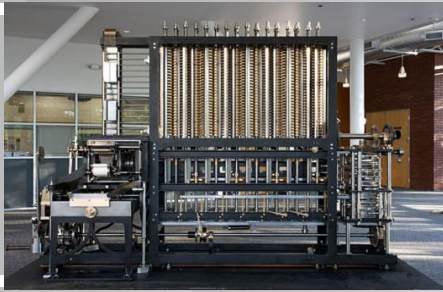
Ada Lovelace (1815-1852)



- **Augusta Ada King, Countess of Lovelace** (née Byron)
- Worked with Charles Babbage on his “Difference Engine” & later the unfinished “Analytical Engine” (mechanical computers)
- The first computer programmer who invented the concept of (but not the name) “software”
- CB saw these computers only as means of generating tables of mathematical functions but AL’s visionary genius foresaw the full potential of computers
- Predicted numerical modelling
- Died at just 37 of womb cancer

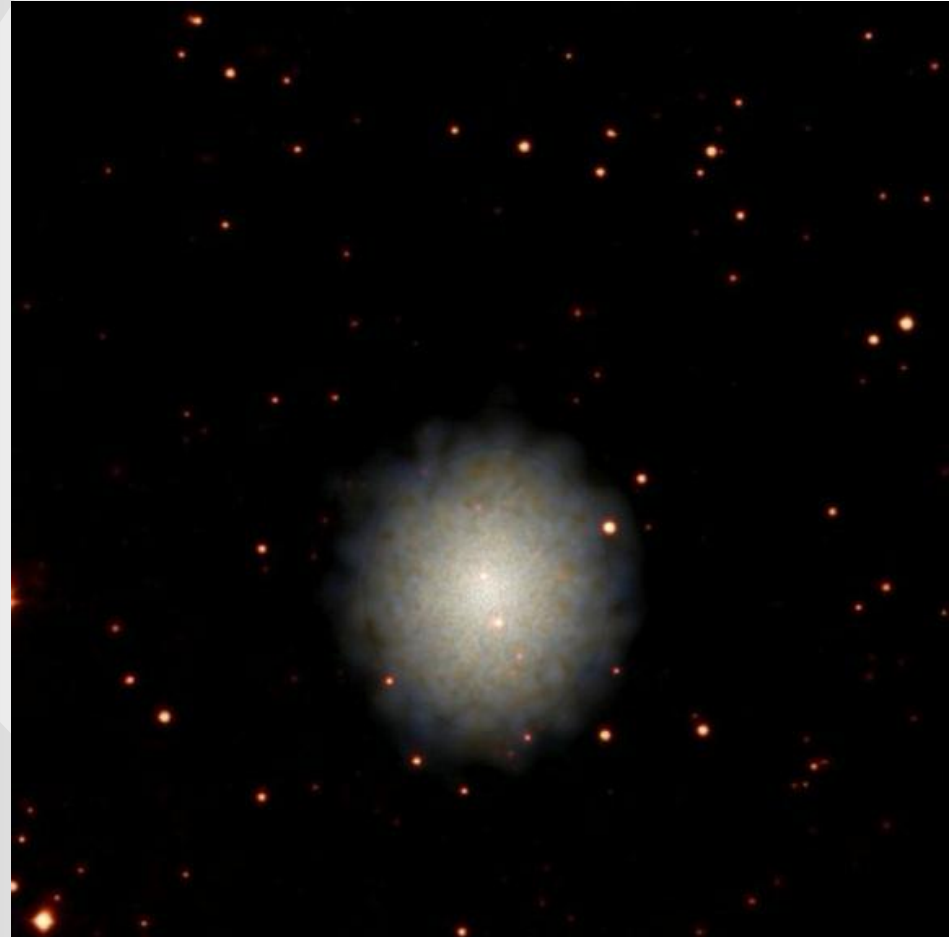


Portrait by Margaret Sarah Carpenter (1836)

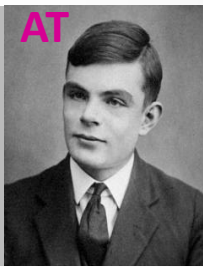


Ada Lovelace

- Numerical modelling - many body interactions
- What happens when our galaxy and Andromeda collide in 3 billion years time?
- other examples:
 - weather forecasting and climate predictions
 - how do drugs behave inside the human body?
 - how do planets form?
 - how do particulates spread inside a room?
 - how does a constriction effect blood flow?
 - where will pyroclastic flows, landslips and floods reach?
 - ... and many, many more

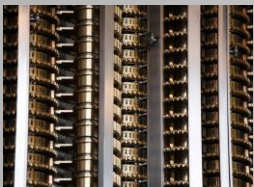


Credit Volker Springel (MPI)



AL, AT & AI

- **1843:** The Lovelace “objection” that computers could never think or create
“It is desirable to guard against the possibility of exaggerated ideas that might arise as to the powers of the Analytical Engine The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform. It can follow analysis, but it has no power of anticipating any analytical relations or truths.”
- **1950:** (107 years later!) Alan Turing argued this was untestable and proposed the “Turing test” would be achieved by 2000
“can a computer give the impression of human thought and surprise us”
- **2023:** AI has passed AT’s test – **BUT** what AL said is still true
- For me AI is **NOT** intelligent and does not think - it knows what words often go together on trusted websites and can follow the rules of grammar. It has no concept of what it is talking about!



Turing, A.M. (1950) Computing machinery and intelligence, Mind, 59 (236), 433–460, doi: 10.1093/mind/lix.236.433

Delacroix, S. (2022) Computing Machinery, Surprise and Originality, Philosophy & Technology, 34, 1195–1211, doi: 10.1007/s13347-021-00453-81

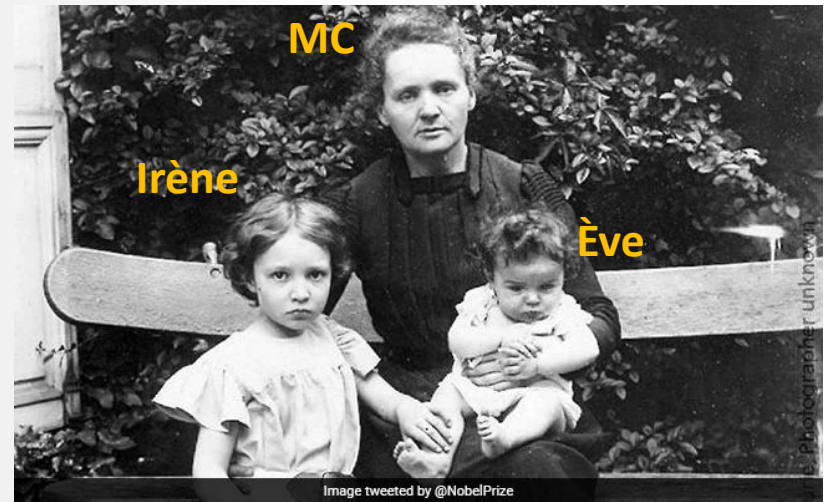


Maria Salomea Skłodowska (Marie Curie) (1867-1934)

- One of only two people to win Nobel Prizes in different disciplines (Physics 1903, Chemistry 1911)*

- With Irene Joliot-Curie the only mother-daughter pair to win Nobel prizes**

- Her personal belongings and notebooks are still so radioactive they are kept in lead safes.



