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RENATE TOBIES

MARGARETE KAHN
KLARA LÖBENSTEIN

MATHEMATICIANS
ASSISTANT HEADMASTERS
FRIENDS

Margarete Kahn and Klara Löbenstein are two noteworthy examples of the emancipation of women and Jews in society and the workplace, as well as the emancipation of mathematics and natural sciences in German schools and universities. A large number of mathematically gifted people were able to develop their talents to a high level within the Jewish tradition. From early on, there was a close connection between the Hebrew alphabet and numerical values. Furthermore, Talmud scholars, Jewish philosophers, Jewish physicians, rabbis and other Jewish professionals have always been intensively occupied with mathematics. Jewish parents supported the development of mathematical abilities in their daughters earlier than parents of other faiths. Women who remained unmarried could use these abilities in the profession of teaching, for a fulfilling occupation. Teaching was considered an acceptable profession for women. The educational paths of Margarete Kahn and Klara Löbenstein occurred during a time when universities had just opened up for women and when scholarly instruction in mathematics and natural sciences had for the first time penetrated into the public secondary educational system for girls. After male and female Jewish mathematicians had found their place in the school and university system, they decisively made their mark on the German-speaking mathematics culture, until they were driven away or murdered by the national socialists.

1 The reform for education of women in mathematics and natural sciences in Preußen

Margarete Kahn and Klara Löbenstein were pioneers in women's education in Germany. They attended university at the beginning of the 20th century, when representatives of mathematics and natural sciences, above all university professors, high school teachers and engineers, strived to obtain an equally entitled place for their subjects in the culture of that time and to modernize instruction of mathematics and natural science in all types of schools. This instructional reform was based on the demands of industry and economics, to which Kaiser Wilhelm II responded with a reform in 1892. In Preußen, this reform led to several changes affecting the education of both boys and girls. In 1899, technical colleges obtained the right to award degrees, and in 1900 the existing three types of colleges for boys were given equal status. These were: 1) the "Humanistisches Gymnasium", which was dominated by the ancient languages such as Latin and Greek, 2) the "Realgymnasium", which was more strongly oriented toward mathematics and natural sciences and included modern languages such as English and French, and also Latin, but not Greek, and 3) the "Oberrealschule", which was even more strongly oriented toward mathematics, natural sciences and modern languages, and did not

include ancient languages. In 1894, a scientific examination for women teachers was introduced and in 1900 the guidelines for the exam were modernized. This examination formed the basis for the educational goal of Margarete Kahn and Klara Löbenstein.

At first the only way they could attend classes was as auditors. They had to ask each professor individually for permission to attend his lectures. This explained the relatively low number of professors with whom they studied. Because of the educational sovereignty of the individual states, the regulations regarding access to the universitites were different in each state. Baden began allowing full matriculation for women in 1900. Preußen, the largest German state, with the most universities and where Margarete Kahn and Klara Löbenstein studied, was the second last state to admit women. The Prussian parliament did so with an ordinance dated August 18, 1908. In contrast to the ordinances of other German states, that of Preußen provided for a fresh organization of the secondary education system for women. Specifically, new secondary schools for women were established which terminated in the Abitur examination. These were institutions of study with the same three types of specialization as the schools for boys (Humanistisches Gymnasium, Realgymnasium and Oberrealschule). It was emphasized that, in quantitative terms, the Realgymnasium type was mostly formed for

girls whereas the Humanistisches Gymnasium was more common for boys. These educational establishments for girls opened up new professional opportunities for mathematically and scientifically trained women teachers.

In the following pages, the paths of these two women will be examined. They succeeded in earning their Ph.D. degrees, writing mathematical dissertations with one of the most reknowned mathematicians of the time. Even before the World War I, they obtained positions as teachers in Prussian high schools. The careers ended for both of these outstanding Jewish women—as for countless others—through the politics of the Nazi regime.

2   Educationally ambitious family homes

It was generally the case for the privileged among the pioneers in women's education that the fathers had a secure enough position to be able to finance the education of both their sons and their daughters. This assertion can be seen to be non-trivial when it is considered that, as early as 1913 or 1914, male students were seen to be more common than female students among the lower social strata. The family had to be united not only relative to the idea of women's education

but also relative to the idea of women studying mathematics and science, formerly associated with a males. Our research has shown that Jewish families with financially sufficient backgrounds and maybe also the wish to show off the social status they had achieved and to distinguish themselves further, made it possible for their daughters to fulfil their educational goals relatively early.

2.1 Kahn Family in Eschwege

Margarete Kahn was born on August 27, 1880, in Eschwege, as the daughter of the Jewish merchant and manufacturer Albert Kahn and his wife, Johanne (whose maiden name was Plaut). Albert and Johanne were first cousins and both came from merchant and manufacturing families, which can be shown to have lived in the city since the early 19th century. At the time of the birth of their daughter Margarete (Grete), the family lived at 29 am Stad. Later they lived at 23 Friedrich-Wilhelm-Straße, 3 Hospitalplatz, 8b an den Anlagen, 17 Bahnhofstraße and 29 Reichensächser Straße.

Grete grew up with siblings. Her brother Otto, one year older, completed his Abitur in Eisenach, then received training to be a master weaver. He then turned to

journalism and worked, starting in 1902, as a successful correspondent for the Frankfurter Zeitung, first in Milan and then in Rome. He also traveled on a short assignment to New York to strengthen the representation of his newspaper there. Outside of his work, he had a special interest in the Latin classics and the master of Italian poetry, Dante Alighieri, in particular his "Divina Commedia". He wrote a book about Dante and the Divine Comedy, hoping to interest German readers in this poet and his work. In November 1932, under circumstances which have never been clarified, Otto Kahn fell to his death from the top of the Colosseum in Rome. He was buried in the Protestant graveyard near the Cestius-Pyramid. Even in death, his journalistic work received impressive recognition in that the German ambassador in Rome as well as the Italian ambassador in Berlin sent their condolences. His only daughter, Nana, lived from that time on with relatives in the town of Attendorn in Westfalen. She also passed her Abitur exam and was the first girl in her town to be permitted to attend a boys' school, since the Catholic high school of the Ursulinen refused to admit children who had been baptized as Protestants.

