

Girlhood in Vienna

And even today I am filled with deep gratitude for the unusual goodness of my parents, and the extraordinarily stimulating intellectual atmosphere in which my sisters and brothers and I grew up.

Lise Meitner was born in Vienna in 1878, the third child of Hedwig and Philipp Meitner. She would live in Vienna twenty-nine years, and then she would leave, not realizing how permanently, to make her professional home in Berlin. Part of her remained sentimentally, irreversibly Viennese. She gave in to it, laughing at herself each time she paid the special fee to maintain her Austrian residency. “Na ja,” she would shrug. “Foolishness costs money.” And later still, after she fled Germany for Stockholm, after every member of her family was gone from Vienna, after the community from which she came was lost forever, even then she clung to her Austrian past, refusing to take Swedish citizenship until she could have both.¹ Had she stayed longer in Vienna, she might not, perhaps, have remained so strongly bound.

Of Lise’s childhood we have few details. Even her date of birth is not entirely certain. In the birth register² of Vienna’s Jewish community it is listed as 17 November 1878, but on all other documents it is 7 November, the day Lise herself observed. It may be that her parents, already ambivalent about their Jewish affiliations,³ somehow delayed the record, or perhaps the discrepancy was merely a case of *Schlamperei*, that well-known imprecision that contributed to Vienna’s charm. Neither explanation is satisfactory. Lise’s name also changed slightly, from its original Elise. In Berlin such things might have caused a flurry of paperwork; in Vienna it made no difference.

Like many of their generation, Lise’s parents were recent arrivals in the capital, a move whose sense of future may explain their lack of attention

to a detailed family history. The Meitners traced themselves back only a few generations,⁴ to the village of Meiethein in Moravia, the fertile region north of Vienna that is now part of the Czech Republic. Toward the end of the eighteenth century, not long before the Rights of Man began drifting toward Austria, Kaiser Josef II initiated a series of reforms designed to consolidate power and secure the loyalty of all his subjects: he made German the official language of government, curtailed the Church, gave peasants some relief from serfdom, and granted Jews their first very limited access to civic employment, military service, and education. The Kaiser's tolerance did not extend to his own environs—fewer than two hundred Jewish families were permitted to live in Vienna—but he cracked the ghetto walls, so that Jews flooded the schools, joined the military, and looked to German language and culture for its promise of emancipation, opportunity, and humanism.⁵

Among Kaiser Josef's administrative reforms was the requirement of a family name. Lise's great-great-grandfather took the name Meietheiner, an indication that the family had lived in the village a long time; the name eventually shortened to Meitheiner, Meithner, Meitner. The family lived modestly;⁶ if some achieved special distinction, it was for their character and good deeds. Lise's great-grandfather, it was told, crept through the town after dark every Friday night to lay a loaf of challah, the Sabbath bread, at the door of every poor Jew. He did this as secretly as possible and did not permit anyone to thank him, but everyone knew it was the work of Reb Meitner. "Reb" did not mean "rabbi"—there were none in the Meitner family—but was a traditional title of respect.

Reb Meitner's son Moriz, Lise's grandfather, married Charlotte Kohn Lowy, a widow with two small boys who had inherited an inn, some property, and a guest house in the town of Wsechowitz. Her granddaughters would remember her as beautiful, well dressed, and as cheerful as she was self-disciplined. "The house might burn down," it was said, "and grandmother sings; there is cholera in the village, and still grandmother sings!" Moriz and Charlotte's son, Philipp, was blond and blue-eyed like his mother; like his grandfather, Reb Meitner, he would later be known for his integrity and kindness. In 1873 he married petite, dark-eyed Hedwig Skovran, whose grandfather had emigrated from Russia to Slovakia to escape the ongoing persecution of Jews.