* *The other is Linus Pauling for Chemistry and the Peace Prize*

** *There are 6 father –son pairs:*

William & Lawrence Bragg; Niels & Aage Bohr; Hans von Euler-Chelpin & Ulf von Euler; Arthur & Roger Kornberg; Manne & Kai Siegbahn; J.J. Thomson & George Paget Thomson

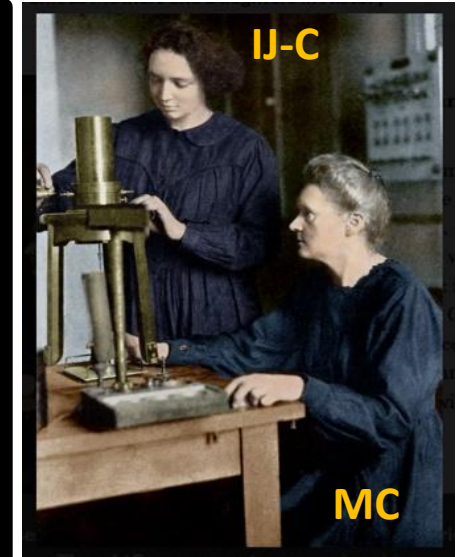
MC



Maria Salomea Skłodowska (Marie Curie)

- In WW1 funded and operated mobile X-ray units, with daughter Irene

- Saved thousands of French soldiers



- Marie died in 1934 aged 66. Her body was exhumed in 1995 and revealed she died, not from radium, but from over-exposure to X-rays

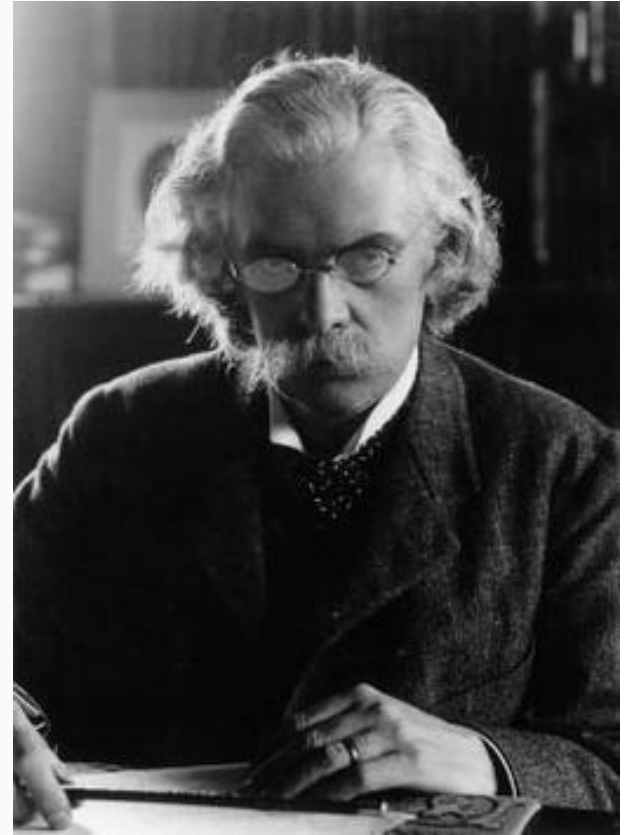
- Irène died in 1956 age 56 - of the same cause





Maria Salomea Skłodowska (Marie Curie)

- The French nomination for the 1903 Physics prize for the discovery of radium only named Pierre Curie and Henri Becquerel and not MC
- Fortunately, Magnus Gustaf Gösta Mittag-Leffler* was on Nobel committee & wrote to Pierre Curie, asking him if he regarded it acceptable if the prize if his wife was excluded – he said “No”



* Mittag-Leffler was a mathematician who developed the use of complex numbers. A committed advocate of gender equality, he ensured that **Sofya Kovalevskaya**, (1850-1891) Russian mathematician became the first European female professor (Stockholm University, 1884). The first female Professor in the UK was Edith Morley, CBE (University of Reading, 1908)



Maria Salomea Skłodowska (MarieCurie)

- on the saga of Curie's 1903 Nobel prize, her good friend Hertha Ayrton said

“errors are notoriously hard to kill, but an error that ascribes to a man what was actually the work of a woman has more lives than a cat”

- A quote from Curie herself:

“You cannot hope to build a better world without improving the individuals. To that end, each of us must work for his own improvement and, at the same time, share a general responsibility for all humanity”

- on the genetic relationship to scientific genius: out of 992 Nobel Laureates by 2024, the 7-1 (independent) parent-child pairs are 0.6% of the total. We will miss out if we fail to educate irrespective of ancestry, wealth, class, race, disability or religion – as well as gender

Hertha Ayrton

(1854-1923)



- Physicist, mathematician, engineer & suffragette. Author of 26 patents
- co-founder of the all-women Girton College Fire Brigade
- awarded the Hughes Medal by the Royal Society for her work on electric arcs and tidal ripple marks. (Only other female winner is Michelle Dougherty)



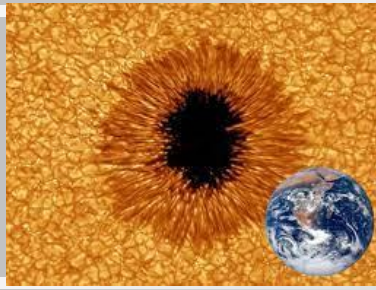
Hertha Ayrton

- born Phoebe Sarah Marks in Portsea, Hampshire
- father was an immigrant Polish watchmaker who died when she was age 7 and she became a child carer for her 7 siblings*
- Funded by Mary Ann Evans (pen name George Eliot), passed all exams at Cambridge but they did not then award degrees to women
- passed exams at the London University, who awarded her a BSc (1881)
- In 1884 attended night classes at Finsbury Technical College by Prof. William Edward Ayrton FRS, a pioneer in electrical engineering and physics education and a widower. She married him a year later
- Proposed for FRS in 1902 but turned down because they would not accept married women
- Developed an “anti-gas fan” to protect WW1 troops in the trenches
- Worked for War Office & Admiralty on improving searchlights



