Women in Physics

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Marie Sklodowska Curie

Warsaw (Poland) 1867 - Sallanches (France) 1934

Family environment and education

His father was a professor of mathematics and physics. The mother was a teacher and pianist. She was the youngest of 5 siblings. The mother and a sister died (when Marie was 12).

She had to work as a governess in Krakow so that his older sister could study medicine in Paris. Later, her sister welcomed her to Paris so that she could study Mathematical and Natural Sciences at the Sorbonne (in 1891).



Life as a scientist and discoveries

At the Sorbonne, he met a young teacher, Pierre Curie, whom he married in 1895.

Marie Curie is a teacher at a girls' school. She does research in the evenings, in a badly ventilated and poorly conditioned shed.

She began working on the radioactivity of Uranium and discovered that it was an intrinsic phenomenon of the atom.



She saw that the "pleschbenda" rocks were more active than the uranium they contained. Using highly developed chemical methods at the time, she and Pierre Curie managed to isolate two new elements, Polonium (Po) and Radium (Ra) in 1898.

She found that cancer cells, exposed to radium, were destroyed more quickly than healthy cells.

In 1906 Pierre died, hit by a carriage

Recognitions

1903: <u>Nobel Prize in Physics</u> (along with her husband and Beckerel) for her studies on radioactivity → first woman to win the Nobel Prize! (A year earlier she had been denied admission to the French Academy of Sciences due to her condition of woman).

1906: first woman to be Professor at the Université de Paris

1911: Nobel Prize in Chemistry for the discovery of Polonium and Radium

1911-1933:

- Attends <u>Solvay</u>
 <u>Conferences</u> with
 other prestigious
 scientists.
- She is a <u>guest of honor</u> <u>in the United States</u>, where she is offered 1g of Radium (\$ 100,000) for her research.



1914: <u>Director of the Radio Institute in Paris</u>, dedicated to research in physics, chemistry and medicine..

1922: Member of the Paris Academy of Medicine

Other curiosities...

Woman of character and determination.

Little interested in material gains:

- she never patented the methods of purifying Radium
- she invested the prizes and donations on research

During the First World War (1914-1918), with her daughter Irene, she worked in a hospital and promoted the creation of mobile units with radiographic equipment to diagnose the wounded on the same front.







Lise Meitner

Viena (Àustria) 1878 - Cambridge (UK)1968



Family environment and education



The third of 8 siblings, she grew up in a wealthy Jewish family in Vienna.

The father was a lawyer and procured her private education at home (girls could not attend high school!).

She was the first woman admitted to study physics at the University of Vienna, where she obtained her doctorate in 1905.

Life as a scientist and discoveries

1907: She moved to Berlin to pursue postdoctoral studies with physicist Max Planck and chemist Otto Hahn. But women could not work in the labs and she had to do it in a basement.

1918: with Otto Hahn, she discovered the element Protactinium (Z = 91)

1923: She discovered that some excited atoms, instead of de-exciting by emitting "light", do so by emitting electrons. This phenomenon would be called the Auger effect (by the French physicist Pierre Victor Auger, who discovered it independently two years later).



1930-1938: she works intensively with Otto Hahn and Fritz Strassmann on how to produce elements heavier than Uranium (Z = 92) (by bombarding it with neutrons). But they didn't understand the results... Lise Meitner had to flee Germany because of her Jewish origins.

1938: from Sweden, together with his nephew physicist Otto Frisch, gives an explanation to the experiments of the chemist Hahn. They discovered nuclear fission (Uranium splitted in two, releasing a huge amount of energy)

Recognitions (or not...) and curiosities

1926: tenured professor at the University of Berlin (first woman in Germany)

1933: director of the Berlin Institute of Chemistry

1942: she was asked to work on the "Manhattan Project" to make the nuclear bomb but declined insisting that "she didn't want to know anything about it."

1944: Otto Hahn was the sole recipient the Nobel Prize in Chemistry for the discovery of fission (out of ego or fear of retaliation from the Nazi regime, Hahn does not recognize Meitner's contribution)

1949: Max Planck Medal of the German Society of Physics

1966: recipient Enrico Fermi Award, along with Hahn and Strassman

1938-1960: She works in Stockholm but travels often, encouraging female students to "remember that science can bring joy and satisfaction to their lives."



Common features ...

- Passion to acquire knowledge
- Middle-upper social environment (many were Jews)
- Resilience to the "hostile" environment
- Husband / fellow scientist
- Active participation in the fight for women's rights

What has changed?

- ✓ Affordable education at all levels of society (in developed countries)
- \checkmark There is more social awareness of gender inequalities
- ✓ We find more female scientists in high-level positions



Fabiola Gianotti director of CERN, 2016-present



Caterina Biscari director of ALBA Synchrotron, 2012-present



... but less than half in scientific-technological fields!

