Remembering Fritz Noether in the Town of Gengenbach

David E. Rowe

Does your hometown have any mathematical tourist attractions such as statues, plaques, graves, the café where the famous conjecture was made, the desk where the famous initials are scratched, birthplaces, houses, or memorials? Have you encountered a mathematical sight on your travels? If so, we invite you to submit an essay to this column. Be sure to include a picture, a description of its mathematical significance, and either a map or directions so that others may follow in your tracks.

Submissions should be uploaded to https://submission.nature.com/new-submission/283/3 or sent directly to Ma. Louise Antonette N. De Las Peñas, mathtourist1@gmail.com.

Visitors attending workshops at the Oberwolfach Research Institute for Mathematics (MFO) in the Black Forest of Germany often arrive by taking a local train from Offenburg to the town of Hausach. From there, they usually take a taxi or other ground transportation that winds through the towns and villages that lie upstream in the scenic valley of the Wolf River, which flows into the Kinzig at Wolfach. By the time these travelers reach the conference center in Oberwolfach-Walke, few will remember having passed through the town of Gengenbach, the train's first stop after leaving Offenburg. Fritz Noether's in-laws had lived in this town, and it was here that he made the arrangements for his wife's burial in 1935. Her grave (Figure 1) can be found at the northwest corner of the cemetery located in the churchyard surrounding Gengenbach's Martinskirche.

Fritz Noether's Early Life

Fritz Noether's life and career have long been overshadowed by the achievements of his famous sister, Emmy, the oldest of four children of Max and Ida Noether (see Figure 2). Their father was a distinguished algebraic geometer in Erlangen, where Emmy and Fritz began studying mathematics together. She would remain there for her doctorate, taking her PhD under Paul Gordan in 1907, whereas Fritz left for Munich after five semesters. He quickly gravitated to the physicist Arnold Sommerfeld, who enlisted his support in writing the fourth and final volume of the classic study of rotating rigid bodies [6]. While working on this project, Fritz completed his dissertation year on a related topic in kinematics [7].

During the academic year 1910–1911, Noether worked as a postdoc in the Institute for Applied Mathematics in Göttingen, led by Carl Runge and Ludwig Prandtl. Mainly under the latter's influence, his interests shifted toward hydrodynamics, including the difficult problems associated with turbulent flows [3]. Noether continued this line of research the following year when he accepted a position under Karl Heun at the Karlsruhe Institute of Technology. There he completed his postdoctoral thesis [8], which dealt with the range of validity of Stokes's law. This empirical formula predicted the force acting on a homogeneous spherical object moving in a very slow flow, as in a highly viscous liquid with low Reynolds number. In 1851, George Gabriel Stokes derived this result under a number of assumptions for laminar flows, which prompted Noether to examine those conditions more closely. Fritz had begun to move very far from the types of mathematical problems that had once attracted his father, not to mention the kind of abstract mathematics his sister would pursue in the future.

Fritz Noether's postdoctoral thesis was accepted for *Habilitation* on December 15, 1911, and just five days later,

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Figure 1. The grave of Regina Noether in Gengenbach together with a plaque commemorating the tragic events that led to the death of her husband, Fritz Noether. (Courtesy of Monica Noether.)

Figure 2. Emmy Noether with her three brothers, ca. 1903: Alfred (left), Fritz (seated), and Robert (Auguste Dick Papers, 12-14, Austrian Academy of Sciences, Vienna).

he crowned his entry into the academic world by marrying Regina Maria Würth, who had grown up in a large Catholic family in southern Germany. Regina was almost exactly Emmy's age and thus two years older than Fritz. She was born and raised in the small village of Randegg, near the Swiss border, where her father, a former military officer, worked as a customs official. After his retirement, the family settled in Gengenbach, located in a region of the Black Forest that Fritz Noether came to know very well. How he and Regina first met remains a mystery, but Fritz surely had his family's approval to marry her, which meant converting to Catholicism.

