Jarník's Notes of the Lecture Course Allgemeine Idealtheorie by B. L. van der Waerden (Göttingen 1927/1928)

Mathematics in Göttingen

In: Jindřich Bečvář (author); Martina Bečvářová (author): Jarník's Notes of the Lecture Course Allgemeine Idealtheorie by B. L. van der Waerden (Göttingen 1927/1928). (English). Praha: Matfyzpress, 2020. pp. 33–[46].

Persistent URL: http://dml.cz/dmlcz/404378

MATHEMATICS IN GÖTTINGEN[1]

University in Göttingen

The University in Göttingen, officially named Georg-August-Universität Göttingen but known informally as Georgia Augusta, was founded in 1734 by George II, King of Great Britain and Elector of Hannover, when he ordered his prime minister Gerlach Adolph von Münchhausen to establish, at Göttingen, a new German university having the four classic faculties of theology, law, philosophy and medicine. His main aim was practical: to improve education in Germany, especially the preparation of lawyers and doctors, state officers and teachers. He hoped, as well, to extend academic freedom in accordance with the then prevailing ideas of the European Enlightenment. The first lectures started in 1734; the official inauguration of the university, however, took place three years later.

Within fifty years of its founding, the university became one of the most important and influential German universities, teaching classical as well as modern science. During the 18th century it was renowned thanks mainly to its law faculty. However, it also enjoyed a lively spirit of inquiry providing a fruitful atmosphere for scientific study, exploration and research. Many students throughout Europe were attracted there by the lectures of Johann Stephan Pütter (1725–1807), one of the most prestigious professors of public law in Europe at that time, August Ludwig Schlözer (1735–1809), the historian, and Christian Gottlieb Heyne (1729–1812), the famous philologist. Those who studied there included Klemens Wenzel Nepomuk Lothar von Metternich (1773–1859), later the diplomat and prime minister of Austria, Karl Wilhelm von Humboldt (1767–1835), later the writer, philologist, organizer of higher education in Germany and professor at the University in Berlin, Napoleon Bonaparte (1769–1821), later French Emperor, Arthur Schopenhauer (1788–1860), later the outstanding German philosopher, Heinrich Heine (1797–1856), later the famous German poet, studied law or philosophy there at the end of 18th century and at the beginning of the 19th century. By 1812, it was acknowledged internationally as a modern European university of the first rank thanks to superior organization, lectures and lecturers as well as to its rich library containing more than 250 000 volumes. From 1810 up to the first half of the 1830s, the university was the Mecca for the study of public law in Germany, and almost every year law students made up more than half of the entire student

[1] The text is a modification of the chapter in [BeNe] and it is taken with the permission of the coauthor.

body. Gustav von Hugo (1764–1844) and Rudolf von Jhering (1818–1892), the founders of the school of law and its most significant jurists, taught there in the 19th century; Otto von Bismarck (1815–1898), the first chancellor of the second German Empire, studied law there in 1833.

A significant role in the further development of the University in Göttingen was played by the political events of the late 18th and early 19th century: the French revolution, Napoleon's wars, political and social disturbances rocking the continent and the economic problems which followed, the Congress in Vienna and the battle for freedom. These phenomena resulted in decreasing the number of students and professors in 1834. One of the most critical times came in 1837 when seven famous professors – Wilhelm Eduard Albrecht (1800–1876), the germanist, Friedrich Christoph Dahlmann (1785–1860), the historian, Georg Heinrich August Ewald (1803–1875), the orientalist, Georg Gottfried Gervinus (1805–1875), the historian, Wilhelm Eduard Weber (1804–1891), the physicist, Jakob Grimm (1785–1863), the philologist, and his brother Wilhelm Grimm (1786–1859), philologist – protested against the revocation of the liberal constitution of 1833 and further restriction of the academic prosperity and freedom by King Ernst Augustus I of Hannover. As a consequence of their protest, they were expelled from the university.

Mathematics in Göttingen

From the 1830s, the University in Göttingen reversed its main scientific and research trends. The exact and natural sciences, especially mathematics, took center stage, which ultimately resulted in Göttingen later becoming one of the most important world mathematical centers. From 1807 to 1855, Carl Friedrich Gauss (1777–1855), the most famous mathematician in the first half of the 19th century, taught and did research there. Later his successors and disciples, including Johann Peter Gustav Lejeune-Dirichlet (1805–1859), Bernhard Georg Friedrich Riemann (1826–1866), Rudolf Friedrich Alfred Clebsch (1833–1872), Hermann Amandus Schwarz (1843–1921), Heinrich Weber (1842–1913), as well as other outstanding mathematicians and their students made their studies and contributions to mathematics at Göttingen; thus, laying the groundwork for subsequent developments in mathematics at the beginning of the 20th century.