Gender temporal evolution of the Nobel Prizes



The percentage of Nobel women has increased to 10% in the last 20 years

The increase is larger in Literature and Peace

The increase in scientific fields comes mainly from Medicine

The gender imbalance in research

Women as a share of total researchers, 2016 or latest year available

28.8% for World

- 39.8% for Arab States
- 39.5% for Central and Eastern Europe
- 48.1% for Central Asia
- 23.4% for East Asia and the Pacific —
- 45.4% for Latin America and the Caribbean
- 32.3% for North America and Western Europe
- 18.5% for South and West Asia
- 31.3% for Sub-Saharan Africa

Only about one in four countries has achieved gender parity, whereby 45% to 55% of researchers are women.

UNESCO Institute for Statistics, June 2018

70.1%-100%

55.1%-70% 45.1%-55%

30.1%-45%

0%-30%

No data



Junming Huang, Alexander J. Gates, Roberta Sinatra, and Albert-László Barabási **PNAS March 3, 2020** 117 (9) 4609-4616; <u>https://doi.org/10.1073/pnas.1914221117</u>

Scissor effect ("glass ceiling")

Universidades públicas y privadas españolas

Gráfico 2.8

Distribución de mujeres y hombres a lo largo de la carrera investigadora en universidades públicas. Curso 2016-17

Porcentaje de mujeres y hombres sobre el total de cada categoría



Data from Catalan Research institutions 11 DE FEBRER DIA INTERNACIONAL DE LA DONA I LA NENA A LA CIÈNCIA **2018**



Les dones als centres CERCA

 El desequilibri en la carrera científica entre homes i dones s'inicia just en acabar el doctorat

The imbalance in the scientific career between men and women begins just after the PhD.



(Font pròpia)

What are the causes?

Cognitive skills?

Many "studies" conclude that:

Women are better in the areas of communication and language

Men have better spatial skills



Technological advances in medical imaging show that brain structures and their functions are neither fixed nor immutable. The human brain is **plastic** (can be trained) and **permeable** (it is affected by social attitudes, stereotypes...). "The search for differences between genders, at best, generates confusion rather than good information (*neurotrash*).

Our brains are intertwined with the world around us. There are more differences between the brains of different individuals than between the female and male brains. "

Gina Rippon (Emeritus Prof. at Aston U. Birmingham),

- The Psychologist. British Psychological Society. 29 (12): 918-922
- Gender and our brains, Published by Pantheon (2019)





"Whether there are fundamentally male or female brains is a misconception.

Brains and behavior are the product of the combined and continuous interactions of countless causal influences, which include gender-related factors but go far beyond them. "

Daphna Joel (Prof. Psychology and Neuroscience, U. Tel Aviv)

- The New York Times, Desembre 2018
- Gender mosaic: beyond the myth of the male and female brain, by: Daphna Joel, Luba Vikhanski, Ed. Little, Brown Spark (2019)

Stereotypes

We are being socially exposed to sexist messages since childhood



Stereotypes

Gender stereotypes about intelectual ability emerge early and influence children's interests

Lin Bian, Sarah-Jane Leslie, Andrei Cimpian

Science 355, 389-391 (2017)

Many children assimilate the idea that high intellectual capacity ("brilliant", "genius") is a masculine quality at a young age (6 years !!). Specifically, 6-year-old girls are less likely than boys to believe that members of their gender are "truly intelligent." Also, at the age of 6, girls begin to avoid doing activities aimed at "truly intelligent" children.

The gender stereotype affects the interests of children as soon as it is acquired and is likely to limit the range of careers they will consider in the future.

Stereotypes

Population : 20 to 55 years (with at least 2 years of higher education after 18 years) Fondation L'Oréal, Women in Science International Survey, August 2015

Women's aptitudes in various fields						
TOTAL						
Question 12 - In your opinion, which of the following fields do women have the most aptitudes for? 5032 people						
		Germany	UK	Spain	France	Italy
Everything except sciences	89%	97%	91%	83%	88%	89%
Social matters	38%	45%	31%	36%	45%	35%
Communication	20%	22%	22%	19%	19%	19%
Languages	13%	17%	12%	9%	10%	16%
The arts	8%	6%	12%	8%	6%	9%
Business	5%	3%	9%	4%	5%	4%
Politics	5%	4%	5%	7%	3%	6%
The sciences	10%	3%	8%	16%	10%	11%
DK	1%	-	1%	1%	2%	-
"oninionuon for	THEN - « Women in science » - August 2015					



Negative stereotypes about girls' abilities to do math or science work affect their performance and learning, diminishing their future prospects for embarking on the path of science.

Gender bias

The work environment in STEM jobs (Science, Technology, Engineering and Mathematics) is dominated by men

→ women are more concerned than men to be judged, criticized and evaluated on the basis of a negative stereotype.

Nepotism and sexism in peer-review

C. Wennerås, A. Wold Nature 387 (1997) 341

We decided to investigate whether the "peer review" system of the Swedish Medical Research Council (MRC), one of the leading funding agencies for biomedical research in Sweden, evaluates women and men on an equal footing. Our research has been motivated by the fact that the success rate of women who applied for postdoctoral fellowships at the MRC in the 1990s has been less than half that of men.