From Karlsruhe to Breslau

In September 1912, Regina gave birth to their son Hermann. Little more than two years later, in January 1915, when the family was still living in Karlsruhe, their second son, Gottfried, was born (Figure 3). By then, the French and German armies had largely dug out their respective trench positions, signaling that the Great War had only just begun. Fritz Noether initially served on that front, until he was wounded in battle; afterward, he was employed to undertake research based on ballistics tests. Although he was still formally a *Privatdozent* in Karlsruhe, by 1917,

Figure 3. Regina Noether with her two sons, Hermann and Gottfried in 1915. (Courtesy of Margaret Noether.)

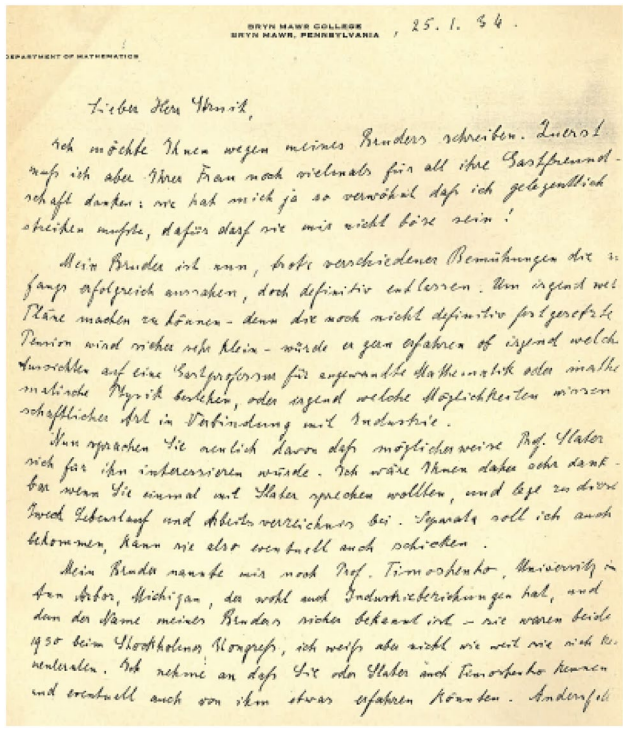
the family had moved into an apartment in Haslach, only a short distance from Regina's family in Gengenbach. After the war ended, Fritz took a leave of absence from the Karlsruhe Technische Hochschule to work at the industrial firm of Siemens & Schuckert in Berlin. As it happened, he did not return to his position in Karlsruhe, because in 1922 he was appointed to the second chair of higher mathematics and mechanics at the Institute of Technology in Breslau. The first chair was occupied by Werner Schmeidler, a protégé of Emmy Noether [14, pp. 147–149].

Following the completion of his doctorate in Munich, a great deal of Fritz Noether's research focused on the problem of turbulence in hydrodynamics (e.g., [9–11]). This field dates back to experiments conducted by the Irish engineer Osbourne Reynolds, who studied the conditions under which a fluid flow in pipes would pass from a laminar to a turbulent state. In 1883, Reynolds demonstrated this transition using colored streaks, which appeared as straight parallel lines in a laminar flow. Beyond a certain critical speed, however, these streaks turned sinuous and turbulent as the flow became unstable. Felix Klein and Arnold Sommerfeld were only two among the many researchers who hoped to understand the underlying mechanism that caused this transition from a mathematical point of view [2, 4].

In 1908, Sommerfeld introduced a new method for attacking this problem for certain special types of flows. He explained his approach in a lecture on turbulence that he delivered that year at the International Congress of Mathematicians in Rome. Some years afterward, his student Ludwig Hopf developed this theory further, but he found that for arbitrary Reynolds numbers, the instabilities dissipated over time, so that the flow always became laminar, contrary to experimental observations. Richard von Mises obtained similar results, and these findings convinced him that Sommerfeld's approach could never account for the observed transition to a turbulent flow. He instead thought that Prandtl's boundary layer theory looked like a more promising method.

