

hAPPY nOETHEMBER

In our textbooks, we often read theorem after theorem named after male mathematicians. This is a natural consequence of greater educational inequality in the past. Nevertheless, at the end of a study day, I often long to hear more from other women doing mathematics. Four of them I will introduce to you now.



Emmy Noether

Mother of Modern Algebra.

One of the first women whose name appears frequently is the first woman to be a mathematics professor in Germany (appointed 101 years ago): Emmy Noether. Her path to this position was not easy at the time, however. Emmy started studying in Erlangen and was one of two women in almost a thousand students. She started teaching at the University of Erlangen and was introduced to the work of David Hilbert by her friend Ernst Fischer, with whom she discussed mathematical ideas after lectures and through postcards. Felix Klein and David Hilbert invited her to Göttingen.

Noether first started teaching under Hilbert's name, as the faculty did not allow a woman to become a professor. She was reported to have a great influence on tal-

ented mathematicians and her students, whom she taught in a spontaneous discussion style, were known as the "Noether boys". In her first year in Göttingen, she proved what is now known as Noether's theorem, which can be stated informally as: "If a system has a continuous symmetry property, then there are corresponding quantities whose values are conserved in time". It has been compared in its relevance to modern physics to the Pythagorean theorem.

Her work was also fundamental to the development of modern algebra. She made use of the "ascending chain condition" (no infinite ascending chain of elements in P exists) to prove important theorems in the area of ideal theory and had a great influence on the style of algebra research

through her teaching and discussions with other mathematicians. Her colleagues continuously fought for her to be hired as a Privatdozent and be paid for her work, which finally happened in 1919. From then on she no longer depended on her family's financial support to be able to do her work.

In 1933 Noether emigrated to the US, where she died shortly after. Noether was well-liked by colleagues, who also remember her response to the occurrences in Germany at the time: "her courage, her frankness, her unconcern about her own fate, her conciliatory spirit—was in the midst of all the hatred and meanness, despair and sorrow surrounding us, a moral solace" (Hermann Weyl).

In the same year as Noether became professor, the second mathematician I would like to introduce to you was born: Julia Robinson. Most of her work focused on the effective solvability or unsolvability of problems (i.e. can we give an algorithm to solve a given problem?). She is famous for her contribution to the resolution of Hilbert's tenth problem, which states the following:

"Given a Diophantine equation with any number of unknown quantities and with rational integral numerical coefficients: To devise a process according to which it can be determined by a finite number of operations whether the equation is solvable in rational integers."

Robinson remembered being

already fascinated by natural numbers as a child. She studied in Berkeley and received her PhD under Alfred Tarski's supervision. She also taught at Berkeley, though never in full capacity, as she was suffering from a heart condition. Her decision to fully pursue mathematical research was only reached after finding out that due to this condition she would likely not be able to have the children she had wished for.

Building on Robinson's preparatory work, Yuri Matiyasevich solved Hilbert's problem in 1969. He has written about the story of their collaboration. Matiyasevich started working on the problem as a student. He had read some of Julia's works



but temporarily given up on solving the problem when friends told him to rush to the library to get the new paper she had published. At first he did not want to read it until he was asked to review it and subsequently started working on the problem again, proving that there was no general algorithm shortly after.

Julia had almost been there herself, but she was happy when she heard of his solution, as she had cared more about knowing the solution than being the first one to find it. A corollary to the impossibility proof was that any diophantine equation can be transformed into one

with the same parameters but exactly N unknowns that is solvable if and only if the original equation is solvable. In the years following Matiyasevich's publication of the result, he cooperated with Robinson to reduce this N from originally approximately 200. They sent letters between the Soviet Union and the US with turnaround times of 30 days. She wrote of "breaking the alphabetical barrier" when they were suddenly able to write their equations with Latin characters only. Later they reached $N=13$. There is still ongoing research into diophantine equations and non-natural solutions.

Robinson received many honours for her work. She was given a MacArthur Fellowship and elected as president of the American Mathematical Society (AMS). She was the first woman to hold the position 1983-1984 and one of only three women until now. In 1982 she held the Noether Lecture. The Noether Lecture is awarded to one outstanding woman every year by AMS and the Association for Women in Mathematics. The list of speakers is a great resource to find more inspirational stories about female mathematicians.

Besides the Noether Lecture, Emmy Noether is also celebrated for her achievements in many other ways. Noethermonth was created as a drawing challenge by mathematician and illustrator Constaza Rojas-Molina in 2018. Rojas-Molina works in the area of mathematical physics, studying Anderson localization with the help of spectral theory of random Schroedinger operators at CY Cergy Paris Université. Some of her drawings for Noethermonth illustrate this article.

Noethermonth Day 26



Tja, that was definitely the road less traveled

On her blog “Rage of the Blackboard”, you can find more graphical depictions of interviews with mathematicians and sketch notes from conferences.

One mathematician she interviewed, who also writes in a non-technical style, is category theorist Eugenia Cheng. Cheng is passionate about bringing mathematics to a wider audience. She has recently published *x+y - A Mathematician’s Manifesto to Rethinking Gender*, which tackles gender questions with the tools of category theory.

Also named after Noether is the Noetherian Ring, both as a mathematical object and an association for women in mathematics. The first Noetherian Ring was founded at the university of Berkeley. Their website contains an excellent collection of writings on mathematics and diversity.

Inspired by the recent debate on most universities in central Europe being named after men, the student council at the Georg-August-University in Göttingen has proclaimed to be in favour of renaming the university.

Robinson visited Göttingen together with her sister, who was writing about Hilbert at the time and later wrote Robinson’s autobiography. In her last days, Robinson talked about her gratefulness to the mathematicians that inspired her and for her friendship with Matiyasevich.

Her sister also remembers Robinson as strongly believing in the abilities of women in mathematics and affirmative action to promote their careers. She writes that Robinson thought of mathematicians “as forming a nation of our own without distinctions of geographical origins, race, creed, sex, age, or even time (the mathematicians of the past and you of the future are our colleagues too)—all dedicated to the most beautiful of the arts and sciences.”

Although all mathematicians mentioned in this article share(d) this vision, we must acknowledge that it is not yet true that there are no such distinctions. Do you have ideas on how to make the nation of mathematicians and physicists more diverse, inclusive and equal? Are you interested in facilitating gender equality within our departments and would you like to discuss gender related issues at ETH? Do you want to get to know like-minded colleagues of all genders? Contact us at phimale-intern@vmp.ethz.ch or visit our website for information on upcoming events and links related to this article:

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