Chapter 2
Designing (for) a New Scientific Discipline

In the mid-1910s, the physicist Victor von Lang, director of the I. Physikalisches Institut in Vienna, and Eduard Suess, director of the Austrian Academy of Sciences, intensified their attempts to establish a new institute appropriate for the study of radioactivity.[1] Up to that point, radioactivity research had been hosted in Vienna's Physics Institute, inside a shabby building with temporary laboratories on Türkenstrasse, a side street close to the university. A "very primitive, converted apartment house" and "a miserable space," as Lise Meitner described it, the institute was interspersed among the neighborhood's residences and shops.[2] Although it included lecture halls and laboratory space, it was insufficient for both teaching and research. In the big lecture hall, there were no desks. The students had to write on their knees. The floor was so rickety that it quivered whenever someone crossed the room, affecting apparatus sensitive to motion.[3] For those who envisioned Austria as "the centre of research on radioactivity," such a makeshift institute was inappropriate for these new "exact studies."[4] 1

Besides being exact, this new science was profoundly interdisciplinary. As Lawrence Badash points out, "radioactivity was something of a hybrid between physics and chemistry." Its data came from an impressively diverse number of scientific disciplines.[5] Tracing the changing cultures of theory in nuclear science from 1920 to 1930, Jeffrey Hughes similarly argues that "in a field [radioactivity] which drew its practitioners from such a wide range of backgrounds, including chemistry, physics, geology, and medicine, the variety of interpretative practices was unusually large."[6] 2

Arne Hessenbruch has recently traced the connections of radioactivity to technology by focusing on Ernest Rutherford's 1901 experiment on radiation energy. As Hessenbruch surmises, "Who precisely were the many different constituencies and individuals involved in the early history of radioactivity? There were physicists, chemists, and medics, each having a different perspective."[7] The cultures engaged in radioactivity research, however, were not only scientific. Soraya Boudia and Xavier Roque have convincingly argued that Marie Curie and her colleagues deliberately organized the radium industry in France and defined radioactivity as a field of enquiry that impinged both on science and on industry.[8] 3

At the same time, those involved in radium research came to consider themselves as a distinct disciplinary community. As Rutherford reported to Bertram Boltwood about the International Congress of Radiology and Electricity held in Brussels in 1910, "we had a rather good section and practically all the radioactive people were present." Self-references to the "radioactive people" or the "radioactivists" certainly signaled newly acquired identities, acknowledged even by K. B. Hasselberg, the president of the Swedish Royal Academy of Sciences.[9] Yet, scientists at the crossroads of well-established disciplines such as physics, chemistry, and an emerging field such as radioactivity experienced the encounter as a transition. As Rutherford admitted, "Really, I was startled at my transformation at first but afterwards saw that it was quite in accord with the disintegration theory."[10] How else might a self-defined physicist describe his feelings at the award ceremony for the 1908 Nobel Prize in Chemistry? Linked to the conventional map of physics and chemistry, radioactivists such as Rutherford were at the same time persistently remaking the map of science, fitting radioactivity within its borders. 4

Recent histories of radioactivity, departing from a linear narrative focused exclusively on theories, have explored the material culture of the discipline and its social practices at the intersection of academia, industry, and the modern state.[11] Attention has been paid to instruments, to experimental cultures, to exchanges of materials and techniques among disciplines, and, recently, to the gender politics that characterized different institutional settings.[12] Here, I introduce urban history and the architecture of science buildings as further important contexts for the history of radioactivity. I investigate what it meant to the Viennese physicists to acquire a new institute for radioactivity research and design a building, the first of its kind, for such a multifaceted field of inquiry, taking into account not only the malleable present but also the future of their discipline. How did architecture and the urban positioning of the institute affect the identities of its scientists? Examination of these questions sheds light on the mostly unexplored history of radioactivity in Vienna. 5

The Biography of an Institute

During the first decade of the twentieth century, the institutionalization of radioactivity was essential to those who wished to legitimize their epistemic claims about new radioactive elements and their cultural position on the map of science. International rewards certainly contributed to this choice of direction.[13] Three 6

Nobel Prizes had already been awarded to researchers in the new field. In 1903, Henri Bequerel shared the Nobel Prize in Physics with Marie and Pierre Curie. In 1908, Ernest Rutherford was awarded the Nobel Prize in Chemistry, and in 1911, Marie received her second Nobel Prize, this time in chemistry. The publication in January 1904 of *Le Radium*, a special French journal devoted to radioactivity research, was yet another attempt to legitimize research on the newly discovered radioactive elements.

The first editors, Jacques Danne and Henri Farjas, aimed to popularize radioactivity. Six months later, in July 1904, the journal shifted toward a more scientific audience, altering its content. The new volumes included scientific sections on radiophysics, radiochemistry, medicine, radiotechniques, and even photography in relation to photochemistry. Danne remained the secretary of the journal while a new committee oversaw the publication. The names of those involved—Becquerel, Antoine Béclère, René Blondlot, André Debierne, the Curies, and Rutherford—reveal efforts to bestow prestige on the field. 7

However important they are for assuring credibility and enlarging epistemic authority, journals and prizes cannot be compared to the advantages that might be provided to researchers by a specialized research center. Indeed, buildings of science play the double role of configuring the identities of those involved in scientific production and symbolically displaying the identity of the scientific processes that take place inside. It is indicative that during the first decade of the twentieth century, radioactivity researchers were distributed across laboratories in Europe and North America but had no single specialized institution devoted exclusively to the new field. Systematic attempts by scientists to obtain a designated space for their practices were related to their coordinated efforts to make disciplinary space within the sciences for their new enterprise. 8

Rutherford, the foremost authority on radioactivity in the Anglo-Saxon world, based his early work at McGill University in Montreal. The director of the physics laboratory there, John Cox, provided Rutherford with a lavish laboratory which, nonetheless, specialized not in radioactivity research but in training students in medicine, engineering, and industrial chemistry.[14] In Paris meanwhile, Marie and Pierre Curie were working at rue Lhomond in the Ecole municipale de physique et de chimie industrielles inside a damp storehouse turned into a physics 9 laboratory.[15] After the announcement of the Nobel Prize in 1903, Pierre hoped that "all this noise will not perhaps have been useless, if it gets me a chair and a laboratory."[16]

A modest laboratory was soon set up, but only at the science faculty in rue Cuvier, where Pierre taught a physics course to those preparing for the *certificat d' études*. Eventually, in 1909, a decision was made to found the Institut du radium, a specialized institute for radium research in Paris. However, it was not until 1914 that the new Curie Institute, including two laboratories, one for physics research and one for biological and medical research, were ready for work. **10**

In 1907 meanwhile, Rutherford had already moved to Manchester, where he once again located his work at the university physics laboratory without gaining an autonomous research centre for his experiments. As he admitted to Bertram Boltwood, "The laboratory is good, but there was not much in the radioactive line." He added that the main advantage to being back in Europe, however, was the "hope to be able to raise a good deal [of radium]."[17] **11**

The precursors of the Curies in institutionalizing radioactivity research were the Viennese physicists. Since the end of the century, radioactivity had attracted the attention of Vienna's physicists through both its promise of scientific development and because, having access to the Bohemian radium and uranium mines in St. Joachimsthal, they were often asked to play the role of radium providers to the wider scientific community. Despite these advantages, bureaucracy and lack of money delayed the foundation of a specialized radium institute for years and embarrassed the Viennese scientists during international meetings.[18] The solution came from Karl Kupelwieser, who offered a munificent sum for the establishment of the Radium Institute in Vienna. **12**

Although one of the most interesting and influential personalities of the late Habsburg era, Kupelwieser has not received much historical attention. He was born in 1841 into a bourgeois Viennese family. His father, Leopold Kupelwieser, was a famous painter and professor at the Academy of Fine Arts in Vienna. Karl's mother, Johanna Lutz, was related to the president of the senate, Theobald Rizy. Both parents were members of an artistic circle including the painter Moritz von Schwind, the musician Franz Lachner, and the composer Franz Schubert.[19] Karl studied law at the University of Vienna, learned to play the piano, and showed literary talent. At the age of 28, he married Bertha Wittgenstein, the sister of his best friend Paul Wittgenstein. This marriage marked the beginning of a strong **13** relationship between the two families, as well as the development of Karl into an astonishingly powerful and affluent industrialist. His brother Paul offered the directorship of a rolling mill in Bohemia to Karl Wittgenstein, later father of the famous philosopher Ludwig Wittgenstein. Within the next five years, the wealth of the company increased enormously thanks to Wittgenstein's organizational skills. As an astute lawyer, Karl Kupelwieser bought most of the company's stocks and two additional smaller enterprises, and served as the legal adviser of the consortium.

