1700 1800 1900 2000

Women of Mathematics

Hypatia of Alexandria (ca. 370-415)

Known to history as the first female mathematician, Hypatia was the daughter of mathematician and philosopher Theon of Alexandria. She assisted in the writing of his eleven part commentary of Ptolemy's Almagest. Following in her father's foots steps, Hypatia wrote commentaries on the works of Diophantus and Apollonious. Though none of these works are extant, we know of them through references in other works. About 400 AD, she became the head of the Platonist school in Alexandria and lectured on mathematics and philosophy. Known as a dynamic teacher, she became the center of learning in Alexandria. Living at the time of the rise of Christianity and the decline of Roman control of Alexandria, she also came to represent paganism and secularism to certain factions of Christians. Legend tells that she was brutally murdered by a mob of Christians, possibly the followers of Peter the Reader.

FOUR WOMEN FROM TAIWAN

Sun-Yung Alice Chang, Fan Chung, Wen-Ching Winnie Li and Karen Uhlenbeck were all undergraduates in the same class at National Taiwan University; now they are, respectively, mathematicians at Princeton University, University of California at San Diego, Pennsylvania State University, and the University of Illinois. Coincidence? Unlikely. While ability was clearly there, as was drive, many women have both. Another important aspect in their success was the close friendship they developed as students in the 1960s, which supported them as they first pursued PhDs in the United States and then careers, all the while juggling research and other life responsibilities. This aspect sheds a light into the past and is a lesson for the future: numbers matter, support matters, and when women have these, research careers blossom.

TRIPOS

The origins of the Cambridge Mathematical Tripos date back at least to the fifteenth century. The examination evolved from disputations or wrangles which required students vying for an honors degree to debate a thesis of their own choosing before opponents in the presence of a moderator who sat on a three legged stool or tripos. The person who ranked first on the Tripos was called the Senior Wrangler. The person who ranked last was designated the Wooden Spoon. By the 1800s the Tripos was a fifty-hour ordeal spread over nine days containing 210 questions, many containing several parts. On the 1880 exam Charlotte Scott of Giron College became the first woman to achieve First Class honors on the Tripos. As a consequence, women were formally admitted to the examinations, their results publicly announced, and if successful given certificates of achievement. Women who completed the program of study at either Girton or Newnham and were successful on the Tripos examinations were not given Cambridge degrees. In order to obtain a degree, women had to pass an examination from a college which offered such external degrees. On the 1890 Tripos, a thirty-six-hour examination spread over six days, Philippa Garrett Fawcett of Newnham College placed above Geoffrey Bennett of St. John's, the Senior Wrangler, by more than thirteen percentage points.

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At the start of the 1700s we find that women are not allowed to attend lectures at a university, nor the discussions in the academic societies, and are not allowed in cafes where much lively exchange was enjoyed by men.

Only those who had the good fortune of being in a prosperous family that supported their desire to learn had access to the sciences. In the 1700s those were few indeed.

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Gabrielle Émilie Le Tonnelier de Breteuil, Marquise du Châtelet (1706 - 1749)

She was married in 1725 to the Marquis du Châtelet. Her aristocratic background and beauty made it possible for her to meet mathematicians and learn mathematics. At various times she studied with Maupertuis, A.-C. Clairaut, and Samuel König. She charmed Voltaire, and lived with him for a number of years. She entered the Paris Academy of Sciences prize competition of 1737 with a paper on the nature and propagation of fire (Euler won). She collaborated with Voltaire on his Elements of the Philosophy of Newton (1738), and published Institutions de physique, in 1740. She is best known for her French translation, with commentary, of Newton's Principia, published after her death in 1759. For 250 years this was the only French translation. Du Châtelet was one of the few French women of this period to seriously develop a talent for mathematics and physics.

Augusta Ada, Countess of Lovelace (1815 - 1852)

Poetry comes in many forms. Lord Byron, father of Ada Lovelace, was a romantic poet. Lovelace translated Luigi Menabrea's notes on Charles Babbage's Analytical Engine, a proposed mechanical calculating device with storage. In her notes accompanying the translation, Lovice made a number of striking observations. She noted the Analytical Engine was a device for manipulating not just numbers, but symbols. Lovelace showed how to use the machine for calculating Bernoulli numbers, writing, in essence, the first computer program. Her tutor, the logician Auguste de Morgan, had described Lovelace as creative and determined "to get beyond the current bounds of knowledge." Lovelace's work lay forgotten for almost a century, but was republished in 1953. In 1980, the U.S. Department of Defense named Ada, a new computer language, after Lovelace.