* including an invalid sister who she cared for the rest of her life. Also raised a daughter Barbara, William's daughter Edith and from 1893 the orphaned Ernestine Mills who became an artist & suffragette

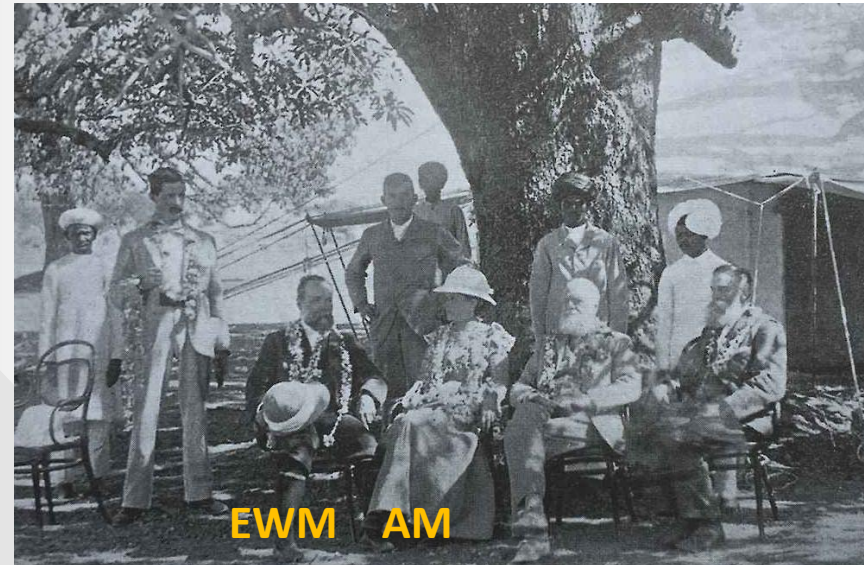
AM



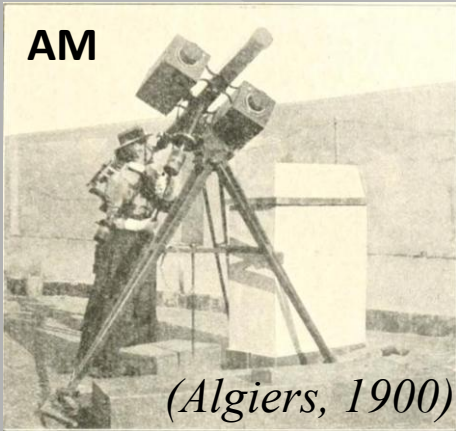
Annie Maunder (1868-1947)

- Solar astronomer
- Born in Strabane, County Tyrone, Ireland where her father was minister of the Presbyterian Church
- One of 6 children, all home schooled and all academically brilliant
- 1886 won a scholarship to Girton College Cambridge to study Maths (£35 p.a. - £5800 in today's money)
- 1889 passed final exams with top mark of her year but Cambridge did not give women degrees until 1948
- 1891 helped by her friend at Girton, Alice Everett, got a job at RGO as a "Lady Computer" in the solar group (£48 p.a - £7,800 today)

- 1895 married her boss at RGO, Edward Walter Maunder, 17 years her senior - a widower with 5 children whose his first wife who had died in 1888. Under Civil Service rules ths required her to retire and RGO
- 1898 Eclipse campaign Talni, India



AM



(Algiers, 1900)

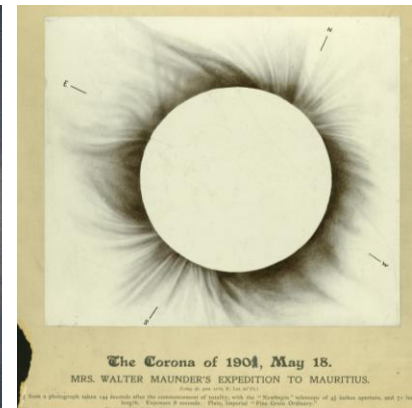


Annie Maunder

- A happy marriage, she was liked and accepted by her stepchildren. Lived in Lewisham
- Walter was the youngest child of a Wesleyan minister and strongly believed in equal opportunities and pay for women. He and Annie formed a highly productive partnership.
- Annie not allowed to talk at RAS or RS (because she didn't have a degree!) so Walter gave their joint-authored talks. He helped set up & was 1st president of British Astronomical Association which welcomed women
- Walter nominated her for Fellowship of the RAS in 1891 refused - eventually granted in 1916, after the RAS allowed women Fellows
- recorded the 1900 eclipse from Algiers with an instrument she had designed and detected more of the corona than all other observers
- awarded campaign grants as a result and observed 5 eclipses in all



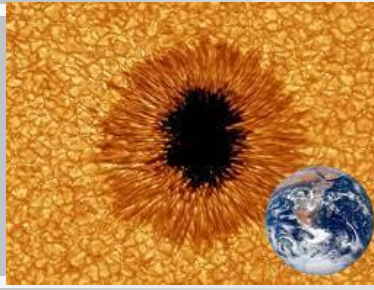
22 July 2009 Enewetak Atoll, Marshall Islands



