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Edmund Landau's Göttingen: From the Life and Death of a Great Mathematical Center Norbert Schappacher

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Dear Mr. President, Ladies and Gentlemen.

Edmund Landau lived from 1877 to 1938, 61 years almost to the day. He was born and died in Berlin. His father, Leopold, was a gynecologist; his mother (Johanna, née Jacoby) came from a very well-to-do banker's family. The Landaus lived in the Jacobys' house, situated in the most elegant quarter of Berlin. The street address was Pariser Platz 6a, close to the Brandenburg gate. The famous painter Max Liebermann was soon to have his studio in a house near by.

Like many assimilated Jews in Berlin at the time, the father was a German patriot. But he also actively promoted Jewish traditions. Thus he was involved in the founding, in 1872, of the *Hochschule für die Wissenschaft des Judentums*—an academy of Judaism in Berlin.

Both the German and the Jewish cause would be close to the heart of Leopold's son Edmund as well. In particular, Edmund Landau became an active supporter of the Hebrew University in Jerusalem. He gave a mathematical lecture—his first in Hebrew—at the opening of the Hebrew University, on 1 April 1925. And during the winter term 1927/28 he took a sabbatical from Göttingen University in order to start mathematical teaching here, with two courses, one on number theory and the other on principles of analysis.

As I learned from correspondence in the archives of the Hebrew University, Landau even considered staying permanently at Jerusalem. Incidentally, Landau was the only Göttingen mathematician who, in our century, was a member of the synagogue community in Göttingen.

Let us not jump ahead, but go back to the early years of Edmund Landau. He was intellectually precocious. He graduated from the French lycée in Berlin at the age of 16, some two years earlier than usual, and immediately entered Berlin University as a student. His clear preference for mathematics showed fairly soon. Also it must have been very early on that he

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developed the sense of duty and precision that characterized his later career. When David Hilbert learned of Landau's death, he succinctly characterized Landau as the "*Pflichttreueste von uns allen*"—the one with the greatest sense of duty among all his colleagues. We shall have occasion to see what Hilbert meant.

Landau's fondness for intellectual games and puzzles, illustrated by numerous later anecdotes, shows already in his first two publications preceding his Berlin dissertation; both deal with mathematical problems related to chess.

In July 1899, at the age of 22, Landau received his doctorate on the basis of his first number-theoretic work. It is also the first of a large number of publications in which Landau managed to shorten substantially the proof of a result previously established by some other mathematician. Both his doctorate and the next academic degree only two years later, the *Habilitation*, by which the candidate obtained the right to teach mathematics courses at Berlin University, were given to Landau without hesitation, but also without any indication by the professors involved—and in particular Georg Frobenius—that Landau was outstanding. In fact, Frobenius's evaluation of Landau's work on the occasion of the *Habilitation* in 1901 concludes with the admonition that Landau should cease to concentrate on this "extremely narrow subject" of analytic number theory! A similar remark, again due to Frobenius, is to be found in a 1917 relative evaluation of Landau and Issai Schur. There the point is made that the majority of Landau's publications would lose all their value the day that "a certain hypothesis of Riemann" was proved. This hypothesis, however—as most of you know—has not been proved to date.

Right from his dissertation, there was a continuous and ever-growing flow of publications by Landau. As of January 1900, he communicated his new findings to David Hilbert, the greatest German mathematician of the time. In 1904, the number of his publications started to exceed his age (27). Soon afterwards, no other German mathematician in the same age bracket could have competed with Landau's impressive list of publications.†

In addition to his relentless publishing, Landau quickly proved to be an extremely successful teacher at Berlin University. He agreed to teach beginners' courses from time to time, even though such was not his duty as a *Privatdozent*. And he was among the first mathematicians in Germany to teach courses outside



Edmund Landau.

his specialty, the analytic theory of numbers, on foundational topics, such as irrational numbers and set theory. This, as well as the pains-taking perfectionism with which he prepared his lectures and the enthusiasm with which he delivered them, accounted for the highly impressive student attendance of his classes. There can be no doubt that Landau remained an inspiring lecturer throughout his life. However, later on, especially in the 1920s, there was also criticism of too much formal rigidity in his style of presentation. And it should also be said that he tended not to have cordial relationships with his students, being rather an aloof person.

† The complete papers of Edmund Landau have recently been published: Edmund Landau, *Collected Works*, Thales Verlag, Essen. This collection of Landau's papers also contains the photographs that are published with this article. Permission from Thales Verlag to publish these pictures here is gratefully acknowledged.