Philipp and Hedwig Meitner grew up with Austria's transition from late feudalism to a recognizably modern society. The liberal revolutions of 1848 were crushed in Austria, but the struggle for individual freedoms and national autonomy went on. Industrialization came to Vienna and with it, a great internal migration from throughout the empire. In 1858, the medieval fortifications ringing the old inner city were torn down; in their place came the imposing Ringstrasse, grand new public buildings, and a parliament with little real power whose Liberal majority pressed for a modern secular state and constitutional government. At a time when the old order was failing and the very notion of empire was threatened by nationalist dissensions, the Habsburg monarchy was humiliated by a string of unwise military ventures and diplomatic blunders. By 1867, Kaiser Franz Josef saved what he could by dividing the empire and letting Hungary go. He granted his people a number of constitutional laws: national and religious toleration, a laissez-faire economy, an impartial judiciary, greater individual freedoms of education, belief, speech, and press. For Jews, this meant full civic equality, including access to professions from which they had previously been barred.⁷ Philipp Meitner was among the first group of Jewish men who were free to study law and be admitted to its practice.

In the twenty years from revolution to constitution (so the saying went), Austria had been dragged into the nineteenth century. By the time Lise Meitner was born in 1878, imperial Vienna was mostly theater, set with palaces of impossible opulence and a Kaiser, the popular and long-lived Franz Josef. It hardly mattered any more. The new Vienna was bursting with life of its own, sprawling into the countryside, its population doubling and doubling again with an influx so constant that for generations most Viennese would be born somewhere else: overwhelmingly Catholic with some Jews and virtually no Protestants, mostly German-speaking with large contingents of Czechs, Hungarians, Italians, Poles, Croats, Ukrainians, and others who retained their languages and national identities in newspapers and ethnic associations. To many of the new arrivals, Vienna was a place of marginal work and much unemployment, water shortages, and summer cholera, with congestion so severe that even the wealthy lived in apartments and the very poor shared beds and slept in shifts. The most heterogeneous city in Europe, it was among the most crowded and un-

sanitary; it had the highest rate of suicide. Still people came: conditions in the provinces were not better. Vienna at least promised improvement and pleasure: music of every sort, opera and theater, newspapers by the dozens, a renowned university, famous physicians and scientists, good food, vineyards at the edge of town, and blue hills shimmering hazily in the distance. If the Danube seemed muddy or the waltz overrated, Vienna was beguiling nonetheless, drawing from every stream of European culture, layered with history and beauty every newcomer could aspire to make his own. The intellectual ferment was very great. By the end of the century, Vienna had given birth to Viktor Adler's democratic socialism and Theodor Herzl's Zionism; it was the home Sigmund Freud loved to hate and the political base for Karl Lueger, the city's longtime mayor, whose heady mix of populism and anti-Semitism drew the rapt attention of the young Adolf Hitler. If the nineteenth century came late to this society, the twentieth arrived early.⁸

When Philipp Meitner entered the legal profession in the early 1870s, it was possible not only to practice law but to have a hand in the creation of a new political order. The new constitution called for sweeping reforms of Austria's entire legal system, and in Vienna, after years of neglect by Crown and Church, the Liberal city council built an ample water supply and provided flood control and improved public health, hospitals, and schools.⁹ It was a time when progress seemed the natural order of things, each decade a noticeable improvement on the one before. As an attorney, "freethinker," and humanist, Philipp Meitner was committed to the Liberal ideals of reason and civic progress, sympathetic to the Social Democratic goals of justice and individual improvement. He immersed himself in Vienna's political life. Although he never sought elective office, he and Hedwig made their home a gathering place for interesting people—legislators, writers, chess players, lawyers. The children stayed up and listened. Years later, when Lise was asked about her childhood, she remembered most of all "the unusual goodness of my parents, and the extraordinarily stimulating intellectual atmosphere in which my brothers and sisters and I grew up."¹⁰

During Lise's childhood the family lived in the second district, known as Leopoldstadt, just north across the Danube canal from the old city. Originally a ghetto, the community was named for Leopold I, who expelled Vienna's Jews in the 1600s, then grudgingly permitted them to return. For

the next two centuries, the number of Jews in the capital remained small, but in the 1860s, when residence restrictions were abolished and Jews from throughout the empire converged on Vienna, Leopoldstadt grew.¹¹ Crowded and run-down in some areas, it was pleasant, even somewhat prosperous, in others.

