

EDMUND LANDAU (February 14, 1877 – February 19, 1938)

by HEINZ KLAUS STRICK, Germany

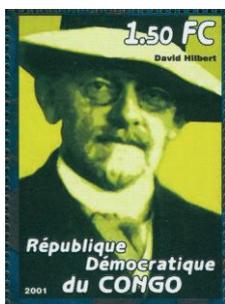
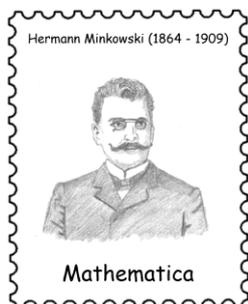
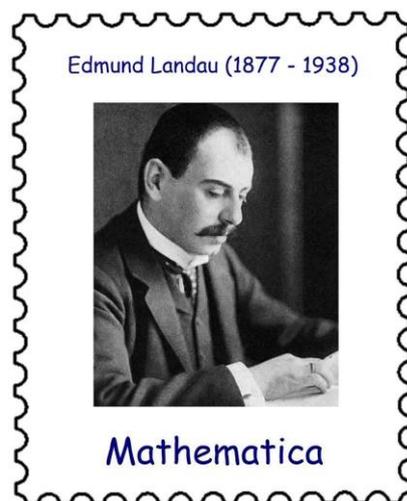
EDMUND GEORG HERMANN YEHEZKEL LANDAU was born in 1877 as the son of the respected and wealthy Berlin gynaecologist LEOPOLD LANDAU and his wife JOHANNA, who came from the JACOBY banking family. For LEOPOLD LANDAU it was no contradiction to take a German-national standpoint on political issues and at the same time to be a convinced Zionist.

At the age of 16, EDMUND passed the *Abitur* examination at the French Gymnasium and began studying mathematics at the University of Berlin. At the age of 22, he completed his doctorate with a number-theoretical thesis of only 14 pages entitled

Neuer Beweis der Gleichung $\sum_{k=1}^{\infty} \frac{\mu(k)}{k} = 0$, which was supervised by FERDINAND GEORG FROBENIUS and

LAZARUS IMMANUEL FUCHS. In this, μ stands for the MÖBIUS function which, depending on the number and multiplicity of the prime factors of k , can only assume the values 0, 1 and -1.

In 1901 he *habilitated* with a thesis on a topic from analytical number theory, which his former doctoral supervisor FROBENIUS considered unimportant, but which in no way irritated the self-confident EDMUND LANDAU. Initially as a private lecturer, and from 1905 as an associate professor, he took over the lectures on number theory and additionally beginners' lectures (which he was not actually obliged to do).



(drawings © Andreas Strick)

After the sudden, early death of HERMANN MINKOWSKI in 1909, LANDAU was appointed as his successor as full professor in Göttingen, where he successfully contributed, together with DAVID HILBERT and FELIX KLEIN, to strengthening the worldwide reputation of Göttingen University. By the time of his appointment to Göttingen, LANDAU had already published 70 scientific papers.

Of LANDAU's more than 250 papers and books, the following are particularly noteworthy: *Handbuch der Lehre von der Verteilung der Primzahlen* (Handbook of the Distribution of Prime Numbers: 1909, two volumes), which contains, among other things, his "simple" proof of the prime number theorem published in 1903. Further: *Lectures on Number Theory* (1927, three volumes), *Fundamentals of Analysis* (1930) and *Introduction to Differential and Integral Calculus* (1934).

LANDAU developed a style typical of him. Many mathematicians subsequently tried to adopt this *LANDAU style*: A seemingly endless *definition-sentence-proof* sequence with carefully polished formulations and concise but complete arguments without annotations or references as to how or why one arrived at this sequence of thoughts.

For representations in analysis, LANDAU further developed a notation of the number theorist PAUL BACHMANN; this so-called LANDAU notation is still used today.

For example, the approximation of the exponential function can be described by the quadratic polynomial $1 + x + \frac{1}{2}x^2$ (in a sufficiently small environment of $x = 0$) with the help of $e^x = 1 + x + \frac{1}{2}x^2 + O(x^3)$. When determining the limit value for $x \rightarrow 0$, the application of DE L'HÔPITAL's rule can often be replaced by the so-called LANDAU calculus, e.g.:

$$\frac{\sin(x) - x}{x \cdot (1 - \cos(x))} = \frac{-\frac{1}{6}x^3 + O(x^5)}{x \cdot (\frac{1}{2}x^2 + O(x^4))} = \frac{-\frac{1}{6} + O(x^2)}{\frac{1}{2} + O(x^2)} \rightarrow -\frac{1}{3}$$

LANDAU did not attach any importance to visualisation. That is why he was never interested in questions of geometry. For example, he introduced the number π as the smallest positive zero of the sine function, which he defined by $\sin(x) = \sum_{m=0}^{\infty} \frac{(-1)^m}{(2m+1)!} \cdot x^{2m+1}$.