By the end of the nineteenth century, Kupelwieser had amassed a huge personal fortune with which he supported several social and scientific projects. His charity work included financing a residence for blind, deaf, and mute people in Vienna and a tuberculosis hospital for children and adults. In 1907, he also patronized the Biological Station in Lunz.[20] His son, the biologist Hans Kupelwieser, became its first director. 14

In 1908, Kupelwieser's role as a patron of science was further boosted by a generous donation to the Academy of Sciences for the foundation of the Institut für Radiumforschung (Institute for Radium Research). In a letter to the academy, Kupelweiser clearly indicated that he wanted to "prevent the shame" of his country, caused by letting others "snatch away" the privilege of conducting radium research.[21] He notified them that he was willing to place a contribution of 500,000 crowns at the disposal of the academy for the construction and maintenance of an institute to be dedicated to research of the physical and chemical properties of radium. It was no surprise that his offer was considered a patriotic act, which would foster the country's progress and increase the empire's prestige.[22] 15

There was indeed a sense of "national pride" in establishing the institute. The institutionalization of the field gave Austrians the chance to put their own radium supplies to good use. This, for example, threatened Bertram Boltwood, as became clear in a letter to Rutherford: "I see that someone has given a lot of money for a Radioactive Institute at Vienna and I am afraid that the wholesome business will drive the small dealer like me to the wall."[23] 16

During the next two years, with his private initiative, Kupelweiser achieved what Exner and his colleagues had not managed to do despite their persistence for over a decade. The negotiations with the sloppy bureaucratic system of the Austro-Hungarian monarchy and its ministries were Kupelweiser's expertise. Being a lawyer, he knew the tricks. His donation set the officialdom into frenzied action. 17

Since 1894, the administrations of the Ministries of Education and Finance had been in constant negotiations about the site where the physics institute should be established. Already on March 14, 1908, Suess and Lang had written the Ministry of Culture and Education, supporting their case. "The new building for the Physics Institute is an essential condition for the possibility of radium research, since the current one is absolutely useless for such exact studies." [24]

When Kupelweiser offered his donation five months later, both physicists and the state unhesitatingly seized the opportunity immediately. On June 5, 1909, a protocol for the erection of the institute was granted by the state and signed by those involved in the construction. The list of signatories reveals the overlapping communities and interests involved: Eduard Suess signed as the president of the Austrian Academy; Franz Exner represented the physicists; Zdenko Skraup, director of the II Chemisches Laboratorium, signified the presence of the Viennese chemists in the project; a number of engineers and city planners stood for the state; and Eduard Frauenfeld was the architect.[25] 18

Following Kupelwieser's specifications, although the institute was established in a separate building, it was located between a physics institute and a chemistry institute. The proposed site was a spacious state property at the intersection of Boltzmanngasse, Währingerstrasse, and Strudlhofgasse in the ninth district of Vienna. The physicists chose the quietest corner of Boltzmangasse and Strudlhofgasse to host their institute. On the corner of Währingerstrasse and Boltzmanngasse, the chemists designed their own facilities. The Radium Institute was located between the two buildings, facing Boltzmangasse. 19

In contrast to the Radium Institute—a semi-autonomous research centre of the academy—the physics and the chemical institutes were subject to the University of Vienna and were to be used for both educational and research purposes. By the time the Radium Institute was completed and ceremonially opened on October 28, 1910, the building of the Physics Institute had already begun and it was finished two years later. The advent of the First World War disrupted the ongoing construction of the Chemical Institute, which was partly completed in 1920 but didn't fully open its doors until 1924.[26] 20

The physicist with direct interest in radioactivity research was Franz Serafin Exner, member of the Austrian Academy of Sciences since 1885 and *Professor Ordinarius* at the University of Vienna since 1891. Soon after the discovery of radium, Exner played a major role in persuading the academy to establish the Commission for 21 the Investigation of Radioactive Substances. He was deliberately trying both to ensure adequate amounts of radium for research and to enlist supporters in establishing radioactivity as a strong field in Vienna.[27] His influence in the Viennese scientific community was distinctive. Following the reorganization of university physics in Vienna and the creation of three separate institutes in 1902, Exner held the directorship of the II. Physikalisches Institut and proved to be the most important experimental physicist of his generation. In 1907, he reached the highest point of his academic career by becoming rector of the University of Vienna and participated in a number of scientific commissions, decisively shaping science in Vienna. During the first decade of the twentieth century, he was the main force in negotiations between the Austrian Academy and the Curies to provide the latter with considerable amounts of pitchblende for their scientific investigations. He was also Rutherford's closest contact in the Austrian Academy, guaranteeing his radium supplies. Scientifically, Exner was acknowledged not only for his original work on atmospheric electricity, color theory, spectral analysis, and radioactivity, but also for the wide circle of students he mentored.[28]

Thus, in 1910, there was no doubt that the establishment of the institute, made **22**
possible by Kupelwieser's donation, was also the result of Exner's attempt to legitimize the field of radioactivity in Austria. Having enormous prestige in the Viennese and international scientific communities, Exner was able to make important decisions on the research agenda, personnel, and research students' work, as well as the entire organization of the institute. He celebrated the building of such a specialized research centre as a symbol of scientific authority. He saw it as having the potential to bring Vienna to the forefront of radioactivity research and probably as a personal victory after twenty years of frustrations and difficulties in the institute at Türkenstrasse. It is significant that his only publication concerning the establishment of the institute appeared in French, in the journal *Le Radium*, the main forum of the international community of the "radioactivists." He proudly described the institute as "unique of its kind," with "the most modern facilities in the world." With the generosity of a confidently satisfied director, he assured the community that "the Academy of Sciences will be glad to see the largest possible number of scientists working there."[29] Exner was, however, already 64 years old and far from being in the most creative period of his scientific career. Under these circumstances, Stefan Meyer seemed best to fit the role of the active director (*Leiter*) of the institute, while Exner retained the position of its official director (*Vorstand*).

A key figure in the institute's history, Meyer belonged to a family of Jewish intellectuals. He studied physics at the University of Vienna under Exner and Ludwig Boltzmann. His ascent in the university hierarchy was remarkable. In 1900, he became *Privatdozent* at the University of Vienna and in 1906, he succeeded Boltzmann as head of Vienna's Institut für Theoretische Physik, a position he held for a year. In 1908, he became *Ausserordentlicher Professor* and Exner's assistant. He expressed an early and strong interest in radium research and when the International Radium Standards Committee was founded in 1910, Meyer was appointed its secretary, an indication of his scientific success. It was this dynamic involvement in the field which prompted Exner to entrust Meyer with the scientific organization of the institute, including its design and the purchase of instruments and furniture.[30] **23**

Concerns About Noise and Vibrations

As Christoph Hoffmann has argued for the German situation, "An ordinary physics institute at the end of the nineteenth century embodies in bricks and mortar, stone and lime precisely this command: disturbances have to be avoided."[31] No case better illustrates physicists' concerns about disturbances than the Physikalisch-Technische Reichsanstalt, Berlin's Imperial Institute of Physics and Technology. At the end of the 1890s, the city's street company decided to lay electric streetcar tracks in front of the Reichsanstalt, which might interfere with the institute's electromagnetic research.[32] The decision generated a serious controversy between the physicists and the streetcar company, which lasted for six years. It ended only when the company agreed to take measures to minimize disturbances for the institute. **24**

Concern about disturbance was not restricted to the Germans, but also troubled Austrian physicists. They were just as uneasy with the heavy traffic of electric streetcars on Währingerstrasse and just as worried about external factors which would interfere with their attempts to measure radium preparations precisely or to perform spectroscopic analysis. Their installations' stability had always been important. When the physics institutes were still at Türkenstrasse, the physicists' main complaint was the shaking of the floor and the disturbances caused by vibrations. "Whenever someone was ironing in the neighboring house," Benndorf recalled, "the needle of the magnet was going here and there and we very often experienced this nasty situation."[33] There was no solid spot where an instrument could be set up nor where magnetic measurements could be carried out. In 1896, **25** the directors of the three physics institutes, Exner, Ludwig Boltzmann, and Viktor von Lang, sent a letter to the deacon of the philosophy faculty, complaining about the intolerable situation in their laboratories:

