Olga Taussky-Todd

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Olga Taussky-Todd, Pasadena, 1960.

Introduction: The Arc of a Life

This article deals with the life and times of Olga Taussky-Todd, the first female professor of mathematics at the California Institute of Technology, and her decades-long quest in Europe and the United States for a permanent academic position. Born into a Jewish family in the Moravian town of Olmütz, then part of the Austro-Hungarian Empire (now Olomouc, in the Czech Republic), on August 30, 1906, she earned a PhD in algebraic number theory in 1930 at the University of Vienna, worked as an editor of Hilbert's collected works, and spent the 1934–35 academic year at Bryn Mawr College near Philadelphia, with the world-class German mathematician Emmy Noether. Oswald Veblen, one of America's leading differential geometers, noted in 1935, on Noether's death, that Taussky had "some claims on the female championship" [OV36]. She then spent time at the University of Cambridge and the University of London, where she met and married fellow mathematician John (Jack) Todd.

In 1957, at the start of the space race between the United States and the Soviet Union, Olga Taussky-Todd arrived at Caltech as a research associate in mathematics. She was fifty-one, a mathematician of considerable range and accomplishment, whose long and winding Caltech career would parallel the evolution of the school's mathematics department into a first-class research group in the 1950s and 1960s. By the time she and Jack received offers from Caltech, she had distinguished herself as a prolific and influential mathematician in the field of matrix theory and number theory and as a teacher and collaborator. None of these accomplishments prompted Caltech's math department to hire her as a professor. That designation was reserved for her husband. Olga, as his wife, became a research associate, a hiring practice that, in the laconic words of a colleague, "was usual at the time."[1] In a memoir written in 1979 at the request of the Caltech Archives, Olga Taussky-Todd said with exquisite understatement, "this created a difficult situation for me" [OT-T85]—one that persisted for nearly fifteen years.

Despite acknowledging her as "the leading living woman mathematician in the world," Caltech's administration, as well as some members of the university's math department, showed little interest in promoting Olga to the same professorial rank enjoyed by her husband, John Todd, a numerical analyst at the Institute. A small private institution, with a formidable reputation for doing cutting-edge science, Caltech was slow to embrace women graduate students. It did so beginning in 1953, and five years later employed them as teaching assistants. Opposition to women undergraduates ended in 1970, with the admission of the first co-ed class. A year later, Olga Taussky-Todd finally became professor of mathematics. In 1977, having reached seventy, then Caltech's mandatory retirement age, she became professor emeritus.

Family Matters

Olga was the middle child of three daughters. Their peripatetic life began early. In 1909, Julius and Ida Taussky moved with their young family—Olga's older sister, Ilona,

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[1] *Chandler Davis,* Remembering Olga Taussky Todd, *in: B. A. Case and A. M. Leggett (eds.), Complexities, 6, Princeton, 2005.*

age six; Olga just turning three—to Vienna, the capital city of Austria-Hungary's Emperor Franz Josef and a flourishing center of Jewish life and culture. There Olga's younger sister, Hertha, was born, at number 1 Adambergergasse, a traditional Jewish neighborhood in the city's Leopoldstadt district. Julius Taussky (1860–1925) worked at multiple jobs to support his growing household. A sometime journalist and the owner of a margarine factory in Moravia, he was also a respected vinegar expert, having learned the vinegar business from his father, Samuel Taussky, author of a turn-of-the-century guide to vinegar production.

In the midst of World War I, he was offered the directorship of a vinegar factory in Linz, in upper Austria. Once again on the move, the Taussky family packed up their belongings and settled down in a house on the edge of the city. Olga was happy to leave Vienna, where, she later wrote, "we were often near starvation" [OT-T85]. A self-taught industrial chemist—Olga remembered him as "a very interesting man, very active, very creative"—Julius Taussky had developed a number of chemical processes, including a closely guarded formula that kept cooking oils from turning rancid. Although he spent a great deal of time, before and after the war, on the road consulting with various food-processing firms and selling them his secret formula, he also found time to lavish attention on the education of his daughters—private music lessons ("very arduous," Olga later recalled), an abundance of concerts, and many hours of drawing classes. He dreamt of Olga and her sisters choosing careers in the arts [OT-T85]. His daughters had other ideas, however. Ilona, who sometimes accompanied her father on his business trips, followed in his footsteps and became a successful consulting chemist after graduating from the University of Vienna with a chemistry degree. Hertha earned two degrees, including one in pharmacy in London, and worked as a clinical biochemist in New York.