*The Corona of 1901, May 15.
MRS. WALTER MAUNDER'S EXPEDITION TO MAURITIUS.*



AM



Annie Maunder

- 1904 “Butterfly diagram” of spot latitudes over solar cycle

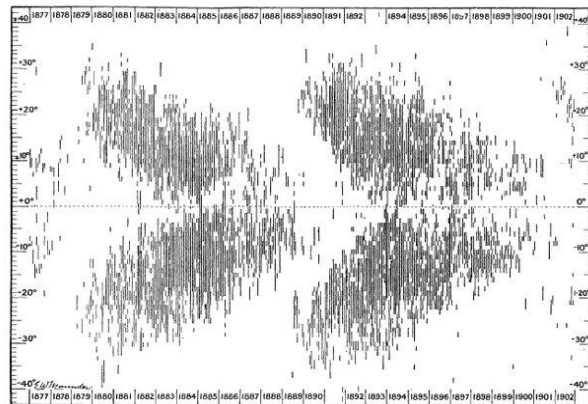
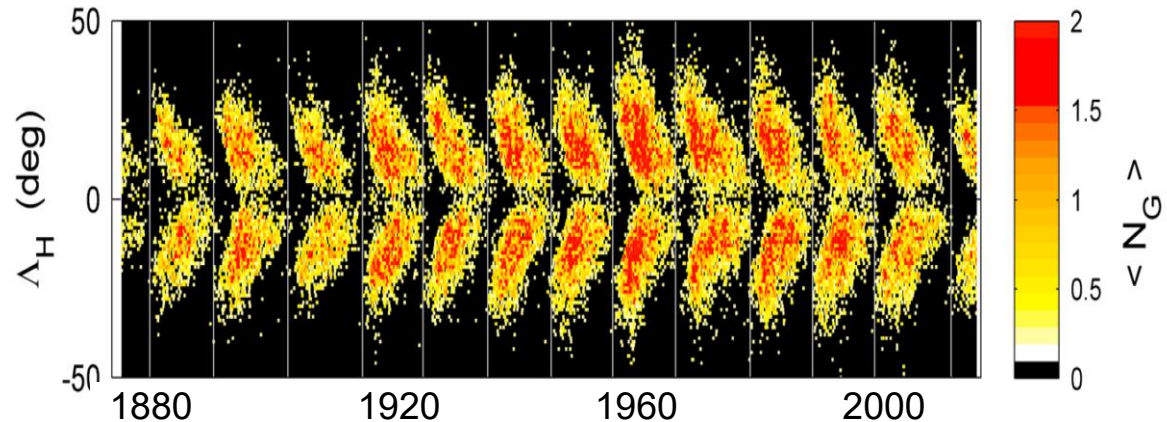
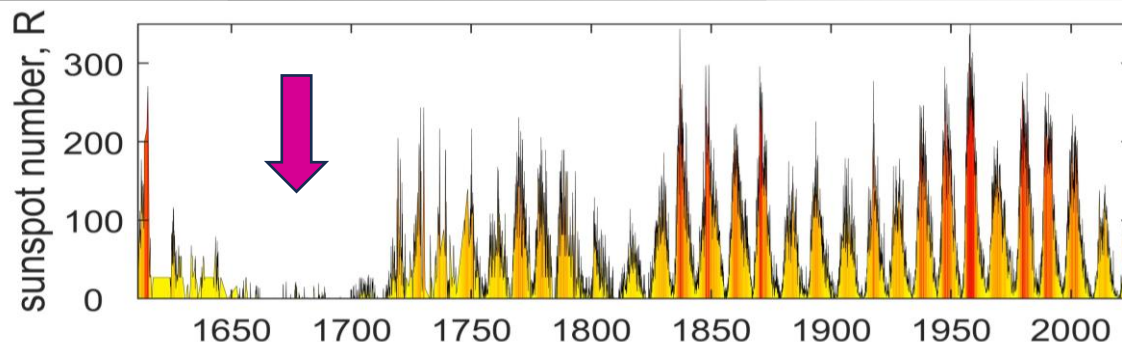


FIG. 8.—DISTRIBUTION OF SPOT-CENTRES IN LATITUDE, ROTATION BY ROTATION, 1877-1902.



- Now a vital constraint on dynamo models of the solar magnetic field
- The couple are famous for the Maunder minimum in sunspots (c.1650-1710) which was actually discovered by Gustav Spörer in 1888

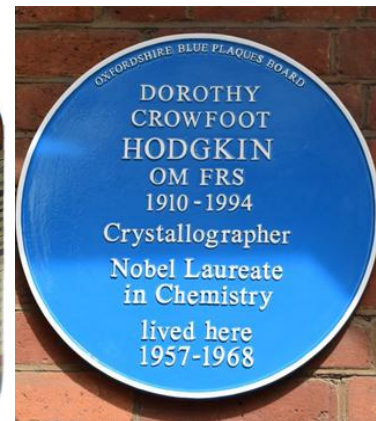
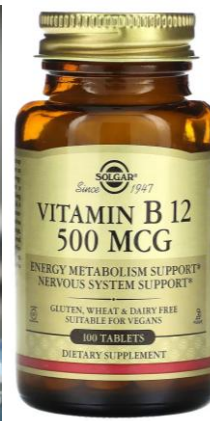


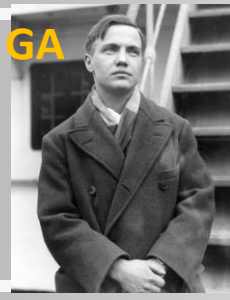
- Annie & Edward Maunder publicised and improved Spörer's work, presenting at the RAS, RSS and BAA



Dame Dorothy Crowfoot Hodgkin (1910-1990)

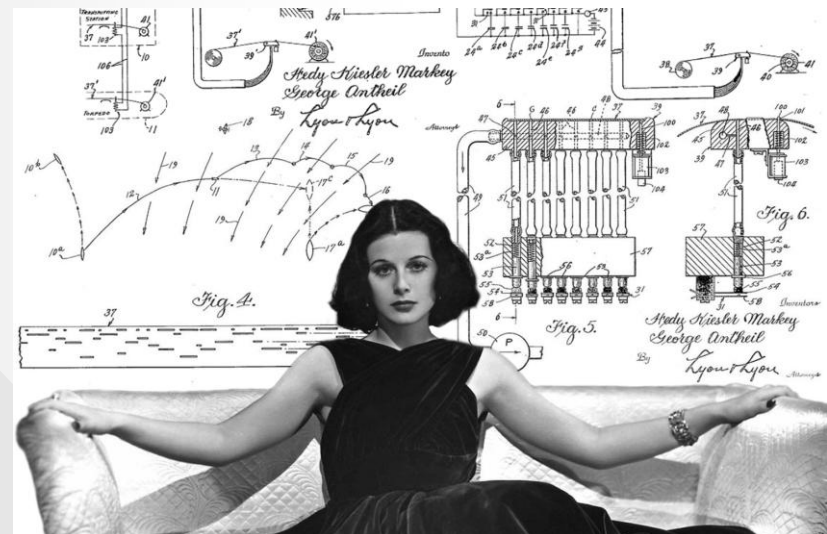
- Brought up mainly by grandparents in Worthing as parents were archaeologists working in Cairo and later Khartoum
- From age 10 had a passion for crystals
- 3rd woman to get a 1st at Oxford in 1932
- Developed X-ray crystallography to reveal the structures of penicillin, insulin and vitamin B12
- Nobel Prize for Chemistry in 1934
- Husband Thomas spent long periods in Africa and she did most of the work bringing up their 3 children





Hedy Lamarr (1914-2000)