Soon after World War I, Prandtl and von Mises headed an initiative to make applied mathematics into an independent discipline. To support this goal, Mises founded the *Zeitschrift für Angewandte Mathematik und Mechanik* (*ZAMM*) in 1921. Fritz Noether helped to launch this journal by publishing a survey article on the turbulence problem, in which he generalized the basic methods that Sommerfeld and Hopf had used earlier. In this survey, Noether also noted a 1907 study by British mathematician William McFadden Orr, which preceded Sommerfeld's Rome lecture by one year. Apparently, no one in Germany knew about Orr's work, but experts in fluid dynamics refer to the Orr–Sommerfeld equation for hydrodynamic stability.

Sommerfeld continued to promote this theory, which led to Werner Heisenberg's doctoral dissertation, published in 1924 [2, pp. 13–15]. Two years later, however, Fritz Noether published a proof that seemed to refute Heisenberg's theory. In [12], he found that one could never establish a critical limit of stability by means of the Orr–Sommerfeld equation, a result that seemed to imply that the theory was doomed to failure. Noether's finding concerned not only Heisenberg's results but also those of Walter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Liebe Herr Struik,

ich möchte Ihnen wegen meines Bruders schreiben. Zuerst muss ich aber Ihrer Frau noch vielmals für all ihre Gastfreundschaft danken; sie hat mich ja so verwöhnt, dass ich gelegentlich scheiden musste, dafür darf sie mir nicht böse sein!

Mein Bruder ist nun, trotz verschiedener Bemühungen die ich ganz erfolgreich anregen, doch definitiv entlassen. Um irgend welche Pläne machen zu können - denn die noch nicht definitiv festgesetzte Pension wird nicht sehr klein - würde es ganz erfahren ob irgend welche Aussichten auf eine Gastprofessur für angewandte Mathematik oder ähnliche mathematische Physik bestehen, oder irgend welche Möglichkeiten in wissenschaftlicher Art in Verbindung mit Industrie.

Nun sprachen Sie neulich davon dass möglicherweise Prof. Slater sich für ihn interessieren würde. Ich wäre Ihnen daher sehr dankbar wenn Sie einmal mit Slater sprechen wollten, und bei ihm zu diesem Zweck Lebenslauf und Arbeitsverzeichnis bei. Sparate soll ich auch bekommen, dann wie also eventuell auch schicken.

Mein Bruder nannte mir noch Prof. Timoshenko, University in Ann Arbor, Michigan, der wohl auch Industrieverbindungen hat, und dem der Name meines Bruders nicht bekannt ist - sie waren beide 1930 beim Mathematiker Kongress, ich weiss aber nicht wie weit sie sich kennen. Ich nehme an dass Sie oder Slater auch Timoshenko kennen und eventuell auch von ihm etwas erfahren könnten. Anderfalls

Figure 4. Emmy Noether to Dirk Struik, January 25, 1934. (Courtesy of Dirk J. Struik.)

Tollmien published three years later. As Michael Eckert commented, "for almost two decades, the Orr–Sommerfeld approach was regarded as inappropriate for analyzing the onset of turbulence" [2, p. 14]. Afterward, the tables suddenly turned, but by then Fritz Noether was no longer among the living.

Starting over in Tomsk

Like his sister Emmy, Fritz lost his position in Germany in 1933 as a result of the Nazi laws that purged various undesirables from the civil service, including those of Jewish descent. As a veteran of the First World War, for which he had been awarded the Iron Cross, Noether was unaffected by the law enacted in April 1933. Nevertheless, Nazi students complained to Breslau's *Rektor* that Noether's presence on the staff was intolerable. To quell further unrest, Fritz decided to stop teaching temporarily, hoping that the campus atmosphere would soon cool off. It didn't, and when he tried to resume lecturing, he faced new attacks from students who claimed that he was politically unreliable. He managed to counter those charges successfully, thereby arranging his dismissal under paragraph 5 of the Civil Service Law, which enabled him to receive a small pension during the coming months, during which he hoped to find a new position in a foreign country.