Lise was born in the family apartment at 27 Kaiser Josefstrasse,¹² a tree-lined avenue that traversed Leopoldstadt from a commercial district at one end to the Prater, Vienna's huge park, at the other. There on a Sunday the family could enjoy amusements and cafés, wooded paths and open fields, and even on occasion glimpse the Kaiser riding by. On the whole Leopoldstadt was a comfortable place to raise a family. The first three Meitner children, Gisela, Auguste (Gusti), and Lise, were born only a year apart, followed not quite so rapidly by five more: Moriz (Fritz), Carola (Lola), another boy, Frida, and finally Walter, the baby brother Lise adored, who was born in 1891.¹³ The large family could afford few luxuries, but Philipp Meitner's law practice did provide the middle-class essentials: books, a few summer weeks in the mountains, and—virtually a necessity in Vienna—music lessons.¹⁴ Gusti was the family's most talented musician, a child prodigy who became a composer and pianist of concert rank.¹⁵ Lise played the piano too; all her life music would be a passion for her, as necessary as food. But she was especially curious about mathematics and science, an eight-year-old who kept a math book under her pillow and would ask about the colors of an oil slick and remember what she was told about thin films and the interference effects of reflected light.¹⁶ In this family children were seen and heard—and expected to think for themselves. Once, when Lise was still very young, her grandmother warned her never to sew on the Sabbath, or the heavens would come tumbling down. Lise was doing some embroidery at the time and decided to make a test. Placing her needle on the embroidery, she stuck just the tip of it in and glanced anxiously at the sky, took a stitch, waited again, and then, satisfied that there would be no objections from above, contentedly went on with her work.¹⁷ Along with books, summer hikes, and music, a certain rational skepticism was a constant of Lise's childhood years.

Judaism was not one of those constants. In Leopoldstadt the Meitner children lived among Jews, in a neighborhood dotted with synagogues and shuls, fully aware that they too were of Jewish origin. And yet it is clear that the family distanced itself from its Jewish past. One of Lise's nephews,

Gusti's son, Otto Robert Frisch, would later have the firm impression that his mother and all the Meitner children had been baptized and raised as Protestants.¹⁸ In fact, this was not so: the children were all registered with the Jewish community at birth and accepted baptism only as adults—Lola and Gisela as Catholics in 1908, Lise as Protestant the same year.¹⁹ But Frisch's impression was in essence true: the Meitners did leave the old religion for the new.

Their reasons were never explicitly stated. Opportunism was apparently not one of them: Philipp and Hedwig Meitner never baptized their children or themselves and thus derived none of the advantages conversion would have offered, particularly in the legal profession where discrimination remained strong and conversion was still a passport to judgeships and other civil service positions.²⁰ One can only assume that the Meitner couple lost interest in Judaism, regarding it as a ghetto relic perhaps, or an undesirable ethnic division; they surely felt little kinship with Leopoldstadt's many *Ostjuden*, Jews from Galicia and other Austrian-held Polish provinces whose language, dress, and orthodoxy set them apart.²¹ Enlightened and progressive, Hedwig and Philipp Meitner were drawn to German culture; freshly emancipated, with optimism bordering on faith, they embraced the culture that freed them.²² By the turn of the century, such optimism must have dimmed somewhat, as the most charismatic Viennese mayor of all time, the handsome Karl Lueger (*der schöne Karl*), rallied his voters by appealing to their Catholicism, nationalism, and anti-Semitism. It is worth noting that none of the Meitner children followed their father into politics, or even law. But their parents' idealism influenced them nonetheless. It was part of the "unusual goodness" Lise remembered, the basis for the extraordinary intellectual atmosphere that nurtured Lise and the other children in their parents' home.

In this atmosphere all the Meitner children, including the five daughters, pursued an advanced education. Even today such a family record would be notable, but at the time it was truly extraordinary, for until the end of the nineteenth century women were by law excluded from Austrian universities and, by the same logic, from rigorous secondary schools as well. While a bright boy might attend a *Gymnasium* and take the *Matura*, a leaving examination that was required before entering the university, public school for girls was over at age fourteen, and it was poor. Lise attended the Mädchen-Bürgerschule at Czerninplatz, a crowded inter-

section not far from home. On 15 July 1892, she received her final *Jahres-Zeugnis*, a report card that was also an *Entlassungs-Zeugnis*, a completion certificate.²³ She had learned bookkeeping arithmetic but not algebra, a smattering of history, geography, and science, the requisite drawing, singing, and “feminine handwork,” a little French and gymnastics. Although her grades were all good and her behavior “entirely appropriate” (*vollkommen entsprechend*), her diligence was rated only “satisfactory” (*befriedigend*) rather than “industrious” (*ausdauernd*), an indication that she did not find school very challenging. Inked at the bottom of her *Jahres-Zeugnis* was the line: “*vom weiteren Schulbesuch befreit*” (released from further schooling). Lise had gone as far in public school as an Austrian girl could go.