It should be mentioned that the years from 1866 up to the beginning of 1880s were not easy for Göttingen because, after the annexation of Hannover's Kingdom by Prussia, the university became one of the German regional schools. But, in 1885, the situation for mathematics changed dramatically when the Prussian minister of education called Felix Klein to the University in Göttingen. Ten years later, David Hilbert was invited to lecture there. By the end of the 19th century, their names and results attracted mathematicians from around the world to study, lecture or spend their scholarships in Göttingen making it the Mecca of mathematics at the beginning of the 20th century; a Mecca which, however, was temporarily interrupted by the First World War.

After the War, Richard Courant came to Göttingen as one of Klein's successors and he dedicated himself towards the advancement of the university and especially of mathematics there. In spite of post war crisis and inflation, he was able to find some state and private funding for the cultivation of mathematics and to help with the recovery of mathematics and physics in Germany. It was his urging that in 1922 mathematics along with the natural sciences formally separated from the other disciplines at the Faculty of Philosophy and a new mathematical center called *Mathematisches Institut der Universität* was created. The next year, he started the German collaboration with the International Education Board founded by John D. Rockefeller, Jr., which offered some fellowships to young scientists to study abroad. German mathematicians could finally travel out of Germany for study and other foreigners could come to work at Göttingen. International collaboration once again flourished.[2]

Courant also introduced many innovations in teaching, subjects matter, and the style of communication with students and colleagues. His new teaching methods brought early achievements:

... Courant quite soon made an instructional innovation, the Anfängerpraktikum or "beginners' practice period," which was to have important results for the new "institute".

The Praktikum paralleled the calculus lectures. The students, often numbering as many as two hundred, received a mimeographed sheet of problems, some requiring inventive thinking as well as understanding of the material of the lectures. The professor regularly held a conference with a group of older students, discussing the problems and pointing out different methods of attack and various aspects of the solutions. The older students then went over the problems in the Praktikum with the beginning students and at the same time became personally acquainted with them. Solutions were written up and graded. Collusion was encouraged. Attendance was purely voluntary.

It is hard to realize today what a revolutionary innovation the Praktikum was in a German university at that time. Up until then, problems were never handed out except in applied courses, where they were usually not corrected. Textbooks were rarely utilized. Examinations were not given. The whole system was one of lecturing on the part of the professors and listening on the side of the students. The moment of truth did not arrive for several years, when the students had to take the state examination for teachers or the oral examination for the doctor's degree. For some, only then did it become clear that knowing mathematics is not like knowing the plot of a work of literature or the general outline of a historical period. The shock they experienced at this revelation not infrequently resulted in a nervous breakdown.

The Praktikum was a way of coping with a greatly increased number of students and a much lower level of ability and preparation It required a group

[2] For more information see [Le], [PR] and [SSr1].

of older students to supervise it and these became additional "assistants" with appropriate financial support from the government.[3]

In the second decade of the 20th century, the University in Göttingen reached its academic peak: a high level of work prevailed not only in mathematics, but also in physics, chemistry, biology as well as in the social sciences and humanities. In Göttingen there again was a vibrant scientific atmosphere owing to the large and revitalized academic community, which included gifted students, distinguished visitors from all over the world, and guest professors who came to present papers, give seminars or hold regular lectures.

December 2, 1929, marked an important day for the mathematical community in Göttingen; the Mathematical Institute of the University in Göttingen formally opened its new residence. This building was a result of decades of work by Klein and by Courant and his contact with the Rockefeller Foundation and the German government. Mathematics obtained its own modern facilities which permitted a new interaction between students and teachers, German mathematicians and their foreign colleagues, as well as between mathematics and other sciences.[4]

In the 1930s, this fruitful and inspiring atmosphere came to its final end. Following the end of the academic year 1931–1932, the consequences of the worldwide depression began to be felt in Germany. Economic restrictions were adopted and Faculties were ordered to dismiss most of the younger assistants. To make matters worse, the university early on became a focal point of the Nazi ideology.