Twice the Berlin Faculty—who by now had realized what an asset this young man was for them—tried to secure a formal position for Landau beyond the mere right to teach courses. The first time, in 1904, this resulted only in the title of *Professor* for Landau without any contract or remuneration. The second time around, in 1908, the Ministry flatly denied the attempt of the Berliners to keep Landau and agreed instead to make him *Ordinarius*—full professor—at Göttingen, as successor to Hermann Minkowski, who had suddenly died from a ruptured appendix at the age of 44.

This move in favor of Göttingen must be seen as part of a program initiated some twenty years earlier by the Prussian administrator Friedrich Althoff and put into action in close collaboration with Felix Klein at Göttingen. The idea was to make Göttingen the stronghold of mathematics and sciences in Prussia, whereas the humanities were to be emphasized more in Berlin. Thus, Hilbert and Minkowski had been drawn to Göttingen, the latter to a chair newly created for the occasion.

On the big continuous rolling blackboards in the lecture halls of the new Göttingen Mathematics Institute built in 1929, Landau apparently tried to arrange longer proofs in such a way that the final conclusion of the proof would end up after a full turn of the board, right above the statement of the theorem.

There are a number of apocryphal stories about how Landau was chosen by the Göttingen faculty as successor to Minkowski. Most of them must be inaccurate, because they do not even give the correct names that were proposed, namely in alphabetical order: Blumenthal, Hurwitz, Landau. Note in passing that all three candidates were Jewish. Such an all-Jewish list of candidates would not have been acceptable at many other German universities at that time. Who chose Landau—whether this was decided at Göttingen or in the Ministry—I do not know. When accepting the offer, Landau thanked both Klein and Hilbert in separate letters for what they had done for him. But the letters show that he, too, was not sure of who had done what.

The Landaus settled at Göttingen and soon had constructed for themselves a beautiful, luxurious mansion in English Cottage style at what was then the eastern edge of the town of Göttingen, close to the woods. Edmund Landau had married Marianne Ehrlich at Frankfurt-am-Main back in 1905. Her father, Paul Ehrlich, had been a colleague and friend of Landau's father. Ehrlich won a Nobel prize in 1908 for his work in immunology. (Considering that a Paul-

Ehrlich-Institute for Immunology has recently been created here at the Hebrew University, today's occasion does not lack a certain family aspect.) The young couple could look forward to a financially easy life. There were going to be two daughters and one son, not counting a first son who died at the age of 5.

Landau stayed in Göttingen until November 1933, when he was forced out by the Nazis because he was Jewish. In a way, these almost twenty-five years that Landau spent in Göttingen, 1909–1933, form a unity because of the uninterrupted continuity of Landau's work.

In the first place, he produced a steady flow of papers and textbooks, some of them famous. Secondly, his courses were, of course, taught every term. And here Landau kept the promises of the young Berlin *Privatdozent*. His lectures were getting increasingly perfectionistic. For instance, on the big continuous rolling blackboards in the lecture halls of the new Göttingen Mathematics Institute built in 1929, Landau apparently tried to arrange longer proofs in such a way that the final conclusion of the proof would end up after a full turn of the board, right above the statement of the theorem. One of his assistants had to sit in his lectures, especially beginners' lectures, to make him immediately correct mistakes that might occur in spite of the conscientious preparation. And thirdly, Landau accepted a great number of research students: twenty-seven received their doctorates in Göttingen under his guidance. Landau recognized Carl Ludwig Siegel's outstanding qualities and led him to a reasonable presentation of his thesis.

Even though Landau's activities appear as one unity all through his stay at Göttingen, Göttingen did of course change and develop while Landau was there. When Landau came to Göttingen, this was still the Göttingen of Klein and Hilbert. Then, whereas Hilbert stayed on through 1930, Klein, thirteen years older than Hilbert, formally retired in 1913, and was less and less present as the organizer he had once been. He died in 1925.

As successor to Klein, Hilbert and Landau attracted the function theorist Carathéodory. "Cara"—as he was commonly called—came to Göttingen in 1913, but did not stay even three years. Then came the brilliant analytic number theorist Hecke. But right after the War, in 1919, Hecke accepted an offer from the newly founded Hamburg University.

The definite successor to Felix Klein was then found in Richard Courant, whose extraordinary talents as an organizer actually made him the right candidate to carry on this part of Klein's legacy. Courant was not altogether to Landau's liking, both for his mathematical specialty (mathematical physics) as well as for the somewhat relaxed style of exposition in his courses. Instead of Courant, Landau had proposed for the chair the algebraist Schur, a former colleague from

Berlin. But Klein and Hilbert preferred Courant.