Not yet fourteen, her choices were few. Most girls would spend the next few years helping at home, sewing, and daydreaming of marriage. The only way for a girl to go on was to attend a private *höhere Töchterschule* for young ladies of the middle class; the only profession she could seek was teaching a subject that did not require university education. Lise chose French. Nothing in her contemporary records or later memoirs indicates that she ever had a real interest in it. Instead, she lavished her energy and love on her baby brother, Walter; he would always be her closest sibling. She also tutored younger girls to help pay for Gusti’s advanced music lessons and volunteered with the poor in relief organizations and schools.²⁴

Of these years Lise would remember little but a sense of loss. “Although I had a very marked bent for mathematics and physics from my early years, I did not begin a life of study immediately,” she wrote later.²⁵ “Thinking back to . . . the time of my youth, one realizes with some astonishment how many problems then existed in the lives of ordinary young girls, which now seem almost unimaginable. Among the most difficult of these problems was the possibility of normal intellectual training.”²⁶

In Austria the issue of higher education for women had been simmering for a generation, certainly since 1867 when universities were first opened to men without regard to economic class, religion, or national origin. Over the years a small number of women had approached the universities, petitioned professors, begged to attend a class or two. At best they were permitted to sit in as unofficial auditors, not expecting and certainly never receiving any credit or documentation. Most of these women were teachers whose prior education did not qualify them for university admission. But

even the few who did qualify—occasionally a young woman from Bohemia or Austrian Poland would somehow manage to attend her local Gymnasium and pass the Matura—were also denied admission. Daughters of the wealthy and the aristocracy were routinely educated in Switzerland. The rest were trapped in a cycle willed by the state: since the universities (all public institutions) excluded women, the government did not see fit to establish schools that would prepare women for university admission. In Europe, only Germany and Turkey offered more resistance to women's education.²⁷

Toward the end of the nineteenth century, however, the resistance began to falter. Women's groups, often led by headmistresses of girls' schools, regularly petitioned for improved secondary education; a private *Mädchengymnasium* was established in Vienna in 1891 even though its graduates were not permitted to take the Matura; the government itself, urgently needing female physicians for Moslem women in occupied Bosnia and Herzegovina, recruited foreign women for many years, hired the first Austrian (Swiss-trained) in 1892, but still denied medical certification to other Swiss-trained Austrian women physicians who wished to enter private practice, although, at the same time, a highly competent eye surgeon who was born in Russia and trained in Zurich received special permission from the Kaiser to establish a clinic with her husband in Salzburg. Publicity accompanied each case, and opinion gradually softened. It seemed plausible, finally, to suppose that in Austria—as in America, France, and Switzerland—women could be educated without suffering mental illness or infertility or social catastrophe. By the mid-1890s, even conservative university professors regarded women students as a flood that could no longer be held back. In 1897 the government granted women access to the philosophical faculties (letters and sciences) of Austrian universities; a few years later women were admitted to medical schools as well.²⁸

With this, the cycle of exclusion was thrown into reverse. Justice, and the need for university educated women teachers, required that universities admit women at once, even without Gymnasium preparation. For the interim women would be required only to pass the Matura, any way they could. This came as good news—late, but not too late—for Lise and her sisters.

Gisela, already twenty-one, came first. After two years of intensive private lessons, Gisela passed the Matura and entered medical school in

1900. Lise meanwhile completed her teacher training (as insurance, her father advised) and in 1899 began her own lessons in a group with two other young women. Together they compressed eight missing school years into two: Greek and Latin, mathematics and physics, botany, zoology, mineralogy, psychology, logic, religion, German literature, history. Lise studied night and day. "You'll fail," her younger brothers and sisters would tease. "You've just walked across the room without picking up a book."²⁹ A photograph shows a pale young woman with dark circles under her eyes.