> Any precision measurements whatsoever are impossible from the start due to the constant shaking [of the building], not only during the day but even at night, finer measurements cannot be carried out, in part due to the traffic on Währingerstrasse and due to the wind, in part due to the constant currents in the adjacent houses. Moreover, the spaces are extremely impractically arranged and far too small for scientific purposes, such that often due to the presence of the observer in the room, the temperature there rises in a troublesome way. Even the local middle schools have far more suitably arranged laboratories than the university.[34]

For the physicists, it was out of the question to put up with similar circumstances in their new location. This was the main reason they refused to accept either of the other two sites originally under consideration for the natural-science district. 26

The first proposed site was on Währingerstrasse, where the Volksoper was finally built. The second was the old Gewehrfabrik, the gun factory at the corner of Währingerstrasse and Schwarzspanierstrasse, where, in 1904, the Institute for Physiology was established.[35] Both sites were very close to the city and within the university quarter. According to the physicists, however, they seemed insufficient for the natural-science district. The first was too close to the street, while the second was next to the Anatomical Institute, which was equipped with high-voltage current. The induction current it generated affected the functioning of the electromagnetic apparatus, which made the physicists' research impossible.[36] 27

In order to control vibrations, noise, and electromagnetic disturbances, Viennese physicists chose the location across the Josephinum as one which might produce a less disruptive environment for research. The proposed location was a spacious state property of 12,065 square meters across from the Josephinum known as Bäckenhäusel.[37] Historically, the building belonged to a baker in the fifteenth century, and from 1648 to 1784 it served as a small hospital. Later on, it was converted into a residential building. Just before Vienna's physicists decided to build their institute at this spot, the building hosted a tobacco administration and storeroom.[38] After tearing down the old Bäckenhäusel, a complex of three buildings went up in its place. Traffic was redirected further away from the new building by adding an extra lane on both sides of the street. Instead of passing close to the institute's building, the streetcars traveled along the middle lane of Währingerstrasse. In this way, mechanical vibrations through the ground were 28 eliminated. In addition, trees on the pavement in front of the buildings and inner courtyards protected the small natural-science quarter from street disturbances. By locating the Radium Institute between the Chemistry Institute and Physics Institute, Exner and Meyer also aimed to eliminate the interference of external factors with research. In collaboration with the architects, they chose to build a relatively small edifice with three stories and about 20 workrooms facing tranquil Boltzmanngasse, thereby avoiding the busy traffic of Währingerstrasse. Concerned with disturbances, they moved the façade two meters further from the street to avoid the noise of the already infrequent traffic on Boltzmanngasse.[39]

Radium: An Unpredicted New Inhabitant

While they were able to take care of external factors, such as noise and mechanical vibrations, the physicists were not yet fully aware of radioactive contamination as a new kind of disturbance. As Meyer admitted, "It was a new concern; we were setting up something untested; experiences of radioactive 'contamination,' mutual interference, and so on were for the most part absent."[40] Unfortunately, they located two storerooms for radioactive materials along with the accumulator (a 469-volt battery) and a transformer in the cellar. Workrooms were grouped on the other side of the cellar, separating the area of research from that of the apparatus and the radioactive sources. Double walls on the external sides reduced the amount of radiation exposure. 29

According to Meyer, it became apparent that such an arrangement was a mistake since the radioactivity was spread throughout the building and was inhaled daily by the personnel. It was not until the mid-1920s that they moved 1 gram of radium to a room on the top floor of the building and surrounded the solution with lead bricks. A better resolution was chosen for the stronger radioactive materials. They built a special room in the cellar with thick concrete walls and a heavy steel door to seal the storage of strong preparations and eliminate contamination. 30

It was probably because of radiation precautions that the institute's design broke with the German architectural stereotype of hosting the director under the roof of the research centre. In Vienna's Radium Institute, there were no residential apartments either for Exner or Meyer. The presence of radium, a new and unpredictable inhabitant, forced changes in the common architectural canon. 31

The institute's first *Ordentliche Assistent*, Viktor Hess, later admitted that a second architectural mistake was to locate the radiochemical laboratory of the institute on its ground floor. Inside the front entrance, one would encounter on the left two rooms for chemical work, a darkroom, and a space for precise measurements of radioactive materials. In the hallway, showcases housed glasses for chemical analysis and other devices. Performing all the radiochemical tasks in the ground floor "was unfortunately a wrong choice," Hess recalled. He added, "The upper floor or a special building for radiochemistry would have been a better solution, because one could not avoid working with large amounts of preparations there."[41] 32

While mechanical vibrations and noise had always been familiar disturbances that could interfere with experiments, radiation hazards were a viciously malevolent disturbance that scientists were neither ready to face nor willing to admit. Elisabeth Rona, one of the female experimenters who worked at the institute and who specialized in polonium preparations, seemed to be one of the few who had a clear sense of how hazardous radiation could be. In the autumn of 1926, she spent a few months in the Curies' laboratory in Paris to learn from Irène Curie how to prepare polonium sources.[42] It was there that Rona first experienced the danger of radioactivity. Marie Curie and she were attempting to open a flask containing a solution of a strong radium salt when a violent explosion scattered glass all over the laboratory. It was only by mere luck that they were not injured or highly contaminated.[43] 33

When Rona returned to the Vienna Institute at the start of 1927, her experience with radium hazards led her to insist on taking precautions. The entire building was by now of course highly contaminated. Although hoods were used and the rooms were fairly well ventilated, the walls of the chemistry laboratory on the ground floor were especially contaminated. Rona recalled that "separated by a narrow corridor was the instrument room containing Geiger counters for beta counting and parallel plate condensers for alpha counting."[44] That spatial arrangement resulted in the contamination of instruments that finally had to be carried to the neighboring Physics Institute. Rona's own room was also one of the most contaminated. As she discovered, it was there during the 1910s that Otto Hönigschmid carried out his atomic weight experiments. The unprotected Hönigschmid often shook the solution by hand in order to homogenize the radium solution.[45] 34

After her accident in Paris, Rona was more cautious. In her work with colleague Gustav Ortner to open sealed tubes with radium salts, Rona insisted on using gas masks. But even in the late 1920s, Meyer was unwilling to take her request seriously: 35

> He laughed and tried to assure me that no danger was involved. However, I was not convinced and bought two gas masks with my own money. When we tried to open the first tube, it exploded, and the same thing happened with the second, scattering radioactive material all around. The gas mask saved us from severe damage. The basement room was closed permanently because it was impossible to get rid of the contamination.[46]

Women's individual bodies occurred as sites of experience, sites where radium and its penetrating radiation literally left their tracks in women's cells. Radiation affected the health and the everyday practices of all workers exposed, but women had a particular concern over the effect of the radiation in their reproductive systems. Unfortunately, there are no statistical data for that time concerning the effects of radiation on women's reproductive system or on the health of the institute's personnel as a whole. 36

Only slowly did scientists become aware of the hazards of radium. When Meyer published his book on radioactivity in 1927, he described different types of hazards, including his own accident. Emptying and transferring radioactive liquid from one bottle to another, his fingers became contaminated and, after the first symptoms of radiation burns appeared, the muscles atrophied. He hoped that "mentioning this will caution those who work with radioactive matter." Yet it is interesting that he did not enforce safety rules in his own institute. Rona admits that he "was probably honest in believing that no danger (at least immediate danger) existed because changes in the blood system, a sensitive organ for radiation, are slow." At the same time, he characterized as "hysterical fear" Kara-Michailova's claims that whenever she entered a room at the institute where 1 gram of radium was kept, she had trouble swallowing and had swelling of her tongue.[47] Ironically, in 1968, Kara-Michailova died of cancer induced by her long exposure to radioactivity. 37

Although Meyer and Exner tried to plan for their future research in radioactivity, the radium hazards were unpredictable at the time. As it proved, so were disciplinary changes. In the 1930s for example, the shift from radioactivity to nuclear physics required changes in instrumentation and the material culture of the institute. Nonetheless, it was not until 1966 that Berta Karlik, director of the 38 institute after the Second World War, finally managed to restructure the building "with the help of a young, very competent architect."[48] By pulling down a few walls, Karlik arranged to fit in a Cockroft-Walton accelerator and add an additional floor. The shift from the electromagnets and the accumulators of the 1910s to the big accelerators of the 1950s had indeed been inconceivable.