Apart from Hilbert, Landau, and Courant, the mathematical chairs at Göttingen were occupied by:

- the applied mathematician Carl David Tolmé Runge. He retired in 1924, and was then succeeded by the Austrian pure mathematician Gustav Herglotz;
- the statistician Felix Bernstein, who more and more leaned towards applied research in medicostatistics, and at least for that reason was not close to Landau.

Last, but certainly not least, Emmy Noether has to

be mentioned: the greatest woman mathematician to date and one of the founders of modern abstract algebra. Solely because of her sex, she did not have any position at the university with civil-servant status. Even to grant her the *Habilitation* had been possible only after long and serious fights by mathematicians against the majority of the *Philosophische Fakultät* during World War I. During the 1920s, a very good collaboration developed between Noether's group of advanced students and Landau's research students. Since Noether did not formally have the right to pass a student on to the doctorate, it was usually Hilbert or Landau who stepped in as official thesis adviser.



From left to right:
Henri Poincaré,
Gösta Mittag-Leffler,
Edmund Landau,
and Carl Runge. (From
the *Collected Works of
Edmund Landau*, vol. 2,
Thales Verlag, Essen. In
the forthcoming vol. 10,
additional biographical
material and many
photographs are
published.)

Having mentioned the applied mathematicians Runge and Bernstein, let me say one word on the broadness of the mathematical-scientific center at Göttingen, a side of it in which Landau did not take interest. Klein, Hilbert, Minkowski, Noether, Courant, then after 1930 Hilbert's successor Hermann Weyl—all of these mathematicians were, at least for some time in their careers, interested in the development of physics. And Göttingen physics—with the two Nobel laureates Max Born and James Franck, as well as young men like Heisenberg—left nothing to be desired. Furthermore, there was not only the contact with theoretical physics but, as the most remarkable if belated result of Felix Klein's efforts to associate even engineering applications with the university, Ludwig Prandtl's Experimental Institute of Aerodynamics became operational in 1917. There was close contact between Prandtl and the Mathematical Institute at least as long as Courant was director of the latter, i.e., until spring 1933.

The glory of Göttingen could also cause grief to those who did not work there.

What made Göttingen probably the most eminent center of mathematics in the world—until 1933—was the unrivaled inspiring atmosphere among the numerous young mathematicians who flocked to Göttingen from everywhere. This is a hard thing to pin down exactly in a general overview—and it is an easy thing to destroy by altering the overall conditions of work.

After Landau had turned down an offer of a chair in Heidelberg in 1913, the Göttingen mathematicians celebrated this success by a party at which Hilbert gave a speech which ended with the words:

Since the mathematical sciences are so vast and varied, it is necessary to localize their cultivation, for all human activity is tied to places and persons. Göttingen is a place which—favoured by tradition, by the cooperation of our Prussian government, and by a series of other favorable circumstances—has become a preferred center of mathematical science. By your decision, you [Landau] have shown that you, too, favor this place. We are most grateful for this. And the best way to show our gratitude is by a continuing, enthusiastic collaboration in our mathematical science. Thus in future histories of Göttingen it should read: Gauss, Riemann, and Klein—those were individual summits rising into the clouds. But then, around the time that Landau came to Göttingen, there started a period of general mathematical high culture; from Göttingen mathematics launched a new conquest into the universe of science. . . .

Let me add that the glory of Göttingen could also cause grief to those who did not work there. Apparently it happened more than once that new results by others were talked about in Göttingen seminars, and

then people from Göttingen quickly developed them further, forgetting about the creator. This process was euphemistically termed the “nostrification” of an idea.

The palpable realization of the glamour of Göttingen mathematics was the construction, finished in 1929, of a grand new building for the Mathematical Institute financed by the Rockefeller Foundation. Two mathematical institutes were thus built in Europe with American money in the 1920s; a few years before Göttingen, the Institut Henri Poincaré in Paris.

Let us now change our perspective of Landau's Göttingen and turn to the major political events—the war and the two turnovers of the whole political system of Germany—and their peculiar effects on Göttingen mathematics.