Grete was only 18 months old when her mother died, at age 25. Two years later, Albert Kahn married Johanne's younger sister, Julie. In 1888, Grete's half sister, Martha, was born to Albert and Julie. Nothing is known about

Martha's education. In 1913, in Eschwege, she married Julius Ursell, the son of a manufacturer from Attendorn. His family owned one of the leading German galvanized sheet metal fabrication factories. He ran the business alone after the early death of his brother. From this marriage came a son and two daughters, who all attended the city's public high school. After the sudden death of Julius in February 1936 during a business trip to Brussels, Martha and the children were largely without any defenses against the persecution from the Nazi regime, especially since religion and race up to then had had scarcely any meaning for them. Since Julius Ursell had already had an interest in the beliefs of the Quakers, the contacts he had made were now helpful to make it possible for the children to travel to England and later to the USA. However, the opportunity for escape was no longer available for Martha. After the installation of Aryans as leaders of the business and the sale of the house, she passed her final years with her sister Grete in Berlin.

2.2 Löbenstein family in Datterode near Eschwege and in Hildesheim

Lehmann Löbenstein, the father of Klara Löbenstein, was from Datterode, a small village near Eschwege, the city in northern Hessen where Margaret Kahn was born.

This area is now called the Werra-Meißner district. The roots of the Löbensteins there go back to the 17th centruy, where they were chiefly occupied as merchants. Lehmann Löbenstein, born in 1847, left his home early. In 1869, presumably after his years of educaion to be a merchant, he moved from Lüneburg to Hildesheim. In 1874, when he was 27, he founded the textile company Löbenstein and Freudenthal, located at 9 Altpetristraße. The company began by bringing industrially produced ready-made men's clothing to Hildesheim. These garments were more affordable than the traditional custom-made clothing, making the purchase of clothes with cash possible for less affluent customers. The business at Altpetristraße expanded steadily and rendering it possible in 1900 to open one of the most modern textile stores at Hoher Weg 14.

Today one no longer realizes that during the time of the monarchy, the Altpetristraße and the Friesenstraße, as an extension of the Hoher Weg, belonged to the pulsing business streets. It was here, in the front of the corner house at Altpetristraße 1, on February 15, 1883, that Klara Löbenstein was born.

Her father, Lehmann Löbenstein, had married Sophie Schönfeld in 1876. She was the daughter of Samuel Schönfeld, a trader in home produce, from Brandenburg upon Havel. Samuel and Sophie had five children, 4

daughters and a son, Hans. It was thought that Hans would one day become the head of his father's firm. He beame a merchant and volunteered, among other places, in the cities of Paris and Berlin-Charlottenburg. In 1909 he returned to Hildesheim and married Edith Dux, the granddaughter of August Dux, the founder of the banking establishment August Dux and Company at Paradeplatz, the present-day Paul-von-Hindenburg-Platz. However, the embodiment of the family's hope fell in World War I. All that was left of Hans Löbenstein was a grave of honor with an iron cross and oak leaves in the Jewish cemetery in Hildesheim. He was identified as a meritorious front soldier and committed patriot. Women were not yet usual in business management and therefore Edith and her sisters did not enter the firm. Annie, the little daughter whom Hans left behind, obtained her Ph.D. in physical chemistry in Basel in 1939 and later became a professor in France. She had begun her dissertation in Munich under the guidance of the reknowned chemist Kasimir Fajans. She probably owed her opportunity to immigrate to Switzerland to her connection to him.

The sisters Klara and Frieda remained unmarried and took up teaching careers. Frieda was highly musical and obtained her education at private institutes, such as the voice program at Tonika-Do-Bund in Hannover. She taught at the famous Stern Konservatorium and at the

Hochshule der Künste (Academy of Fine Arts) in Berlin. The dismissal, because of her Jewish descent in 1933, shook her existence. At first, from necessity, she held lectures on Gregorianic in her home in Berlin-Charlottenburg. Later she was taken in at the house of the Johannis nuns in Oranienburg and, with their help, was able to flee to Brasil. She entered the Benedictine order there and taught Gregorianic according to the Tonika-Do method in Sao Paulo.

Dora, the oldest, and Erna, the youngest of the sisters, married. Dora, who had been born in 1880, married the merchant Bernhard Rubensohn in Kassel in 1903, and had two sons with him. In January, 1925, after their marriage foundered, Dora moved back to her parents' home in Hildeshiem. In December, her father, Lehmann Löbenstein, died in Hannover-Linden and, shortly afterwards, her divorced husband also died. Erna married Erich Kary in Berlin in 1923, but there is no entry in the Berlin address book. Klara's mother, Sophie Löbenstein, died in 1928 in Hildesheim. The family house, which Lehmann had had built for his family in 1889, with a columned front door and balcony towards the street, was located at Goslarsche Straße 64, right next to the city secondary school for girls.

3 School education at secondary school for girls and external Abitur (university qualifying exam)

Margarete Kahn and Klara Löbenstein attended secondary schools for girls in their home towns. These were schools that did not lead all the way to the university and did not yet offer instruction in mathematics and natural sciences. However, they did provide the basic foundations of arithmetic and natural history. They both needed to have private instruction to obtain knowledge required for the Abitur, the university entrance exam. For this exam, they had to register at the authorized provincial school board, which at the time referred them to a boys' high school. The Abitur exams usually lasted a week. It was usual to introduce oneself in person at the house of the examining professor. Both earned their certificate in 1904. In so doing, they belonged to a small group of talented German women who were qualified to enter a university. In 1906, only 268 women passed the Abitur in Germany.

3.1   Margarete Kahn—the path to the Abitur

Margarete Kahn attended the elementary school in Eschwege starting in 1887. From 1889 to 1896, she attended the Höhere Töchterschule (secondary school for girls) including the "Selecta", a newly organized

intermediate class, in Eschwege. The financial circumstances of the family made it possible for them to provide her with supplemental private instruction in the years between 1901 and 1904. Because of this, she could acquire knowledge that was necessary for the Abitur exam she was working towards. She passed this exam in August 1904 as an external candidate at the Royal Gymnasium for boys in Hersfeld, to which she had been directed by the appropriate authority, the provincial school council in Kassel.