The girls' mother, Ida Pollach (1875–1951), was born in Holic, a town in West Slovakia, near the Moravian border. She was "a country girl," in Olga's words, who had little schooling. Olga noted in her memoir that Ida "compared herself to a mother hen who had been made to hatch duck eggs and then felt terrified on seeing her offspring swimming in a pond." But she came across as "intelligent and practical," and kept the household running smoothly during her husband's frequent business trips, insisting that her daughters do their share of housework. Olga must have disappointed: "I am by nature very clumsy and not practical" [OT-T85]. However, Ida saw no problem with Olga accepting pay for tutoring other students in high school (unlike Julius, who initially had forbade it). In 1940, fifteen years after her husband's death, Ida and Hertha would flee Nazi Germany for England and then brave German submarine-infested waters to cross the Atlantic to New York, where Ilona was already living. There, for the rest of her days, Ida regaled friends in her newly acquired English with tales of her remarkable offspring.

Of the three children, Olga's interests were, from her parents' standpoint, the most unorthodox. By the time she was about fifteen, as she recalled, in one of several unpublished biographical accounts, "thinking of scientific theories, even experiments, meant more to me than anything one could read in a book."[2] In 1921 she entered the Kőrnerschule Linz, a private girls' *Gymnasium*, or high school (and the only one in Linz open to females), whose demanding classical curriculum included eight hours of Latin a week. She found the mathematics taught there boring, compared to her favorite subjects, poetry and Latin grammar, but even they could not match the appeal of the "little utterances about the real mathematics" she heard on fleeting occasions in the classroom. "I would have given a lot could I have interchanged eight hours per week of Latin for the same amount of any branch of science or mathematics," she remembers [OT-T85]. Even the phrase "number theory" piqued her imagination. Although she had not gone looking for it, mathematics had found her.

The sense that her future had now been revealed ("I saw this alone as a career, as my profession" [OT-T85]) brought with it a sense "of guilt and of disloyalty."[3] As she explained in a draft of the memoir she wrote for the Caltech Archives, "My upbringing had led me to believe that the pursuit of some of the arts was the highest thing a human being could contemplate." Looking back, Olga recalls her father challenging his daughters to excel in school and at the same time imbuing them with "a profound sense of duty all around" [OT-T85]. That deep "sense of duty," drilled into her as a child, remained her moral compass well into her eighties and may account for her willingness to take on so many commitments that she routinely felt overworked. "I have so much to do," runs a typical closing line in a letter to one of her colleagues. If her life has one enduring leitmotif, it is this sense that she is drowning in work, with less and less time for anything else.

Julius Taussky once challenged the family's aspiring mathematician to calculate the proportions of water and vinegar required to produce a barrel of vinegar with the acidity level specified by law. Using, as she recalls, "a Diophantine equation to be solved in positive integers," Olga presented her father with a "little table with colored pencil entries" that he promptly tacked up on the factory wall. After his death in 1925, she was offered a full-time job as comptroller at the factory. But Olga worked there only briefly, instead doubling her tutoring schedule and enrolling that fall, as her older sister had, at the University of Vienna. "I see myself then a worn-out looking young woman, dressed shabbily," she remembered, "but determined to make a go of it" [OT-T85]. (Ilona, by now a self-employed chemist, would step in to help support both her sisters' university education.) On the opening page of

[2]*Undated "Biography," OT-T Papers, Caltech Archives, box 46.4–5.*

[3]*See footnote 2.*

a small diary, dated August 13, 1925, Olga wrote, "mit Gott" [with God], which testifies perhaps to the financial obstacles she faced in enrolling at the university and the career challenges yet to come.