He had little understanding for colleagues who were also interested in the application of mathematics; he derisively referred to the theoretical research work of fluid mechanics as "lubricating oil mathematics".

His publications quickly gained international recognition. In 1912, he was invited to give one of the main lectures at the *International Mathematical Congress* in Cambridge (*Solved and Unsolved Problems from the Theory of Prime Number Distribution and RIEMANN's Zeta Function*).

He mentioned four topics which have entered the literature as LANDAU problems and remain unsolved:

- The GOLDBACH conjecture (*Every even number greater than 2 can be represented as the sum of two primes.*)
- LEGENDRE's conjecture (*For all natural numbers n , the following holds: there exists at least one prime between n^2 and $(n+1)^2$.*)
- *The conjecture that there are infinitely many prime twins.*
- *The conjecture that there exist infinitely many primes of the form $n^2 + 1$.*

At the opening of the Hebrew University in Jerusalem in 1925, the mathematician, who practised his Jewish faith, gave a lecture in Hebrew. In 1927/28, he accepted a guest professorship there, also to test out the working conditions. Life in Palestine proved to be less than comfortable; his family missed the luxury they were used to at home (his wife also came from a wealthy family; she was the daughter of the *NOBEL Prize* winner in medicine PAUL EHRLICH). In addition, the staffing of the department did not meet LANDAU's expectations. LANDAU was asked whether he would be prepared to take on the office of rector of the university.

He learnt that ALBERT EINSTEIN and CHAIM WEIZMANN favoured another candidate, and as he shied away from the expected personnel dispute, he returned to his Göttingen chair.



LANDAU's professional qualifications are beyond doubt, but his occasionally arrogant behaviour did not win him friends. His usual saying *My house in Göttingen: you can't miss – it's the most beautiful in town* is one of the more harmless phrases.

Normally, a scientist is pleased when someone else refers to his own publication. LANDAU, however, all too often provided such references with comments such as "*unnecessarily complicated*" or even "*superfluous*". He also commented on publications by WILHELM BLASCHKE, full professor in Hamburg, and LUDWIG BIEBERBACH, successor to FROBENIUS in Berlin. A letter from BLASCHKE to BIEBERBACH from 1921 concluded with *Don't you feel like ridding Göttingen of LANDAU?* (Both mathematicians later proved to be supporters of the Nazi regime).

LANDAU's friend FRITZ RATHENAU, head of department in the Prussian Ministry of the Interior and brother of the Foreign Minister of the German Reich, who was assassinated in 1922, already sensed the dangers facing Jewish citizens in 1932 when the *National Socialist Party* came to power. He feared that Jews would then be deported to concentration camps. LANDAU did not take this seriously and scoffed: *In such a case I would have a room reserved for me with a balcony facing south.*

Only five weeks after the seizure of power, the *Law for the Restoration of the Professional Civil Service* came into force. For LANDAU, who had taken up his post before 1914, this meant early retirement. Before the actual decree arrived, the dean of the university asked him in anticipatory obedience to be substituted by his assistant in the following summer semester.

But when LANDAU then wanted to give his lectures again himself in the winter semester of 1933/34, his listeners were prevented from entering the lecture hall by student Stormtrooper members led by OSWALD TEICHMÜLLER. (BIEBERBACH saw this staged event as confirmation of his theory that representatives of different races could not work together. The students had obviously developed a sense that LANDAU held un-German positions). TEICHMÜLLER then told his teacher LANDAU that although he held him in high esteem as a mathematician, he refused to let him give another beginners' lecture.

LANDAU's last-minute application for leave to give guest lectures at the Dutch University in Groningen during the current semester was approved. At the beginning of February 1934, he was then transferred to early retirement.

The previously extremely active scholar could not cope with his forced retirement. Even further guest lectures in Cambridge and Brussels could not distract him from the fact and the manner in which he had been prevented from continuing his life's work.

In 1938 he died as a result of a heart attack. Most of his 33 doctoral students, such as HARALD BOHR, ERICH KAMKE and ALEXANDER OSTROWSKI, took on important chairs at various universities in Europe, thus helping to ensure that LANDAU's work was not forgotten.

First published 2017 by Spektrum der Wissenschaft Verlagsgesellschaft Heidelberg

<https://www.spektrum.de/wissen/edmund-landau-1877-1938/1440350>

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