Let us start at the end: Between April and November of 1933, the Mathematical Institute at Göttingen was virtually destroyed because the Nazis quickly put on leave or dismissed a good part of the staff. The Göttingen case is unique among German universities for the rapidity and thoroughness of destruction of a big institute. This is all the more remarkable as not one of the Göttingen professors of mathematics was affected by the non-Aryan clause of the new civil service law of 7 April 1933. More precisely, this non-Aryan clause (§3) specified that Jewish civil servants had to be dismissed, *unless* they had been civil servants before World War I or had done frontline fighting during the war.

Let us recall that many German Jews occupying eminent positions in society not only shared patriotic feelings for Germany but thought that World War I was the historic occasion to prove, even beyond duty, their allegiance with the German cause. This idea of having to do maybe more than non-Jewish Germans was undoubtedly fostered by the presentiment that otherwise they would be accused of indifference to the national cause. And sure enough, right after the capitulation, which so surprised the fighting troops and toppled the monarchy in Germany, right-wingers tried to restore as much as possible of the old order and often accused Jewish citizens of having contributed to the disaster by evading their part of the duty during the war (*Drückebergerei*).

In the small world of the Göttingen mathematicians, Richard Courant is an example of a German Jew who participated beyond the necessary minimum in the military. Courant was seriously wounded in September 1915 at the Western Front and afterwards tried to develop a long-wave broadcasting device to help communication between the trench lines (*Erdtelegraph*). Thus Courant was exempted from §3 of the law.

As for Landau, he was not affected because he had been appointed professor, and thus civil servant, in 1909. During World War I, he reached his forties and was repeatedly found not apt for military service. It is



From left to right: G. T. Whyburn, Marianne Landau, Edmund Landau, Earl Hedrick, Susanne Landau, and Karl Menger at Metro-Goldwyn-Mayer Studios in Hollywood, June 1931.

indicative of the wild right-wing political agitation of the first few months after the war that Landau (along with three other faculty members) was accused of military service evasion in an anonymous letter, published on 24 December 1918, to the editors of the right-wing paper *Göttinger Tageblatt*. In his—and only his—case, however, the paper printed a formal apology the following day.

Now, to get back to the law of 1933, Felix Bernstein, just like Landau, had been a civil servant already before the war; Herglotz and Weyl were not Jewish, and Emmy Noether was not affected because, at first, the law covered only people in civil servant status. But now suddenly, for the only time in her life, she was treated by a German government according to her real merit, not according to her formal position: In a telegram dated 25 April 1933, the ministry put on temporary leave the mathematicians Bernstein, Courant, and Emmy Noether “until final decision of their cases according to the civil service law.” This highly unusual and precipitate action calls for explanation.

First of all, there were other clauses in the law besides the non-Aryan clause that enabled the government to remove civil servants whose political opinions were thought to make it impossible for them to serve the new regime faithfully. Thus Courant, having

learned of the telegram, assumed that it implicitly accused him of such political unreliability; Courant tried to defend himself against this, because he still wanted to save whatever he could of all that he had built up in Göttingen.

This political theme squared very well with a veritable street campaign in Göttingen—apparently orchestrated by national-socialist activist students and/or by faculty members from other disciplines—which explicitly focused on the Mathematical Institute, calling it a “fortress of Marxism,” a “center of liberalism,” and the like. The telegram therefore can be explained as a quick action by the ministry to prevent the street forces from doing things on their own. Already on 28 March 1933, Göttingen had in fact witnessed a boycott of Jewish shops, with violent harassment of some of their owners, which was a spontaneous action of the local SA (and also SS), anticipating the centrally planned boycott actions.

The attempt by the ministry to keep the situation under control can also be seen from the “recommendations” sent out shortly after the telegram to all academic teachers who were considered to be not liked by the national-socialist student majority. Thus at the Mathematical Institute, Landau was asked not to teach his calculus class himself. Consequently, all through the summer term of 1933, Landau prepared the lectures with his assistant Werner Weber—at that time already a fervent Nazi—and then actually sat in his office during each class, just in case a message from the ministry would reach him that further caution was not needed, and he could take over the class himself again. He heard nothing from Berlin.

The political agitation of the Göttingen students in general is not too unusual considering the general almost religious fervor that gripped so many Germans in 1933. But why, you will ask, did they focus on the Mathematical Institute, out of all possible targets? In the light of documents that I only got to know fairly recently, it becomes clear that the political agitation in the spring of 1933 was the direct continuation of political fights going back at least to 1918.

