Some Great Women in Science

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IISER Pune
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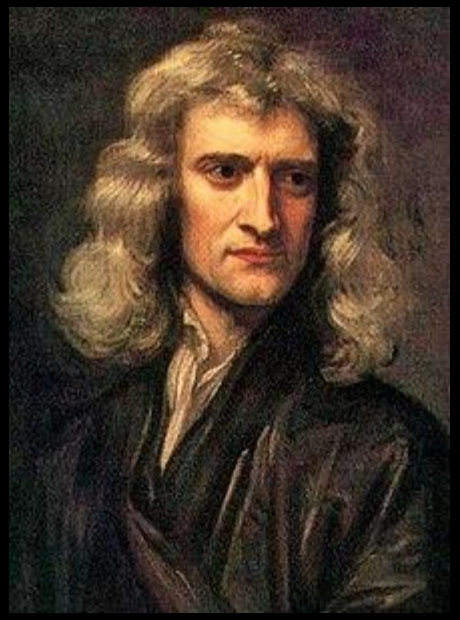
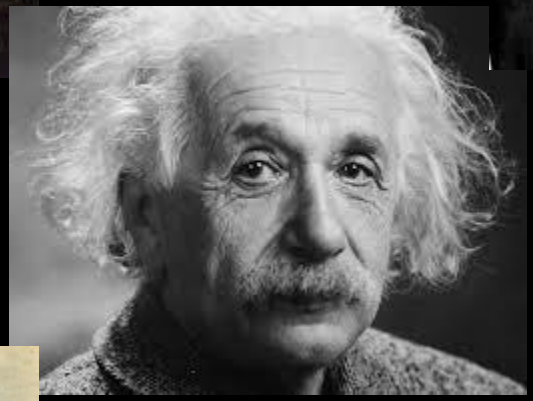
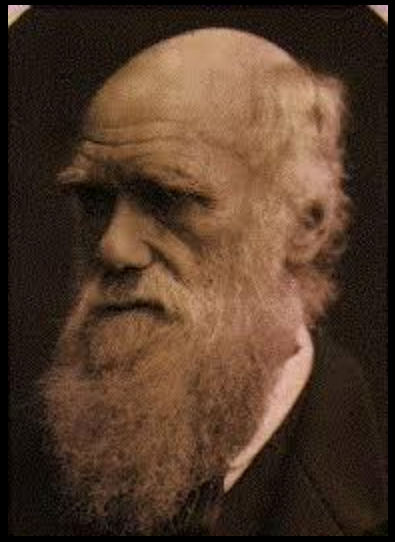






The Mushroom Hunters – Neil Gaiman (2018)

Science, as you know, my little one, is the study
of the nature and behaviour of the universe.
It's based on observation, on experiment, and measurement,
and the formulation of laws to describe the facts revealed.

In the old times, they say, the men came already fitted with brains
designed to follow flesh-beasts at a run,
to hurdle blindly into the unknown,
and then to find their way back home when lost
with a slain antelope to carry between them.
Or, on bad hunting days, nothing.

The women, who did not need to run down prey,
had brains that spotted landmarks and made paths between them
left at the thorn bush and across the scree
and look down in the bole of the half-fallen tree,
because sometimes there are mushrooms.

Before the flint club, or flint butcher's tools,
The first tool of all was a sling for the baby
to keep our hands free
and something to put the berries and the mushrooms in,
the roots and the good leaves, the seeds and the crawlers.
Then a flint pestle to smash, to crush, to grind or break.

And sometimes men chased the beasts
into the deep woods,
and never came back.

Some mushrooms will kill you,
while some will show you gods
and some will feed the hunger in our bellies. Identify.
Others will kill us if we eat them raw,
and kill us again if we cook them once,
but if we boil them up in spring water, and pour the water away,
and then boil them once more, and pour the water away,
only then can we eat them safely. Observe.

Observe childbirth, measure the swell of bellies and the shape of breasts,
and through experience discover how to bring babies safely into the world.

Observe everything.

And the mushroom hunters walk the ways they walk
and watch the world, and see what they observe.
And some of them would thrive and lick their lips,
While others clutched their stomachs and expired.
So laws are made and handed down on what is safe. Formulate.

The tools we make to build our lives:
our clothes, our food, our path home…
all these things we base on observation,
on experiment, on measurement, on truth.