Brown shirts and swastikas suddenly began to appear in mathematics lecture halls. The wearers of these were not members of the "in group" but several of them were good mathematicians. Werner Weber, one of the most active of the pro-Nazi students, had been a Privatdozent since 1931. The 20-year-old Oswald Teichmüller was extremely gifted. The Nazi sympathies of these and others came as a complete shock to Courant and the young mathematicians of the "in group".[5]

On April 7, 1933, the government announced a series of laws – the Reichsgesetze – for the "restoration of the professional civil service". Their main intent was to remove Jewish professors, professors married to Jews or people who sympathized with Jews, as well as any academic freedom or left-

[3] [R1], p. 99.

[4] The list of visitors looks like a "who's who" of the world of mathematics. There can be found: B.L. van der Waerden (from Netherlands), G.M.H. Köthe and O. Taussky (from Austria), K. Shoda and T. Takagi (from Japan), C. Chevalley and A. Weil (from France), P.S. Aleksandrov, A.O. Gel'fond, A.N. Kolmogorov, O.Yu. Schmidt, P.S. Urysohn (from the Soviet Union), Chiungtze C. Tsen (from China, known as Tseng Chiung-chih or Zeng Jiongzhi), K. Kuratowski (from Poland), G.D. Birkhoff, S. Lefschetz, S. Mac Lane, N. Wiener (from the USA), E. Artin, R.D. Brauer, H. Hasse, J. von Neumann, C.L. Siegel (from Germany). For more information on the development of the Mathematical Institute in Göttingen see [BS], [Gj], [No], [PR], [R1], [R2], [R3], [Ro1], [Ro2], [Te], [To1] and [W1].

[5] [R1], pp. 137–138.

leaning opinions that might still remain in political, social and intellectual life. As a result of these laws many "non-Aryans" were expelled from the universities or simply fled abroad before the summons came. This, later called the "great purge", included academics as Max Born, Victor Goldschmidt, James Franck, Eugene Wigner, Leó Szilárd, Edward Teller, Emmy Noether, Richard Courant, Otto Neugebauer, Hermann Weyl, Edmund Landau, Carl Ludwig Siegel, Felix Bernstein, Paul Bernays, etc. The legacy and effort of the last one hundred years was destroyed.[6]

Although in 1945, after the Second World War, the University was reopened under the British control and quickly began to develop its facilities, the mathematics department never attained the unique reputation and the prestige it had had before the war.

Mathematical circle

As we have already mentioned, the mathematical circle at the University in Göttingen dated its origins to the early 18th century. It started as a very small community concentrated around one regular professor's chair and one other professor named only for his person. Only a few students chose mathematics as their main area of study at that time and only a minority those continued on towards their doctorate. In 1848, a second regular chair was created and from that time, two or three professors (two ordinary and one "special") and some private docents lectured and collaborated together. At the beginning of the 20th century the number of students of mathematics increased and the ministry of education officially decided to establish a third chair for pure mathematics and a fourth chair for applied mathematics. After the First World War, the community consisted of four ordinary professors, three or more extraordinary professors, some guest professors, several private docents, lecturers, senior and junior assistants, about two hundreds undergraduate and graduate students and visitors. The growth of the faculty is described in the following tables:[7]

First Department of Mathematics

1807–1855	Carl Friedrich Gauss
1856–1859	Johann Peter Gustav Lejeune-Dirichlet
1860–1866	Bernhard Georg Friedrich Riemann
1868–1872	Rudolf Friedrich Alfred Clebsch
1874–1875	Lazarus Fuchs
1875–1892	Hermann Amandus Schwarz
1892–1895	Heinrich Weber
1895–1930	**David Hilbert**
1930–1933	**Hermann Weyl**
1934–1945	Helmut Hasse

[6] For more information on the situation in Germany in the 1930s see for example [BS], [Ep], [NS], [PR], [R1], [R2], [S1], [Su], [SSr1], [SSr2] and [Te].

[7] The names of professors who were van der Waerden's colleagues and contemporaries in Göttingen are written in bold.