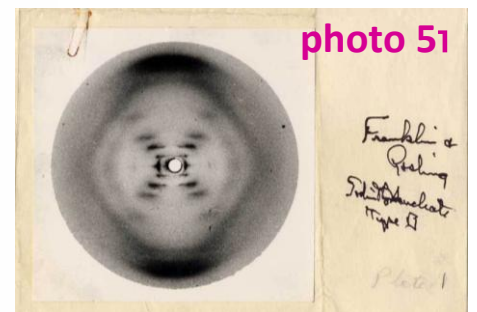
- film star, born Hedwig Eva Maria Kiesler in Austria, escaped a controlling first husband and the NAZIs and fled to Hollywood in 1938
- a brilliant electronic engineer and inventor, with composer George Antheil she invented and patented (1942) frequency-hopping spread-spectrum FHSS to evade WW2 U-boat electronic counter-measures
- had a rider in her contracts to allow her workshop in a caravan to be near the film set so she could work in it between takes
- 1989: Nils Rydbeck of Ericsson Mobile in Lund uses FHSS in what is now called Bluetooth to give security and noise suppression
- 1999: Wi-Fi developed by an Australian CSIRO team. Uses Direct Sequence Spread Spectrum (DSSS which spreads the signal using a coded spectrum, rather than FHSS (switching the frequency with time)





Rosalind Franklin (1920-1958)

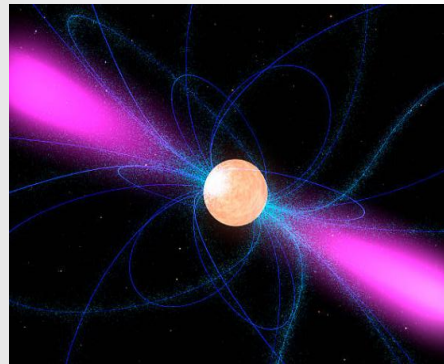
- PhD (war-work on coal!) from Cambridge in 1945
- In 4 years in Paris as a “chercheur” (postdoctoral researcher) she became a top class crystallographer
- Back in the UK, she carried out the X-ray crystallography that revealed the double helix structure of DNA
- Was treated appallingly at King’s & was forced out by Maurice Wilkins who had isolated the DNA
- She published in 1953 in the same issue of Nature as Crick and Watson but used less sensational wording
- The Nobel prize could not be granted to 4 nor posthumously – the suspicion lingers that they waited for Franklin to die (of ovarian cancer) in 1958 before awarding to Crick, Watson and Wilkins in 1962
- She went on to do ground-breaking studies of the molecular structure of viruses, but died the day it was published. Her colleague Aaron Klug continued her research & won the Nobel Prize in Chemistry in 1982.



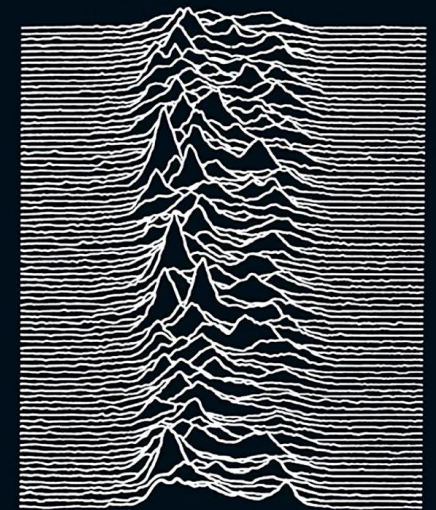


Dame Susan Jocelyn Bell Burnell (b. 1943)

- Famously discovered pulsars as a PhD student at Cambridge
- Even more famously was not awarded a Nobel Prize for it when her PhD supervisor was
- Has won at least a dozen other major awards
- 2nd female president of RAS (we have had 4 now)
- 1st female president of the Royal Society of Edinburgh (had 2 now)
- 1st female president of the Institute of Physics (had 3 now)
- A Quaker elder
- won £2.5m “Breakthrough prize in fundamental physics” in 2018. Donated it all to female, minority and refugee students to help them become research physicists



Cambridge Pulsar 1919 (CP1919)



Joy Division's album "Unknown Pleasures"

Female Nobel Laureates

1901-2024



1&2.



3.



x Lise Meitner

(1878-1968)
Nuclear physicist



x



4. Gerty Cori

(1896-1957)
Biochemist



5. Maria Goeppert-Mayer

(1896-1957)
Nuclear physicist



6.

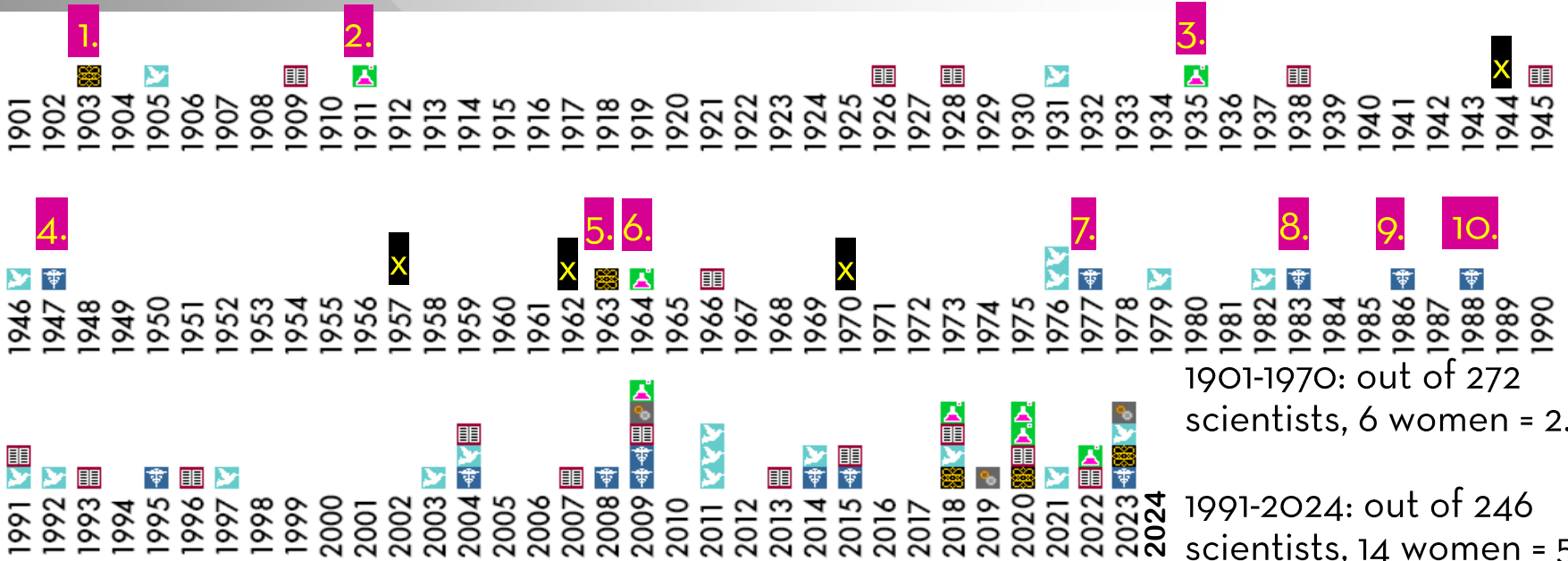


x Chien-Shiung Wu

(1912-1997)
Particle physicist



x



Chemistry

Economics

Literature

Peace

Physics

Physiology or Medicine

Bias (conscious & unconscious)