The test consisted of four written pieces of work on four consecutive days: a German essay, a mathematics section, a translation of Cicero into Latin and a translation of Xenophon from Greek. Seven weeks later came oral exams in Latin (Livius), Greek (Homer), French, German (courtly poetry/Schiller's Maid of Orleans), math (theorems relating to similar triangles), physics (magnetism), as well as history and geography. As the final result, she received a composite score of "sufficient", which would correspond to a present day score of "2+". Four of the ten total examinees, all from good middle class families, failed the exam. One of these students was granted the opportunity to take the exam again after waiting one year. The chairman of the test committee was Dr. Konrad Duden who was the principal of the Gymnasium from 1876 to 1905. In 1980, this school was named "Konrad-Duden-Schule".

With the Abitur in her pocket, Grete Kahn was able to begin her mathematics studies in Berlin as early as the 1904/1905 winter semester. The early death of her father, Albert, at the age of only 52 years, in the summer of 1905, must have been very upsetting to Grete, all the more so as he now would not have the pleasure of following her successful career path. The fact that she was nevertheless able to continue her studies can be taken as evidence of how well off the Kahn family was.

3.2   Klara Löbenstein—the path to the Abitur

In 1899, like all the Löbenstein sisters, Klara completed nine obligitory years at the city secondary school for girls in Hildesheim. She then attended the "Selecta" as one of three most gifted and motivated female students. Many female students, in these years about 10 percent, came from Jewish families. Klara passed the Abitur in 1904 as an external candidate of the Realgymnasium I in Hannover. This school, later called the Tellkampf school after its founder Adolf Tellkampf, was one of the already described schools for boys specializing in natural science, engineering, economics and modern languages. Graduation from this school had been recognized to qualify for university study since 1900.

4. Study in Berlin and Göttingen

Margarete Kahn and Klara Löbenstein studied together for nine semesters in Berlin and Göttingen, taking courses in mathematics, physics and philosophy. They studied with the same professors and, as already mentioned, at first as auditors. They started in the winter semester of 1904/05 in Berlin and stayed there the next three semesters. They attended both the University of Berlin and the Technical Institute of Berlin-Charlottenburg. At the latter they earned training certificates whch satisfied requirements for a diploma. In their C.V.s for their dissertations, the only courses they included from Berlin were courses with the university mathematics professor Hermann Amandus Schwartz and the physics professor Paul Drude. These professors were open to study by women and had very close connections with Göttingen. Schwartz had been a professor in Göttingen until 1892, before he was recruited to Berlin to the endowed chair of his Ph.D. advisor, the prominent function theoretician, Karl Weierstraß. Drude had entered the field of theoretical optics, following the track of his outstanding Ph.D. advisor at Gottingen, Woldemar Voigt.

In the summer semester of 1906, both Grete and Klara moved to Göttingen, where, in the meantime, the International Center of Mathematics and Physics had

developed. When they returned to Berlin for the 1906/07 winter semester, they found Drude's professorship vacant; in July 1906, he had, for unknown reasons, voluntarily ended his life. Now the decision in favor of Göttingen had become final. Here they were sponsored by the prominent mathematicians David Hilbert and Felix Klein, who had already guided numerous women to the rank of doctor. Incidentally, in 1932, Felix Klein's daughter, Elisabeth Staiger, who was an instructor for mathematics, physics and english, was named headmaster of the School in Hildesheim, where Klara Löbenstein had once attended. In 1933, Elisabeth Staiger was demoted from this position because she had not been in agreement with the dismissal of two female Jewish colleagues.

After 1906, Kahn and Löbenstein could cultivate their interests not only in mathematics but also for their second subject, physics, especially in theoretical optics with Woldemar Voigt. In addition, they found an outstanding scientist for their third subject, philosophy/psychology, which they chose for their state teachers' exam as well as the doctoral exam. They pursued scientific studies with Georg-Elias Müller, who, within the scope of his professorship in philosophy, had established the second international institute for experimental psychology in Göttingen. The first such institute had been founded in 1879 in Leipzig.

Significantly, the names and addresses of the female students in Göttingen were not entered into the class lists. Even in 1909, when women could officially enroll, their names were not in the list. Klara Löbenstein lived in the desirable east quarter. From May to October 1906, she rented a room at Schildweg 28 on the second floor in the house of Elfriede Kuhlenbeck, who was designated in the address book as "doctor's widow" and in another place as "high school teacher's widow". After April 1907, she lived at Hainholzweg 20. During intersessions, she gave addresses in her hometown Hildesheim and Berlin. Margarete Kahn lived somewhat ouside the city center. She lived at Goßlerstraße 2 in 1906 and at Güterbahnhofstraße 2 in 1907. In 1908, she lived at Walkemühlenweg 19 and at Bürgerstraße 60 on the third floor. The owner of the house was the regional veterinary physician Dr. Hermann Ehlers. In 1910, she lived at Schildweg 28, where Klara Löbenstein had lived in 1906; except that Grete lived on the ground floor. Between the semesters she always gave her address as in Eschwege.

5 Doctoral degree study with David Hilbert

Hilbert had been a professor of mathematics in Göttingen since 1895, and was, next to Henri Poincaré in France, considered at that time the internationally most

prominent mathematician. A total of 69 people obtained their Ph.D. studying with Hilbert. Among them were six women. Before Margarete Kahn and Klara Löbenstein, Hilbert had already had other female students earn their Ph.D. degrees including a woman from the United States and three Russian women. Margarete Kahn and Klara Löbenstein were among the first German-born women to be awarded a Ph.D. in mathematics in Germany. The very first German woman to be awarded a mathematical Ph.D. was Marie Gernet (1865-1924), a catholic. She had studied with the Jewish professor Leo Königsberger (1837-1921) in Heidelberg. The second was the Jewish woman Emmy Noether in 1907; her Ph.D. oral exam was on Dec. 12, 1907, at the University of Erlangen. She would become the most prominent female mathematician of the 20th century. She had at first studied in Göttingen for just one semester in 1903/04 but then was brought there in 1915 by Klein and Hilbert. They advised her up through the research associate level (1919) and then to the title of professor (unofficial special professor, 1922). This was the highest designation allowed for women by the Prussian state. Before Margarete Kahn and Klara Löbenstein, there was another female mathematician who was also Jewish and who in 1909 obtained her Ph.D. under Rudolf Sturm at the University of Breslau. Her name was Frieda Goldmann. Her Ph.D. oral exam was a few days before that of Kahn and Löbenstein, on June 9, 1909. She