Turmoil in Vienna

When Olga returned to postwar Vienna in 1925, Austria—like its capital—had undergone a stunning transformation. The Habsburg monarchy had ended, the country had become a republic, and Vienna's city government, under the leadership of the Social Democrats—the political party of the moderate left—had introduced public housing, schools, and hospitals, and other programs intended to improve the lot of the city's working class. In the predominantly Catholic countryside, the right-leaning Christian Social Party held sway. In *Last Waltz in Vienna*, his haunting memoir of the Austrian capital between the wars, George Clare describes the party as espousing "German Christian values…anything that was not 'Jewish-Bolshevik'" [GC07]. The mounting tensions between the two parties and their respective private armies came to a bloody climax in July 1927, when a mob of city workers, outraged by a judicial verdict they regarded as tainted and unjust, marched on Vienna's Palace of Justice and set it ablaze. The police fired on the crowds, killing eighty workers. It was a portent of greater troubles to come.

Philipp Furtwängler (1869–1940).

Furtwängler, Olga Taussky, and Class Field Theory

In this tense environment Olga pursued her studies, taking classes in chemistry, astronomy, and several areas of mathematics. No subject spoke to her the way number theory did. When it came time to choose a thesis advisor, she readily opted for the university's sole number theorist, the German mathematician Philipp Furtwängler. He had serious mobility issues, the result of encroaching paralysis. He would arrive at the university by taxi, walk into the lecture hall on the arms of two students, and lecture from a wheelchair while an assistant—a role sometimes filled by Olga—wrote the proofs on the blackboard. He excelled as a lecturer and apparently thrived on speaking to a packed auditorium of hundreds of students. The logician Kurt Gödel, who had entered the university in 1924 planning to major in physics, was so stimulated by Furtwängler's elegant lectures on class field theory that he switched fields to mathematics.[4]

A Göttingen-trained mathematician, Furtwängler had learned his number theory from Felix Klein, earned his doctorate in 1895, and spent several years as a researcher at the Geodetic Institute in Potsdam. He then held a series of university teaching assignments in Aachen and Bonn, culminating in his professorial appointment at Vienna in 1912. By then, he had become something of an expert on David Hilbert's magisterial *Die Theorie der algebraischen Zahlkörper* (better known as the *Zahlbericht*), a report on algebraic number fields commissioned by the German Mathematical Society and issued in 1897. In his assessment of Hilbert's mathematical works decades later, the distinguished German mathematician Hermann Weyl, who accepted Hilbert's professorship at Göttingen after Hilbert retired in 1930, commented that "a study of this book is indispensable for anybody who wishes to master the theory of algebraic numbers. Filling the gaps by a number of original investigations, Hilbert welded the theory into an imposing unified body" [HW44]. The report also clarified previous results in algebraic number theory, simplifying the arguments in the process. In his preface, Hilbert wrote:

> The most richly executed part of [the theory of algebraic number fields], as it appears to me, is the theory of Abelian fields which Kummer by his work on the higher laws of reciprocity, and Kronecker by his investigations on the complex multiplication of elliptic functions, have opened up to us. The deep glimpses into the theory which the work of these two mathematicians affords reveal at the same time that there still lies an abundance of priceless treasures hidden in this domain, beckoning as a rich reward to the explorer who knows the value of such treasures and with love pursues the art to win them. [HW44]

Hilbert himself showed the way by publishing two papers. The first, in 1899, was a restatement of Carl Friedrich Gauss's first proof of the quadratic reciprocity law—a proof that Gauss himself would go on to call the *theorema aureum* ("the gem of arithmetic"). The second, three years later, was entitled, "On the theory of relative abelian number fields." They are considered a prescient "conjectural anticipation of most of the theorems of class field theory" [FL-NS98], a term coined by the German algebraist and number theorist Heinrich Weber in 1891. It was Furtwängler who in

[4] *John W. Dawson Jr.*, Logical Dilemmas: The Life and Work of Kurt Gödel, *A. K. Peters, Wellesley, MA, 1997, p. 24.*

1907 proved, and in several instances disproved, Hilbert's conjectures in this field, although the two mathematicians had apparently never interacted at Göttingen. Twenty years later, Furtwängler would prove one more theorem,[5] and in the process uncover a thesis topic for Olga.

