

Women in mathematics and society

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Hypatia, 355 (?) - 414 AD



Hypatia (Alexandria 355(?)-414 AD) was born approximately 640 years later than Archimedes, the last of the three giants of the Greek mathematics, the first two being Pythagoras and Euclid.

She was in her time the world's leading mathematician, astronomer and philosopher.

She was the first woman mathematician in the world and, at the same time, the last mathematician of the Greco-Roman culture.

With the tools and methods of that time (and with the unpractical way Greeks and Romans represented numbers) the scientific work was reduced to copying old manuscripts and making comments on them.

There are dozens of books, novels and plays (and a movie) dedicated to her. There are two reasons for that. One is of course that she has been the first woman who excelled in scientific subjects, the other is her tragic death.

In the occasion of one of the many riots a mob of Christians kidnapped Hypatia, completely stripped her, and then cruelly murdered her with tiles.

There are authors who see in this tragic episode the end of the Greco-Roman culture.

And then the Dark Ages came which lasted for more than half of a millenium.

The small pilot flame of western culture has been preserved in monasteries (mostly run by monks rather than nuns).

First universities

In 11th century the first universities have been created (**Bologna in 1088** and **Oxford in 1096**).

Soon other followed: **Salamanca (1134)**, **Paris*** (~ 1150), **Cambridge (1209)**, **Padua (1222)**, **Naples (1224)** and others.

But women were excluded from them and it took centuries before the more motivated and courageous succeeded to break the male monopoly.

Surprisingly enough, the golden, silver and bronze medal goes to three Italian ladies.

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Elena Lucrezia Cornaro (Corner) Piscopia (1646 -1684)





Elena Lucrezia Cornaro (Corner) Piscopia, known also as Helen Cornaro (1646 -1684), was an Italian philosopher born in a noble family, who became in 1678 the first woman in the world to receive a Ph.D. degree.

When her father asked if she could obtain from the University of Padua a degree in theology, the bishop of Padua refused it on the grounds that she was a woman, defining the request "bizarre".

However, she was allowed to get a degree in philosophy (in 1678), the first woman in the world to get a title equivalent to what is today a PhD.

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Laura Maria Caterina Bassi (1711-1778)



Laura Bassi

Laura Maria Caterina Bassi (1711-1778) was an Italian **physicist**. She received a doctoral degree from the University of Bologna in 1732, the second degree ever given to a woman by a university.

She brought to Italy Newton's ideas, fighting with her advisor.

In 1776 she applied and obtained the vacant chair of experimental physics.

She was the first woman in the world to obtain a university chair in a scientific field.

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Maria Gaetana Agnesi (1718-1799)



Maria Gaetana Agnesi (1718-1799) was born in Milan. Her family was rich and cultured.

She published in 1748 the book “Istituzioni analitiche ad uso della gioventù italiana”, (Analytical Institutions for the Use of Italian Youth) discussing differential and integral calculus.

This is the **first book on mathematics on the university level written by a woman**. It was regarded as the best existent introduction to the works of Euler and has been translated in French and English.

In 1750 she was appointed by Pope Benedict XIV to the chair of mathematics at the university of Bologna, but she did not accept the offer.

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In the 19th century there were many more women active in scientific subjects and mathematics in particular, so one has to make a selection in such a short review.

The most important women mathematicians who lived in the 19th century are, in my opinion, **Marie-Sophie Germain, Ada Lovelace and Sofia Kowalevskaya.**

They obtained the first original results.

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Marie-Sophie Germain (1776-1831)



Since women could not enrolle at the École Polytechnique (established in 1794), she resorted to a trick and used as nome de plume the name of a male student (Antoin-August Le Blanc) who abandoned the studies.

She could get of the notes of the courses and submitted written essays under her nome de plum.

Lagrange, surprised by the impressive progress of Le Blanc, wanted to see the author of the written notes.

She was afraid that Lagrange will be angry because she cheated on l' École. But he understood the situation and, on the contrary, acted with great understanding. He praised her talent and encouraged her to continue the studies.

She worked on the Fermat last theorem and obtained some partial results. In the process she introduced certain prime numbers (called also nowadays Germain primes).

Using again her nome de plume she wrote to Gauß who was at that time also interested in the problem.

When Napoleon invaded Prussia, she became afraid of what could happen to Gauß. So she talked to a general who was family's friend.

He actually took care of the famous mathematician, but her name did not say anything to Gauß. Only months later he discovered the truth.

He wrote to her

“How can I describe my astonishment and admiration on seeing my esteemed correspondent M. Le Blanc metamorphosed into this celebrated person [...] when a woman, because of her sex, our customs and prejudices, encounters infinitely more obstacles than men in familiarising herself with [number theory's] knotty problems, yet overcomes these fetters and penetrates that which is most hidden, she doubtless has the most noble courage, extraordinary talent, and superior genius.”