The Urban Setting of the Institute

According to contemporary tradition, the director of a prospective institute provided plans and oversaw its design and construction. At the start of 1909, Meyer and Exner thus worked on the *Raumprogram*, literarily the "room program," of the building.[49] They soon gave Frauenfeld and Berghof, a Viennese architectural firm, a sketch of the complex of the Physics Institute and Chemistry Institute as well as the Institute for Radium Research. The extended area around the new natural-science district was known as the Mediziner-Viertel, the physician's quarter.[50] 39

Devoted exclusively to research, the Institute for Radium Research offered possibilities for *Praktikum*, laboratory research positions for doctoral candidates to complete their thesis requirements. In the years that followed the institute's inception, a number of research students together with the permanent personnel probed the chemical and physical properties of radioactive elements. The research carried out during the first decade of the institute's operation eventually led to at least two Nobel Prizes and involved a significant number of young creative researchers with backgrounds in fields such as biology, physiology, chemistry, geology, and physics. 40

A surprising condition imposed in 1910 by Kupelwieser restrained the institute from radium research on medicine and from medical experiments on living organisms. For such work, the researchers depended on the Radiumstation of Vienna's Allgemeines Krankenhaus, near the institute.[51] Inderdisciplinary exchanges of this kind were facilitated by the fact that the institute was Austria's official radium standard-holder, acting as information center for scientific questions related to radioactivity. It also supplied the hospital's Radiumstation with radium for medical use. 41

Archival references and publications illustrate how these interdisciplinary activities were tied to the buildings, and the growing network of radioactivity researchers was drawn from physics and medicine. First, these activities included research 42 students commuting between the different institutes. The space of the Josephinum, which was located at Währingerstrasse 25, housed the surgical and medical faculty. It was used for a variety of courses in experimental physics for medical students and in experimental chemistry for pharmaceutical students taught by physicists and chemists. Also, courses on microscope theory, inorganic chemistry and theoretical and physical chemistry at the Physics Institute were much attended by medical students.[52] Occasionally, the institute's research students pursued medical studies in the neighboring institutes. As Marietta Blau described her work at the end of the 1910s, "I conducted theoretical studies and at the same time was a research assistant at the Laboratory for Medical Radiology at the Holzknecht Clinic, where I studied medical physics."[53] The clinic was offered at the Allgemeines Krankenhaus.

Second, trade of radioactive materials as well as transfer of apparatus and expertise extended the list of activities in the Viertel. In 1911, a protocol for trade in radium preparations and a provisional plan for the function of the Radiumstation at the Allgemeines Krankenhaus were signed at the Radium Institute.[54] Shortly afterwards and on several occasions, radium was prepared at the Radium Institute and delivered to the hospital's station, which was equipped with the latest apparatus for cancer therapy.[55] 43

Besides those working at the Radium Institute, a growing network of scientists researching the application of a variety of radioactive materials was expanding in the neighboring medical and biological institutions. For example, Goldschmidt, from the Physiological Institute, collaborated with Rona at the Radium Institute on the study of polonium in the cure of leukemia.[56] E. Knaff-Lenz, a Vienna University pharmacologist, studied the influence of radioactivity on humans. The map of the Mediziner-Viertel soon reflected the same modes of scientific collaboration and radium trading as did the list of committee members of the Radiology and Electricity Congress, planned by Meyer and Rutherford in 1913. Unsurprisingly, besides the physicists of the Radium Institute, the Vienna delegation included the radiologist Guido Holzknecht, the roentgenologist Robert Kienböck, the physician Hans Horst Meyer, and the director of the Radiumstation at the Allgemeines Krankenhaus Gustav Riehl. Knaff-Lenz was suggested as secretary of the congress's medical committee.[57] 44

The point is that the proximity of science institutes located in the Mediziner-Viertel mattered seriously to the science produced and the scientists involved in its production. Within the boundaries of the Viertel, personal communication took 45 place that facilitated interdisciplinary exchanges. Along with the flow of ideas, there was a reciprocal flow of people across Währingerstrasse and within the institutes. The few women in science became visible. As we will see, this helped them to become surprisingly well integrated within the Viennese scientific community.

Most of all, the architectural interconnectedness of science buildings provided a sense of stability to the scientists of the Viertel for their collaborations. Hosting a trafficking material, the Institute for Radium Research and its scientists depended on interdisciplinary collaborations and, thus, were in need of stable routes of scientific exchanges. 46

The Architecture of Radioactivity

Locating radioactivity in the city and addressing safety issues in the institute's design might principally have concerned Meyer and Exner, but their patron was preoccupied with the aesthetics of the new discipline. In his donation, Kupelwieser imposed the interesting condition that the institute ought to be built in a "pleasant architectural form," without defining what that should be.[58] Vienna's architecture was then in transition; it was a period of "creative unrest."[59] From the construction of the Ringstrasse—the boulevard with its monumental Renaissance and Baroque-style buildings surrounding the old Vienna—architecture had moved through a period of radical change to the Moderne movement.[60] 47

The most representative architect of the period, Otto Wagner, paid great attention to the traditional architecture of the city and adopted the Viennese style of weight and monumentality. Yet, he also certainly broke with this past, establishing his Nutzstil, the functional style, arguing for artistic simplicity.[61] His motto—necessity is art's only mistress—was reflected in his buildings and exemplified Vienna's architecture during the first decade of the twentieth century.[62] 48

"The form of the Radium Institute appeared to meet the artistic demands of the time," as Rainer Pawkowicz notes.[63] Deeply influenced by Wagner's simplicity, the architecture of the institute, though it demonstrated nothing of Wagner's authentic architectural skill, adopted the principle that "nothing unpractical can be pretty."[64] The form of the building smoothly followed its function. In the original plans, the façade of the institute combined elements of architectural historicism with an austere structure. The ornamentation was discreet with simple motifs above the windows, a narrow balcony at the second floor, and external ornamented pilasters. 49

When the institute was actually built, the façade was simpler with less ornamentation and pure lines, just a simple arch above the entrance and plain motifs above the windows. A few architectural elements such as the balcony and the akrotiria on the four upper corners of the roof signified the transition from Historismus to Moderne.

On the one hand, the exterior of the building made a clear reference to the modernity of its occupants, appropriate to the new discipline they were establishing. The architectural style of the Radium Institute was especially revealing in comparison to the Josephinum, the last Baroque building constructed in Vienna between 1783 and 1785, which stood opposite the natural-science quarter. Besides its heavy ornamentation, the courtyard of the Josephinum, which was also a science building, created a strong separation between the public and scientists. In contrast, the façade of the Radium Institute did not incorporate a visibly intermediate space, but extended into the street, reorganizing boundaries between those who had the right to cross the building's threshold and those who were excluded. Social and political changes in fin de siècle Vienna had for example drawn more women to the sciences, including radioactivity. The designers of the institute can be seen as responding to changes in access to science which were already occurring in Viennese society and the city's university. 50

On the other hand, the interior of the institute could be understood as a combination of a modernizing and a comforting functionalism. All spaces were equipped with modern facilities that the Türkenstrasse physicists would probably have found hard to imagine. Windows provided natural light to laboratories and office spaces from all sides while thick roller blinds protected experiments and experimenters from the unpleasantly hot summer sun. During cold Viennese winters, gas central heating created a pleasant working atmosphere, relegating the chilly winters at Türkenstrasse to the status of a nightmare. Each floor was equipped with gas and with two chemical stoves, a new technological development. The electrical company Stögermayr designed the electrical system, providing each floor with direct, alternating and accumulator current, and with currents of different strength and voltage for different types of research. Delicate, simply ornamented lamps were installed in the institute, illustrating the value of functionalism combined with artistic pleasure. Meyer's office was expensively furnished by the well-known American Trade Company.[65] There were telephones in each working space, making the institute one of the most luxurious, 51 technologically advanced, and prestigious science buildings of its time. In this respect, Vienna's Radium Institute resembled most leading science institutes built in Europe around the same time.