Maternity



The age at which many women choose to be mothers coincides with the most active and competitive stage of their research career.



NSF Survey of Graduate Students and Postdoctorates, 2012



Solutions?

Manifesto <u>**#FORWOMENINSCIENCE</u></u></u>**

("L'Oréal-UNESCO For Women in Science" association)



1/ Encourage girls to explore scientific career paths

2/ Break down the barriers that prevent women scientists from pursuing long term careers in research

3/ Prioritise women's access to senior positions and leadership positions in the sciences

4/ Celebrate with the general public the contribution that women scientists make to scientific progress and to society

5/ Ensure gender equality through participation and leadership in symposiums and scientific commissions, such as conferences, committees and board meetings

6/ Promote mentoring and networking for young scientists to enable them to plan and develop careers that meet their expectations 1/ Encourage girls to explore scientific career paths

... breaking stereotypes

Girls also invent and build!



GoldieBlox: A company created to stimulate girls' interest in engineering.

Her toys combine the story of Goldie, an inventive girl who loves to build, with a construction kit.

... making visible, in schools and institutes, the female heroines of science

... explain science in a "feminine" way

Women are more likely than men to prefer jobs with a social purpose. However, STEM occupations are not perceived as jobs that directly benefit society or individuals.

It is important to convey that any field of science has made relevant contributions, not only in the creation of knowledge, but also, and very especially, in making a better society.

What is Nuclear Physics?

It is the science that studies atomic nuclei, their structure, their modes of decay, the interactions between their elementary constituents and among other nuclei.

What does research in Nuclear Physics bring us?



Understanding the Universe: elements, neutron stars, GW



Health: Analysis tools (PET) and treatment of diseases (radiotherapy).



Energy (nuclear fission), being a challenge of the 21st century the use of nuclear fusion as a wastefree energy source.

2/ Break down the barriers that prevent women scientists from pursuing long term careers in research

... MUCH support in the period of motherhood and care of young children (reconcile work and family life)

- Reductions in working hours. Make schedules flexible.
- Discount maternity leave in competitions or evaluations
- Child care in meetings and conferences
- . . .

... incentives and awards specifically aimed at women



International **Rising Talents** awards L'Oréal-**UNESCO** For Women In On selection

National and regional programs L'Oréal-UNESCO For Women In Science On application

3/ Prioritise women's access to senior positions and leadership positions in the sciences

... changing perceptions / stereotypes

"Women are not perceived as leaders. It is an attitude that both men and women have and we need to change. Women need to be able to recognize themselves and each other as leaders."

Dava Sobel, science disseminator, El Pais, 20-03-2019

... keeping awareness that it is necessary to correct. (on equal merits, choose woman)

Important to build references (models to follow)

"Women attract women"

4/ Celebrate with the general public the contribution that women scientists make to scientific progress and to society

• Make women visible. Convey their contributions and their successes.

→ We are not just numbers!

3 Premis Nobel en Física

Marie Curie (1903)



In recognition of the extraordinary service carried out in the investigation of the radiation phenomenon

Maria Goeppert-Mayer (1963)

For her nuclear shell model

Donna Strickland (2018)



For her innovative discoveries in the field of laser physics.

5/ Ensure gender equality through participation and leadership in symposiums and scientific commissions, such as conferences, committees and board meetings

... women in plenary talks

... gender parity in committees

6/ Promote mentoring and networking for young scientists to enable them to plan and develop careers that meet their expectations

... Mentoring programs (guidance)

Programa Mentoria M2m (UPC)

expert woman

female student or recently graduated



Erasmus+ "Diversity in the cultures of physics"



For final year women students or at the beginning tof their PhD

Cecilia Payne-Gaposchkin (1900-1979), Astronomer Discovers the composition of the stars (and the universe)

"Young people, especially young women, often ask me for advice. Here it is, valeat quantum. Do not undertake a scientific career in quest of fame or money. There are easier and better ways to reach them. Undertake it only if nothing else will satisfy you; for nothing else is probably what you will receive. Your reward will be the widening of the horizon as you climb. And if you achieve that reward you will ask no other."



Mae Jemison (1956), the first African-American astronaut in space



"Don't let anyone rob you of your imagination, your creativity, or your curiosity. It's your place in the world; it's your life. Go on and do all you can with it, and make it the life you want to live."

Ann Nelson (1958-1919) Theoretical particle physics, Important contributions to the understanding of elementary interactions

"If your career is established and you are not making an explicit and continual effort to encourage, mentor, and support all young physicists, to create a welcoming climate in your department, and to promote the hiring of diverse faculty members, you are part of the problem."



We have a common challenge: to **close the gender gap** in science!

It requires the involvement of all (women and men), at all levels (group leaders, young researchers, evaluators, ...) and all types of institutions (scientific agencies, universities, research centers, funders, citizens, ...) Thank you!