Sofia Kovalevskaya (1850 - 1891)

Influenced by the radical movements of the 1860s in Russia, Kovalevskaia dedicated herself to becoming a mathematician and a pioneer of women's education. She began with private mathematics tutoring at home, but to continue her studies, she had to leave Russia. She was taught privately by Weierstrass, who persuaded Göttingen University to award "the most talented of my students" a doctorate in 1874 based on three of her papers. The Cauchy-Kovalevskaia Theorem, fundamental in the theory of partial differential equations, came from this thesis work. Kovalevskaia eventually obtained a professorship in Stockholm; she was the first woman to receive a Ph.D. in mathematics and the first to teach it at the university level in Europe. In 1888 she won the Bordin Prize of the Paris Academy of Sciences for her work on rotation of a solid body about a fixed point.

Christine Ladd-Franklin (1847 - 1930)

Christine Ladd-Franklin was instrumental in breaking down social and educational barriers enabling women to pursue graduate degrees. She authored over a hundred articles in mathematics, symbolic logic, and psychology. After graduating as valedictorian from Wesleyan Academy in Wilbraham, Massachusetts, she attended Vassar College. After one year, she was forced to drop out due to lack of funds. She taught in Utica, New York before the generosity of an aunt enabled her to resume her studies at Vassar. After graduation she taught in secondary schools for twelve years before beginning graduate studies in mathematics at John Hopkins under the supervision of James J. Sylvester and Charles Sanders Peirce. By 1882 she had completed all her course work and dissertation but at the time Johns Hopkins did not grant degrees to women. In 1887, she received the only honorary degree ever awarded by Vassar College. In 1926, at age seventy-nine she finally received her Ph.D. from Johns Hopkins.

Florence Nightingale (1820 - 1910)

Florence Nightingale is best known as a pioneering nurse and leader in the professionalization of nursing in Britain. Educated by her father in languages and, more unusually for a woman, mathematics, she became a pioneer in the collection, analysis, and explanation of social statistics. As a nurse in the Crimean war, she recognized the importance of reliable data in learning how to prevent deaths in the military. She collected such data, and used statistical evidence to help reform sanitary conditions and treatments for soldiers both in wartime and peacetime. She demonstrated how uniform and accurate hospital statistics could be used to evaluate the value of specific methods of treatment and operations. Nightingale was also a pioneer in the graphical representation of statistics. She im ented polar-area charts, in which the statistic is represented as proportional to a wedge in a circular diagram.

Marie-Sophie Germain (1776 - 1831)

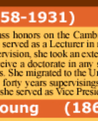
Though born into affluence, Germain was largely self-taught. Against her parent's wishes, she studied mathematics secretly at night. Not allowed to attend university because she was a woman, Germain assumed the male persona of M. Le Blanc and studied lecture notes of Legrandre from the Ecole Polytechnique. Later she worked via correspondence with Carl Friedrich Gauss who became her mentor. She only revealed herself to Gauss when the French occupation of Germany threatened his life, and she used her connections in the French army to help protect him. Germain proved that Fermat's Last Theorem would fave a solution for odd exponents, n, less than 100, only if n divides x, y or z. In particular, she showed there is no solution for n=5. This result is known as Germain's Theorem. She also did research in elasticity, as well as philosophy.

Caroline Lucretia `Lina' Herschel (1750 - 1848)

Caroline Herschel was born in Hanover, Germany. Her astronomer brother, William Herschel, who in 1781 discovered the planet Uranus, became an organist in England, where Caroline joined him in 1772. William taught her music, but also astronomy and mathematics. She began a career as a singer, but William's need and her skill in applied mathematics led her to assist William by making calculations based on his observations. She also sy stematically searched for comets, and discovered 8 between 1786 and 1797. She also discovered three new nebulae, including the companion to the Andromeda nebula. Her revised and updated version of Flamsteed's star catalogue was published by the Royal Society in 1798. Later, assisting William's son John F. W. Herschel, she catalogued 2500 nebulae; in 1828 the Royal Astronomical Society awarded her its gold medal for this work. She was named an honorary member of the Royal Society in 1835.

Maria Gaetana Agnesi (1718 - 1799)

The eldest child of a wealthy family, Maria Agnesi was first educated at home, then read l'Hospital and Reyneau, and also discussed mathematics with Riccati. She was the first woman to publish a work in pure mathematics. Her Analytical Institutions (1748) was the most complete book-length treatment of algebra, analytic geometry, and calculus in the eighteenth century. The book was translated from Italian into English, with the curve's name "versiera" mistranslated as "witch," resulting in the curve's being called "the witch of Agnesi." According to ideas prominent in the Catholic Enlightenment in Italy, mathematics, unlike other subjects, was thought to provide true knowledge, and there was space for a few talented women. Pope Benedict XIV offered Agnesi the chair of mathematics at the University of Bologna, though she did not take it up. In 1752 she turned from mathematics to hospital work, and died in poverty.