The different message the institute conveyed, mainly through its exterior design, was that a new science demanded new architectural forms and aesthetics. Heinrich von Ferstel's heavy ornamentation and Renaissance designs of the natural-science institutes in fin de siècle Vienna did not fit a modern world. Rather, it was efficiency, economy, and the facilitation of science that Kupelwieser, Exner, and Meyer had in mind when planning the institute. Compared, for example, to the Kaiser-Wilhelm-Institute for Chemistry that opened in 1912 in Berlin and included a department for radioactivity research under the directorship of Otto Hahn and Lise Meitner, the architecture of Vienna's institute followed a much simpler form. Although the original conception of the exterior of the Kaiser-Wilhelm-Institute was planned with a conical roof on the turret, when it was finally built, there was a cupola instead, a decorative touch that seriously concerned the scientists. **52**

Despite the suggestions of Emil Fischer, Germany's leading chemist, that "simplicity is characteristic of all experimental science . . . therefore the workshops of experimental research should also be free from any splendor but equipped with all the means of advanced technology," the architecture of the Kaiser-Wilhelm-Institute demonstrated the difficulty of well-established disciplines such as chemistry to break with traditional architectural forms of imperial Germany.[66] **53**

On the contrary, in Vienna, the architecture of the newly created natural-science quarter reconfigured the relationship between the traditional disciplines of physics and chemistry and the newly emergent field of radioactivity, allowing them to coexist while drawing boundaries and protecting distinctions. As an indication of the common interests that the communities of physicists and radioactivists wanted to pursue, the Radium Institute's blueprints show a bridge at the third-floor level connecting it to the Physics Institute. "The bridge to the Physics Institute was not only a material connection," as Meyer pointed out, "but also an ideal one; friendly relationships with the neighboring institute were necessities of life."[67] **54**

During the 1920s, the contacts proved to be exceptionally important for both sides. In 1922, Swedish physicist Hans Pettersson arrived in Vienna with his wife, the chemist Dagmar Pettersson, both intending to work on the artificial disintegration of light elements. He and his Radium Institute collaborators soon seriously challenged assumptions about the nature of the atomic nucleus put **55** forward by Ernest Rutherford and his colleagues at the Cavendish Laboratory in England. The need for specialized personnel led workers on other projects to shift to Pettersson's group, attracted young researchers to the institute, and drew others from the Physics Institute next door.

Among those who joined the group were female physicists such as Marietta Blau, Elisabeth Rona, Hertha Wambacher, Stephanie Zila, and Elvira Steppan. In response to the continuing controversy with the Cambridge group, the Viennese mobilized the facilities offered by the better-equipped neighboring institute, which housed more reliable measuring instruments. Indeed, the physicists next door had an impressive library, experimental apparatus and, most important, uncontaminated rooms, all lacking at the Radium Institute. 56

In his formal report to the International Educational Board in 1928, Pettersson repeatedly emphasized that: 57

> As these investigations [on artificial disintegration] must necessarily be divided into one "contaminated" and one "uncontaminated" part, the first for preparing and measuring the intense radioactive sources, the second for detecting their extremely minute effects on the shape of the rare atomic fragments, the work would not have been possible had not the Radium Institute happened to be in such close and excellent cooperation with the adjacent I and II Physics Institutes, the directors of which have also put a considerable part of their apartments and equipment at our disposal.[68]

The same advantages were recognized by Rona who recalled that Geiger counters and parallel plate condensers had to be moved to the Physics Institute because their own institute was highly contaminated. Above and beyond material benefits, the bridge offered the science practitioners in both institutes the opportunity to exchange ideas and to learn about their colleagues' latest research. At a symbolic level, the bridge supported feelings of membership in the same physics community, while it gave stability to particular collaborations. 58

Although he was director of the II. Physikalisches Institut, Exner remained the official director of the Radium Institute until his retirement in 1920, and retained his offices in both buildings. The bridge made material his and his colleagues' dual affiliation. On the other side of the building, the proximity of the Chemical Institute became essential after the end of the First World War for it facilitated the already existing collaboration between physicists and chemists yet maintained the rigidity of their disciplines' boundaries. 59

Disciplinary boundaries were certainly projected onto the institute's architecture, but to understand how the boundaries between the traditional disciplines and the emergent field of radioactivity were established and enforced, we need to follow the practices of the institute's experimenters. For example, although Meyer and his colleagues were required by the Austrian Academy of Sciences to publish their work in its *Sitzungsberichte*, they also published in the institute's *Mitteilungen*, a separate annual edition which collected all the papers of the institute's researchers. Partly because of its practical orientation toward research purposes, this distinct publication on radioactivity legitimized the new field and shaped its boundaries. Most scientists nevertheless continued to publish extensively in prestigious physics journals, such as the *Zeitschrift für Physik* or the *Physikalische Zeitschrift*, but they also contributed to the *Zeitschrift für Physikalische Chemie*, to the *Zeitschrift für Technische Physik*, and to *Strahlentherapie*, a journal of medical physics. 60

Deciphering the Interrelation of Gender, Radioactivity, and Architecture

Marelene and Geoffrey Rayner-Canham have recently brought our attention to the fact that women were drawn to radioactivity research in the early twentieth century. Identifying three different European research schools on radioactivity—the French, the English, and the Austro-German—the Rayner-Canhams argue that women "seemed to play a disproportionately large share in the research work in radioactivity compared to many other fields of physical science."[69] In the case of Vienna, Peter Galison has fairly characterized the institute as "a Mecca" for women in radiochemistry and radiophysics.[70] Most of these women were fluent in major European languages and moved easily from Vienna for short periods to the laboratories of the Curies, Lise Meitner, Otto Hahn, or Rutherford. They participated as full colleagues in the research of the Radium Institute and played an important role in the broader scientific community. 61

Attention to internal arrangements and spatial layout proves to be an important tool in identifying gender relations in the laboratory workplace and in deciphering exceptional gender assumptions about accessibility in Vienna radioactivity research. The Radium Institute's architecture gave physical meaning to conditions not just on who might enter the building but also on who might gain access to the new discipline. To explore the space where women and men were involved in 62 radioactivity research is therefore to look for exclusions and inclusions based on gender, and for ownership of space and for gender assumptions in architectural design.

Before architects began to draw detailed plans of the institute, Meyer and Exner had already defined for them the exact space requirements for laboratories, offices, and support rooms. Sharing a collegial ethos in physics work, they placed a high value on a welcoming environment for their research personnel, combining spaces for socializing and spacious research laboratories. Their design referred not only to the peculiar interdisciplinary nature of the new field by combining chemical and physics laboratories but also to the fact that both men and women were involved in radioactivity research. **63**

The building was characterized by its central symmetry around the axis of the staircase, which in its slim form suggested its function as a means for vertical traffic. In each intermediate floor, the staircase had large open landings that gave enough room to accommodate sanitary installations, including one bathroom between the ground floor and the mezzanine. The bathroom was designed for the needs of those who worked with radium preparations or polonium sources and were often contaminated with radioactive powder. It was not at all unusual for the researchers to take a shower or wash dirty laboratory uniforms. Besides those in the cellar and the top floor, the remaining landings provided access to two small toilets, one on the left and one on the right, most probably designated for men and women. The fact that not every floor had two separate sanitary installations may reflect the smaller number of women in the institute. **64**

Was the existence of toilets for women a common architectural feature of science buildings at the time? Sophie Forgan mentions that even today in physics and engineering departments, one has to go a long way to find women's toilets.[71] In this respect, Vienna's Radium Institute was indeed an exception and differed, for example, from another radioactivity research centre, the Physics Institute in Heidelberg built around the same time. **65**

In 1908, the physicist Philip Lenard, director of the new institute in Heidelberg, submitted to the state the building's *Raumprogram*. The architect Friedrich Ostendorf provided the detailed designs. In addition to the Physics Institute, the plans included a radiological institute with three departments: radiophysics, technical radiology, and medical radiology. Financial disagreements between the **66** state and the institute's designers delayed the process until July 1909. Yet the final blueprints had to be modified again in order to meet the approval of the state solely because they did not include separate toilets for women.[72]

As the early twentieth century saw increased female participation in science, architects, city planners, and the state apparently had to accommodate this newly developing body politics. The existence of separate sanitary installations suggests that women were a common feature of the Radium Institute's scholarly life. Not only were both Meyer and Exner familiar with the fact that women participated in physics as students and researchers, they also encouraged such participation. In 1893, when women were not yet admitted to the University of Vienna, Exner was among those who signed a petition supporting women's right to higher education.[73] The accounts of many of the women who later worked at the institute further suggest that Meyer was a central, encouraging figure in their laboratory work. Thus, it is not at all surprising that Meyer and Exner acknowledged women's bodily needs in the institute's everyday life, anticipating the state's inspectors. 67