For physics and mathematics, Lise's group was tutored by Arthur Szarvassy, a young physicist who had just completed his doctorate at the University of Vienna.³⁰

Dr. Szarvasy [*sic*] had a real gift for presenting the subject matter of mathematics and physics in an extraordinarily stimulating manner. Sometimes he was able to show us apparatus in the Vienna University [Physics] Institute, a rarity in private coaching—usually all one was given were figures and diagrams of apparatus. I must confess that I did not always get correct ideas from these, and today it amuses me to think of the astonishment with which I saw certain apparatus for the first time.³¹

Lise took the Matura in July 1901 at the Akademisches Gymnasium, a distinguished boys' school on Beethovenplatz in the old city.³² The course of study had been so intense and the examination conditions so terrifying—as *Externisten* (outside students), Lise and the other women were examined in strange surroundings by teachers they had never met—that Lise never failed to mention it in her later remembrances. Of fourteen who took the exam, only four passed;³³ three were the students of Dr. Szarvassy. The fourth was Henriette Boltzmann,³⁴ whose father would soon be a formative influence in Lise's life.

Lise would always think of Arthur Szarvassy as her first true teacher. And she was grateful to her parents, who made it possible for her to achieve what few other young women of her generation could.

Many parents shared the prejudice of the time against [women's] education, so that their daughters either had to forgo the education they desired, or fight for it. . . . [I knew] a young woman who at age 24 wanted to be privately tutored by her cousin to prepare for the Matura; her parents—in other respects very loving, I'm sure—literally kept her prisoner in their apartment to keep her from carrying out her intentions. Only when she disappeared from the apartment one day and let her parents know that she would not return unless she had permission to study, did they give in.³⁵

Although Lise herself had no such obstacles, she sensed that for her mother, at least, it was not always easy.

I had the feeling that in the beginning, when first my older sister, and then I passed the Matura, that my mother was inwardly somewhat depressed by it. But she was much too loving a mother ever to express it in any way.³⁶

From her father there was no such ambivalence. On the contrary, he was a steady source of support and advice.

Even as a child I was strongly interested in mathematics and physics, and as I grew up I also developed a very pronounced inclination for social responsibility. . . . When I was 23 years old and about to enter the university, I entertained the idea of primarily pursuing medicine, for its social usefulness, and studying mathematics and physics only at the side. My father kept me from this incorrect choice by making it clear to me that such a course of study might be possible for a genius like Hermann Helmholtz, but not for another person.³⁷

Lise entered the University of Vienna in October 1901. Small and slender, with a faraway expression and serious dark eyes, she looked younger than her twenty-three years. A bluestocking, her nephew would judge later, a young woman who cared for nothing but study. He was probably right. Anxious to make up for lost time, Lise filled her university registration book with physics, calculus, chemistry, and botany—twenty-five hours a week of lectures, laboratories, demonstration and discussion sections.³⁸

No doubt, like many other young students, I began by attending too many lectures. . . . I cannot say I have a very lively recollection of the lectures on experimental physics. These were delivered almost without experiments, between noon and one p.m., when most of the students were already very tired. Sometimes I was really afraid I would slip off my chair.

But for calculus, at eight o'clock in the morning, she was awake.

My first term I studied differential and integral calculus with Professor Gegenbauer. In my second term he asked me to detect an error in the work of an Italian mathematician. However I needed his considerable assistance before I found the error, and when he kindly suggested to me that I might like to publish this work on my own, I felt it would be wrong to do so, and so unfortunately annoyed him forever.

Here was Lise, a first-year student, refusing to publish as her famous professor asked. Assertive in one way, self-deprecating in another—neither

to her academic advantage. "This incident did make it clear to me, however, that I wanted to become a physicist, not a mathematician."³⁹

In fact, the physics course Lise attended, her drowsiness notwithstanding, had the reputation of being exceptionally well taught. It had been designed for pharmacy students, but Professor Franz Exner brought such clarity and perspective to the subject that students from all disciplines thronged to it.⁴⁰ The laboratory was directed by Anton Lampa, a promising young physicist and teacher.⁴¹ Lise may have been drowsy in lecture, but she vividly remembered the laboratory: the somewhat aloof instructor, the primitive equipment, the experiments requiring ice that could be done only when there was snow in the courtyard below.⁴² For this young woman who had never had science in school, whose only previous encounter with apparatus was to view it with astonishment, the laboratory was of paramount interest. She would study physics after all.