became an instructor and lost her job on September 1, 1933. Her fate after that is not known. Only a few days after Kahn and Löbenstein, the Jewish woman Nelly Neumann passed her Ph.D. oral examination studying with Sturm in Breslau. She is above all known because of her short marriage (1912-1916) with the Jewish mathematician Richard Courant, who later became very famous. He had obtained his Ph.D. in 1910 with Hilbert in Göttingen. Nelly Neumann, who went back to her maiden name, became an instructor in Essen, did not emigrate after her dismissal and was deported to Minsk in 1942 and murdered. The next woman, Marie Vaerting, from the Catholic area of Emsland, received her Ph.D. in 1910 working with the Jewish mathematician Moritz Pasch in Gießen. In the first decades of the 20th century, Jewish women made up 13% of the total number of people awarded Ph.D.'s in mathematics, a relatively high percentage.

In Göttingen, talented students were encouraged regardless of their sex or religion. The (non Jewish) mathematician David Hilbert, as the president of the German Mathematical Association, was invited in 1900 to give a keynote address at the II. International Mathematics Congress in Paris. The 23 unsolved mathematical problems that he formulated in his lecture would stimulate research for decades. Kahn and Löbenstein, among others, tackled his problem 16 and

achieved valuable results. This problem originated from the field of the topology of algebraic curves and surfaces. Hilbert had formulated:

16. Problem of the topology of algebraic curves and surfaces

The maximal number of closed and separate components that a two-dimensional nth order algebraic curve can have has been defined by Harnack (Mathematische Annalen, Vol. 10); there arises the further question regarding the relative location of the curve's components in the plane. As concerns the curves of the 6th order, I have convinced myself (admittedly by a complicated way) that the 11 components which the curves can have according to Harnack can never be totally outside each other, but rather one component must exist that has one component inside it and 9 components outside it, or vice versa. A thorough investigation of the relative locations of the maximal number of separate components appears to me to be of interest, as is the corresponding investigation on the number, form and location of the sheets of an algebraic surface in space: the maximal number of sheets that a 4th order surface in 3-dimensional space can have is after all not yet known. {cf. Rohn, 4th-order surfaces, Preisschriften der Fürstlich Jablonowskischen Gesellschaft, Leipzig 1886} In conjunction with this

purely algebraic problem, I would like to raise a question which, it seems to me, lets itself be attacked by means of the same methods of the continuous alteration of coefficients, and the solution of which is of corresponding importance for the topology of curves defined by differential equations. That is to say, the question about the maximal number and location of the Poincaré border cycles (cycles limités) for a first order and first power differential equation of the form: dy/dx=y/x, where x and y are integral rational functions of nth power in x and y, or in homogeneous expression X(y dz/dt - z dy/dt) + Y(z dx/dt - x dz/dt) + Z(x dy/dt – y dx/dt) = 0 where X, Y and Z mean integral rational homogenous functions of nth power of x, y and z and these are defined as functions of the parameters t.

5.1   The dissertations in the field of topology

Kahn and Löbenstein belonged to the small number of people who at that time received their Ph.D. degrees in the relatively new field of topology and achieved outstanding results. They took up the fundamental studies of Axel Harnach and Hilbert, studied the attempts other male and female mathematicians had undertaken in connection with these and arrived at a *general method* for investigation of the question about

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the relative locations of the curve components in the plane.

In a previous study, Hilbert had, in a side remark, formulated a theorem which proved that a 6th-order curve with the maximal number of real components also must always possess the maximal number, i.e. two curves where one is contained in the other. He had emphasized the 6th-order curve because this is especially important for the topology of 4th-order surfaces. Margarete Kahn emphasized that similar questions can also be asked for curves of any order: is the topologically simplest case always possible for a non-singular n-order curve with the maximal number of components, i.e. can all ovals lie separately? The American Virginia Ragsdale had already shown that curves of odd-numbered order exist in this arrangement. In relation to this it should be stressed that she had also studied for a year in Göttingen and had been inspired by Hilbert to do research in this field. Ragsdale had furthermore modified the theorem of Hilbert about the 6th-order curve and attached a general expectation (the Ragsdale conjecture) without proving this: If the non-singular 2n-order curves have the maximal number of components, then at least $1/2(n-1)(n-2)$ of the $p + 1$ ovals must be internal.

Margarete Kahn developed a general continuity method for the solution of the problem in her dissertation *A general method for study of the form of algebraic curves.*

Hilbert emphasized in the evaluation of her dissertation:

The methods previously used in the theory of algebraic curves are insufficient to handle successfully the deeper and more difficult problems which relate to the location of the features of individual curves (topology of curves). For this, a totally new research method is needed, a method which can be designated as a continuity procedure. This procedure, the idea for which I communicated to Fräulein Kahn, is now elaborated in the present work with a high level of conscientiousness, diligence and incisiveness. In order to make the ideas that are essential for the method stand out clearly and to avoid losing the interest of the reader through an attempt to apply the method too generally, Fräulein Kahn has, at my suggestion, specifically dealt only with the developments for the exact singularities which are necessary for investigating the location of the features of a two-dimensional curve of the 6th order, from the point of view of their separateness. These chosen developments have been covered extremely thoroughly.

Klara Löbenstein applied these methods to an important proposition in her dissertation, proof of the statement

that an algebraic curve of the 6th order with 11 separate ovals cannot exist. She was able to show that a 6th-order curve with 11 non-overlapping ovals could be converted to a 3rd-order curve through the process of reduction in the quadrat.

Hilbert wrote in his evaluation of her dissertation: *This difficult proof[1] is completely rigorous, worked out with insight and diligence, and I am convinced that it will be received with great interest by scholars in this subject since this theorem presents the first profound and difficult fact from the field of curve topology. The presentation is fluent and easy to understand.*

Curves of this type are used today in CAD (computer aided design) systems to describe selected surfaces. CAD computer programs for architects make it possible, for example, to produce three-dimensional designs.