Charlotte Angas Scott (1858-1931)

In 1880, Scott was the first woman to achieve First Class honors on the Cambridge Mathematical Tripos. As a consequence, women were formally admitted to the examinations. She served as a Lecturer in mathematics at Girton College, Cambridge and attended Arthur Cayley's lectures. In 1885, under his supervision, she took an external D.Sc. degree with honors from the University of London, becoming the first British woman to receive a doctorate in any subject and the second European woman, after Sofia Kovalevskaia, to receive a doctorate in mathematics. She migrated to the United States to become chair of the mathematics department at Bryn Mawr, a position she held for nearly forty years supervisingseven doctoral dissertations. She served as co-editor of the American Journal of Mathematics. In 1905, she served as Vice President of the American Mathematical Society.

Grace Chisholm Young (1868 - 1944)

In 1896, Grace Chisholm became the first woman to receive a Ph.D. in any field from a German University through coursework and a dissertation. Her Ph.D., Magna Cum Laude from the University of Göttingen, was supervised by Felix Klein. Educated at home, then at Girton College, Cambridge, she received the "equivalent" of a first-class degree on the Cambridge 1892 Mathematical Tripos, Part I. After the Ph.D., she married William Henry Young, a tutor at Girton. Together they wrote over 200 mathematical articles and several books that established their reputations, particularly in the field of real analysis. Her most famous result, later called the "Denjoy-Young-Saks Theorem", concerns the derivates of a real function. She completed a medical degree except for the internship, was fluent in six languages and brought up six children. In 1915 she was awarded the Gamble Prize from Girton for her essay on "Infinite derivatives".

Anna Johnson Pell Wheeler (1883 - 1966)

Wheeler was born in Iowa to Swedish immigrants. She earned her PhD from the University of Chicago under the direction of E.H. Moore in 1909 with work in integral equations. While working towards her doctorate, she studied in Germany under David Hilbert in the new field of functional analysis. In particular she studied infinite dimensional linear spaces. In 1918 Wheeler took a position at Bryn Mawr, where she became department chair in 1924. In 1927 Wheeler became the first women to give the Colloquium Lectures of the American Mathematical Association (the next would be Julia Robinson in 1980.) Her talk was on the "Theory of quadratic forms in infinitely many variables and applications". She was an editor of the Annals of Mathematics for 18 years and retired from Bryn Mawr in 1948.

Mina Rees (1902-1997)

Mathematicians often claim that abstraction provides deep insights that enables the solution of hard problems; Mina Rees lived it. She received her doctorate at the University of Chicago in 1931 under the supervision L.E Dickson. An algebraist by training, while a professor at Hunter College, Rees was called to Washington during World War II to serve on the Applied Mathematics Panel of the National Defense Research Committee. She was central to the panel's effort of taking hard military problems (including fire control and resource allocation) and abstracting out their mathematical essence, then finding the mathematical expertise to solve it. After the war Rees was awarded the President's Order of Merit (U.S.) and the King's Medal for Service in the Cause of Freedom (U.K). Later Rees headed the mathematics division of the Office of Naval Research, directing government support of research and demonstrating great foresight. In 1971 Rees was the founding president of the CUNY Grad Center and the first woman president of the American Association for the Advancement of Science.

Emma Lehmer (1906-2007)

Born in Samara, Russia, Emma Trotskaia Lehmer grew up in Manchuria, being tutored at home until she was 14. She received her B.A in mathematics from UC Berkeley in 1928 and her masters from Brown in 1930. Though holding a university teaching position only during the war years, and never receiving a PhD, She wrote 56 mathematical papers, 22 of them joint with her husband, Derrick Lehmer. She worked on Fermat's Last Theorem and computational aspects of algebraic number theory. She was among the first to use the ENIAC computer on number theory problems, and in fact all of her work was characterized by a strong computational component. The Lehmers are generally recognized as inaugurating the modern era of experimental and computational number theory. In 1969, the Lehmers founded the West Coast Number Theory Conference, an informal, student-friendly meeting which continues annually. Lehmer conducted mathematical research well into her eighties.