Soon after Emmy Noether arrived in the United States, she visited her friends Dirk and Ruth Struik in Cambridge,

Figure 5. Regina and Fritz Noether with Emmy vacationing with Herbert and Lotte Heisig in Dierhagen, on the Baltic coast, August 1933 (Auguste Dick Papers, 12-14, Austrian Academy of Sciences, Vienna).

Massachusetts. She told them about her brother's situation, hoping that Dirk's contacts at the Massachusetts Institute of Technology and elsewhere might enable Fritz to find employment either at an academic institution or somewhere in industry. On returning to Bryn Mawr after her visit, Emmy sent Dirk a letter asking for his help (see Figure 4; translation by the author):

Bryn Mawr College 25.1.34

Dear Mr. Struik,
I would like to write to you about my brother. First, however, I must thank your wife very much for all her hospitality: she has spoiled me so much that I occasionally had to refuse something, and she must not be angry with me for that!

My brother is now, despite various efforts that initially looked successful, definitely dismissed. In order to be able to make any plans—because his pension, which is not yet definitely fixed, will certainly be very small—he would like to know whether there are any prospects for a visiting professorship in applied mathematics or mathematical physics, or any possibilities of a scientific nature in connection with industry.

Now, you said the other day that Prof. Slater might possibly be interested in him. I would therefore be very grateful if you would talk to Slater, and for this purpose I enclose a curriculum vitae and a list of publications. I should also be receiving reprints, and can thus possibly send them. My brother also mentioned Prof. Timoshenko, University in Ann Arbor, Michigan, who probably also has industrial connections, and to whom my brother's name is certainly known—they were both at the Stockholm Congress in 1930, but I don't know how closely they know each other … Of course, you can get additional scientific information through Prof. Mises, University of Istanbul, Turkey—I know that he appreciates my brother very much. You can also see the works connected with Siemens-Schuckert (1920–22) from the list of publications.

I would be very grateful for a preliminary, quick answer.

Figure 6. Participants at the Moscow Topology Conference held in September 1935. Pavel Alexandrov is seated in the front row on the far right next to Heinz Hopf. For a full list of those shown in the photo, see https://link.springer.com/article/10.1007/s00283-019-09907-6.

With many greetings for you and your wife,
Your Emmy Noether

Emmy's efforts to find a position for her brother in the United States proved fruitless, but meanwhile, he had received positive news from Zurich. There, in reaction to the Nazi laws, a group of German scholars in exile had founded the *Notgemeinschaft deutscher Wissenschaftler im Ausland* (Emergency Association of German Scientists Abroad), an organization that succeeded in placing more than a thousand German refugee scholars in new jobs. Fritz Noether was offered a position at the University of Tomsk's Institute of Technology in western Siberia, located roughly 3,000 kilometers from Moscow.

Emmy was relieved but also elated to get this news, since she knew that Tomsk was by no means a barren wilderness. Her friend Pavel Alexandrov had described its climate as ideal for skiing, a favorite hobby in the region. She thus made plans to visit Göttingen in the summer of 1934, and during that trip she wanted to visit with her brother and his family before they departed on the long journey to Tomsk. They would again spend some time together swimming in the Baltic, as they had during the summer of 1933 (Figure 5). Little did they realize that this would be their last time together.

No one, including Emmy herself, had any inkling that her life might soon end. Her health problems were a well-kept secret, but in Bryn Mawr she agreed to submit to an unplanned operation on a large uterine fibroid. Her surgeon succeeded in removing it, but a few days afterward her body temperature shot up to 111°F, and she never left the Bryn Mawr hospital. Her death came on April 14, 1935. In September of that year, Fritz attended the topology conference in Moscow (Figure 6), during which Alexandrov delivered his stirring eulogy honoring Fritz's sister [1].