Both women submitted their dissertations at the same time, on June 4, 1909. Hilbert credited them with having demonstrated ability to accomplish rigorously analytical research and awarded the projects the level

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[1] From a document of 12.19.1909 written by Hilbert to the dean it is seen that the deadline for submission of the printed paper had been postponed until 3.1.1910 in order to fix a last minute problem in the proof. The title of the dissertation was slightly changed in the printed version (cf. Löbenstein 1910).

"opus valde laudabile" (very good), and emphasized that the submitted theses satisfied all requirements. He recommended that Kahn and Löbenstein be accepted for the oral doctoral degree exam. However, this was at first delayed by opponents of women's education.

5.2 Altercations with opponents of women's education

When Hilbert in 1899 planned to put forward his first female doctoral candidate, Ann Lucy Bosworth, to receive her doctoral degree, he had prepared thoroughly for the decisive meeting of the philosophical faculty, in which mathematicians, scientists, philosophers, philologists and historians would make a decision about this procedure. Hilbert's text "On women's education", a handwritten version of which has been preserved with his effects, contains among other things the words, "There are some among you, gentlemen, who are not in favor of women's education. I ask you though, for the subject of math. [ematics] to refrain from acting on this aversion". Hilbert knew that a few members of his faculty in the field of the arts were conspicuous opponents of women's education, among them the English language professor Lorenz Morsbach and the German language professor Edward Schröder. They belonged to a German national movement, which had

existed since 1891, that promoted a nationalistic, expansionistic and in part an antisemitic and antislavic program. The rigidity of Morsbach's and Schröder's positions is shown by a later communication from the Jewish mathematician, Richard Courant, who wrote to his Ph.D. advisor Hilbert on October 12, 1918, from deployment in World War I, "I am already looking forward to the moment when I can take off the "King's coat" to return not to the Germany of Morsbach and Schröder but rather to work with that of Hilbert and Einstein".

The professors Morsbach and Schröder were members of the doctoral degree committee which in 1909 would decide about the proceedings for Margarete Kahn and Klara Löbenstein. This committee was led by the professor for applied mathematics Carl Runge, at that time dean of the faculty and prominent proponent of women's education. Also on the committee were: the mathematicians Hilbert, Felix Klein and Edmund Landau, the physicist Woldemar Voigt, the experimental psychologist Georg-Elias Müller, the professor for applied electrical theory Hermann Theodor Simon and the Egyptologist Kurt Sethe. To obtain admittance to the oral doctoral exam, Margarethe Kahn and Klara Löbenstein were required to submit their biographical sketches, and they submitted sketches that were worded similarly. These biographical sketches were used by

Schröder as a reason to state that the faculty found their work unsatisfactory and to recommend non-admittance to the oral exam. Schröder wrote in his own handwriting in Margarethe Kahn's doctoral degree file on June 18, 1909: *"I propose that the admission be postponed for now. The fact, not noticed by the dean, the references and the voting committee members, which was discovered by colleague Simon, that the vita submitted by one of the candidates (a tasteless vita[2] which could never be published) was copied word for word by the other candidate, is such that the faculty must be notified of this. If this does not constitute a straightforward mockery of the faculty, it nevertheless demonstrates contempt for their institutions and a lack of maturity and tact which cannot be accepted without a serious reprimand. I suggest that we view the evaluation of the submitted scholarly work as satisfied but the decision as*

[2] For comparison, Löbenstein's vita is cited, which then in the printed version was slightly changed: "Biographical sketch, I, Klara Löbenstein, was born on February 15, 1883 in Hildesheim. After I received my diploma from the Realgymnasium I high school in Hannover in 1904, I turned to the study of mathematics, physics and philosophy. My 1st 3 semesters of study were in Berlin, the 4th in Göttingen, the 5th in Berlin and the following 4 back in Göttingen. I attended the lectures and discussions of professors Drude and Schwartz in Berlin, Hilbert, Klein, Müller, Voigt in Göttingen. To all these professors, especially my revered teacher Professor David Hilbert, I express my heartfelt thanks." (UAG, Phil. Fak. Prom.-Spec. L, Vol. II 1908-13, Nr. 4)

to the worthiness of the two candidates be placed before the faculty. First the committee will vote on this."

Morsbach and Sethe agreed with this proposal. All members of the committee submitted comments to include in the doctoral degree files. Hilbert was motivated to include a detailed statement: *"The fact that the two candidates have described the course of the studies they carried out together using the same words is a bit foolish, but nothing more than that. Least of all have they intended to insult the institutions of our faculty. I know the candidates very well, since they have worked with me for a long time, and I can say that I have the highest regard for them—because of their genuine commitment to their studies, their tireless diligence and their obvious talents. In years they have not allowed themselves any time off during the vacations and only traveled home for a few holidays. The total amount of work they have done goes far beyond the results they present in their dissertations. The two women definitely do not consider their studies to be completed, but rather they want to stay on for several semesters after passing their exams. They want to participate in the activities of our mathematical society, which I have told them they should be accepted to. I intend to publish the results of*

their dissertations, which I consider to be very important, in the mathematical journals[3]."

If the committee thinks nothing of this judgement of mine, of the worthiness of the two candidates, I ask you to request a reference for the women from my colleague G. E. Müller. They also worked for a long time very industriously with him. They wrote a paper on experimental physiology which Müller wants to publish.

I am convinced that the faculty will bring honor on itself with the two doctoral candidates. I propose that we follow the procedure suggested by the dean.

P. S. I cannot refrain from particularly expressing my opposition to the vote of Dr. Schröder. His statement contains an affront to logic. It did not occur to Dr. Simon "to discover the fact" that one of the candidates wrote the same words as the other. If there would happen to be a similar sounding satirical epithet in the writings of Goethe or Schiller, the reasonable conclusion would be common authorship. Finally, as concerns the notion of Dr. Schröder—of a mockery of

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[3] The work of the women was never published on its own but Hilbert referred to their work in his 1909 article in the journal Mathematische Annalen; entitled "On the form of a 4th order surface", stating that "one of the most profound theorems of the topology of 2-dimensional algebraic curves" has been proven (Hilbert 1933 p. 453).

the faculty on the part of the two women or even that it is a case of disrespect toward the faculties' institutions which, according to Dr. Schröder, the two women are expressing in their biographical sketches, this is an atrocity the likes of which I have not yet seen in the faculty files, rich though they are in strange things.
Hilbert

The skill of the dean, Carl Runge, and the positive vote of the majority of the committee members led in the end to the approval for acceptance of Margarete Kahn and Klara Löbenstein to the doctoral exam without reconsideration of the decision by the entire faculty. Runge, who had held the first endowed chair for applied mathematics in Germany since 1904 in Göttingen was, like most mathematicians, in favor of women's education. Two of his four daughters attained the Ph.D. degree. The conflict within the philosphical faculty contributed to the division of this faculty in 1910 into a mathematical-natural science department and a historical-philological department, which formed separate faculties after 1922.

