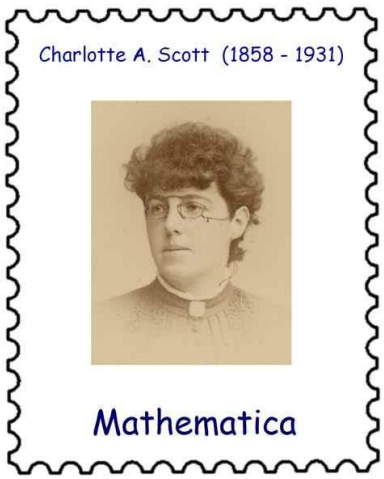
CHARLOTTE ANGAS SCOTT (June 8, 1858 – November 10, 1931)

by HEINZ KLAUS STRICK, Germany



The fact that CHARLOTTE ANGAS SCOTT was able to make a career as a mathematician was due in no small part to the fact that her father, Reverend CALEB SCOTT, minister of the Congregational Church, was headmaster of one of the only two secondary schools in England that girls were allowed to attend. The Protestant Free Church (so-called *Nonconformists*) was one of the first institutions in England to actively campaign for women's rights – this included in particular free access for girls to all educational institutions.

(Portrait photo courtesy of Bryn Mawr College Special Collections)

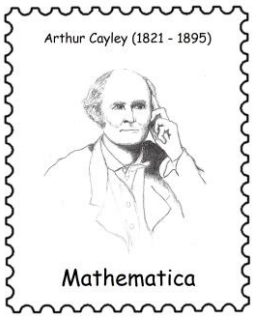
As headmaster, CALEB SCOTT was able to ensure that his daughter CHARLOTTE was prepared for university studies within the framework of normal school lessons and did not have to rely on private tutors, as was generally the case for girls. Thanks to a scholarship, CHARLOTTE SCOTT was one of the eleven female students to study mathematics at *Girton College* Cambridge in 1876.

The young women from *Girton College* were only allowed to attend lectures at the University of Cambridge if the respective lecturers had given their consent (which was not always the case). Actually, the female students would even have to pay additional fees to attend; but in most cases they were accepted as "chaperones".

In 1880, CHARLOTTE SCOTT was granted permission to take part in the *Mathematical Tripos Examinations* at the University of Cambridge upon application. But: even if the examination was passed successfully, no official degree of any kind was associated with it.

In the 1880s, the *Mathematical Tripos* consisted of a series of examinations which, spread over nine days, took a total of 50 hours. The exam papers came from the subject areas of algebra, geometry, analytical geometry, probability, calculus and from physics (basics of statics, dynamics, hydrostatics, optics and astronomy of the solar system).

During her four years of study, word had spread among the male students that CHARLOTTE SCOTT had an exceptional aptitude for maths, and somehow it has also leaked out that she had achieved the eighth best examination performance of the year. Then at the formal announcement of the names of the successful (male) examinees, the speaker failed to announce the name of the nominated eighth prize winner because the students present (only males were allowed) loudly chanted "SCOTT of Girton" and applauded. – Even the *Times* and *Punch magazine* reported on the event, and within three months 8000 people signed a petition to open Cambridge University's courses and degrees to women as well. But the only thing that changed after that was that from the following year onwards, women were allowed to attend the *Tripos* without a special application, but still without being able to earn degrees.



During the following four years CHARLOTTE SCOTT was employed as a teacher at *Girton College*, at the same time she attended the lectures of ARTHUR CAYLEY, who had held a chair in mathematics at Cambridge since 1863. CAYLEY was not too popular among the students because his lectures were always on the topics he was working on at the time, and these had little to do with the Tripos Examinations – but for CHARLOTTE SCOTT this was a wonderful opportunity to find out what topics mathematical research was currently dealing with.

She also enrolled at *University College London* (UCL), which, unlike the universities of Cambridge, Oxford and Durham, was open to non-members of the *Church of England* and had been open to women since 1879. (In the first place UCL was set up specifically for the purpose of allowing students from colleges across the country to gain a certificate; it was only later that lectures were offered there).

CHARLOTTE SCOTT passed the *Bachelor of Science* (BSc) examination in 1882, and in 1885 – under the supervision of ARTHUR CAYLEY – she earned the academic title of *Doctor of Science* (DSc) – passing both examinations with top marks.

When in the same year, through a generous foundation, a private college for women was founded in *Bryn Mawr* (today a suburb of Philadelphia, Pennsylvania) where young women could obtain all academic degrees, CHARLOTTE SCOTT (based on ARTHUR CAYLEY's recommendation) was offered the position of Associate Professor there – with an annual salary of $2,000.

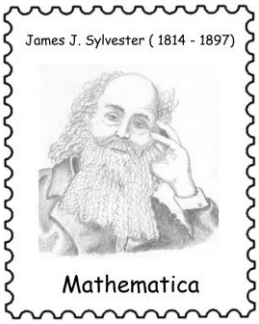
For more than 30 years, this exceptionally gifted teacher devoted all her strength and skills to her students, and was particularly committed to young women from disadvantaged backgrounds. She was a strict and performance-oriented teacher, but all those willing to learn were given a fair chance by her.