The physics institute was on the Türkenstrasse, a short side street in Vienna's ninth district, on the same block as the institutes for pharmaceutical chemistry and medicinal chemistry, not far from the renowned medical school and its clinics. The university had no central campus; its buildings were interspersed among the residences and shops of the neighborhood. A photographer's studio and a coffee house stood on either side of Türkenstrasse 3; Sigmund Freud lived and worked on the steep Berggasse nearby. Originally the structure had been a small apartment house, already run-down when the university purchased it as a temporary building in 1875 (a permanent physics building opened in 1913). Its entrance reminded Lise Meitner of the door to a hen house. "I often thought, 'If a fire breaks out here, very few of us will get out alive.'"⁴³ Inside were worn stairs and shaky floors, makeshift laboratories with untold amounts of mercury in the floor cracks, a lecture room with neither podium nor desks, ceiling beams so rotten they looked as though they had been chewed by termites.⁴⁴

The lecture halls in particular were downright life-threatening. This was so widely known that the Viennese newspaper *Arbeiterzeitung* once carried this notice: "Once again a student has registered at the Physics Institute on the Türkenstrasse; unhappiness in love is said to be the motive for the deed."⁴⁵

But in that shabby building the quality of teaching and research was very high. Exner, the first professor students encountered, was a multifaceted

experimental physicist whose research included electrochemistry, atmospheric electricity, crystal physics, spectroscopy, and optics. A friend of Wilhelm Röntgen, Exner had introduced x-ray research and its medical applications to Vienna; one of the first to take an interest in radioactivity, Exner secured uranium ore residues for Marie and Pierre Curie, received an enriched radium sample in return, and made Vienna an early center for radioactivity research. Although Exner lectured only to first-year students, he directed the advanced physics laboratories and supervised a large number of doctoral candidates. One of Lise's fellow students, Karl Przibam, remembered Exner for his contagious enthusiasm and for the community spirit that went far beyond the usual relationship between teacher and students.⁴⁶

This sense of community was essential for Lise in finding her way. She had come to the university on her own, very conscious of how few women there were and how visible she was, how some of the men went out of their way to be pleasant and others, just as conspicuously, did the opposite. Never having gone to a Gymnasium, she could only imagine that she had missed some vital aspect of normal student life, in academics, perhaps, or student friendships, or relationships with teachers. With Professor Gegenbauer she had apparently been awkward and then embarrassed by her awkwardness; not ready to be singled out, she needed first to be convinced that she could be a student like any other.

For Lise, this happened in the old building on the Türkenstrasse, in the cluttered laboratory, during the informal give-and-take of teachers and students. It helped that the subject was difficult, chosen only by a few. In Vienna, indeed worldwide, the number of physicists was small; nearly all were engaged in teaching and research, very few in business or industry. Physics was more a calling than a career.⁴⁷ Students who committed themselves to physics did so because they could not imagine a more fascinating way to spend their lives. By 1902, Lise Meitner knew she was one of them.

In her second university year, she began studying physics in earnest. Over the next six semesters, her *Meldungsbuch* lists analytical mechanics, electricity and magnetism, elasticity and hydrodynamics, acoustics, optics, thermodynamics, and kinetic theory of gases as well as mathematical physics each semester and a course in philosophy of science. A fairly typical curriculum, it was highly unusual in one respect: all of it was taught by just one person, the theoretical physicist Ludwig Boltzmann.

Fifty years later Lise Meitner would still remember Boltzmann's lectures as "the most beautiful and stimulating that I have ever heard. . . . He himself was so enthusiastic about everything he taught us that one left every lecture with the feeling that a completely new and wonderful world had been revealed."⁴⁸

One can scarcely imagine a better teacher for the atomic world that lay ahead. In 1902, Boltzmann was fifty-eight years old, the famed theoretical physicist who had extended kinetic theory and established statistical mechanics, the leading "atomist" who tied the second law of thermodynamics to atomic theory by showing that the inherent irreversibility of natural processes arises from the statistical behavior of atoms in the aggregate. The notion of unseeable atoms with indeterminate behavior was more than some scientists could swallow. For years Boltzmann was forced to defend his work against the fairly widespread philosophy of scientific positivism that denied the value of scientific theory and the reality of anything that could not be directly observed.