5.3 Oral doctoral exam and state exam for the higher teaching profession

Margarete Kahn and Klara Löbenstein completed their oral doctoral exams on the subjects they chose on June 30, 1909 in the small lecture hall. 6:05 [i.e. 18:05; the authors] is noted in the files as the time the exams started. They were tested in the major subject, mathematics, by Hilbert and in the minor subjects of physics and philosophy/psychology by Woldemar Voigt and Georg-Elias Müller. First Hilbert tested Margarete Kahn for 45 minutes on the following themes: *Theory of the analytical functions: Cauchy-Riemann and Weierstraß definition, characterization of the function classes according to their singularities, exponent and height of a function. Transcendence from e and π, surface curvature. Partial differential equations of the first order, Legendre transformation. The answers were satisfactory.* Voigt chose the following areas to test in 30 minutes: *Equations of the living force in mechanics and energy, application in thermodynamics and electrodynamics. The Maxwell equations; electrical oscillations. Oscillating electrons, Zeemann effect. Electrostatic and electromagnetic measuring systems. The candidate has a wide range of knowledge but lacks a deeper penetrating understanding.* Likewise, for 30 minutes Müller examined her and wrote in his notes: *The exam was on anomolous color systems, the different forms of color blindness and the like, on the methodology of research on the "Konstanzmethode", the regular course of results, the learning of complexes,*

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rythmic learning, introspection. The candidate showed satisfactory understanding. For the oral exam, overall, she was awarded *cum laude* and "good".

Klara Löbenstein's oral exam took place at the same time, with the order of the examiners switched. First she was examined by Voigt: *Various types of partial differential equations, electricity, conditions for the potential, Green's theorem, potentials of dielectrics and magnetism. Elastic oscillations, Maxwell's equations. Transition to electromagnetic light theory. Electrons. The areas of knowledge of the candidate are somewhat narrow but can suffice.* Müller reported: *The exam covered the appearance of an after image with momentary light stimulation, the peculiarities of the black-white perception progression, the colors of memory, the galvanic perception of faces, the summary of research on the influence of location in time, the judgement direction, the economy of learning. The knowledge was fairly scantly but still adequate.* Hilbert noted almost identical test subjects as for Kahn: *Foundations of the theory of analytical functions, Cauchy's and Weierstraß's definition. Theory of characteristics of partial differential equations. The answers were fairly satisfactory.* The composite score of pass was given. Considering the conflicts they had gone through, she may have been especially agitated and the examiners especially severe.

One year later, on July 22, 1910, they both passed the scientific exam for teaching positions at secondary schools. They were certified in the subjects of mathematics, physics and introductory philosophy. In the framework of this test, the dissertations were accepted as one of the two required written portions of the state exam. With this exam, they had overcome the main hurdles to reach a professional career as high school teachers. Because of the newly established institutions for secondary education of girls, there was, at exactly the time their studies terminated, a large need for educated teaching power. Thus even with their Jewish faith, which often enough represented an obstacle to obtaining a position in public service, they could get positions in the Prussian public girls' school system.

Klara Löbenstein stayed in contact with Hilbert for a long time. She wrote to him on January 21, 1922, on the occasion of his 60th birthday as well as 10 years later for his 70th birthday. The letters are preserved in Hilbert's literary effects.

Highly honored Mr. Privy Councillor,
As a former student I am permitting myself to join with the certainly very large number of people congratulating you and wishing you on your 60th birthday strength and health for all coming years.

The spiritual goodness that I have acquired under your guidance is the secure foundation upon which I have, as a teacher of mathematics, built my professional work. I think of this constantly with the greatest gratitude.
Yours in reverence
Klara Löbenstein

6. Jewish women in the secondary school teaching profession

Margarete Kahn and Klara Löbenstein belonged to the few Jewish women who were active as secondary school teachers, and later as assistant masters, in the Prussian public service. Our analysis of a representative sample of people who in the time period from 1902 to 1940 passed the state teachers' exam in mathematics and two other subjects in Prussia revealed that 2.7 percent of the females stated their religion as "Jewish". Of the women who from 1907 to 1936 received the Ph.D. degree with a mathematical dissertation at a German university, approximately 13 percent belonged to the Jewish religion, as mentioned previously. In the course of their further career, none of these Jewish women could advance beyond the position of assistant master, to senior assistant master or headmaster. This also applied to their male Jewish colleagues.

For example, in Hildesheim, Amalie Loewenberg in the 1920's was the only Jewish assistant master. Like Klara Löbenstein, she had completed a preparation year at the Sophienschule in Hannover. She studied German, French and Latin in Heidelberg, Munich and Bonn. During World War I, the director of the Hildesheimer Lyzeum, formerly Girls' School, "fixed his eye on her as an academic replacement teacher" since teachers who were wounded at the front or killed left positions open at all schools.

Margarete Kahn and Klara Löbenstein at first did not have a chance for employment together or even near their home towns. As assistant masters on probation, probationary schoolmasters, and assistant masters, they moved to locations far apart from each other. As Klara Löbenstein reported to Hilbert in a letter on March 23, 1922, they at first had contact only through letters, then after World War I they had entirely lost touch with each other:

It will surprise you to hear that the two of us have not corresponded for several years. We were already far apart as soon as we started working, Fräulein Kahn going to the east, to Kattowitz, and I going to the extreme West, to Metz. In the beginning, we bridged the large distance by exchanging letters, but finally even that stopped. Still I know from you that, already a few

years before the peace catastrophe, she succeeded in
obtaining a position at the Dortmund Girls' Secondary
School. To there I conveyed your wish, and the letter
has not yet come back.
It was a welcome opportunity to get back in touch with
the companion of the most worthwhile years of my life.