(from Wikipedia)

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Ada Lovelace (1815-1852)



Ada Lovelace (1815-1852) was the only legitimate daughter of Lord Byron. She (with her mother) was abandoned when she was one month old and she never had any contact with him.

One of her first tutors was Augustus De Morgan.

Her social and educational path brought her in contact with men like Michael Faraday and Charles Dickens.

In 1833, she met the mathematician Charles Babbage. He is famous in particular for having imagined the first “computer”. He called it the Analytical Engine.

An Italian engineer wrote an article on the Engine.

Ada translated it adding consistent notes.

The notes contain the first “computer program”, an algorithm which would allow the Engine to calculate the Bernoulli numbers.

But the Engine has never been constructed, because the existing technology was not precise enough.

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Sofia Kovalevskaya (1850-1891)



The most eminent female in mathematics of that period was certainly Sofia Kowalevskaya.

Her story is different from the others.

Germain, Lovelace, and also the three Italian ladies mentioned at the beginning, had full support from their (wealthy) families and did not have to worry about their subsistence.

A Russian lady could only study abroad, but she would need written permission from her father or, if married, from her husband.

But her father would not allow her to go abroad alone.

So she negotiated a fictitious marriage with a young (radical and nihilist) student Vladimir Kovalevskij (who would later become a collaborator of Charles Darwin).

The married couple emigrated from Russia in 1867.

Sofia went first to Heidelberg and then, in 1870, to Berlin to study with Weierstraß, but Berlin university was even stricter than Heidelberg. Women were even not admitted to sporadic lectures.

Weierstraß was so deeply impressed by Sofia that, “**notwithstanding a strong prejudice against higher education for women, he agreed to teach her privately**”.

By 1874 Sofia produced three original works. But it was impossible to get the doctoral degree in Berlin.

Weierstraß knew of a precedent in Göttingen, where doctoral degrees have been awarded to foreigners “in absentia”. So in the same year she obtained summa cum laude a doctorate in mathematics.

For almost ten years she and her husband lived in Germany. Needless to say, Sofia could not get a position at a university.

Vladimir run into psychological problems and in 1883 he committed suicide.

In the same year, thanks to the help of Mittag-Leffler, she got a position of Privat-Docent at the university of Stockholm.

The next year she obtained a five-year position as Professor Extraordinarius. **In 1889 she was appointed Professor Ordinarius at Stockholm University.**

She was the first woman to become full professor of mathematics.

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The number of women mathematician is, fortunately, strictly increasing.

Therefore, while the selection I made of the three lady scientists of the 19th century is disputable, but does not offer many alternatives, for the 20th and 21st century it is not possible to make any “list”.

In fact one can find in internet something called the “**List of women in mathematics**” (entry of the authoritative Wikipedia) with about 600 names.

But I believe that forming such lists is counterproductive because it heavily underestimates the contribution women are giving to mathematics at the university level nowadays.

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(Emmy Noether (1882-1935))





Whichever criterion we chose, 20th century is dominated by Emmy Noether.

She was born in Erlangen in 1882. She studied mathematics there and completed her **dissertation in 1907**.

In 1915 she was invited by David Hilbert and Felix Klein to join the mathematics department in **Göttingen**.

Her **Habilitation was approved in 1919**, and she obtained the title of **Privatdozent**.

Hilbert tried to obtain a position for her, but all his efforts were in vain. When he lost any hope, he addressed to his colleagues the famous sentence: **“Meine Herren, eine Universität ist doch keine Badeanstalt!”** (Gentlemen, a university is not a seaside resort!)

She was “wrong” for three reasons: she was woman, a Jew and left-wing.

In 1933 the Nazis withdrew her the licence to teach, so she moved to the States.

She took up a Faculty position at Bryn Mawr, a women’s college, one of the Seven Sisters.

Emmy Noether also gave weekly lectures in Princeton.

She died prematurely in 1935 after an operation.

She was described by Pavel Alexandrov, Albert Einstein, Jean Dieudonné, Hermann Weyl, and Norbert Wiener as the most important woman in the history of mathematics.

She will be remembered mostly for her contribution to abstract algebra and for Noether's theorem, as it is now called. It unites two important aspects of physics: symmetry in nature and the universal laws of conservation.

Some consider it as important as Einstein's theory of relativity.

It supports much of today's advanced research in physics.

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The last two mathematicians I mentioned, Sophia Kowalevskaya and Emmy Noether remained me of the period I spent as visiting professor in Erlangen (academic year '82/'83 and six months in '84).

If we don't mention the staff (secretaries, librarian) the only female presence were the pictures of the two distinguished scientists, apart from a single woman PhD student (without stipend) who periodically came to see her advisor.