Olga Taussky-Todd (1906 - 1995)

Olga Taussky received her doctorate from the University of Vienna. After instructorships at the Universities of Vienna and Göttingen, she pursued research at Girton College, Cambridge and Bryn Mahr and became the first women to be admitted to the faculty of California Institute of Technology. During WWII she worked at the National Physical Laboratory at Teddington, England and after the war at the National Bureau of Standards in the United States. She had over 200 publications. Her work was in algebraic number theory, matrix theory, group theory, and partial differential equations. The Mathematical Association of America awarded her the Ford Prize in 1971 for her article on sums of squares. In 1978 the Austrian government gave her their highest award, The Cross of Honour in Science and Arts, First Class. She served on the Councils of the London Mathematical Society and the American Mathematical Society and as a Vice-President of the American Mathematical Society.

Hanna Neumann (1914 - 1971)

Hanna Neumann, author of the important monograph Varieties of Groups (1967), was born in Berlin, Germany. She studied mathematics at Berlin, notably with Bieberbach, Schmidt, and Schur. She actively opposed Nazism, so avoided the "political knowledge" part of the doctoral examination by taking the Staatsexamen in 1936. Her fiance Bernhard Neumann, who was Jewish, had fled to Britain, where she married him in 1938. Under Olga Taussky-Todd, she received a D. Phil from Oxford. She taught at Hull for twelve years, doing notable work on Hopf groups. In 1960-61, she, Bernhard, and their son Peter solved the problem of the structure of the semigroup of varieties of groups. In 1964 she took up the newly created chair in Pure Mathematics at the Australian National University, where she built a most distinguished department. An eminent algebraist and innovator in mathematics education, she was also a beloved teacher and mentor.

Olga Alexandrovna Ladyzhenskaya (1922 - 2004)

Taught first by her father, who became a victim of the NKVD in 1937, Ladyzhenskaya eventually studied at the University of Moscow under Gel'fand, Petrovskii, Tikhonov, and Sobolev, who supervised her Ph. D. from Leningrad. She headed the Department of Mathematical Physics at the Steklov Institute, staying even after 1989 when she could have emigrated. In her major field of PDEs, she made fundamental contributions, for instance to the theory of initial boundary value problems for hyperbolic equations. She developed the functional-analytic treatment of nonlinear stationary problems by Leray-Schauder degree theory. She pioneered the theory of attractors for dissipative equations, and obtained the key result of global unique solvability of the initial boundary problem for the two-dimensional Navier-Stokes equation. She and her coauthors completed the solution to Hilbert's nineteenth problem. She mixed with major Russian cultural figures, was President of the Mathematical Society of St. Petersburg, and received many prizes and honorary degrees from institutions worldwide.

Etta Zubner Falconer (1932 - 2002)

If being a woman mathematician was difficult in the mid twentieth century, being a black woman mathematician was exponentially harder. Etta Zuber Falconer received her Ph.D. in mathematics at Emory University. Instead of continuing in research, Falconer chose to focus on education, devoting her career to increasing the number of African Americans in mathematics and mathematics-related careers. Teaching at Spelman College, a historically black college, Falconer upgraded the science and mathematics curriculum; the number of Spelman students studying science and engineering tripled to over a third of the student population. Falconer's national efforts included the NASA Women in Science program for directing high-ability students to PhD programs and helping to found the National Association of Mathematicians, a professional organization for black mathematicians and students. Falconer received many awards, including the Louise Hay Award of the Association for Women in Mathematics and the Lifetime Mentor Award from the American Association for the Advancement of Science.

Olga Arsen'enva Oleinik (1925-2001)

Olga Arsen'evna Oleinik authored over 340 articles and 8 books mainly in the fields of algebraic geometry, linear and non-linear partial differential equations, and mathematical physics. She was the first to derive a mathematical formulation of Stefan's problem that dealt with phase change phenomena. She was a member of the Russian Academy of Sciences and held the title of Honored Scientist of the Russian Federation. She received her Ph.D. from Moscow State University where she taught for her entire career eventually becoming chair of the Department of Differential Equations. She supervised fifty-eight doctoral students. She was also active with the Steklov Mathematical Institute and the Institute for Problems in Mechanics, both part of the Academy of Science of the USSR. She received the Chebotaev Prize for her work on elliptical equations, the Lomonosov Prize for her research in mathematical physics, the State Prize for her work on boundary-value problems, and the medal of the College de France.

Julia Bowman Robinson (1919 - 1985)

There is a general procedure that decides whether any standard (first-order) mathematical statement about the real numbers is true; there is no such general algorithm for the integers. Julia Robinson, in her PhD thesis, showed that the rational numbers, like the integers, are undecidable. Combining her interests in logic and number theory, Robinson made major progress on Hilbert's Tenth Problem which seeks an algorithm to determine if a diophantine equation has integer solutions. With Martin Davis and Hillary Putnam, she proved that there is no such algorithm when exponentiation is allowed along with addition and multiplication. In 1971, Matijasevich used this work to prove that Hilbert's Tenth Problem is unsolvable. In 1975 Robinson became the first woman mathematician to be elected to the National Academy of Sciences, and in 1983 she was elected the first woman president of the American Mathematical Society.