Olga's introduction to Furtwängler came in her freshman year, when she signed up for his one-semester introduction to number theory. She also took part in a seminar on the philosophy of mathematics, under the direction of the philosopher Moritz Schlick; her friendship with Kurt Gödel, another member of the seminar, dates from this period. Eventually, however, she quit that seminar as well as her attendance in the Vienna Circle, Schlick's exclusive band of logical positivists. "Had I realized what Gödel would achieve later [a proof of the existence of undecidable mathematical statements]," she subsequently confessed, "I would not have run away" [OT-T88]. In her second year, Furtwängler offered a seminar in algebraic number theory; it met twice a week and, as she later reported, "even included some of his work in class field theory" [OT-T85].

At the end of her sophomore year, Olga asked Furtwängler if she could do a thesis in number theory under his supervision. Deeply invested in number theory himself, Furtwängler told Olga without hesitation that her thesis would instead be in class field theory. Although Olga did not appreciate it at the time, Furtwängler launched her career by leading her to a very interesting and deep field of mathematics, instead of directing her to a topic in, say, elementary number theory.

But instead of handing her a topic immediately, as Olga had expected, Furtwängler made her wait. In her Caltech memoir, Olga criticizes him for this; he was, she felt, too secretive, and not supportive of her "need to enter the job market as early as possible" [OT-T85]. However, class field theory was a new branch of mathematics, not yet fully understood by its practitioners. (The subject had only started to emerge as a well-defined research area in the wake of a fundamental paper that the Japanese mathematician Teiji Takagi published in 1920.) Years later, Olga relents somewhat: "While elementary number theory means something to a layman, I now felt led into a very impressive and beautiful, but also rather strange subject,"[6] she wrote in an unpublished biographical sketch. In her eighties, then renowned as a world-class mathematician, she echoed that sentiment, noting that "being introduced to such a profound mountain of great beauty has lifted me up forever" [OT-T89].

While Olga was grappling with the literature in the math department's library, the Hamburg mathematician Emil Artin, building on Takagi's work, was solving Hilbert's problem on a general law of reciprocity,[7] at that time only a conjecture and a subject Furtwängler himself had contributed to. Artin had used "a most ingenious method for translating one of the then-still unsolved major problems, the principal ideal theorem into a statement on finite nonabelian groups," Olga later wrote [OT-T85]. Artin transmitted the news to Furtwängler, who in turn told his anxious thesis student a little about Artin's work but offered no details. Furtwängler, she soon learned, had good reason to play his cards close to his chest.


At the Taussky home in Vienna: Kurt Gödel and Olga Taussky, ca. 1930.

In a 1987 article, "Some Noncommutative Methods in Algebraic Number Theory," commissioned by the American Mathematical Society, Olga relates how one year after the 1927 publication of Artin's general reciprocity law, "Furtwängler announced that he had proved the principal ideal theorem—via nonabelian p-group work" [OT-T89]. And, indeed, in late summer 1928, Furtwängler did prove Artin's group theoretic formulation of Hilbert's principal ideal theorem (the *Hauptidealsatz*) to be true[8]—a towering achievement, although the mathematical community, according to Olga, "was not very grateful, and considered his proof as ugly" [OT-T85]. Furtwängler's proof brought to a close the classical theory of class fields.

Although her advisor now had plenty of thesis topics available, Olga disliked the one he assigned to her. Fifty years later, she still resented the problem Furtwängler had

[5] *In this theorem, Furtwängler showed under certain conditions the 2-class number of the 2-class field H_2 is 1, leading to the question of what happens to this if 2 is replaced by any other prime p.*

[6] *See footnote 2.*

[7] *The simplest case was the ubiquitous "quadratic reciprocity" of Gauss.*

[8] *The most important achievement of Furtwängler was the settling of the principal ideal theorem (PIT), conjectured by Hilbert. Emil Artin reduced the proof to a nontrivial statement on group theory, which Furtwängler established. PIT says that every ideal in an algebraic number field K, such as $Q\sqrt{D}$, becomes principal ("capitulates") in the maximal unramified extension H of K, now called the Hilbert class field.*

her take on—"odd prime numbers"[9]—and his pedagogical style.