Second Department of Mathematics

1848–1883	Moritz Abraham Stern
1886–1913	Felix Klein
1913–1918	Constantin Carathéodory
1918–1919	Erich Hecke
1920–1934	**Richard Courant**
1934–1954	Theodor Kaluza

Third Department of Mathematics

1902–1909	Hermann Minkowski
1909–1934	**Edmund Landau**
1934–1936	Erhard Tornier
1936–1937	Rolf Nevanlinna
1938–1940	Carl Ludwig Siegel

Fourth Department of Mathematics – Applied Mathematics

1904–1924	**Carl David Tolmé Runge**
1925–1948	**Gustav Herglotz**

Other Professors of Mathematics[8]

1802–1832	Bernard Friedrich Thibaut
1817–1879	Georg Karl Justus Ulrich
1857–1859	Bernhard Riemann
1860–1897	Ernst Schering

Extraordinary Professors of Mathematics

1907–1933	**Felix Bernstein**
1919–1920	Richard Courant
1919–1933	**Paul Bernays**
1919–1933	**Emmy Amalie Noether**
1927–1936	**Otto Neugebauer**

From 1797 up to 1945, eighty four mathematicians obtained their *Habilitation* in mathematics, applied mathematics or mathematical physics at the University in Göttingen. Some of them continued their careers as private docents, extraordinary professors or ordinary professors there; others lectured at German universities as well as at European mathematical institutions or later moved on to positions in the USA. During 1924–1930, when van der Waerden studied and lectured in Göttingen, among his young colleagues, who finished their *Habilitation* thesis, we can find the following mathematicians:

[8] In the 19th century, there was no position of extraordinary professor at the University in Göttingen.

A. Walther	1924	1924–1928
E. Bessel-Hagen	1925	1925–1927
K. Grandjot	1925	1925–1929
O. Neugebauer	1927	1927–1932
B.L. van der Waerden	1927	1927–1928
H. Lewy	1927	1927–1933
W. Cauer	1928	1928–1935
U. Wegner	1929	1929–1931
W. Prager	1927	1929–1934
K. Friedrichs	1929	1929–1930
S. Cohn-Vossen	1929	1929–1930

It should be mentioned that W. Prager obtained his *Habilitation* in Darmstadt in 1927 and K. Friedrichs in Aachen in 1929.[9]

During the 1920s and at the beginning of 1930s many visiting professors spent some time in Göttingen in order to lecture or to collaborate with others there [for example Emil Artin (from Hamburg), Reinhold Baer (from Freiburg), Ruth Moufang (from Frankfurt), Richard von Mises (from Berlin), John von Neumann (from Berlin), George Polya (from Zurich), Oswald Veblen (from Princeton)]. At the same time, some of the future outstanding mathematicians studied in Göttingen or worked there as Courant's, Hilbert's or Landau's assistants (for example Herbert Busemann, Max Deuring, Saunders Mac Lane, Gerhard Gentzen, Olga Taussky).

In their memoirs, several distinguished mathematicians described the unusually fruitful, open and friendly atmosphere that existed in the mathematical circle at Göttingen and stressed Courant's decisive role in the development of international contacts among young mathematicians. In [R1], for instance we can find:

Friedrichs remembers the seminar as being impressively well attended.

"Siegel and Artin came, also Kneser. There was present every assistant who was in Göttingen at that time. They all had to come and participate. Such a group of people, who knew everything about everything – it was very exciting to me."

"When you say 'they had to come and participate,' do you mean that Courant required them to come, or that it was customary for everybody to come to the seminars?"

Friedrichs laughed.

"That question cannot be answered. Such a notion did not exist for Courant. He did not ask the people as a requirement as Klein might have done. No. He would say, 'It's very important that you help us with this, we need your help'; and he would manage somehow that everybody who had something to contribute did attend. That's the way he always operated."[10]

[9] For more information about the academic staff in Göttingen see [BN], [E] and [Su].

[10] This English quotation is taken from [R1], pp. 91–92.

In Göttingen, informal personal contacts and discussions played a very important role in the development of mathematical ideas. In [R1], we can read:

Much of the social life in Göttingen depended on the parties which the professors gave at various time during the year. These were characteristic. Landau's parties were intellectual tests, to which Hilbert never came. Games were played, there were winners and losers. "Hilbert didn't like the premises", Courant explained to me. Herglotz, naturally, gave no parties. Emmy Noether was famous for her "children's parties", to which Hilbert did come. The Weyls hosted a tea dance on a Saturday afternoon – very elegant and formal with many pretty girls present. At the Courant's house there was an unending succession of musical evenings, to which some students were always invited.[11]

Van der Waerden and his activities in Göttingen

As we described in the previous chapter, van der Waerden studied and then regularly lectured at the University in Göttingen in 1924/1925, 1926/1927, 1927/1928 and 1929/1930. His lectures on modern algebra and algebraical geometry became popular and many students attended them attracted by his deep mathematical knowledge, his interest in abstract algebra and his pedagogical talent.