I followed there a course of German language. One of the teachers, who was about seventy, told us what happened to her when she was young.

Women were at that time admitted, but one of her professors was old-fashioned and nasty. When he saw her in the classroom (she was the only girl) he stood in front of the class and said "Ich warte", and did not begin the lecture as long as she did not leave.

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Important encounters

With Emmy Noether, a sort of female Gauß, I end the historical introduction.

I will mention now three important woman mathematicians I met in my life and who were important for my growth as a mathematician.

This choice of course is very personal, depends essentially on my research interests and is by no means a ranking.

The first I would like to mention is **Dorothy Maharam (1917-2014)**.

She was one of the co-organisers (together with Dietrich Kölzow, from Erlangen) of the meetings on measure theory in Oberwolfach and I met her the first time there in 1979. I continued to meet her at various meetings in Oberwolfach, in Italy and around the world.

Once I invited her to my university, at that time Trieste, together with her husband, Arthur H. Stone, a leading topologist.

Dorothy Maharam (1917-2014)





She graduated at Bryn Mawr College. Unfortunately she arrived two years after Emmy Noether passed away. One of her advisors there was John Oxtoby.

After her graduation Dorothy got the support to spend a year at Princeton in 1940.

There she met Kakutani, Erdős and von Neumann, but also Arthur Stone who came from Cambridge to get his PhD.

She and Arthur married in 1942.

This is how she describes in an interview her year in Princeton:

“When I came to the Institute for Advanced Study, as a shy post-graduate student, I expected to be ignored, and that everyone would assume that I had been admitted as a pretty face. . . . So I persisted in staying quiet, not wanting to breathe a word about any mathematics I was doing.

Paul Erdős absolutely insisted on bringing me out, pulling from me to the work I had done, and discussing it with me. When I had new results, he (and Kakutani) went around to the other mathematicians there, saying ‘Dorothy has proved a theorem’.”

She will be remembered in particular for her theorem on the existence of liftings.

Answering a question of Haar, von Neumann proved in 1931 the existence of a lifting on the real line.

Dorothy proved the general case in 1958.

In 1961 she and Arthur became professors at the University of Rochester in spite of the anti-nepotism rules which were in place at most universities.

These rules represented an additional obstacle for women undertaking the university career.

A famous negative example is Maria Goeppert-Mayer, who won the 1963 Nobel Prize in physics for developing the nuclear shell model of atomic nuclei.

Goeppert-Mayer obtained her first paid position at the University of San Diego in 1959, when she was fiftythree, just four years before she won the Nobel Prize.

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Marry Ellen Rudin (1924- 2013)



One of my fields of interest has been general topology.

So I inevitably run into the papers of Marry Ellen Rudin, who was the most important woman topologist of her time.

She proved several important results, but she was particularly good in constructing examples and counterexamples.

She served as vice-president of the AMS.

In 1993 I was one of the co-organizers of the International Conference in Topology in Trieste and she was the star of that event.

Walter Rudin, her husband, was the accompanying person.

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Alexandra Bellow (1935-)





She was born in Bucharest. She graduated in 1957 at the university of Bucharest and got her PhD at Yale in 1959 under the supervision of Kakutani.

She and her husband (Cassius Ionescu Tulcea) wrote in 1969 the important monograph "Topics in the theory of liftings". This book was one of my "bibles".

I met her the first time in Oberwolfach in 1979 and then several times at various meetings.

In the sixties and seventies the Ionescu Tulceas provided the definitive treatment of the theory of liftings.

Later she obtained many important results in ergodic theory.

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Maryam Mirzakhani (1977-2017)



In an event like this it is appropriate to commemorate Maryam Mirzakhani, the first and, for the time being, the only woman who got the Fields Medal (in 2014).

She proved that there is no limit in the progress women can make in mathematics.

She was born in Teheran. After getting her Bachelor of Science degree in 1999 in Iran, she moved to the States and obtained the PhD degree at Harvard in 2004.

In the same year she was research fellow of the Clay Mathematics Institute and a professor at Princeton University.

In 2008 she became a professor at Stanford University. She passed away much too early on July 14 this year.

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Margherita Hack (1922-2013)





Let me use this opportunity to dedicate an affectionate thought to my former colleague and friend Margherita Hack.

She was a famous astronomer, also well-known in Italy for the many books of popular science she wrote.

She was hostile to any form of superstition, including pseudoscience. She was honorary president of the Union of Rationalist, Atheists and Agnostics.

She was not a mathematician, but I mention her since there has been an attempt to discriminate her as a woman.

She got the chair in Trieste in 1964, when I was a student.

The Science Faculty, which appointed her, was formed at that time by a dozen of professors, all male.