The term "odd primes" owes its genesis to the fact that while there are infinitely many primes, the number 2 is the only even prime, being divisible by 2. All other primes are therefore "odd." Without telling Olga what he had done, Furtwängler had shown the principal ideal theorem for the prime 2. Only then did he ask Olga "to generalize this [the principal ideal theorem] for odd p's starting with $p = 3$." After considerable difficulty, Olga did prove the theorem for 3 and then later for all odd primes. She writes: "In any case, my results showed that the problem was not a very attractive one" [OT-T85]. Earlier, when a junior member of the department, the *Privatdozent* Walther Mayer, had asked how her thesis was progressing, she replied that it wasn't. (Furtwängler shared his proof with her only *after* she had completed her dissertation.) "Remember that you are not married to Furtwängler," Mayer said, perhaps thinking to sign her up as one of his own thesis students [OT-T85].

However, Mayer, who was later to become Einstein's mathematical assistant, was a differential geometer, and Olga was, as she would later put it, "married to number theory." But not necessarily class fields. Nevertheless, as one of her Caltech postdocs, the Canadian number theorist Hershy Kisilevsky, put it in his assessment of her mathematical legacy, "The prospect of contributing at the frontiers of class field theory sparked in Olga a deep interest in this problem which lasted her entire career" [HK97].

Campus Politics

Olga had made no bones about her interest in an academic career after graduation. However, the challenges facing a Jew and a woman aspiring to this in interwar Austria were daunting. After successfully defending her thesis, *Über eine Verschärfung des Hauptidealsatz* ("A tightening of the principal ideal theorem"), in March 1930, she continued to tutor while also working without pay in the mathematics department. But she apparently made no effort to earn the title of *Privatdozent* (an unsalaried freelance lecturer), although that would have been the first step in climbing the university's academic ladder. Perhaps she had quietly taken note that, aside from the distinguished functional analyst Hans Hahn, there were no Jewish professors in the mathematics department in Vienna during her years at the university, nor did this situation improve in the decade before Hitler's annexation of Austria in 1938. "The element of rowdy student antisemitism was most virulent in Austria, where it complemented the genteel Christian-conservative variety of anti-Jewish discrimination practiced by the academic establishment," Max Pinl and Lux Furtmüller note in their pioneering work on mathematicians who suffered persecution under the Third Reich [MP-LF73]. The average age (forty-eight) of the department's three *Privatdozents* might also have suggested to Olga the advantages of seeking academic advancement elsewhere.

Her Caltech autobiography avoids discussing the turbulent and deteriorating political climate in Austria and at the university between the world wars. At the university, demonstrations, anti-Jewish leaflets, and instances of right-wing students beating up left-wing and Jewish students were not uncommon, particularly at the schools of medicine and law. Olga confines her observations on this period to exactly one sentence that mentions "the terrible political upheavals going on in Austria then" [OT-T85].

David Hilbert, Göttingen, 1912.

Göttingen

Olga's thesis, perhaps the first ever submitted in class field theory, was her entrée to the University of Göttingen, a destination for ambitious mathematicians since the time of Gauss. In 1931, at a meeting of the German Mathematical Association at Bad Elster, a town known for its mineral springs, she gave a talk about class field theory, in hopes of landing a job. Hans Hahn, one of her favorite professors, was in the audience and spoke highly of her abilities to Richard Courant, the head of the new Mathematical Institute in Göttingen. After meeting her, Courant sent her a short note that October, asking if she would be prepared to come to Göttingen "for the entire winter term...firstly to work very intensively in a collaboration to complete the number theory volume of Hilbert's works, and secondly, to possibly also help a little with routines and operations of the Institute" [RC31]. One red flag appeared in the final sentence of his letter, to wit: "The term starts on November 1. The Hilbert volume must be ready by mid-January."