After World War I, in the wake of the capitulation and the half-hearted German revolution, Bernstein and Courant took an active part in the campaign for the elections to a new National Assembly (19 January 1919). Bernstein was vice-president of the newly founded left-liberal party “DDP” at Göttingen; Courant was commonly referred to as a “well-known socialist” in the newspaper reports on his numerous public speeches. The elder daughter of the applied mathematician Runge also was in the papers almost every day in December 1918/January 1919; and David Hilbert, though he did not give speeches, was conspicuously present at various liberal or leftist election rallies. Emmy Noether did not make public appearances at the time, but the nationalistic circles in 1933

clearly considered her socialist, if not communist. She had been a member of the USPD, then the SPD—the social democratic party—in the early 1920s. But for the Nazi students the mere fact that she had given lectures in Moscow in 1928/29 was sufficient to condemn her.

The intertwining of anti-Semitic and political agitation against Göttingen mathematicians can also be traced through the Weimar republic. Thus Bernstein devised a quite successful state loan to stabilize the faltering finances of the young republic in 1919/20 and subsequently was badly hassled in Göttingen for his

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allegedly irresponsible behaviour in that context: some faculty claimed he had tried to enrich himself in an inadmissible way. But it is obvious from looking at the attackers that this was also simply a fight against the liberal democrats and against the whole republican system, which the right refused to accept.

On an almost hilarious note, Courant was implicated, in 1926/27, in a political affair because he had failed a female student in an oral exam. The attempts of the student to sue Courant because he had written in the notes of the exam that she appeared “psychopathic” had no success at all before court. In fact, a doctor’s report confirmed Courant’s impression. But she managed to enlist the help of the right wing *Deutsch Nationale Volkspartei*, which took the affair all the way to parliament.

I hope these few indications, unpleasant as they are, suffice to show the picture of the political turmoil at Göttingen that prompted the quick action of the ministry against mathematicians.

By the beginning of the winter term 1933/34, in November 1933, Courant was still on leave; Noether had been dismissed according to §3 (the law had quickly been extended to non-civil-servant employees); Hermann Weyl had preferred to leave for Princeton (the fact that his wife was Jewish would have cost him his job in 1937, if he had stayed on); and Bernstein, who had not been in Göttingen at all since the end of 1932, was about to be formally dismissed.

Thus, only Herglotz and Landau remained, and on 2 November 1933, Landau made an attempt to resume his calculus class himself. The students had apparently been alerted by Werner Weber, who had not been asked by Landau to take over the teaching, and

they staged a boycott with SA guards at the entrances to the lecture hall deterring by their mere presence the students from entering. Only one student had found his way in. So Landau had to give up, retired to his office, and there, a few minutes later, was visited by the student leader of the boycott, Oswald Teichmüller, who proceeded to explain the reasons for the boycott. Landau asked Teichmüller to write up these reasons and send them to him within two days so that he would have something written in hand. Teichmüller complied with this request, and then Landau drew up a letter to the ministry asking for his early retirement. He enclosed a copy of the text of Teichmüller’s letter; but—as a last and supreme act of his incredible sense of duty and correctness—he did not communicate Teichmüller’s name to the ministry, evidently in order not to create problems for this young and extremely talented student.

I am not personally familiar with Teichmüller’s letter, maybe it is no longer extant. That it was actually Teichmüller who led the boycott is proved, for example, by a letter written by Teichmüller’s mother after the war in which she also mentions this shameful letter. The contents of it must have been pure anti-Semitism, something to the effect that German (“Aryan”) students no longer wanted to be instructed by Jewish teachers. The well-known Berlin professor of mathematics Ludwig Bieberbach, himself hardly ten years younger than Landau, shortly afterwards praised the Göttingen students for what he called their “manly” action against Landau, and he proceeded to explain an incompatibility of Landau’s Jewish way of presenting calculus with the German way of thinking.

Landau was granted his retirement at the beginning of 1934. The Landaus gave up their house in Göttingen that same year and moved to Berlin. After a few years highlighted by mathematical trips to Holland and England, Landau died in Berlin on 19 February 1938. He died of natural causes although it is of course impossible to tell how much the distress of the last years may have precipitated his death. He is buried in the Jewish cemetery of Berlin-Weissensee.

As for Teichmüller, he grew to be probably the greatest mathematical talent of the 1930s—certainly the most original mathematician who ever believed in National Socialism. He perished at the Eastern Front in September 1943, shortly after having volunteered to go there in order to help stop the retreat of the German troops after Stalingrad.

[Some of the information concerning Landau has been taken from W. Kluge: *Edmund Landau—Sein Werk und sein Einfluß auf die Entwicklung der Mathematik*; Staatsexamensarbeit, Duisburg, 1983.]

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