A second architectural element of the institute's building reflected its remarkable arrangement for keeping the institute and its laboratories in order by accommodating special housekeeping personnel. Inside the front entrance, one would first reach the mechanic's apartment on the right. The apartment was directly linked to a room where a housemaid cleaned the devices used in chemical procedures.[74] Clearly, the institute's designers were trying to create comfortable conditions for the research staff, who were now concerned only with their own scientific projects. A similar setting in the Kaiser-Wilhelm Institute for Brain Research in Berlin around the same period had a notable result. As Annette Vogt has documented, the personnel responsible for the housekeeping of the institute were also responsible for cleaning the apartments of all the scientists and technical assistants who resided near the institute. This arrangement, Vogt argues, created unique conditions for the women who worked at the institute by freeing their time from everyday home tasks and laboratory cleaning, thus enabling them to play an exceptional role in scientific research.[75] So given the fact that they did not carry the burden of laboratory cleaning, a stereotypical role for women in science, women researchers in Vienna's Radium Institute enjoyed in this respect similar work conditions to that of their male colleagues. 68

Focusing on the architecture of laboratory and office spaces in the institute reveals that there were several other respects in which men and women made use of the space in a more or less equal way. Among the peculiarities of the institute's design 69 was that the workrooms on each floor were all small but interconnected, providing wider access to other practitioners while maintaining the feeling of working in a semi-secluded, personal space. One was able to enter each room from at least two different doors, and interconnectedness was the inevitable result. Doors served to articulate the flow of scientists and probably that of small portable apparatus in a variety of workspaces with different functions. Men and women had access to all of these rooms regardless of their gender. As the pictures of Rona and Georg Stetter illustrate, what mattered was their scientific expertise, their knowledge of operating a specific apparatus, and their need to perform an experiment.

New scientific demands shaped and transformed spatial arrangements, especially after the Second World War. Pettersson's experiments on the artificial disintegration of light elements signaled a shift from radioactivity to nuclear physics in the institute's research agenda. Introducing scintillation counters, photographic emulsions, and Shimizu–Wilson ray track apparatus, he altered not only the materials used at the institute but also the space and culture that surrounded them. The new experiments required larger collaborative groups. Stools and chairs replaced the long benches. Plane tables were arranged around the wall with one of their short sides attached to it. Although they served as individual desks, these tables had enough empty space around them to accommodate more coworkers when needed. In addition, lack of space in the institute forced specific transformations in laboratory design, which continued to allow workbenches to be allotted to each researcher by assigning more than one scientist to a given room. Photographic material suggests that there was an interesting symmetry in the arrangements of space between men and women at the institute. **70**

Textual evidence for women's ownership of laboratory space complements the suggestive photographic material. According to Elisabeth Rona's autobiography, when she entered the institute in the early 1920s, she was assigned Exner's former office due to a shortage of office space.[76] From the Pettersson–Karlik correspondence we also learn that Karlik "had locked the room so that only a 'Funktionär' could have entered,"[77] and later that Przibram "could hear the pump running in *my room* all the time."[78] Karl Przibram was the *Ordentlicher Assistent* at the institute from 1919 to 1938. He worked on the phenomenon of radiophotoluminescence, which he had discovered in 1921. He also extensively studied the coloring of crystals and the fluorescence of fluorites. His studies **71** attracted a number of researchers, many women among them. His main collaborator was Maria Belar, but Elisabeth Kara-Michailova, Luisa Gröger, Marie Hoschtalek, Berta Karlik, and Berta Zekert also worked with him.[79]

Furthermore, at the Radium Institute there was no confusion over responsibility for keeping space and equipment neat for the next user or over the ownership of instruments and laboratory benches. From several of the institute's publications, it becomes obvious that possessiveness concerning instruments was clearly acknowledged and respected by personnel. In 1927, for example, Kara-Michailova thanked Georg Stetter for his generosity in lending her his apparatus for her experiments on the brightness of scintillations.[80] In a letter to Pettersson in 1933, Karlik mentioned that "Ortner had actually borrowed the Cenco-Hyrac-pump (we had agreed on that) and that he and Frau Sehork had just replaced it."[81] 72

Another facility of the institute—the library—reflects ways in which women made space their own. By doing so, they reinforced their role as members of their scientific community. The institute's library situated in the mezzanine was planned to serve as a bibliographical source, a space where researchers could consult recent publications related to radioactivity. Facing Boltzmanngasse at the right-hand corner of the building, the library had two external sides where windows allowed in the maximum amount of light. The literature stocked specialized exclusively in radioactivity. "For the remaining literature," as Meyer explained, "one was dependent on the big neighboring library of the Physics Institute (as well as the institutes of mathematics and chemistry)."[82] 73

The library served to reinforce the message. By moving to the Radium Institute, researchers working in the boundary field of radioactivity marked their own distinct community at the intersection of the physics and chemical institutes. They preserved their individuality, yet seriously depended on colleagues in the neighboring institutes. The move from the old Physics Institute at Türkenstrasse to the new natural-science quarter was followed by a corresponding move from the neighboring coffee houses where physicists used to spend their time to the more secluded institute library for social gatherings. It was a move from the public to the semi-private domain of the Radium Institute. Scientific discourse was moved out of cafés to a new institution that legitimized researchers in radioactivity and gave them a unique institutional persona. From the *Kaffehaus* to the institute's library, the physicists carried with them the Viennese cultural identity which permeated their scientific ethos. They shaped their library into a space where 74 people went to meet friends and colleagues, to relax, and to consult the latest journals. It became the space where the Viennese "radioactivists" reinforced their feelings of belonging to a new discipline.

The social activities that took place in the library and surrounded the practice of radioactivity research allow us to identify more precisely the nature of the radioactivity community in Vienna. The small library was transformed into the heart of the institute by serving as the setting for exciting discussions on ongoing experiments, scientific developments, political upheavals, and the cultural life of Vienna. Every evening from the institute's inception until 1938 researchers met informally in the library to drink coffee and converse with their colleagues. "As I remember," Pettersson's daughter Agnes Rodhe recalled, "every day at four o'clock they had the so called 'jauze,' afternoon tea, and all the institute met, at least the ones who were free to drink coffee, chocolate, or tea and have desserts."[83] Strong friendships among the researchers started in that period and were developed through the collegiality of those coffee hours. "We all ended up close together," as Hess later put it, "and the collegial relations were extremely cordial. I thank here my friends Kohlrausch, Schrödinger, Przibram, Paneth, Hevesy, and Thirring, all in the old Exner-circle joined together, so to speak, we built a family."[84] **75**

Those who tied the library to their social activities were not only the men of the institute. Archival sources document that women not only used the library for research, but that they participated in the social gatherings as well. As Karlik reported in a letter to Pettersson in 1938: **76**

> The tea standard has been very high lately; no political remarks. Ortner getting more and more interested in theory and taking part regularly; a theoretician called Ludloff who has now got his *Dozentur* here (he comes from Breslau), Frau Dr. Seidl, occasionally even Sexl coming. Mattauch belongs already quite to the family.[85]

Franziska Seidl was one of the few women who, as early as 1923, worked as *Wissenschaftlicher Hilfskraft* (scientific assistant) at the first Physics Institute and in 1924, she was promoted to the position of *Assistentin* (assistant).[86] After her habilitation in experimental physics in 1932, Seidl became *Privatdozentin* (private lecturer) at the University of Vienna, teaching a course every semester from 1933 onwards. She focused on several topics in experimental physics including x-rays **77** and their use.[87] Josef Mattauch and Theodor Sexl worked as *Assistenten* at the Physics Institute next door and Hans Ludloff had just arrived in Vienna from Breslau to teach a course on quantum theory.[88]

In addition to the regular "jauze," the women of the institute were visible during the formal visits of internationally known physicists. In 1933, when J. J. Thomson and his wife paid a formal visit to the Vienna Institute, Karlik entertained them socially with the rest of her colleagues. "At the Przibrams, we had the most delightful afternoon," as she reported to Pettersson on July 26, 1933.[89] As the episode suggests, women had established a lasting presence in the field. As in the case of Karlik, this was carried over even after the Second War World when she became the institute's director. **78**