Hilbert played no role in the editing of his number theory papers. Olga's coeditors on the project were Wilhelm Magnus and Helmut Ulm, talented young mathematicians but new to class field theory and without much experience in proofreading, a skill that Olga had in abundance. Caught between spotting "quite a number of technical errors of various degree which [the three editors]…corrected without consulting anybody" [OT-T77], and Courant rushing her

[9] *For odd primes p, Furtwängler wanted Olga to generalize his result on 2-class numbers of 2-class fields to p-class numbers for p-class fields. She did solve this first for $p = 3$ by a new method, which also recovered Furtwängler's result for $p = 2$ by a different argument.*

to meet Hilbert's seventieth birthday deadline in January, Olga often worked into the early morning hours, catching what sleep she could. (Courant had also put her in charge of grading papers for his course in differential geometry, effectively doubling her work assignment.) As word of her project spread among mathematicians, she received many letters. Some urged her to recast Hilbert's number theory report in abstract language; others contained corrections of small errors that she easily incorporated into the book. Furtwängler replied quickly to a letter she sent him asking about several propositions in Hilbert's 1899 paper, jotting down several observations, such as this one: "If the group theoretic proposition is incorrect, it doesn't follow that Hilbert's claims are incorrect. One could then only refute them with a counter-example" [PHF31].

Under the circumstances, it is hardly surprising that only the page proofs were ready when Ferdinand Springer, the publisher of Hilbert's collected works, came in person to Göttingen to present him with the first volume. Courant was annoyed that the publication of volume 1 had been delayed, and possibly Hilbert also. Olga, however, seems to have had no misgivings about her work. In a lengthy letter to Constance Reid in 1977, when plans for a new edition of Reid's biography of Hilbert were under way, she had this to say: "I want you to understand that I was definitely more than a young woman then trying to eliminate what they used to call '*schiefe i-Punkte*'—this means correcting a 'misaligned dot of an i into an i' in a manuscript. And Hilbert's errors were many times bigger than that anyhow; but they did not spoil Hilbert's fantastic influence on algebraic number theory, and in particular class field theory, which is still amazingly strong" [OT-T77].[10]

At Göttingen, one of the first to welcome Olga had been Emmy Noether, the famed abstract algebraist. The daughter of Max Noether, a distinguished mathematician in his own right, Noether's career at Göttingen included serving as Hilbert's assistant beginning in 1916. Three years later she began lecturing in her own name, teaching algebra, for which she received a small income, and had students of her own. Although she had held the rank of professor when she taught in Moscow (1928–29), the level of her academic career at Göttingen remained that of a *nichtbeamteter ausserordentlicher Professor* or professor without tenure. Noether, who came from a Jewish family, was among the first to be suspended by Hitler's government, in April 1933. She and Olga, who had offices in the same building, were apparently the only women on the math faculty [DR89].

Noether "saw her frequently," Olga later told Auguste Dick, who had been a doctoral student of Hahn's in the 1930s and now was writing a biography of Noether, "but the difference in age and status was too big for a closer contact" [OT-T67]. However, Noether, who had been studying class field theory and was keen to "reprove the current achievements in algebraic number theory using her own tools of abstract algebra" [OT-T89], had organized a seminar on the subject and invited Olga to lecture. "My favorite subject is number theory, and I like actual numbers," Olga reminded Dick, while "Emmy liked only abstract things on the whole, and so she scolded me frequently when my proofs for number theoretical facts were too computational" [OT-T67].

Emmy Noether and a small group of "Noether's boys" gather for a meal in the countryside, near Göttingen, 1932. Emmy is standing between Otto Shilling, one of her students, and Olga Taussky. Other guests in the group include Hans Schwerdtfeger, Emmy's doctoral student (behind Olga), Ernst Witt and Paul Bernays (fifth and sixth from left), and Paul Alexandroff and Erna Bannow (first and second from right).

Bryn Mawr

These "scoldings" did not deter Olga from accepting a one-year scholarship for the 1934–35 academic year at Bryn Mawr College in Pennsylvania, where Noether, who taught there, held a Rockefeller Fellowship. In her Caltech memoir, Olga writes: "I held the so-called foreign women scholarship that year, so I was registered as a graduate student and had to obey the rules of a student—register for classes and pay the college back most of the money that was allocated for me" [OT-T85]. In effect, the scholarship required Olga to pay tuition, which must have been a bitter pill to swallow for the ambitious young mathematician who had won her doctorate four years earlier, but she faced limited options in Germany and had been strongly advised by Courant not to plan, in the current political climate, on an academic post there. (As a Jew, Courant himself would be forced out of Göttingen in 1933, following Hitler's rise to power.) Olga had apparently hoped a job with tenure might materialize in the United States, a futile expectation as it turned out.