Emmy Noether's tragic death was soon followed by another. Fritz Noether had begun teaching at the Tomsk Institute of Technology while his sons continued their studies there. All three had adapted well to these new circumstances, but Regina had not; she fell into a deep depression. Alarmed by her state of mind, Fritz brought her to Gengenbach so that her sisters could look after her. She nevertheless took her own life in July 1935, shortly before Fritz and his sons came to visit her in Gengenbach. Only with great difficulty did they manage to convince the local Catholic priest to grant her a burial plot in the cemetery (Figure 1).

Little more than two years later, in November 1937, agents from the NKVD (People's Commissariat for Internal Affairs) came to the Noethers' home and arrested Fritz. The Russians treated the matter so casually that he and his sons assumed he would soon return after some routine questioning; instead, they would never see or hear from their father again. All their efforts to find out where he was being held proved futile. A few months later, Hermann and Fritz received orders that they were to leave the Soviet Union. After taking temporary refuge in Sweden, they eventually obtained visas that enabled them to study in the United States [14, pp. 267–278]. Herman (now spelled with one n) took his doctorate in chemistry from Harvard and later worked as a researcher for the Celanese Corporation. Gottfried studied mathematics at Ohio State and the University of Illinois before entering the army and becoming a "Ritchie boy." After the war, he took his doctorate in statistics at Columbia in 1949 and subsequently taught at Boston University and the University of Connecticut. By this time, both he and Herman were convinced that their father must have perished, but they never gave up trying to gain information about his fate.

Figure 7. Gottfried Noether in Oberwolfach. Photo by Konrad Jacobs. (Source: Archives of the Mathematisches Forschungsinstitut Oberwolfach.)

Searching for News of Their Father

Probably the most concrete indications the Noether brothers received after the war came from a fellow prisoner, Fritz Houtermans, a nuclear physicist who had studied in Göttingen under James Franck [5]. After the signing of the Hitler–Stalin Pact in August 1939, thousands of political prisoners were transferred to the Butyrka Prison in Moscow. From there, many Germans were repatriated, which only meant that they fell into the hands of the Nazis. Jewish ex-prisoners were usually sent to a work camp in Lublin, where very few survived the war. In Houtermans's case, he was released in May 1940 to the Gestapo, after which he spent the next three months in a prison in Berlin. Owing to his scientific expertise, he regained his freedom after Max von Laue intervened on his behalf, and he later obtained a position in Göttingen.

After the war had ended, Houtermans wrote a letter on February 20, 1946, in which he recalled the two months he spent together with Fritz Noether in Moscow's Butyrka Prison.[1] From December 1, 1939, until the end of January 1940 they had shared a cell with some thirty other German prisoners. He had no information about Fritz Noether's fate after he was transferred from their common cell, but he remembered him as a man of sterling character. "His constitution is very strong," Houtermans wrote, and "in spite of all the suffering he was always in good humor and had inexhaustible courage to live and was a real comfort to his comrades."[2] At the time they were together in Butyrka, Fritz Noether asked Houtermans to help him contact his sons, should he gain his release. Noether assumed that they were living in Göteborg, Sweden, and he wanted to let them know he was alive and well. Through a chain of subsequent contacts, Herman and Gottfried Noether (Figure 7) learned that their father had been briefly imprisoned in Butyrka. After several more futile attempts to learn what had happened to their father, the two brothers reached the tentative conclusion that he was no longer alive.

In 1985, Gottfried Noether published a short article about his father's career that ended as follows:

> Information about Fritz Noether after his arrest is fragmentary. At some time, most likely before the end

[1]A transcript of this letter is contained in "Noether Brothers – File 463" compiled by the American Friends Service Committee. The author is indebted to Margaret Noether for sharing these documents.

[2]Ibid.

Figure 8. The commemorative plaque in Gengenbach honoring Fritz Noether (Auguste Dick Papers, 12-14, Austrian Academy of Sciences, Vienna).