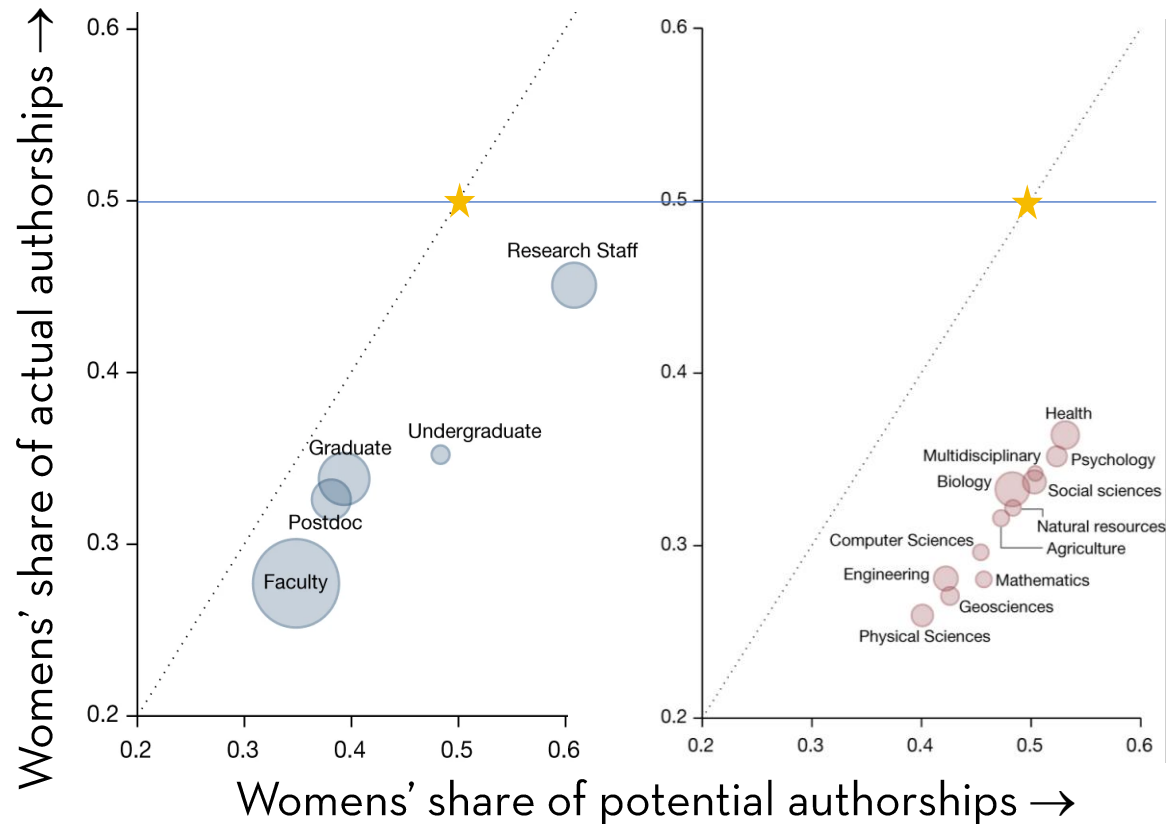
Ross, M.B., et al. (2022) Women are credited less in science than men. *Nature* 608, 135–145
<https://doi.org/10.1038/s41586-022-04966-w>



Emma Bunce OBE
(b. 1986)

Space Scientist
4th female President of the
the Royal Astronomical
Society

● e.g., RAS now acting on an RAS bullying and harassment survey & report that EB set up



● need better appreciation of women's work, more female scientists, more provision for career breaks, more female role models, and more women in places of influence to make these happen



Katherine Johnson, Mary Jackson, Dorothy Vaughan, Christine Darden & Margaret Hamilton



KJ



DV



MJ



MH



CD



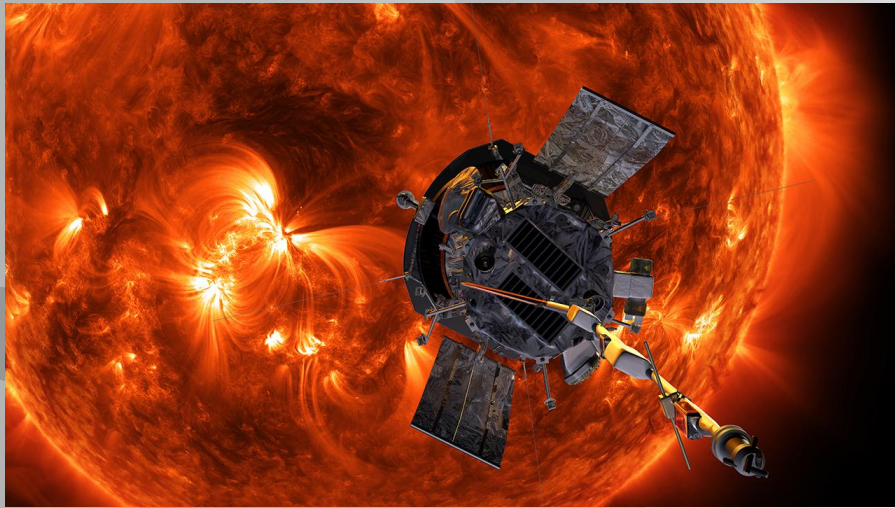
● NASA just did it - key roles played by Kazimierz Czarnecki and astronaut John Glenn