England, Ireland, and the War Years

After commencement at Bryn Mawr in spring 1935, Olga returned to Europe, where she took up residence for two

[10] *Olga was perhaps sensitive to remarks made by the French number theorist André Weil that Hilbert had not given adequate credit to Kummer and by his dislike of Kummer's p-adic methods, Hilbert had set back the field by some years.*

years as a fellow at Girton College in Cambridge, England. In 1937, with the help of Cambridge number theorist G. H. Hardy, she secured a junior-level teaching position at Westfield College, a women's college and part of the University of London. She met John (Jack) Todd, who taught at King's College London, at an intercollegiate seminar, and they were married in London on September 29, 1938, a day before Neville Chamberlain proclaimed "Peace for our time," following the signing of the Munich Agreement with Hitler. More than fifty years later, Olga commented to an interviewer, "My life and my career would have been so different if my Irishman had not come along" [LM91].

When the European war broke out in 1939, John and Olga, together with Ida and Hertha Taussky, moved in with John's parents in Belfast. Olga taught briefly at Queen's University in Belfast before taking on war work at the British National Physical Laboratory in Teddington, near London. After the war ended, she and Jack left for the United States, spending several months at the Institute for Advanced Study in Princeton and another six months in Los Angeles at the Institute for Numerical Analysis of the US National Bureau of Standards. They returned to England for the 1948–49 academic year before returning to the USNBS headquarters in Washington, DC, and moving finally and permanently to Pasadena, California, and Caltech in 1957.

Caltech

Jack Todd had much experience in the applied mathematics field, knew his way around governmental agencies, and had plenty of organizational skills. What he lacked, according to Caltech mathematical physicist H. P. Robertson, who rose to prominence as an American theoretician of general relativity, was "general recognition in pure mathematical circles" [ROB55]. A Princeton faculty member for a number of years, Robertson had met Olga and Jack more than once when they were at the Institute for Advanced Study. As his daughter, Marietta Fay, was later to recall, "My father always said, 'They [the Caltech mathematicians] wanted Olga, but there was no way they were going to get Olga without her husband, and they knew she wouldn't come without him.'"[11]

Natalie Cohen, the wife of Donald Cohen, for many years professor of applied mathematics at Caltech, echoes Fay's remarks: "Don always used to say that she was brilliant. According to him, she was the best mathematician in the entire department."[12]

When the Todds arrived at Caltech in 1957, H. F. Bohnenblust was chairman of the mathematics department, which was embedded in Caltech's Division of Physics, Mathematics, and Astronomy, headed by nuclear physicist Robert Bacher, a veteran of the Manhattan Project. Bacher had handled the hiring negotiations with the Todds

Jack and Olga Todd, London, 1938.

in the spring of that year after some lobbying on Robertson's part. Although Bohnenblust had begun to transform the mathematics faculty from a largely service department into a full-fledged research group, the growth of the school's computing center was given top billing when appointments for Olga and John were presented to the Board of Trustees at their April 1957 meeting. In addition to his extensive background in the field of numerical analysis, John Todd had played an important role in the development of high-speed computing machines. In Olga's case, the minutes of the board read: "Olga Taussky Todd is Professor John Todd's wife. She is considered the leading living woman mathematician in the world. She would supplement and strengthen the work in algebra and number theory at the Institute" [CIT57]. On the question of nepotism, Caltech "has no fixed or stated policy," the trustees were told, although according to the board's minutes there had been plenty of discussion on this very point by the faculty. (To date, no record of this particular faculty discussion has come to light.) John Todd's appointment came with tenure, but, as the trustee minutes state, "there would be no tenure for Mrs. Todd" [CIT57]. Olga's starting salary as a research associate was $9,000; John was offered, and accepted, $12,000.