Cora Ratto de Sadosky (1912 - 1981)

Cora Ratto de Sadosky was an Argentine mathematician, an inspiring teacher who worked in a part of the world that did not have a long tradition of mathematics research. She received her doctorate in mathematics from the University of Buenos Aires in 1958. Sadosky was part of the team that built a modern School of Sciences at the University and helped organize advanced courses for several generations of mathematicians and scientists, many of whom later became leaders of research communities in various parts of Latin America, North America, and Europe. She initiated a celebrated series of research publications and co-authored "Introduction to Linear Algebra", a rigorous, modern text, and the first of its kind in Spanish. One of her most important contributions while at the University was to create the "Albert Einstein Foundation," aimed at supporting talented mathematics and science students in need of financial help. Sadosky's fellowship and mentoring program helped hundreds of young Argentines, and was the first stage in establishing a university-wide scholarship system.

Grace Hopper (1906 - 1992)

In 1952 Grace Hopper invented the compiler, software that translates a high-level language such as C into machine language. Compilers were a major step forward in simplifying programming. In the 1970s Hopper pioneered the use of standards for testing conformance of computer systems. She enjoyed "presenting" nanoseconds: foot-long pieces of wire representing the distance electricity could travel in a billionth of a second. Hopper displayed her fascination with machines early on, disassembling all eight clocks in her parent's home in order to understand how they worked. She obtained a PhD in mathematics from Yale and taught at Vassar, but once the US entered WWII, Hopper sought to join the armed forces. In 1943 she was assigned to the Bureau of Ordnance Computation Project, where she worked on computers. She never looked back. Hopper retired from the Navy at the age of eighty, a Rear Admiral and at the time the oldest active duty officer in the US.

Ruth Moufang (1905 - 1977)

The first woman to become a professor of mathematics in Germany, Moufang had 21 doctoral students. After receiving her doctorate in 1931 from Dehn, and her habilitation in 1936, the Nazi government thwarted her in obtaining an academic position due to her sex. Instead she became an industrial mathematician, perhaps the first doctoral-level woman in history to have such a postion. After the war she was hired by the University of Frankfurt where she became a full professor in 1957. Her field of study included the foundations of geometry and connections to algebra. Following Hilbert, who showed that the Desargues incidence relations can be realized by skew-field coordinates, Moufang showed how the theorem of the complete quadrilateral leads to coordinates over an alternating division algebra. Certain nonassociative algebraic structures are now known as Moufang loops.

Dame Mary Lucy Cartwright (1900 - 1998)

Mary Lucy Cartwright was the first woman mathematician elected to the Royal Society of London. At Cambridge University, her thesis under the supervision of G.H. Hardy and E.C. Titschmarsh on zeros of integral functions generated a series of papers and eventually led to her book on integral functions. Although she did important work with Dirichlets's series, Abel summation, analytic functions regular on the unit circle, integral functions and cluster sets, she is best known for her work with Littlewood on van der Pol's equation and nonlinear oscillators. Cartwright served as Mistress of Girton College and as president of Great Britian's Mathematical Association and the London Mathematical Society. She was a recipient of the Sylvester Medal from the Royal Society and the De Morgan Medal from the London Mathematical Society. She authored nearly 100 articles and books. She was a very effective administrator at Cambridge University and ambassador for several mathematical and scientific organizations. In 1969, Queen Elizabeth elevated her to Dame Commander of the British Empire.

Amalie "Emmy" Noether (1882 - 1935)

Emmy Noether was among the greatest mathematicians of the twentieth century. Daughter of algebraist Max Noether, she studied at Erlangen, and then attended lectures by Hilbert, Klein, and Minkowski at Göttingen. Erlangen eventually allowed her, though a woman, to take her doctorate under Paul Gordan in 1904. In 1919 Hilbert and Klein persuaded Göttingen to grant her Habilitation. In 1924 van der Waerden studied with her; much of the second volume of his influential Modern Algebra is her work. Her major achievements include the foundation of the general theory of ideals; and the study of non-commutative algebras, their representations by linear transformations, and their application to commutative number fields. She also contributed to invariant theory, and suggested constructing combinatorial topology through the theory of Abelian groups. Dismissed from Göttingen in 1933 because she was Jewish, she moved to the United States, where she taught at Bryn Mawr until the end of her life.

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