

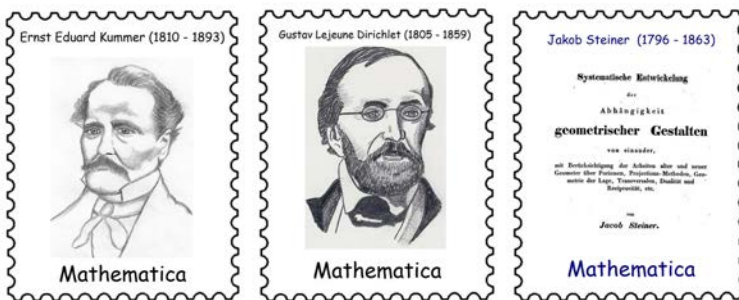
LEOPOLD KRONECKER (December 7, 1823 – December 29, 1891)

by HEINZ KLAUS STRICK, Germany

LEOPOLD KRONECKER, who came from a wealthy Jewish merchant family, grew up in Liegnitz (Silesia). First, he was taught by private tutors; later he attended the local high school. His mathematics teacher was ERNST EDUARD KUMMER, who recognized and promoted his talent for mathematics.

Despite his background, he took part in Protestant religious education. Later he would have his own children baptized; he himself converted a year before his death.

In 1841 KRONECKER began studying mathematics, physics and philosophy at the University of Berlin, and went to lectures by GUSTAV LEJEUNE DIRICHLET and JAKOB STEINER. After a semester in Bonn, he moved to Breslau, where his former mathematics teacher KUMMER took over the chair of mathematics. Back in Berlin, he wrote a remarkable doctoral thesis on *De Unitatibus Complexis*. In the final exam he was asked not only about mathematical topics from very different areas, but also about the application of stochastic methods in astronomy and the history of philosophy; his knowledge of ancient Greek was also tested.



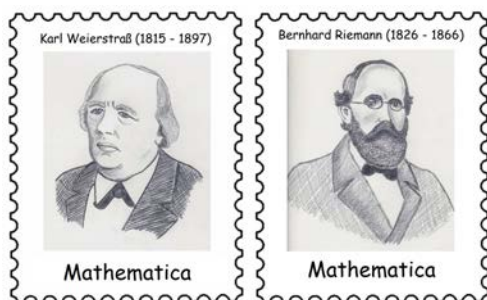
It looked like the beginning of a brilliant academic career when – at his father's request – he surprisingly left Berlin and took over the administration of the family estate in Silesia. He also had to take care of the liquidation of his uncle's bank. He married his uncle's daughter FANNY in 1848; in this happy marriage six children were born.

Despite the many and varied tasks, he still found time for a professional correspondence with KUMMER, which led to the treatise *On the Algebraically Solvable Equations* in 1853 – the first of a total of 144 scientific papers.

In 1855 all his business matters were settled satisfactorily. KRONECKER moved into a villa in Berlin with his young family. Thanks to his wealth, he was not dependent on a job. In quick succession he published further contributions to number theory and algebra, further developing the theories of ÉVARISTE GALOIS and NIELS HENRIK ABEL on the solvability of higher degree equations and studying elliptic functions.



In 1861, on KUMMER's suggestion, he became a member of the *Prussian Academy of Sciences*, and as such he was given the right to give lectures. With KUMMER and KARL WEIERSTRASS, who had held the mathematics chairs at the University of Berlin since 1855/56, and now also with KRONECKER, this university had developed into a new German centre of mathematics that competed with Göttingen (later one could talk of the golden age of mathematics in Berlin). The University of Göttingen tried to poach KRONECKER by offering him the professorship to succeed BERNHARD RIEMANN but he rejected the offer - partly because he did not want to give up his social life in Berlin.



(drawings: © Andreas Strick)

His challenging lectures were attended by only a few students, who often had difficulty following his train of thought. Gradually KRONECKER came to the conclusion that the methods WEIERSTRASS used in analysis were wrong. In his opinion, analysis needed to be "arithmetized" – starting from the natural numbers.