Still largely an all-male school in 1957 (women had only been admitted to graduate standing in 1953), Olga was the

[11] *Personal communication.*

[12] *Ibid.*

first woman to receive a formal Caltech teaching position. The following year, at the board's direction, teaching assistantships were awarded for the first time to women graduate students. Eager to connect with math graduate students, Olga began her teaching career at Caltech offering courses in various advanced subjects including abstract algebra, topics in numerical analysis, matrix theory, and algebraic number theory. "While I was not required to teach [as a research associate], I did," Olga told a campus interviewer. She added, "During my years here, I taught every year until I had to retire" [LM91]. Of her fourteen PhD students, two were women—one joined the faculty at Swarthmore, and the other began teaching at CalState, Northridge. "It was unfortunate," she later wrote, "that I was not in positions where I could have done more such work earlier in my life."[13]

At the start of her career, Olga recalled wanting to work only on number theory. With time, as she writes in a 1979 memoir, she discovered that she "liked to nibble at all subjects....[and] I developed rather early a great desire to see the links between the various branches of mathematics" [OT-T85]. She continues, "This struck me with great force when I drifted, on my own, into topological algebra, a subject where one studies mathematical structures from an algebraic and from a geometric point of view simultaneously. From this subject I developed a liking for sums of squares, a subject where one observes strange links between number theory, geometry, topology, partial differential equations, Galois theory, and algebras." Turning next to her own research interests, Olga writes,

> At present, these are commutativity and generalized commutativity of finite matrices, which includes the difficult problems concerning eigenvalues of sums and products of matrices and, on the other hand, integral matrices… These two subjects sound quite different, but they have important intersections, a fact on which I am working very hard, with some success, interpreting facts in number theory via facts in matrix theory, which involves non-commutativity. This is nothing new in principle, but has not been exploited sufficiently until recently. Some facts in modern number theory have been better understood by considering numbers as one-dimensional matrices, and then generalizing to matrices of higher dimension, thus giving more meaning to the original results. I became interested in these methods as soon as I heard of them. Some go back to Poincaré who had great ideas in more subjects that people realize. I have gone my own way on this kind of work.

[13]*Undated draft of talk (?), OT-T Papers, 46.6.*

In 1963, six years after she arrived, Olga *was* granted tenure as a research associate in mathematics. Hers was "a special case," according to the trustee minutes for May 1963 [CIT63], and the board was told, yet again, that she "is undoubtedly the leading living woman mathematician in the world." By the end of that year, the secret must have leaked out, because the *Los Angeles Times* named Olga Taussky-Todd one of its 1963 Women of the Year. Olga Taussky-Todd waited fourteen years for her promotion to professor of mathematics, which finally occurred in 1971.[14] That same year, Olga's article on sums of squares in the *Monthly* gained the Ford Prize of the Mathematical Association of America.

Four years later, she reached the mandatory age of retirement and was reduced to half-time. She was promoted to professor of mathematics, emeritus, on July 1, 1977.

Summing Up

Olga Taussky-Todd died in her home in Pasadena, on October 7, 1995, at the age of eighty-nine. In the late 1960s, mathematician and National Medal of Science winner Cathleen Synge Morawetz had approached her about the possibility of an interview centering on her career and professional history. After some hesitation, Olga agreed to a conversation, provided it remained off the record. "[It] was an opportunity for her to put away her wonderful smile and air her complaints," Morawetz observed after Olga's death, when she no longer considered herself bound by her informal nondisclosure agreement. "Her greatest difficulties had come from being Jewish and a woman." And she added, tellingly, "not having a regular position at Caltech rankled within her. But her beloved work in mathematics saved her" [CM68].

Olga was always suspicious of history, which she described as "a tricky unscientific subject," noting that "even a full-fledged biography is a function of its writer, however honest he may be."[15] While Olga actively planned certain parts of her career trajectory, many other episodes were shaped by the practices and biases of the cultures and institutions within which she worked. There is much left unsaid in the memoir she wrote for the Caltech Archives, whose epigraph reads: "The truth, nothing but the truth, but not all the truth." To put it bluntly, Olga *intentionally* omitted certain details from her memoir. Despite her reservations, when Constance Reid, Hilbert's biographer, proposed writing a biography of her, Olga readily agreed. Unfortunately, Reid's project never got off the ground. The need for such a work remains.

[14]*By the late 1960s, according to the website for the history of the Rutgers mathematics department, women held under 1 percent of senior faculty positions on average across the nation.*

[15]*P. Weingarnter and L. Schmetterer (eds.),* Gődel Remembered, *Princeton, 1987, p. 31.*

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