Saunders Mac Lane, one of outstanding mathematicians, recalled his Göttingen experience from 1931 to 1933 in these words:

Göttingen was at that time one of the great world centers of mathematics. There were only a few other centers at a comparable level: Paris, Berlin, and perhaps Moscow. Centers in the United States, such as Princeton, were not then quite up to that standard. In the late 1920s the Rockefeller Foundation had made grants to construct two buildings for mathematics, one at Göttingen and one at Paris ...

The mathematical staff at the Institute in Göttingen was small compared to present-day centres of mathematics. Nevertheless, that institute did have a dominant position in mathematics ...

One of the best restaurants in town was in the railroad station, not far from the Mathematical Institute. Nearly every noon a number of the Dozenten and senior students repaired there for luncheon. After a bit of introduction I often joined them and found this a lively and stimulating affair. One also met one's fellow students in the well-stocked library of the Institute and between lectures. The usual lecture was for two hours with a fifteen minute break between the hours. In the break, one walked up and down the hall outside, admired the numerous mathematical models displayed in elegant glass cases, and talked to other students.

Göttingen was at that time a major centre of mathematical research, setting the style for centers everywhere. Nevertheless, the number of full professors was

[11] [R1], p. 128.

very small and one wonders in retrospect how this preeminence was achieved. I am unclear as to the answer. Part of it lies in the provision of a considerable number of junior faculty members (Privatdozenten and assistants who were there on temporary appointments). Also the major professors, according to long-standing German tradition, had assistants who gave them a great deal of support and took care of much of the routine work and writing. There must be many other less tangible aspects of Göttingen's dominance. Certainly, its long tradition stretching back to Gauss and Riemann is an important element.

Mathematics at that time was surely not as finely subdivided into specialities as it now is. This must have made it easier for one place to be in the lead in most of the currently important fields – especially when Hilbert and others "took over" promising ideas (like integral equations) which started elsewhere. At any rate, in many of the then prominent specialities, Göttingen was clearly the leading center:

Mathematical logic	*Hilbert, Bernays, and others (also Vienna)*
Lie groups	*Weyl, Herglotz, etc. (also Paris)*
Algebra	*Noether (also Hamburg)*
Algebraic geometry	*van der Waerden (also Lepzig)*
Analytical number theory	*Landau (also Cambridge, England)*
Partial differential equations	*Hans Lewy and others (also Berlin)*
Functional analysis	*Rellich and others ...*[12]

Saunders Mac Lane wrote on Göttingen's algebra, its influence on other European mathematicians and his own studies the following sentences:

When I first came to Göttingen I spoke to Professor Weyl and expressed my interest in logic and in algebra. He immediately remarked that in algebra Göttingen was excellently presented by Professor Noether; he recommended that I attend her courses and seminars. ... Her work was much admired and her influence was widespread.

... Her lectures were jerky and very enthusiastic, but also rather obscure. Since she was in the process of working out the ideas of the paper, she did some of the working out right there in class. I am afraid that at the time I was sufficiently putt off by this obscurity that I did not attend her subsequent courses. Her courses were sparsely attended but by enthusiastic students, plus some faculty members. I remembered in particular that Ernest Witt was then one of her most devoted students, and that Paul Bernays regularly came to her courses. ...

Noether's enthusiasm for lecturing was not much impeded by days when the Institute was shut. I recall one day when the Institute was not scheduled to be open because of a state holiday. Noether announced that the class would go on

[12] This English quotation is taken from [BS], pp. 65, 73–74.

just the same, but would take the form of an "Ausflug". So we all met on the steps of the Institute and walked the short distance out to the country through the woods to a suitable coffee house, talking about algebra, other mathematical topics, and Russia on the way. Evidently this great enthusiasm of Noether's was a major element in her considerable influence on algebraists throughout Germany.