His demand culminated at the annual meeting of natural scientists in 1886 in the famous statement:

- *Die ganzen Zahlen hat der liebe Gott gemacht, alles andere ist Menschenwerk.*
(The whole numbers were made by the good Lord, everything else is the work of Man).

Only objects which could be derived in a finite number of steps could be considered to exist. He rejected existential statements, for whose proof, in principle, an infinite sequence of steps was necessary. This mathematical philosophy of finitism was later developed into constructivism by LUITZEN EGBERTUS JAN BROUWER. (For example, the Constructivists rejected the method of indirect proof, since this does not "construct" an object).

When a treatise on FOURIER series was published in *Crelle's Journal* in 1870, he tried to prevent this (in his function as co-editor of the journal) and even asked the author EDUARD HEINE, professor of mathematics in Halle since 1856, to withdraw the article.

Something similar happens to GEORG CANTOR, whose contribution about the countability of algebraic numbers he did not want to allow for publication; because, as he argued, it dealt with objects that did not even exist.

When the managing editor of the magazine, KARL WILHELM BORCHARDT, died in 1880, KRONECKER and WEIERSTRASS jointly took over the editorship, which increasingly led to violent technical disputes between the two.

In 1882 FERDINAND VON LINDEMANN succeeded in proving the transcendence of the geometric number π , which even KRONECKER recognized to a certain extent. He considered the argument to be *elegant* but *senseless*, since he believed that transcendental numbers *did not exist*.

After KUMMER's retirement in 1883, KRONECKER took over his chair. WEIERSTRASS felt more and more uncomfortable at Berlin University, partly because he feared that his influence on the coming generation of mathematicians was waning, since KRONECKER did not hesitate to announce that WEIERSTRASS's works were worthless and senseless.

He resigned, and accepted an invitation to the Federal Polytechnic (now ETH) in Zurich in 1888, but then withdrew his resignation when he realized that KRONECKER's influence would then be even greater. KRONECKER did not notice how much he hurt WEIERSTRASS through his statements. He still publicly described him as his friend.

In 1889 the Swedish King OSCAR II, on the occasion of his 60th birthday, announced a mathematics competition and entrusted WEIERSTRASS, CHARLES HERMITE and MAGNUS GÖSTA MITTAG-LEFFLER with its implementation. (MITTAG-LEFFLER had first studied in Paris with HERMITE, then with WEIERSTRASS. In 1881 he became the first professor of mathematics at the newly founded Stockholm University).



KRONECKER felt ignored. He told MITTAG-LEFFLER to inform the Swedish king about the "true state" of mathematics, and that no other mathematician had developed a competency comparable to him in algebraic questions (which was certainly true). When MITTAG-LEFFLER sided with CANTOR in the argument about set theory, KRONECKER announced that he would no longer publish articles in the *Acta Mathematica* journal edited by MITTAG-LEFFLER.

At the first general meeting of the *German Mathematical Society* (DMV) in 1891, which had been founded on the initiative of FELIX KLEIN and GEORG CANTOR the previous year, CANTOR (in his function as chairman of the DMV) invited LEOPOLD KRONECKER to give one of the main lectures – out of mutual respect for the person who undoubtedly made a contribution to the development of mathematics, and also out of gratitude to his former university lecturer, and despite all the insults he had personally experienced in recent years.

KRONECKER had publicly described him as the "spoiler of the youth" and made a devastating judgment about his set theory: "*I don't know what's in CANTOR's theory - philosophy or theology, but I'm sure there is no mathematics.*" (KRONECKER was convinced that the human mind could only deal with finitely many things. In his opinion, the infinite did not belong in mathematics.)

KRONECKER did not attend the meeting. His absence was probably less a result of the rejection of the association than of the tragic accident of his wife when climbing in the mountains. Her injuries were so severe that she died shortly afterwards. KRONECKER only survived his wife for a few months. He died of bronchitis.

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<https://www.spektrum.de/wissen/leopold-kronecker-1823-1891/1429551>

Translated 2020 by John O'Connor, University of St Andrews

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