

Sophie Germain

1776-1831

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Figure: Sophie Germain (1776-1831)



<http://www.matematicasdigitales.com/mujeres-matematicas/>

Background

Childhood

- Born in Paris, France in 1776.
- She was exposed to mathematics reading books in her father's library [1].



<http://archimedespalimpsest.org/about/>

Background

Childhood

- Against her parent's wishes, she read the works of mathematicians such as Euler and Newton [5].
- At the time, it was very uncommon for women to study mathematics.

Background

Education

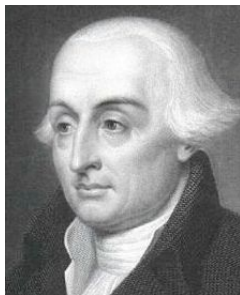


<https://www.kth.se/en/student/program/utlandsstudier/utbyte/frankrike-ecole-polytechnique-1.633170>

- École Polytechnique was founded in 1794, when Germain was 22.
- Using the alias “M. Le Blanc” she was able to obtain lecture notes from courses at the institution taught by Lagrange.

Background

Education



<http://www.luschny.de/math/factorial/AlHaythamLagrangeTheorem.html>

- Germain submitted papers and assignments under the false name.
- Lagrange was so impressed with her work, that he wished to meet her.



<http://scienceworld.wolfram.com/biography/Legendre.html>

- After reading Legendre's *Test on the Theory of Numbers*, Germain wrote to him regarding some of the problems that he posed [5].
- The pair worked together and Legendre included some of her work in another edition of the text.



<https://www.thefamouspeople.com/profiles/carl-f-gauss-442.php>

- Additionally, Germain studied Gauss' *Disquisitiones Arithmeticae* and wrote to him, under the alias M. Le Blanc, sharing her work.
- Gauss was quite impressed with the work that was submitted to him.

- Gauss wrote to Germain saying:
“... But when a person of the sex which, according to our customs and prejudices, must encounter infinitely more difficulties than men to familiarize herself with these thorny researches, succeeds nevertheless in surmounting these obstacles and penetrating the most obscure parts of them, then without doubt she must have the noblest courage, quite extraordinary talents and superior genius.”

- Excerpt from “Fermats Enigma: The Epic Quest to Solve the Worlds Greatest Mathematical Problem” in [1]

- While studying the works of Legendre and Gauss, Germain worked heavily on proving Fermat's Last Theorem. Recall, Fermat's Last Theorem (FLT) states:

Theorem

$x^n + y^n = z^n$ has no positive integer solutions for $n > 2$.

- “What is important about Germain’s technique is that she was the first person we know of who attempted to prove FLT for infinitely many prime exponents, rather than just on a case-by-case basis” .
 - “Sophie Germain and Fermats Last Theorem” in [1].

- Ultimately, she proved a result that was later entitled “Sophie Germain’s Theorem”. [1].

- Germain also studied the subject of elasticity.
- In 1808 the Institut de France announced a contest for whoever could address the following task:

formulate a mathematical theory of elastic surfaces and indicate just how it agrees with empirical evidence [5].

- Ultimately, Germain won the contest and received a medal of one kilogram of gold for her efforts.
- She did not feel respected or valued by the judges of the contest and the scientific community.



<http://www.matematicasdigitales.com/mujeres-matematicas/>

- Germain died from breast cancer at the age of 55.
- Sadly, even her death certificate listed her as a property holder, and not as a mathematician [1].

Applications and Importance

- Sophie Germain's work on Fermat's Last Theorem aided other mathematicians efforts in proving it.
- It wasn't until 1993, over 150 years later, that Andrew Wiles provided a proof of FLT [2].

Applications and Importance

- Today, a prime number p , where $2p + 1$ is also prime, is called a Sophie Germain prime.

Applications and Importance

- Germain primes have applications in cryptography and pseudorandom number generation [6].
- Germain's work on the subject of elasticity made it possible to construct the Eiffel Tower [3].

Why is studying Sophie Germain relevant?

- “In mathematics, just 15 percent of tenure-track positions are held by women, one of the lowest percentages among the sciences” [4].
- Hopefully, learning about mathematicians like Sophie Germain will inspire other females to pursue mathematics and other related fields.

- [1] Colleen Alkalay-Houlihan. Sophie germain and special cases of fermats last theorem.
- [2] N. Boston. The proof of fermat's last theorem. 2003.
- [3] C. Conrad. Sophie germain.
- [4] J.C. Hu. Why are there so few women mathematicians? 2016.
- [5] J.J. O'Connor and E.F. Robertson. Marie-sophie germain.
- [6] T. Wall. Prime sieves, sophie germain primes and the diffie-hellman key exchange.

Questions?