As head of the mathematics department, she shaped the standard of the entire university (introduction of entrance examinations that were not common before, as well as the uniform design of the final examinations).

When the president of Bryn Mawr College suggested to the teachers – probably somewhat condescendingly – that they lower the requirements in order to adapt them to the abilities of women, she wrote an angry letter of protest.

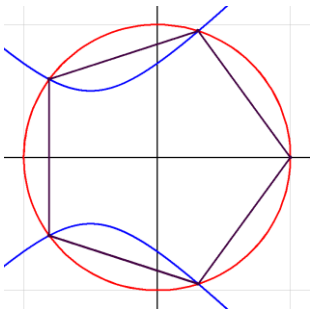
CHARLOTTE SCOTT was known for her adherence to principles, including resolutions to remain single, not to use make-up and not to smoke.

She was the author of the textbook *An Introductory Account of Certain Modern Ideas and Methods in Plane Analytical Geometry* (title from 3rd edition: *Projective Methods in Plane Analytic Geometry*). She supervised a total of seven doctoral theses.

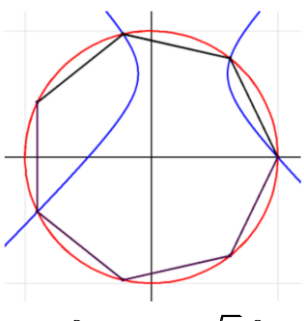


In 1894 she was a founding member of the *American Mathematical Society* and in 1906 vice-president of the association. In 1899 she became co-editor of the *American Journal of Mathematics*, founded by JAMES JOSEPH SYLVESTER (1814-1897). She was one of the four women who attended the first *International Congress of Mathematicians* in Zurich in 1897.

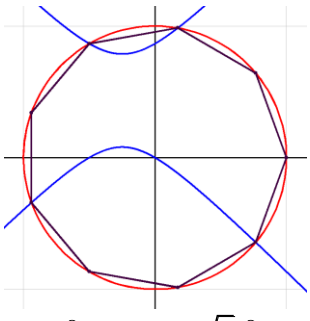
She wrote over 30 papers for journals, including *Note on Regular Polygons*. Here she showed that right-angled hyperbolas can be laid in such a way that their four intersections with the unit circle can be vertices of a regular 5-gon, 7-gon and 9-gon respectively.



$(x+\frac{1}{2})^2 - y^2 = -\frac{1}{4}$



$(x-\frac{3}{4})^2 - (y-\frac{1}{4}\cdot\sqrt{7})^2 = \frac{1}{8}$



$(x+\frac{1}{4})^2 - (y-\frac{1}{4}\cdot\sqrt{3})^2 = -\frac{1}{8}$

A Proof of Noether's Fundamental Theorem caused a sensation. This was the first contribution from an American journal that was also noted in Europe; in 1899 it was printed in the *Mathematische Annalen*.

The paper referred to a theorem of MAX NOETHER (1844-1921, father of EMMY NOETHER) from 1869. Since CHARLOTTE SCOTT's proof, various proof variants have been published, but all with similar approaches.

NOETHER's fundamental theorem for algebraic functions

If $U(x, y)$ and $V(x, y)$ are two polynomials of the mth and nth degree, respectively, then the equations $U(x, y) = 0$ and $V(x, y) = 0$ describe two algebraic curves in the x-y plane. If then $W(x, y)$ is a polynomial of degree $m+n$ whose associated curve passes through the intersections of the two algebraic curves, then two polynomials $A(x, y)$ and $B(x, y)$ can always be found, so that $W(x, y)$ can be represented as $W = A \cdot U + B \cdot V$.

Over the years CHARLOTTE SCOTT returned to Europe several times; since her alternative proof of NOETHER's theorem she was now also known there. She became an honorary member of the mathematical societies in London, Edinburgh, Palermo and Amsterdam as well as of the *German Mathematical Society*.

From 1904 onwards, her hearing, already impaired when she was at Girton College, deteriorated dramatically and she became almost deaf. Furthermore she suffered from rheumatoid arthritis. She nevertheless continued her teaching until it was no longer possible.

After supervising her last doctoral student, she was given a ceremonial farewell by the *Department of Mathematics of Bryn Mawr College*. The philosopher ALFRED NORTH WHITEHEAD (who, together with BERTRAND RUSSELL, had written *Principia Mathematica*) travelled from England especially for the occasion. He praised her merits as a scientist and as a lecturer, but above all her humanity.

After her retirement, in 1925, she returned to Cambridge, bought a house and grew chrysanthemums. CHARLOTTE SCOTT died in 1931 at the age of 73 after a fulfilled life, happy despite health problems.

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https://www.spektrum.de/wissen/charlotte-scott-mathe-pionierin/1937374

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