One of the professors motivated his opposition saying that in their gatherings they will not be any more allowed to use the word "idiot" (he used in fact a dirty word to express the concept).

But the majority decided in her favour, proving that he was wrong, because later she frequently used that word talking to him.

I learned this sweet and sour story several years later from one of my older colleagues, who took part of the discussion (and voted in her favour).

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When I was twenty I was playing chess (on an amateur level). I never played against a woman and never saw a woman playing chess.

But things are changing. Among the about 1600 GM in the world there are 35 women, and their number (and percentage) is increasing. There is a serious discussion in FIDE on the abolishment of the women federation and of the tournaments for women only.

A great deal of the swing is due to three sisters: Susan, Sofia and Judit Polgár. The first is GM, the second is International Master, but Judit is the most talented.

Judit, Sofia and Susan Polgár



Judit became GM at the age of 15.

In 2003 (at the age of 27) she was No. 8 in the world according to the Elo ranking.

In 2004 she took some time off to give birth to her son, but in 2005 she was again No. 8.

Later she gave birth to her daughter.

In 2014, at the age of 38, she announced that she was abandoning the professional chess.

Kasparov touch move controversy

In 1994, when Judit was 17, she played in the important Linares tournament in Spain.

In the fifth round she played against Garry Kasparov. He was at that time the world champion and is considered one of the greatest chess players of all times.

After about thirty moves he obtained a clear advantage, but then moved one of his pieces and dropped it on a square. He immediately realized that the move was losing, so after a fraction of second he moved the piece to a different square.

This is against the rules, but the Arbiter took no action.

Judit said later that she “was playing against the world champion and did not want to cause any unpleasantness during my first invitation to such an important event”.

She spoke to Kasparov the same day, but he never recognized publicly his violation of the rules.

The incident was videotaped by a Spanish TV and on one frame Kasparov’s fingers were free from the piece.

For years after they were not on speaking terms, though they have since been reconciliated.

In 2002 she took the revenge and beat him in the very important match “Russia against the World”.

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Two years ago an article appeared on a website in which the novelist Catherine Nichols told about an experiment she performed.

She sent out the first chapter of her novel to several agents and did not receive any answer.

But then she made up a male nom de plume with a new email address.

“I put in the address of one of the agents I intended to query under my own name. I did not expect to hear back for a few weeks, if at all. It would only be a few queries and then I would close my experiment. I began preparing another query. When I clicked back, there was already a new message, the first one in the empty inbox.

‘Mr. So-and-so. Delighted. Excited. Please send the manuscript.’ ”

After more than 150 years another Brontës case.

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Penelope Gazin, Kate Dwyar and Keith Mann



Two entrepreneurs named Penelope Gazin and Kate Dwyer founded an online marketplace for art. In August this year they disclosed a secret.

They had the impression that the mostly male designers and developers they hired were disrespectful and slow in answering their requests.

So they brought in a third partner: a fictional character bearing the significant name of Keith **Mann** (what else).

In an interview they declared “It was like night and day. It would take us days to get a response, but Keith could not only get a response and a status update, but also be asked if he wanted anything else or if there was anything else that Keith needed help with.”

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Barres was assigned female at his birth in 1955 and named Barbara.

After a brilliant career at the Stanford School of Medicine, in 2008 he was appointed to the Chair of Neurobiology.

In 1997, he changed sex from female to male and changed his name to Ben.

As a student, after solving a math problem that was too difficult for many male students, he was accused that it was solved for him by a boyfriend.

He lost a scholarship to a man who had only one publication, while he already had six.

After transitioning, he noticed that people who were not aware of his transgender status treated him with respect much more than when he presented as a woman.

After delivering his first seminar as a man, one scientist was overheard to comment “Ben Barres gave a great seminar today, but his work is much better than his sister’s work [believing Barbara to be his sister].”

Catherine Nichols, Penelope Gazin with Kate Dwyar and Ben Barres are all examples of the wide-spread “Kasparov syndrome”.

Some women have a social position which allows them to bring their case to the attention of the general public.

But, as the influential Italian newspaper Sole 24ore writes (April 2017) in Italy the gender salary gap is of about 11% and the difference rises to more than 36% among those who have a university degree.

Today's event is dedicated to women in mathematics and their discrimination. Justly so, since everybody has to fight his or her own battle.

At the same time we should not forget that in the world there are many other discriminations. Sexual orientation borders the issue on which we are putting the spotlight today.

But we should not forget discrimination on the basis of age, caste, disability, race or ethnicity, religion, language, nationality and drug use (from "Discrimination", entry of Wikipedia).

I hesitated to copy the last cause for discrimination from Wikipedia. But then I decided to put it.

I must be a bad guy. Possibly I would discriminate somebody who uses drugs.

With this remark and warning I would like to end.

Thank you for your attention!