A big man, heavy, very nearsighted, with curly brown hair and a full reddish beard that framed his broad face,⁴⁹ Boltzmann aroused admiration and affection in his students. He began his mechanics course in 1902 by offering his students "everything I have: myself, my entire way of thinking and feeling," and asking the same of them: "strict attention, iron discipline, tireless strength of mind. But forgive me if I [first] ask you for that which means most to me: for your trust, your affection, your love—in a word, for the most you have the power to give, yourself."⁵⁰

Like many of the others, Lise was swept away. He was immensely engaging, she remembered, this famous professor whose lectures were models of clarity, this warmhearted *Hofrat* (Excellency) who would shrug at his title and laugh, "Ach, how dumb of me!" at his blackboard errors.⁵¹

Boltzmann had no inhibitions whatsoever about showing his enthusiasm when he spoke, and this naturally carried his listeners along. He was fond of introducing remarks of an entirely personal character into his lectures. I particularly remember how, in describing the kinetic theory of gases, he told us how much difficulty and opposition he had encountered because he had been convinced of the real existence of atoms and how he had been attacked from the philosophical side without always understanding what the philosophers held against him. . . . I wonder what he would say about our huge machines and teamwork [today], when I remember how bitterly he complained . . . about the great extension of the subject matter of physics and

the resulting overspecialization. He stated categorically that [Hermann] Helmholtz was the last physicist who had been able to have an overall view of the whole subject.⁵²

His relationship to students was very personal. . . . He not only saw to their knowledge of physics, but tried to understand their character. Formalities meant nothing to him, and he had no reservations about expressing his feelings. The few students who took part in the advanced seminar were invited to his house from time to time. There he would play for us—he was a very good pianist—and tell us all sorts of personal experiences.⁵³

Boltzmann accepted women students as a matter of course. In 1872, long before women were admitted to Austrian universities, he met Henriette von Aigentler, an aspiring teacher of mathematics and physics in Graz. From their four-year correspondence we know of her desire to attend the university (“out of eagerness to learn and to qualify for teaching”), how she was refused permission to unofficially audit lectures (an administrator declared himself “delighted” to keep women out, since “the character of the university would be lost and the institution endangered” by their presence), that Boltzmann advised her to appeal (she did, successfully), and that when he proposed marriage, finally, he began, “It seems to me that a constant love cannot endure if the wife has no understanding, no enthusiasm for the endeavors of the husband, but is merely his housekeeper rather than the companion in his struggles.”⁵⁴

Lise may have heard some of this; she came to know his wife and daughters and considered their family life harmonious.⁵⁵ In any case, her university years were free of the obstacles she had encountered earlier and the difficulties that lay ahead. With his intellect and spirit, Boltzmann created a community to which she fully belonged. “He was in a way a ‘pure soul,’ full of goodness of heart, idealism, and reverence for the wonder of the natural order of things.”⁵⁶

All who were close to Boltzmann were also aware of his bouts of severe depression and his suicide attempts.⁵⁷ His students blamed it on the bitter controversy over whether atoms existed, in which Boltzmann gained many adherents among younger scientists but never the satisfaction of convincing his opponents. It was not that simple. Boltzmann himself jestingly attributed his rapid changes in temperament to the fact that he was born during the night between Shrove Tuesday and Ash Wednesday: he was, almost certainly, manic-depressive.⁵⁸ But he was also very sensitive. As

Meitner reflected, “[He] may have been wounded by many things a more robust person would have hardly noticed. . . . I believe he was such a powerful teacher just because of his uncommon humanity.”⁵⁹