Noether also actively encouraged visitors. I remember well a visit by Emil Artin, then a professor at Hamburg. He had recently been a postdoctoral fellow at Göttingen; he had, with Noether, a considerable influence on founding of abstract algebra – as represented in the acknowledgments in van der Waerden's book Moderne Algebra (1931). During his Göttingen visit, Artin gave three brilliant but condensed lectures on class field theory. I recall meeting Artin subsequently over tea in Noether's or in Courant's home. Artin was, as always, articulate and full of specific promising problems. He formulated to me with emphasis some such explicit problem in class field theory; though it sounded attractive, my knowledge of this theory was then so sketchy that there was no hope of my tackling it. It did not dare admit this ignorance.[13]

Other lovely memories of the Göttingen mathematical community in the twenties and thirties of the 20th century can be also found in [A], [G] and [R1].

Van der Waerden's recollections of Göttingen

Van der Waerden considered the accademic years he spent in Göttingen the most decisive and creative years for his scientific work and teaching activities. In his article *Obituary of Emmy Noether*, he described the very fruitful atmosphere at the Mathematical Institute in Göttingen and his professional as well as personal contacts with Noether:

As characteristic features we have found: An exceptionally energic and consistent pursuit of abstract elucidation of the material to complete methodical clarity; a stubborn clingig to methods and concepts once they had been acknowledged as being correct, even when they still appeared to her contemporaries as abstract and futile; an aspiration to classify all special relationships under specific general abstract models.

Indeed, her thoughts deviated in some respects from those of most other mathematicians. We are so dependent on figures and formulas. For her these resources were useless, rather annoying. Her sole concern was with concepts, not with intuition or calculations. The German letters which she sribbled down hurriedly on the blackboard or on paper in typical simplified form were for her representations of concepts, not objects of a more or less mechanical calculation.

This totally unintuitive and unanalytical attitude was undoubtedly also one of the main causes of the complexity of her lectures. She had no didactical

[13] This English quotation is taken from [BS], pp. 70–71.

gifts, and the great pains she took to explain her remarks by quickly spoken interjections even before she had finished speaking were more likely to have the opposite effect. And still how exceptionally great was the impact of her talks, everything notwithstanding! The small, faithful audience, mostly consisting of a few advanced students and often just as many lectures and foreign guests, had to exert themselves to the utmost to keep up. When that was done, however, one had learned far more than from the most excellent lecture. Completed theories were almost never presented, but usually those that were still in the making. Each of her lecture series was a paper. And nobody was happier than she herself such a paper was completed by her students. Completely unegotistical and free of vanity, she never claimed anything for herself, but promoted the works of her students above all. For all of us she always wrote the introductions in which the main ideas of our work, which we initially never could understand and express in such clarity on our own, were explained. She was a faithful friend to us and at the same time a strict and unprejudiced judge. As such she was also invaluable to Mathematische Annalen.[14]

In [R1], for instance, we can find these paragraphs on van der Waerden's studies in Göttingen:

The proof sheets of the final common work with Courant were shown by Friedrichs and Lewy to van der Waerden, who was an active member of the Göttingen circle at that time.[15] *When I interviewed him in the summer or 1971 in Zurich, he still spoke with enthusiasm – almost half a century later – of the vivid impression made on him by the paper on the existence and uniqueness of the solutions of partial differential equations in the elliptic, hyperbolic, and parabolic cases. Before he came to Göttingen, he told me, he had agreed to tutor an engineer who wanted to learn something about partial differential equations so that he could solve an equation relating to the conduction of heat in a cylinder.*

"I had a bad conscience about him because I had taken his money and he hadn't leardned anything useful. So when I came to Göttingen, my mind was much more open to these important things. All my life", he added "I have had great advantage from having read that paper at that moment."[16]

REFERENCES

[A] Александров П.С., *Воспоминания о Геттингене*, Историко-математические исследования **32** (1977), pp. 242–245 (Russian). [Aleksandrov P. S., *Memories on Göttingen*, Istoriko-Matematicheskie Issledovanija **32** (1977), pp. 242–245].

[BeNe] Bečvářová M., Netuka I., *Jarník's Notes of the Lecture Course Punktmengen und reelle Funktionen by P.S. Aleksandrov* (*Göttingen 1928*), Edition History of Mathematics, volume 43, Matfyzpress, Prague, 2010, 143 pages.

[14] This English quotation is taken from [BS], pp. 97–98.

[15] The author means the years 1926–1928.

[16] [R1], p. 117.

[BS] Brewer J.W., Smith M.K., *Emmy Noether. A Tribute to her Life and Work*, Marcel Dekker, Inc., New York, Basel, 1981, 180 pages.