6.1 Margarete Kahn

Margarete Kahn completed her seminar and
probationary year starting in October 1910 in Kassel, in
the Municipal High School for Girls at Ständeplatz 1,
administered through the responsible Royal Educational
Seminar at Wilhelmshöher Platz (nowadays Brüder
Grimm-Platz). During this time, she mostly lived with
the widow of the major Umbach at Königstor 23, and
also lived for a few weeks at Ständeplatz and on
Wolfsschlucht. Immediately after her exam as a
probationary schoolmaster, she was appointed to a
position of senior assistant master. Already on October
21, 1912, she left Kassel to start her first position at the
high school in Kattowitz in Upper Silesia.

From there she moved to the Schiller-High School in
Dortmund in 1917. In the meantime, she had tried and
failed to get a position at the Lyceum in her home town
of Eschwege. Starting in the winter semester of the

1926-1927 school year, she additionally studied biology at the University of Münster. She at first took leave from her position as assistant master in Dortmund, then later pursued these studies along with teaching. In the summer of 1929, she changed schools again. She accepted a position as teacher at a lyceum in Berlin-Tegel, Steinbergstraße 39 (now Tile-Brügge-Weg 63; since 1938 Gabriele-von-Bülow Oberschule). In the winter of the 1929-1930 school year, she went to the Berlin First Municipal Realgymnasium School for Girls, at Frankfurter Allee 37 in Friedrichshain. This school was destroyed during the war; it is presently the Georg-Friedrich-Händel-School at Frankfurter Allee 8. From this time, a handwritten evaluation by Kahn has been preserved, documenting her activity as a supervisor of assistant masters on probation. Dated March 20, 1932, she evaluates as "good" the work of the assistant master on probation Rose Gadebusch (later married to the mathematician Hans Rohrbach). Gadebusch had written an "introduction to trigonometry in a fifth form class in a realgymnasial school for girls". Kahn wrote:

The accomplishments show that the problems, that on the one hand are in the subject matter and on the other hand are developed through the work in a particular class, are clearly comprehended by the author and are treated in a logical order.

6.2 Klara Löbenstein

After her state examination for secondary school teaching, Klara Löbenstein applied to the school board of the Prussian province Hessen-Nassau for a seminar position, with a handwritten letter dated July 28, 1910:

I hereby allow myself the submitted question as to whether on the basis of my enclosed certificates I can be admitted to a girls'school in Kassel for completion of my seminar year.
Your most obedient
Dr. Klara Löbenstein.

It could have been that she wanted to be together again with her friend Grete. Also her sister Dora, who had just married at a young age, lived in Kassel.

Finally she began the first preparation year, today called teacher on probation, on Easter of 1911 in Hildesheim at the former Andreas-Realgymnasium for Boys (the present Scharnhorst-Gymnasium) which in 1885 had branched off from the humanistic, i.e. ancient language and traditional educational content oriented Andreanum Gymnasium.

She completed her second preparation year from Easter 1912 to Easter 1913 at the Sophienschule in Hannover.

A girls'school had been added to this school in 1910, making it one of the first girls'schools in the Hannover area. During this time, Klara Löbenstein reviewed mathematics textbooks for girls' high schools in the periodical "Die Lehrerin" [The Female Teacher]. In her discussion, we read: *The modification of the girls' high school education system since 1908 has changed the instruction of arithmetic so fundamentally, that the arithmetic books used previously are no longer useful.*

She avoided comfortable calculation according to memorized rules in the absence of conscious execution of the arithmetic operations. This was because *the shortened rules used exclusively for practical calculations have to be artificially developed rather than organically grown out of the emergent observations. The relationship between theory and application remains so loose that the students tend to overlook it and divide according to the ready-made rule without being able to account for the origin of the rule.*

From September 15, 1913 to August 15, 1916, Klara Löbenstein was senior assistent master at the Girls' High School and Teacher Training Institute in Metz, which at that time, as the capital of Lothringen (Lorraine) belonged to Germany. Since there was already in 1914 activity associated with the war in the border area near France, she moved on September 16, 1916 to Landsberg

an der Warthe (the Polish city Gorzów Wielkopolski) where she taught mostly mathematics in the realgymnasium school for women of the lyceum. She apparently never lost her love of her home town Hildesheim. In the yearly report of the school for the 1927 to 1928 school year, she wrote about her field trip with the sixth form students: *We got to Hildesheim in the evening, very tired. When we suddenly stood in the middle of the old city between the old half-timbered houses, all tiredness was forgotten. (...) The next morning, an artist from Hildesheim gave an enlightning lecture on the historical developent of Hildesheim up to the present. He was mostly in charge of serving as a guide for the female students for the next few days. He was able to introduce them to Romantic and Gothic architecture and the style of the Renaissance, and to make them enthusiastic about the treasures of medieval churches and secular art. He made accessible to the students many a quiet corner, meaningful saying, magnificent facade decoration or valuable piece of art, which would have remained hidden to many visitors.*

7   Dismissal from school employment and further fate

Margarethe Kahn and Klara Löbenstein were finally 52 and 50 years old, respectively, when their existence was

threatened with the beginning of the National Socialist government in Germany. Since they had already become civil servants before World War I, they remained two years longer. Many colleagues of Jewish descent had already been dismissed at the end of 1933 in accordance with the law for readjustment of the professional civil service of April 17, 1933, § 3 BBG. This law had a stipulated exception, that Jewish civil servants—Jewish in the sense of the race laws—were allowed to stay in their positions if they had been hired before the war. After an order on Sept. 15, 1935 from the so-called Reichsbürgergesetz (German citizen law) even these people were forced out of their positions. In 1933, Emmy Noether immediately lost her position as a non-civil-servant lecturer at the University of Göttingen and was able to emigrate to the USA. For secondary school assistant masters of this generation it was more difficult to obtain certificates of employment for the countries which were accepting exiles. The best situation was to have relatives who had already emigrated and who could vouch for them.