Boltzmann’s academic career was a series of wanderings. Born in Vienna in 1844, he graduated from the Akademisches Gymnasium, where Lise Meitner and also his daughter, Henriette, later took their Matura. At the University of Vienna, he was a student of Josef Loschmidt (1821–1895), who made reliable early estimates of molecular size and the number of molecules per mole,⁶⁰ and he was assistant to Josef Stefan (1835–1893), who devised an empirical formula for black body radiation that Boltzmann subsequently gave a theoretical basis.⁶¹ Between 1869 and 1890, Boltzmann held appointments in Graz, then Vienna, then Graz again, a period during which he contributed to all branches of theoretical physics: electromagnetic theory, kinetic theory, the Maxwell-Boltzmann distribution, statistical mechanics. He went to Munich in 1890, returned to Vienna as Stefan’s successor in 1894, left for Leipzig in 1900, and came back again in 1902. The university had kept his position open in the expectation that he would return.⁶²

Boltzmann was torn between his attachment to Austria, especially Vienna, and the attractions of German universities. Meitner recalled that Boltzmann would tell how in Munich there was “wonderful equipment, but far fewer good ideas” than in Vienna and then hastily add, “One must not let the Austrian [education] ministry know that good work can sometimes be done with inferior equipment.”⁶³ Of all universities, he most preferred Berlin, for its intense scientific atmosphere and the presence of Hermann Helmholtz, whom Boltzmann regarded as the greatest physicist of the nineteenth century. Yet in 1888 he refused the offer of a chair in Berlin, in part out of concern for his health,⁶⁴ in part, it was said, because he disliked the formality of the Prussian capital.⁶⁵ Later he would tell his students how much he regretted that decision. The position he refused went to a younger theoretical physicist, Max Planck.

A year after Boltzmann came to Vienna in 1894, he was joined on the faculty by one of his principal scientific adversaries, the formidable Ernst Mach. The leading proponent of the philosophy of scientific positivism, Mach argued that science can do no more than conduct positive—that is, direct—observations: while scientific theory may be of use for organizing such data, it must not create “pictures,” as he called it, of underlying

reality. Mach's impetus was antimetaphysical, a reaction against nineteenth-century attempts to reduce all of physics to mechanical principles; he opposed the kinetic theory of gases, based as it was on molecular motion, and dismissed the existence of atoms in broad Viennese, "'Ave y'seen one of 'em?"⁶⁶ In the 1890s, according to Boltzmann, the attitude toward the gas theory was "malevolent,"⁶⁷ complete with angry debates at meetings, struggles for the allegiance of young scientists, fights over appointments to faculties and journals.⁶⁸ In central Europe especially, Mach attracted a sizable following, including "energeticists" led by the physical chemist Wilhelm Ostwald, for whom energy was the primary reality and the second law of thermodynamics superfluous. For his part, Boltzmann attacked positivism as a modern version of an "old aberration," going back to the philosophy of George Berkeley. In 1905 he visited a university in California whose campus he described as "the loveliest place one can imagine," except for its "philosophical aura":⁶⁹ "The name Berkeley is that of a highly reputed English [*sic*] philosopher who is famous for the greatest foolishness ever hatched by the human brain, philosophical idealism, which denies the existence of the material world."⁷⁰

In 1898 Mach suffered a stroke, and he retired from teaching in 1901. When Boltzmann returned to Vienna in 1902, he claimed the philosophy of science course that had been Mach's for many years. Boltzmann's inaugural philosophy lecture in 1903 was thronged by the press, students, including Lise Meitner, and six hundred "sensation-seekers." With his predecessor in mind, Boltzmann confessed to his "dislike, even hate of philosophy," comparing it to "a hallowed virgin . . . [that] will remain eternally barren"⁷¹ as long as it denies the existence of physical reality. Thus the hostilities between the atomic theorists and the followers of Mach went on.

But the dispute over the reality of atoms was nearing an end. The discovery of radioactivity in 1896 and the electron in 1897 transformed atoms from disputed specks of mass to complex structures that were divisible, measurable, packed with amazing amounts of internal energy, and composed of fundamental particles of electric charge. "No physicist today believes atoms are indivisible,"⁷² Boltzmann told an audience at the World's Fair in St. Louis in 1904. That was probably true for those who believed in atoms, but not all physicists did, yet. The final blow came after Albert Einstein in 1905 and Jean Perrin in 1908 made detailed studies of