And science, you remember, is the study
of the nature and behaviour of the universe,
based on observation, experiment, and measurement,
and the formulation of laws to describe these facts.

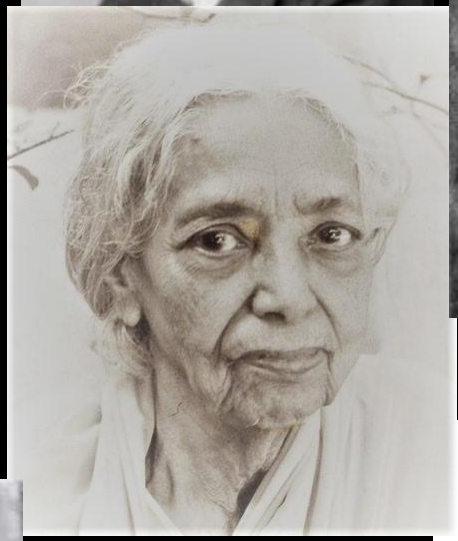
The race continues. An early scientist
drew beasts upon the walls of caves
to show her children, now all fat on mushrooms
and on berries, what would be safe to hunt.

The men go running on after beasts.

The scientists walk more slowly, over to the brow of the hill
and down to the water’s edge and past the place where the red clay runs.
They are carrying their babies in the slings they made,
freeing their hands to pick the mushrooms.






Emilie du Chatelet

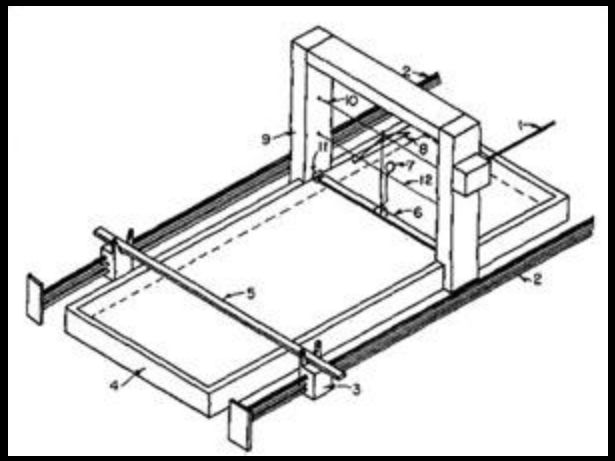
- 1706-1749, Paris
- Educated at home, but learned from prominent mathematicians and physicists
- Did her own experiments at home
- Had a flair for gambling, used her math skills to win and used the money to buy books and equipment!
- 1737: wrote on a paper on the nature of light, heat, and fire, suggested that different colours of light carry different heating powers, anticipated infrared radiation
- Greatly interested in Newton's work; co-authored *Elements of Newton's Philosophy* (not credited)
- Did experiments and corrected Newton's statement that energy is proportional to mv to mv^2
- Translated and commented on Newton's *Principia*, adding clarifications, explanations, and experimental data—her translation remains definitive even today
- Is responsible for having encouraged Newtonian science in France

Caroline Herschel

- 1750-1848, Hanover
- First woman to receive full recognition in astronomy
- Began by housekeeping for her brother Freidrich, an organist and telescope maker
- Was a brilliant singer; began helping her brother with telescope making; made reflecting telescopes
- Got interested in astronomical theory—mastered algebra, formulae for calculations for measuring astronomical distances
- Got a 50 pound per year salary as a qualified assistant by the Royal British court; first woman ever to receive a salary for scientific work
- 1786-1797: discovered 8 comets! (none bear her name)
- Discovered 14 nebulae such as Messier 110 (NGC 205), the second companion to Andromeda
- Began a catalogue for star clusters using north polar distance; compiled a supplemental catalogue of 561 stars to Flamsteeds Atlas
- 1802: her catalogue was published by the Royal Society under her brother's name
- She arranged 2500 nebulae and clusters for her nephew (John Herschel); this list was eventually expanded and called New General Catalogue (NGC)—many non-stellar objects are still identified by their NGC number
- 1828: Gold medal from the Royal Astronomical Society; elected as an Honorary Member in 1835
- 1846: Gold medal from the Prussian Academy of Sciences
- A crater on the moon bears her name