Nicky Fox

Head of Science for NASA





Nicky Fox

Head of Science for NASA

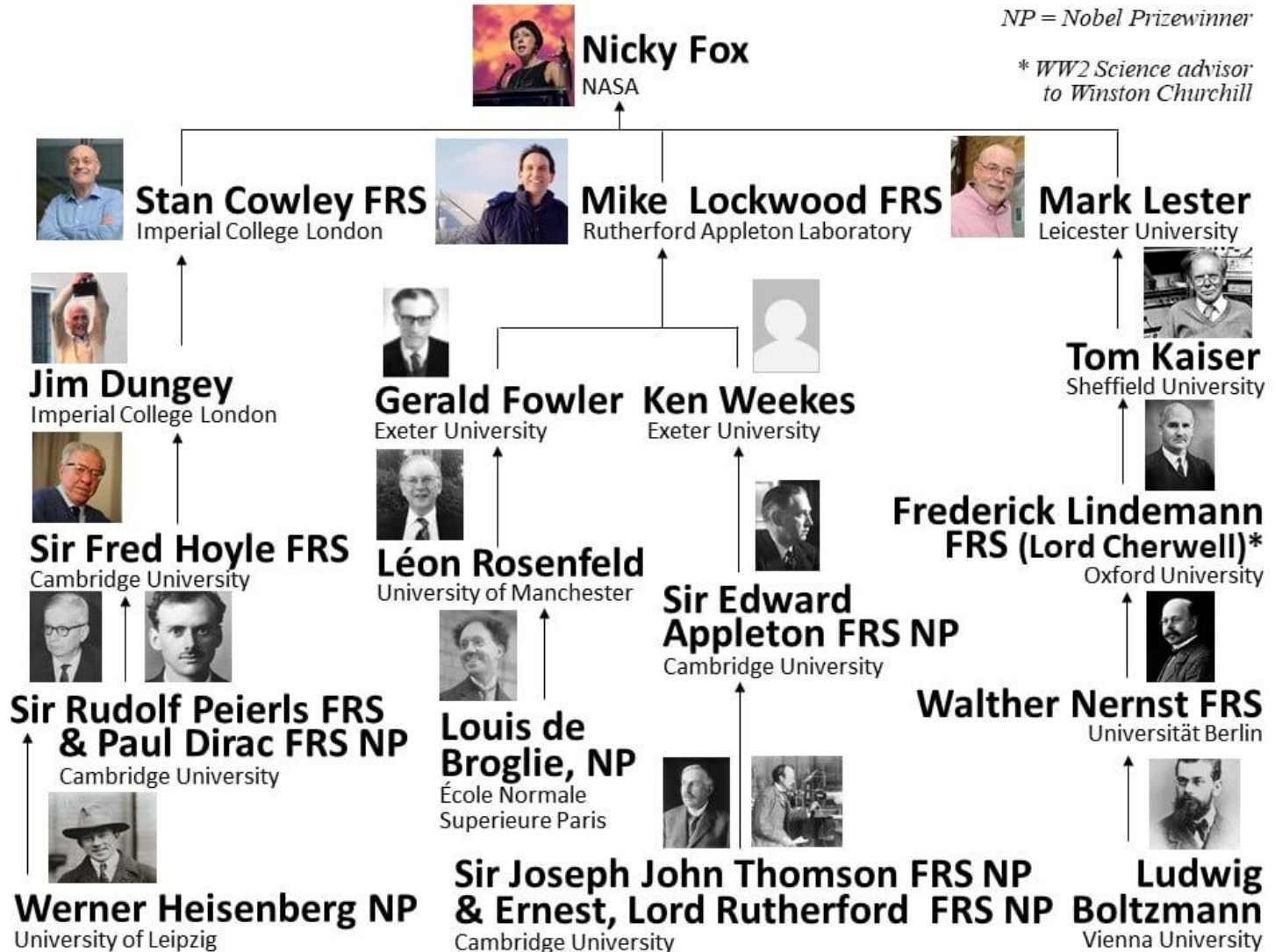




Nicky Fox

Academic “Old-PhD Supervisor” Family Tree

● made to celebrate her winning the 2021 Carl Sagan Space Exploration prize



12 more great scientists

Caroline
Herschel
(1750-1828)
Astronomer



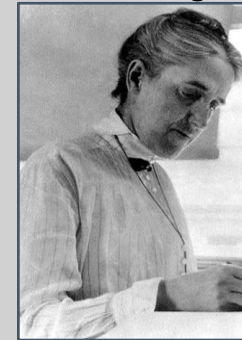
Mary Anning
(1799-1870)
palaeontologist

Mary
Somerville
(1780-1872)
mathematician
& astronomer



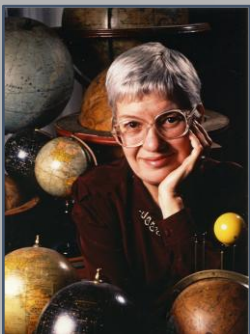
Eunice Newton
Foote
(1819-1888)
Atmospheric chemist
& climatologist

Henrietta Swan
Leavitt
(1819-1888)
Astronomer
& cosmologist



Cecelia Payne-
Gaposchkin
(1900-1979)
Astronomer

Vera Rubin
(1928-2016)
Astronomer



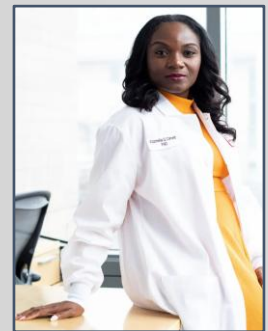
Françoise
Barré-Sinoussi
(b.1947)
Epidemiologist &
virologist

Frances Arnold
(b. 1956)
Biochemical
Engineer



Fabiola
Gianotti
(b. 1960)
Particle
Physicist

Michele
Dougherty
(b. 1961)
Space
Scientist



Kizzmekia
Shanta
Corbett
(b. 1986)
Immunologist

from Merit Ptah to Nicky Fox 40 women & 4000 years



from Merit Ptah to Nicky Fox

40 women & 4000 years

Caroline Herschel First paid female astronomer, first woman to discover a comet. Made first map of the milky way and catalogued 2500 nebulae.

Mary Anning the first modern paleontologist funded herself through a fossil shop in Lyme Regis couldn't publish because of her gender but her notes show many discoveries and she was the first to use coprolites to work out what they ate.