Reading the History of Radioactivity Through the Architecture of Its Buildings

The concept of Vienna's Radium Institute and its architecture grew in response to the needs and interests of its designers and the concerns of the network of academics, their financial supporters, and the state. In 1910, the institute's planners created a place that had not existed before, both physically by building the institute and institutionally by creating a separate space for the new discipline. It was conceived as more than a research institution, since those in charge sought to provide both male and female researchers with a sense of scientific community. Yet over the years, the institute functioned as a contingent space, being constantly shaped by those who inhabited it. It grew in response to their demands, their scientific practices, the material culture that surrounded them and, most interestingly, their gender. **79**

Architecture is more than the trace of these practices. I have argued that by designing for a new discipline, scientists and architects were collaboratively designing the new discipline in a strong sense. It is necessary but not sufficient to observe that the architecture and urban location of the institute were shaped by the subject matter of the new discipline and radium's properties as a trafficking material, allowing different scientific disciplines to coexist and to contribute to the making of radioactivity as a field, while protecting their distinct identities. Most important is that the institute's planners saw the design of the new discipline as their main goal, in the sense of reinforcing specific disciplinary exchanges, forming a distinct community, and even encouraging the entrance of women into the field. **80**

The institute proved to be an embodiment of the disciplinary, cultural and scientific status, and of the gender ideology of its researchers. The new aesthetics of the modern era, as they were expressed in the institute's architectural form, provided the physicists who specialized in radioactivity research with a new disciplinary identity. The building helped give tangible existence to the new field by making the researchers visible and institutionalizing their practices. It further added to their prestige and offered them unique opportunities for research. At the same time, the building's internal architectural arrangements made it possible to increase scientific collaboration and social interactions among scientists with a variety of expertise. Specific architectural features, such as the existence of women's toilets, point to the gendering of the laboratory space and to the fact that women's existence in the institute was both acknowledged and facilitated. Women working on radioactivity succeeded in acquiring "a laboratory bench of their own," indicating a shift in the political importance of the role of women in science. The reconfiguration of their space in laboratory work was in fact emblematic of their presence in the field and of their membership of the radioactivity community. **81**

Radioactivity researchers considered themselves members of a distinct discipline, but at the same time ensured their connections to traditional ones as a way to empower their newly acquired identities. Indeed, the institute cannot be seen solely in terms of the forging of a singular community, that of "radioactivists." This would draw too tight a circle around those who lived and worked in and around it. Although it emerged in the city as a place apart, the Radium Institute was rather an inhabitant of the city, more specifically of the Mediziner-Viertel, a space which created a fluid relation between professional and private spheres. Its location manifested new modes of exchange between physics, chemistry, and medicine, which were enforced by the field of radioactivity. Both its urban location and architectural form were driven by the kind of interdisciplinary research done in its laboratories, the instruments in use, the hazardous properties of radium, its modes of trafficking, and, to a surprising extent, the gender identities of its personnel. Equally, the urban sitting of the institute in the Mediziner-Viertel reinforced exchanges of apparatus, ideas, and personnel among the institute and Vienna's medical institutions, as well as the physics and chemical institutes. In brief, as a space and as a concept, the Radium Institute took advantage of a transitional moment in the development of radioactivity as a discrete discipline; it was bound to traditional fields through a complex of architectural features. **82**

Notes

Note 1: See, for example, Lang and Suess to the Austrian Ministry of Agriculture, January 15, 1904; Lang and Suess to Ritter von Hartel, January 15, 1904; Lang and Suess to the Ministry of Culture and Education, March 14, 1908, all in AÖAW.

Note 2: Meitner, "Looking Back" (1964); H. Benndorf, "Worte der Erinnerung an Franz Exner" (1926), Nachlass Exner, AÖAW.

Note 3: Benndorf, "Gedenkrede auf Franz Serafin Exner aus Anlass der Enthullung seines Denkmals in der Universitat Wien am 23 Janner 1937," Nachlass Exner, AÖAW.

Note 4: Lang and Suess to the Ministry of Culture and Education, March 14, 1908, AÖAW; Lang and Suess to the Ministry of Work, December 21, 1908, AÖAW.

Note 5: Badash, "The Suicidal Success of Radiochemistry" (1979), 12.

Note 6: Hughes, " Modernists With a Vengeance" (1998), 342.

Note 7: Hessenbruch, "Rutherford's 1901 Experiment" (2000), 419.

Note 8: Boudia, "The Curie Laboratory, Radioactivity and Metrology" (1997); Boudia, *Marie Curie et son laboratoire: Sciences et industrie de la radioactivitè en France*, Paris, (2001); Roque, "Marie Curie and the Radium Industry" (1997); Roque, "Displacing Radioactivity" (2001).

Note 9: Rutherford's similar references to "radioactive world" go back as early as 1905. In 1919, he informed Boltwood that it seems "to be an epidemic of marriages among the Radioactive people" as both Hevesy and Hönigschmid were getting ready to marry. Badash, *Rutherford and Boltwood: Letters on Radiaoctivity*, (1969), 322. See also Hughes, *The Radioactivists* (1993), 6. In his presentation speech for the Nobel Prize in chemistry in 1908, Hasselberg recognized that researchers such as Rutherford, Curie, and Becquerel "are closely allied to, and form a worthy continuation of work," referring to radioactivity research. See K. B. Hasselberg, *Presentation Speech, The Nobel Prize in Chemistry*, December 10, 1908. http://nobelprize.org/nobel_prizes/chemistry/laureates/1908/press.html.

Note 10: Badash, *Rutherford and Boltwood* (1969), 205.

Note 11: Hughes, "Radioactivity and Nuclear Physics" (2003).

Note 12: See the special section on radioactivity research by Rentetzi, (coordinator), "Women Pioneers in Radioactivity Research" (2004).

Note 13: Historian of Victorian science Roy MacLeod suggested long ago that medals "codified schools of thought and legitimized scientific paradigms." Macleod, "Of Medals and Men" (1971).

Note 14: Lawrence, "The Origins of Big Science—Rutherford at McGill" (1979). See also Burcham, "Rutherford at Manchester, 1907–19" (1964).

Note 15: Mould, "The Discovery of Radium" (1998); Peh, "The Discovery of Radioactivity and Radium" (1996).

Note 16: Quinn, *Marie Curie* (1995), 203.

Note 17: Badash, *Rutherford and Boltwood*, (1969), 158–59.

Note 18: For example, embarrassed by his provisional laboratory, Franz Exner, the director of the Second Physics Institute, left Vienna before his international colleagues arrived for the meeting of German scientists and physicians in 1894. Moore, *A Life of Erwin Schrödinger* (1994), 57.

Note 19: Wettstein, "Karl Kupelwieser" (1928). See also Löffler, "Limnology in Austria" (2001), 15; Reiter, "Vienna: a Random Walk in Science" (2001), 476. Janik and Veigl, *Wittgenstein in Vienna* (1998), 38–39.

Note 20: Occasionally, Kupelwieser also made donations to the medical society of Vienna. Fischer, *Geschichte der Gesellschaft der Ärtze in Wien 1837–1937* (1938), 115. His was such a powerful figure in fin de siècle Vienna that when the state decided to construct a huge hydroelectric station close to the Biological Station, Kupelwieser was able to maneuver politically and cancel the decision. Wettstein, "Karl Kupelwieser" (1928), 14.

Note 21: Karl Kupelwieser to the Academy of Sciences, August 2, 1908, AÖAW.

Note 22: For example, Franz Serafin Exner characterized Kupelwieser as "the patriotic friend of science." *Almanac of the Austrian Academy of Sciences* (1912), 327, AÖAW.

Note 23: Badash, *Rutherford and Boltwood* (1969), 193.

Note 24: Suess and Lang to the Ministry of Culture and Education, March 14, 1908, AÖAW.

Note 25: Pawkowicz, "Die Österreichische Akademie der Wissenschaften und die Bauten für ihre Forschungsinstitute" (1978), 72. Unfortunately, I was unable to locate any specific information on the architects of the project.

Note 26: Ipser and Schönfeld, *Die Geschichte der Chemie an der Universität Wien und des Instituts für Anorganische Chemie* (1996), 22. As Wolfgang Reiter argues, the Vienna Radium Institute became the model for the Institut du Radium in Paris which architecturally resembled it. Reiter, "Stefan Meyer: Pioneer of Radioactivity" (2001), 114–16.