[BN] Burmann H.W., Neuenschwander E., *Die Entwicklung der Mathematik an der Universität Göttingen*, Die Geschichte der Verfassung und der Fachbereiche der Georg-August-Universität zu Göttingen, Göttinger Universitätsschr. Ser. A, **16** (1994), pp. 141–159.

[E] Ebel W., *Catalogus Professorum Gottingensium 1734–1962* [Catalogue of Professors in Göttingen], Göttingen, 1962, 222 pages (German).

[Ep] *Exodus Professorum*, Göttinger Universitätsreden 86, Vandenhoeck & Ruprecht, Göttingen, 1989, 48 pages (German).

[G] Гельфонд А.О., *Некоторые впечатления о научной поездке в Германию в 1930 г.*, Историко-математические исследования **32** (1977), pp. 246–251 (Russian). [Gel'fond A.O., *Some Impressions on Scientific Sightseeing Trip to Göttingen in the Year of 1930*, Istoriko-Matematicheskie Issledovanija **32** (1977), pp. 246–251].

[Gj] Gray J.J., *The Hilbert Challenge*, Oxford University Press, Oxford, 2000, 315 pages.

[Le] Lehto O., *Mathematics Without Borders: A History of the International Mathematical Union*, Springer-Verlag, New York, 1998, 399 pages.

[NS] Nachmanson D., Schmid R., *Die große Ära der Wissenschaft in Deutschland 1900 bis 1933. Jüdische und Nichtjüdische Pioniere in der Atomphysik, Chemie und Biochemie*, Wissenschaftliche Verlagsgesellschaft mbH Stuttgart, Stuttgart, 1988, 398 pages.

[No] Neugebauer O., *Das mathematische Institut der Universität Göttingen*, Die Naturwissenschaften **18** (1930), pp. 1–4.

[PR] Parshall K.H., Rice A.C. (eds.), *Mathematics Unbound: The Evolution of an International Mathematical Research Community, 1800–1945*, History of Mathematics, Volume 23, American Mathematical Society, London Mathematical Society, Providence, 2002, 406 pages.

[R1] Reid C., *Courant in Göttingen and New York. The Story of an Improbable Mathematician*, Springer-Verlag, New York, Heidelberg, Berlin, 1976, 314 pages.

[R2] Reid C., *Richard Courant 1888–1972. Der Mathematiker als Zeitgenosse*, Springer-Verlag, Berlin, Heidelberg, New York, 1979, 376 pages.

[R3] Reid C., *Hilbert*, Copernicus an imprint of Springer-Verlag, New York, 1996, 228 pages.

[Ro1] Rowe D.E., *Jewish Mathematics at Göttingen in the Era of Felix Klein*, Isis **77** (1986), pp. 422–449.

[Ro2] Rowe D.E., *Klein, Hilbert, and the Göttingen Mathematical Tradition*, Osiris **(2) 5** (1989), pp. 186–213.

[S1] Schappacher W., *Das Mathematische Institut der Universität Göttingen 1929–1950*, pp. 345–373, in Becker H., Dahms H.-J., Wegeler C. (eds.), *Die Universität Göttingen unter dem Nationalsozialismus. Das verdrängte Kapitel ihrer 250jährigen Geschichte*, K.G. Sauer, München, 1987, 523 pages.

[Su] Scharlau W., *Mathematische Institute in Deutschland 1800–1945*, Deutsche Mathematiker-Vereinigung, Friedr. Vieweg & Sohn, Braunschweig, Wiesbaden, 1990, 291 pages.

[SSr1] Siegmund-Schultze R., *Rockefeller and the Internationalization of Mathematics Between the Two World Wars*, Birkhäuser, Basel, 2001, 341 pages.

[SSr2] Siegmund-Schultze R., *Mathematicians Fleeing from Nazi Germany. Individual Fates and Global Impact*, Princeton University Press, Princeton, 2009, 504 pages.

[Te] Tent M.B.W., *Emmy Noether. The Mother of Modern Algebra*, A.K. Peters, Ltd., Wellesley, Massachusetts, 2008, 184 pages.

[To1] Tobies R., *Felix Klein: Visionen für Mathematik*, Anwendungen und Unterricht, Springer-Verlag, Berlin, 2019, 574 pages.

www pages

[W1] http://www.uni-goettingen.de/en/1.html [9.8.2019].