Agnes Pockels

- 1862- 1935, Venice
- Pioneer in surface tension studies
- No formal training in the sciences; carried out experiments in the kitchen using buttons and trays with soaps and oils while taking care of her parents
- Was not allowed to study science in college
- Experimented to study the effects of impurities on surface tensions of liquids
- Invented Pockels trough (eventually developed by Nobel Laureate Irving Langmuir) to measure surface tension
- Had her research published in *Nature*
- 1932: honorary doctorate from the Technical University of Braunschweig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Henrietta Swan Leavitt

- 1868 – 1921, Massachusetts
- One of Harvard's "Computers"- their job was to study photographic plates for fundamental properties of stars (worked for salaries that men would not be paid for the amount of work done)
- Discovered close to 2400 variable stars
- Her discovery about Cepheid stars enabled Edward Hubble to measure galaxy distances in the 1920s
- Considered now to be "the woman who discovered how to measure the Universe"
- Her research was published by her boss Edward Charles Pickering under his name
- Her research helped Harlow Shapley find out distances around the Milky Way, but he did not credit her
- 1924: Gosta Mittag-Leffler of the Swedish Academy of Sciences tried to nominate her for the Nobel Prize, not knowing that she had already died
- 2011: Nobel Laureate (Physics) Adam Reiss credited Leavitt's work as the best tool to study the universe
- Her discovery of luminosity and position is now called Leavitt's Law


Dec 1888

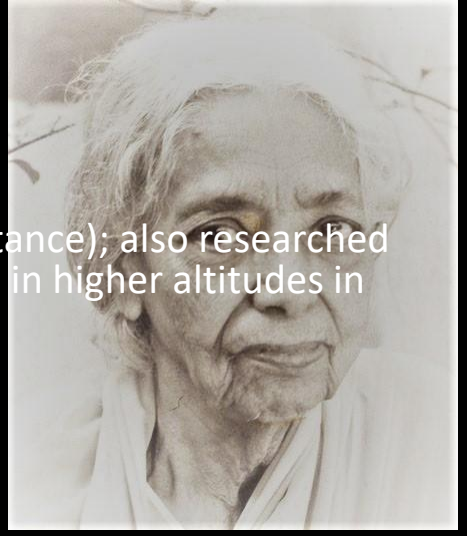
Lise Meitner

- 1908-1992, Vienna (died in Cambridge)
- Studied with Max Planck
- Researched the physics of radioactive substances; great findings in the then new field of nuclear physics
- She and Otto Frisch (her nephew) together published a paper in *Nature* explaining nuclear fission (they also named the process)
- 1945: Otto Hahn, her long time collaborator awarded the Nobel Prize in Chemistry for the discovery of nuclear fission; Meitner was overlooked in spite of being an equal contributor and for giving the theoretical explanation for it
- 1992: Element 109, the heaviest element known named Meitnerium in her honour
- Wrongly celebrated as the “mother of the atomic bomb” – had no role to play in that

Amalie (Emmy) Noether

- 1882-1935, Erlangen (died in the US)
- Initially trained in languages and music (thought appropriate for a woman)
- Noether's theorem combines two conceptual pillars of physics: symmetry in nature and the universal laws of conservation; many scientists believe this theorem to be as important as Einstein's theory of relativity; it is the basis for much of modern research in physics, including the Higgs-Boson particle
- Sometimes published her papers under a man's name
- Worked in the fields of ring theory, abstract algebra; discovered rules of how time and energy are related; formulated mathematical variance; discovered how the geometry of the universe is related to the behavior of mass and energy;
- Women were not allowed to be students, so she simply audited all the math courses at the U of Erlangen; went to graduate school at the U of Gottingen, and came back to Erlangen for her PhD
- Worked for 7 years there without pay. Why?
- Several male mathematicians recognized her brilliance, fought for her appointment as professor in U of Gottingen; failed because other faculty objected to a woman being appointed; so she became a teacher under David Hilbert's name (one of her champions); was not paid for 4 years
- Was appointed "Privatdozent" in 1919.
- Was among the first to be fired from her position for being a Jew.
- Einstein was instrumental in getting her a job in the US after that; called her the most "significant" and "creative" female mathematician of all time

Janaki Ammal



1897-1984, Tellichery (Kerala)