Mary Somerville Scottish Mathematician and Astronomer. Solved the long standing "Diophantine problem". In her hugely popular book "Mechanism of the Heavens" she brought together many astronomical findings in a common framework. Suggested Neptune must exist. Tutored Ada Lovelace

Eunice Newton Foote in 1856, 3 years before John Tyndall she showed CO₂ absorbed heat and 40 years before Svante Ahrenius she reasoned atmospheric CO₂ must warm the climate. Joseph Henry famously wouldn't initially allow her paper to be read at the AAAS (American Association for the Advancement of Science) but he had actually read it himself he relented and read it for her

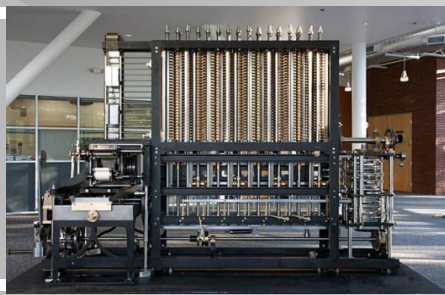
Henrietta Swan Leavitt

Cecelia Payne-Gaposchkin

Vera Rubin

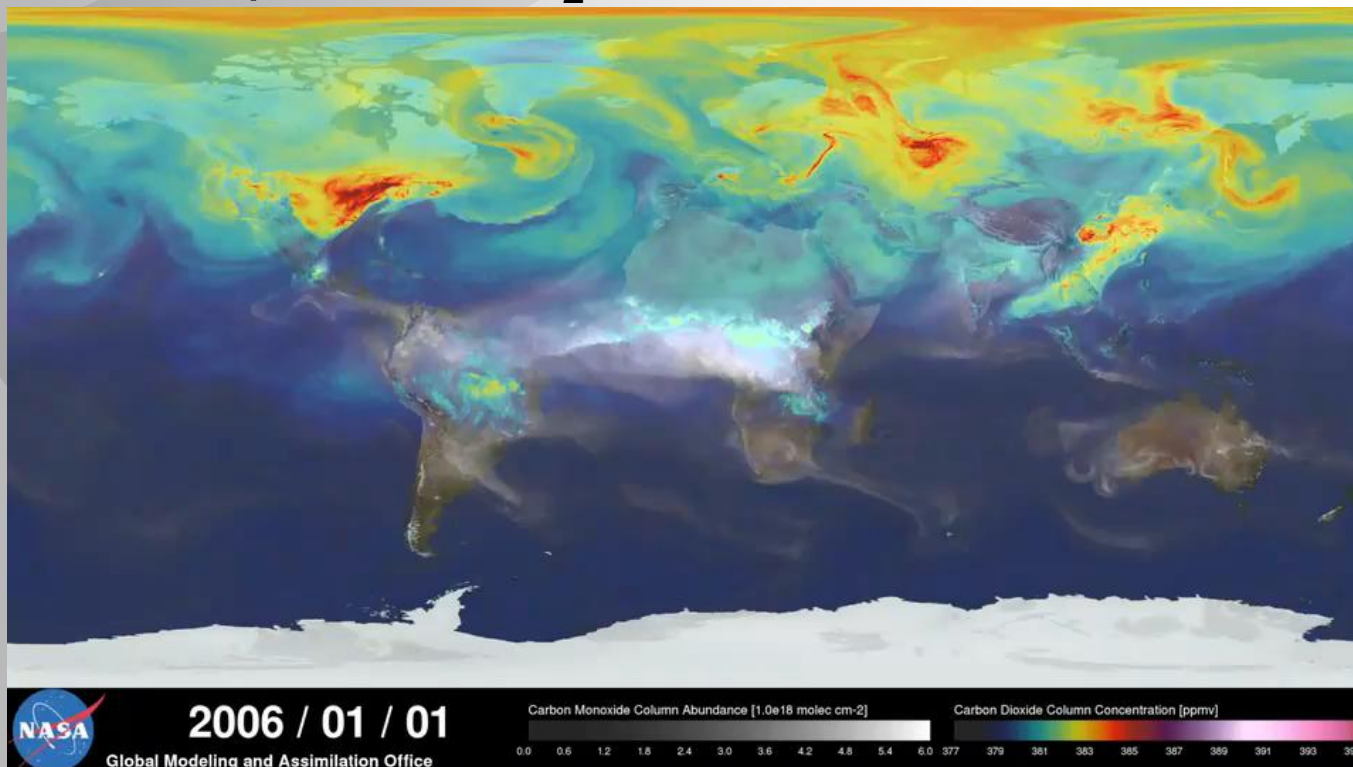
Françoise Barré-Sinoussi

Frances Arnold



Ada Lovelace

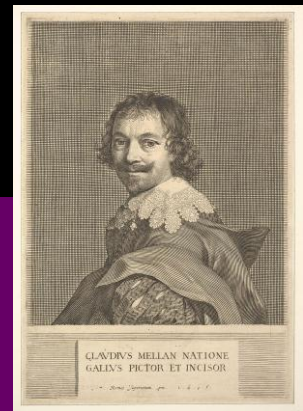
- Global modelling
- e.g., numerical simulation of CO₂ spreading around the globe from known sources & showing annual variation as trees take up more CO₂ in summer

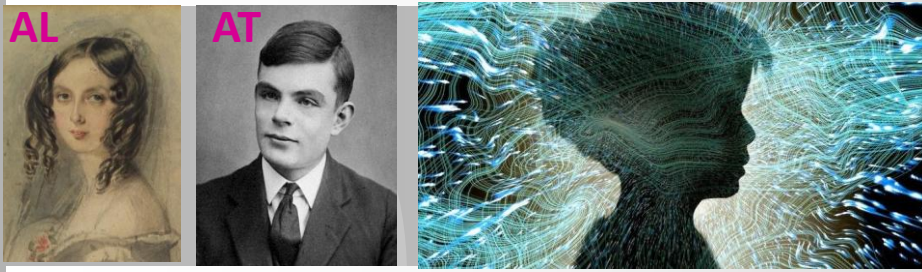


Credit William Putman (NASA)



← Giovanni Domenico Cassini
Claude Mellan (1697) →





AL, AT & AI

- I think AT grossly underestimated AL & her insights on the nature of consciousness
- and anyway, is the Lovelace “objection” due to misunderstanding and selective misquoting. The missing part of her statement is really interesting

“It is desirable to guard against the possibility of exaggerated ideas that might arise as to the powers of the Analytical Engine. In considering any new subject, there is frequently a tendency, first, to overrate what we find to be already interesting or remarkable; and, secondly, by a sort of natural reaction, to undervalue the true state of the case, when we do discover that our notions have surpassed those that were really tenable”

(Lovelace, 1843: 722)



Natale, S. and L. Henrickson (2022) *The Lovelace effect: Perceptions of creativity in machines*, *New Media & Society*, pp1-18, doi: 10.1177/14614448221077278