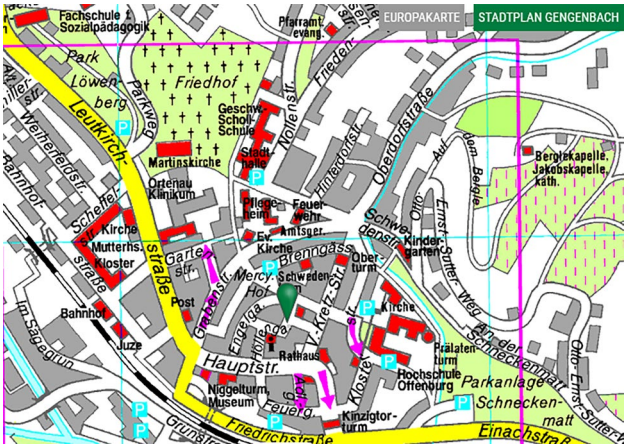

Figure 9. Map of Gengenbach showing the train station ("Bahnhof," lower left) and cemetery ("Friedhof," upper left of center).

of 1939, he was in Orel. In December 1939 and January 1940, he was seen in Butyrka Prison in Moscow. There is a report that he was seen in the center of Moscow toward the end of 1941 or the beginning of 1942. But numerous attempts, official and unofficial, to find out more about his fate remain unsuccessful [13, p. 576].

Fritz Noether's Fate Revealed

One year later, in 1986, Mikhail Gorbachev adopted the new policy of "glasnost," an encouraging sign that the Soviet Union might enter a period of peace and prosperity. Herman Noether then wrote to Gorbachev, describing all previous efforts to obtain information, and he afterward received a brief reply from the Soviet Embassy stating that Fritz Noether had died on September 10, 1941. After learning this, Herman wrote Gorbachev a second time, asking for details about what had transpired.

In May 1989, Herman and Gottfried Noether finally received definitive news from the Soviet authorities. They learned that Fritz Noether had initially been sentenced to 25 years imprisonment for alleged acts of espionage. Along with several other Germans, he was held in a prison in the Orel military district located in the far west. There, on September 8, 1941, Noether was summarily sentenced to death for supposedly engaging in anti-Soviet agitation; just two days later, he was executed. Though not stated in the communication from the Soviet Embassy, Fritz Noether's swift execution was clearly motivated by the impending evacuation of Orel that soon followed. Some two months earlier, Hitler had decided to break the Molotov–Ribbentrop nonaggression pact by ordering the German army to launch a surprise attack on Soviet Russia. Caught off guard, Stalin gave orders to liquidate the prisoners held in Orel before the territory fell to the Germans.

Herman and Gottfried Noether were further informed that the USSR Supreme Court had recently reviewed the charges against Fritz Noether and found they were entirely groundless. The court thus ruled that he had been wrongfully convicted and it therefore declared him fully rehabilitated. Herman had been particularly vigilant in his efforts to learn what had happened to his father after his arrest in November 1937. After receiving this definitive information, he designed a plaque with a replica of his father's signature, which he placed at the base of his mother's gravestone (Figure 8). The text reads:

In Memoriam
Prof. Dr. Fritz Alexander Noether
7. Oct. 1884 Erlangen – 10 Sept. 1941 Orel
Iron Cross 1914–1918
Victim of Two Dictatorships
1934 driven from Germany due to race
1938 charged and convicted by the Soviets
1941 executed – 1988 declared innocent

Directions to Gravesite: It is easy to reach Gengenbach by train (about twenty minutes from Hausach and less than ten from Offenburg). From the Gengenbach train station to the cemetery is only an eight-minute walk (Figure 9). Cross over to the Leutkirchstraße and go left to the entrance leading to the Martinskirche. Regina Noether's grave is located along the wall of the cemetery at its northernmost corner.

Acknowledgments

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