7.1 Margarete Kahn

Margarete Kahn was soon sent into mandatory leave of absence because of the law of April 7, 1933, mentioned above. She was notified that she had to terminate all

affiliation with the Prussian school system by September 30, 1933. Because she had already attained her first position as a teacher before World War I, she could still continue her occupation in Berlin-Pankow. She was called to the Oberlyceum (now Carl-von-Ossietzky-Gymnasium) on Görschstraße 42/44 to take over a position as a classroom teacher which was left vacant upon the sudden death of a colleague. Because of the Reichsbürgergesetz on October 30, 1935, "the purely Jewish assistant master Kahn" was finally once again laid off and effective January 1, 1936 placed into retirement.

Since she did not emigrate, or more precisely, could not emigrate, she suffered the fate of numerous Jewish citizens who remained in Germany. She had lived for years in an apartment in Schöneberg at 127 Rudolstädter Straße. Her sister Martha Ursell, by now totally on her own, moved from Attendorn to live with Margarete in December 1939. In July, 1941, they had to give up this apartment and move to 75 Motzstraße where they shared a front room with "bathroom and kitchen privileges including warm water twice a week" as subleasers from a Jewish tenant. Besides this, they were required to perform forced labor as "factory workers" in the company "Nordland Schneeketten" at 105 Lützowstraße for 48 hours a week, for which they were paid 55 cents each. Martha was now over 50 and Grete was over 60

years old. On March 28, 1942, they were deported from the collecting point at Levetzowstraße to the Polish location Piaski, Lublin region (interpretable as transport to Trawniki). Before this, on March 14, they both had to fill out a so-called "Vermögenserklärung" (declaration of wealth) in which, along with a financial overview, all large and small possessions had to be listed, from furniture to "heavily used" underwear. These possessions would later be offered by the financial authorities for sale to "interested fellow countrymen". Grete still had 100 Reichsmarks in cash left and Martha had 65 Reichsmarks. The German railways calculated a charge of 50 Reichsmarks each for transporting them to their deaths. Since then, both have been classified as "missing".

At the collecting point at the Synagogue Levetzowstraße an der Spree, unimaginable things took place, according to reports of survivors. Before being transported, the prisoners, as mentioned above, had to enter detailed personal information into forms concerning their liquid assets, stocks and bonds, lodgings, art and valuable objects, accounts and insurance policies, household inventory and articles of clothing.

Mathematicians of Berlin arranged for a Stolperstein ("stumbling stone") in memory of Margarete Kahn to be set into the sidewalk in front of the house at 127

Rudolstäder Straße in Berlin-Wilmersdorf, the last place she freely chose to live. The stone was placed on September 13, 2008. There is also a Stolperstein in her home town of Eschwege in front of the house where she grew up (am Stad 29). This stone was placed on May 26, 2010 and commemorates her as the first "Fraulein Doktor" from Eschwege.

7.2 Klara Löbenstein

Klara Löbenstein was also soon laid off because of the previously mentioned Reichsbürgergesetz and on January 1, 1936, placed into retirement. This was an opportunity for her to go back to Hildesheim. After 1933, the girls' secondary school (Lyzeum) had been replaced by a modern secondary school for women (Frauenoberschule). In this new type of school, home economics predominated. Instead of mathematics, arithmetic was once again the emphasis of instruction. The "Draft of a Teaching Plan" from this school in Hildesheim, which was praised by the ministry in authority, actually called for "German arithmetic" as opposed to "Jewish mathematics".

As early as October of 1936, the textile company Löbenstein and Freudenthal was made purely Aryan. A photo from 1940 shows the downfall of the family and

the house that Klara Löbenstein had lived in with her sister Dora Rubensohn. The facade had been rebuilt, the front porch broken off, and the columns were stumps next to a shabby veranda. Apparently there were insufficient means to keep it intact. In 1938 the Löbenstein home needed to be sold to a physician. From then on, Klara Löbenstein lived at 3 Friesenstraße, in one of the terrible houses for Jews, where Hildesheimer Jews had to pack together under catastrophically restricted conditions. Among the people at the house were former students of the girls' high school, who were deported from here in 1942. Many of these people were old, impoverished or without family and had remained in Germany perhaps counting on being respected because of their age or their social status or also because of their patriotic feelings for Germany. Klara Löbenstein experienced the pogroms in November 1938 and the destruction of the Synagogue am Lappenberg. Under this pressure, she saw, like other Jews who had stayed in Hildesheim, that emigration was the only way to save herself. With the vague plan "to find refuge in a Quaker colony in England in order to continue on to Palestine after that" she applied to the authorities to have her "pension continued to be paid to her after transfer of her residence to outside of Germany". She was unable to access her money in her savings account in the Deutsche Bank. The secret police communicated that through the "transfer of the interest due on her blocked money in the

amount of 3,000 Reichsmarks per year, the financial support of Löbenstein (sic!) would be guaranteed for the foreseeable future. On August 9, 1939, her request was denied. A Hildesheim lawyer reported years later in his memoirs that Dr. Klara Löbenstein emigrated to Argentina. On October 5, 1941, she arrived in Buenos Aires. On October 23 she went to the Hilfsverein Deutschsprechender Juden (Association for Aid to German-speaking Jews), later called the AFI, Asociación Filantrópica Israelita. She was entered as a secondary school assistant master. "Languages: English, French, Spanish and Hebrew. Requested by the sister Erna Kary. Travel financed by Erich Kary. Good position as teacher of mathematics and languages!" On December 21, 1941, she received a recommendation from the British Consulate in Buenos Aires, which could indicate a preceding stay in Great Britain. At this time, immigration into Argentina had already become very difficult and was only still possible in the framework of uniting families, and even then only with proof that the relatives could financially support the refugee. The sisters Klara and Erna were thus reunited through emigration whereas Dora had escaped to England and finally died in Santiago de Chile in 1953. Klara Löbenstein was still alive in 1957 when making requests for restitution and payment of her Gernmab pension. Only then, she was able to give up teaching and to rent a decent room for her own. Klara Löbenstein died on June

16, 1968. Her mortal remains were laid to rest in the Cementerio Alemán of La Chacarita National Cemetery of Buenos Aires.

During the last months of the war in 1945, bomb attacks resulted in the burning of the old streets of her hometown Hildesheim, the Löbenstein family's business building, her family home, and the girl's high school in Goslarschen Straße, as well as the Andreas-Realgymnasium. Hildesheim and the university town Göttingen, as Klara Löbenstein knew them, with rich tradition, culture and civilization, and with middle class and Jewish life were forever destroyed.

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