- A pioneering botanist and cytogeneticist (study of chromosomes and inheritance); also researched ecology, biodiversity, medicinal plants, and sustainable agricultural practices in higher altitudes in India
- One of the first women to win the Padma Shri (1977)
- Got her PhD from Michigan University in 1931
  (possibly the first woman to get a PhD in botany in the US)
- Honored with a honorary DSc from the U of Michigan
- Created newer varieties of sugarcane through selective crossbreeding of hybrids at the Sugarcane Breeding Station, Coimbatore; discovered that the S. Spontaneum variety is native to India
- Studied chromosomes of thousands of species of flowering plants
- Colleagues at Coimbatore did not like her because she was an unmarried woman and from a caste lower than theirs; facing discrimination, she joined the John Innes Horticultural Institute, London
- 1935: CV Raman invited her to be a research fellow at IAS
- Invited to be a cytologist at Kew Gardens by the Royal Horticultural Society, England
- Co-authored *The Chromosome Atlas of Cultivated Plants*
- 1951: Jawaharlal Nehru invited her back to India to head the Botanical Survey of India
- An ardent environmentalist, she opposed the building of a hydro-power plant in Kerala's Silent Valley
- 1955: Only woman to be invited to the International Symposium on Environmental History at Princeton
- 2000: the Ministry of Environment and Forestry created the National Award of Taxonomy in her name
- A herbarium with 25,000 species in Jammu Tawi is named after her


Magnolia Kobus Janaki Ammal
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Kamala Sohonie

- 1911-1998
- BSc in Chemistry at Bombay Presidency College, topped her class
- Applied to IISc (like her father and uncle), but CV Raman (the head) denied her admission because she was a woman
- She persisted; was not allowed in as a regular candidate at first, until she proved her brilliance
- Microbiologist; worked on proteins in milk, legumes, and pulses (with focus on nutritional practices in India)
- 1936: went to Cambridge for a PhD (1937, Raman opened the doors of IISc to women!)
- 1939: Won a fellowship to Nobel Laureate Frederick Hopkins's lab
- Dissertation was on the role Cytochrome C (responsible for energy creation) in the respiration of plant tissue; finished it in 14 months!
- Ardent Gandhian, returned to India in 1939 to help with the freedom struggle
- Asst. Director at Nutrition Research Lab in Coonoor, conducted research in the role of vitamins in nutrition
- Worked on neera as a source of nutrition for the poor; awarded the Rashtrapati Award for this
- Founding member of the Consumer Guidance Society of India

Anna Mani

1918- 2001 , Travancore

- As a young girl, deeply influenced by Satyagraha and swadeshi philosophy; took to wearing only Khadi
- Not encouraged by her family to study
- 1940: right after her Bachelor's degree, she got a scholarship to join Raman's lab at IISc
- Worked on the spectroscopy of diamonds and rubies
- Though she submitted her thesis to Madras University, the University claimed she did not have an official Master's degree, so she couldn't get a PhD
- Got a scholarship to study at Imperial College, London, where she specialised in meteorological instrumentation
- Was Deputy General of the Indian Meteorological Department, Pune (till 1976)
- Standardized drawings of nearly 100 different weather instruments and began their production
- Set up stations around India to study solar radiation
- Developed "ozonesonde", an apparatus to measure ozone
- Made significant contributions to solar radiation, ozone, and wind energy instrumentation
- Has published books on solar radiation that remain definitive for solar technology
- Did research on wind energy, pioneering the study of alternative sources of energy in India

Take Aways

- Most of the women we have talked about today had to fight a lot of gender based prejudices from society, family, colleagues, and teachers; oddly enough, support also came for some from the same quarters
- Many of these women were not allowed to be students or teachers in institutes of higher learning and many others found their work being appropriated by male colleagues
- They have all made stellar contributions to their fields, and several got recognition in their own time but not nearly enough
- History and institutions tend not to remember them or give them due importance
- In a world dominated by men, they proved that women are intelligent, capable, strong, and in spite of hardships, capable of great work
- Remember, these some of them lived through times when women were not allowed to own property, vote, and all decisions were made for them by their families
- They have made it easier for you and me to pursue our interests in STEM
- We have only looked at some bright spots of the last 300 years—you must discover the others!