Note 27: Suess and Lang to Auer von Welsbach, July 10, 1901, AÖAW.

Note 28: As Karlik and Schmid put it, "Exner had also carried out essential organizational work for the University of Vienna. This concerned the planning, the preparation, the construction, and the establishment of the new Physics Institute at the corner of Boltzmanngasse and Strudlhofgasse." So besides working at the Radium Institute, Exner played a fundamental role in building the whole natural-science quarter. In collaboration with his friend Ernst Lecher, director of the neighboring institute, and his assistant Edward Haschek, he provided the plans for the Physics Institute. Karlik and Schmid, *Franz Serafin Exner und sein Kreis* (1982), 88. On Exner, see also Przibram, "Errinerungen an ein altes physikalisches Institut" (1959), 3; Schweidler, "Bericht des Generalsekretärs" (1927); Stöltzner, "Franz Serafin Exner's Indeterminist Theory of Culture" (2002).

Note 29: Exner, "Le nouvel Institut pour le radium à Vienne" (1910).

Note 30: Reiter, "Stefan Meyer: Pioneer of Radioactivity" (2001). The letters concerning the construction and furnishing of the institute were all addressed to Meyer. See, for example, the files "Bau des Institut, Erstausstattung," AÖAW.

Note 31: Hoffmann, "The Design of Disturbance" (2002), 9.

Note 32: Cahan, *An Institute for an Empiire* (1989), 168–75.

Note 33: Benndorf, "Gedenkrede auf Franz Serafin Exner aus Anlass der Enthullung seines Denkmals in der Universitat Wien am 23 Janner 1937" Nachlass Exner, AÖAW.

Note 34: Philosophische Dekanat 1895/6, Akt 117, Archive of the University of Vienna, quoted in Coen, *A Scientific Dynasty* (2004), 228.

Note 35: Golitschek and Elbwart, *Der Neubau des Physikalischen Institutes der Wiener k.k. Universität* (1915), 1.

Note 36: Hittner, *Geschichte des Studienfaches Physik* (1949), 73–75.

Note 37: Hittner, *Geschichte des Studienfaches Physik* (1949), 73.

Note 38: Schönfeld and Ipser, "Die Geschichte der Chemie" (2000), 22.

Note 39: Pawkowicz, "Die Österreichische Akademie der Wissenschaften und die Bauten für ihre Forschungsinstitute" (1978), 73.

Note 40: Meyer, "Das erste Jahrzehnt des Wiener Instituts für Radiumforschung" (1920), 3.

Note 41: Hess, "Persönliche Erinnerungen aus dem ersten Jahrzehnt des Instituts für Radiumforschung" (1950), 44.

Note 42: Hans Pettersson's report on the investigations regarding artificial disintegration, first half of 1926, GUB (in English).

Note 43: Rona, *How it Came About* (1978), 24–5.

Note 44: Rona, "Laboratory Contamination" (1979), 724.

Note 45: Rona, *How it Came About* (1978), 29.

Note 46: Rona, "Laboratory Contamination" (1979), 724.

Note 47: Rona, "Laboratory Contamination" (1979), 724, 727.

Note 48: Karlik to Pettersson, January 16, 1966, GUB.

Note 49: Meyer, "Das erste Jahrzehnt des Wiener Instituts für Radiumforschung" (1920), 3.

Note 50: Brinda-Konopik, "Robert Wilhelm Bunsen und die chemische Schule an der Universität Wien (Alma Mater Rudolphina)" (1992), 3; Rentetzi, "The City as a Context of Scientific Activity" (2004).

Note 51: After its discovery, it became clear that radium affected human tissues, a finding that provoked medical practitioners to use it in cancer therapy. It is a surprise that although Viennese physicists as well as physicians were among the pioneers in the new field, when the Radium Institute was established medical research was explicitly excluded. Kupelwieser did not state the reasons for such exclusion. See also Paneth, "Über die Arbeit des Instituts für Radiumforschung" (1915).

Note 52: In 1910, for example, Ernst Lecher taught experimental physics for medical students and a year later, he published one of the first textbooks on physics for physicians and biologists (Schweidler, Schweidler, "Bericht des Generalsekretärs" (1927), 178). Egon Schweidler offered a course on experimental physics for pharmaceutical students and Felix Ehrenhaft lectured on the theory of the microscope. The same year, Skraup Zdenko taught inorganic chemistry for pharmaceutical students and Herzig Josef offered pharmaceutical chemistry (Vorlesungen an der k.k. Universität zu Wien, 1910–1911, AÖAW).

Note 53: Marietta Blau, curriculum vitae, 1941, GDSCA.

Note 54: Meyer to Riehl, June 7, 1912, AÖAW.

Note 55: Fernau to Meyer, October 17, 1912; Fernau to Meyer, February 8, 1913; Meyer to Fernau, May 10, 1912; Fernau to Meyer, June 10, 1912, all in AÖAW.

Note 56: Meyer, "Die Vorgeschichte der Gründung und das erste Jahrzehnt des Institutes für Radiumforschung" (1950), 20. I was unable to identify the first name of Goldschmidt, the woman who collaborated with Rona.

Note 57: Meyer to Rutherford, December 5, 1913; Meyer to Rutherford, December 16, 1913, Rutherford Papers, CUL.

Note 58: Kupelwieser to the Academy of Sciences, August 2, 1908, AÖAW. Probably Kupelwieser himself decided on the project architects as these were the only ones he paid directly. For the rest of the expenses, he transferred money to the account of the academy. Suess to Exner, October 28, 1910, AÖAW.

Note 59: Borngässer, "Architecture From the Turn of the Nineteenth Century to the Present Day" (1999), 273.

Note 60: Schorske, *Fin-de-Siècle Vienna* (1980).

Note 61: Pintaric, *Vienna 1900* (1989).

Note 62: Schorske, *Fin-de-Siècle Vienna* (1980), 73.

Note 63: Pawkowicz, "Die Österreichische Akademie der Wissenschaften und die Bauten für ihre Forschungsinstitute" (1978), 81.

Note 64: O. Wagner, *Die Baukunst unserer Zeit*, Wien, 1979, 45.

Note 65: American Trading Company to Meyer, May 20, 1910, AÖAW.

Note 66: Johnson, *The Kaiser's Chemists* (1990).

Note 67: Meyer, "Das erste Jahrzehnt des Wiener Instituts für Radiumforschung" (1920), 6.

Note 68: Hans Pettersson's report to the International Education Board, Part III, April 1928, GUB (in English).

Note 69: Rayner-Canham, M. and G. (eds.), *A Devotion to Their Science* (1997), 12.

Note 70: Galison, *Image and Logic* (1997), 150.

Note 71: Forgan, "Eine angemessen Häuslichkeit? Frauen und die Architecture der Wissenschaft im 19. Jahrhundert" (2003), 145.

Note 72: Auer, *Das Physikalische Institut der Universität Heidelberg an der Albert-Überle-Strasse 7* (1983), 15. I owe thanks to Christoph Hoffmann for pointing out this article to me.

Note 73: Bischof, *Frauen am Wiener Institut für Radiumforschung* (2000), 23.

Note 74: Meyer, "Das erste Jahrzehnt des Wiener Instituts für Radiumforschung" (1920), 4. From the early days of the institute to 1938, Karl Kornher was the mechanic and until 1922, Stanislaus Kijowski served as maid. In 1924, Kijowski was promoted to laboratory assistant (*Laborant*) until his retirement in 1936, when his son, Julian Kijowski, took over the position. In 1930, Josefine Schörg was hired as an additional cleaning lady. *Almanac of the Austrian Academy of Sciences*, 1920–38, AÖAW.

Note 75: Vogt, "The Timofeeff-Ressovsky's—a Couple in Science" (2000), 4.

Note 76: Rona, *How it Came About* (1978), 15.

Note 77: Karlik to Pettersson, 1 August 1933, GUB.

Note 78: Karlik to Pettersson, 9 March, 1934, GUB. Added emphasis.

Note 79: Karlik, "Karl Przibram Nachruf"(1974); Przibram, *Irradiation Colors* (1956).

Note 80: Kara-Michailova, "Helligkeit und Zällbarkeit" (1927).

Note 81: Karlik to Pettersson, August 1, 1933, GUB.

Note 82: Meyer, "Das erste Jahrzehnt des Wiener Instituts für Radiumforschung" (1920), 4.

Note 83: Agnes Rodhe, interview by the author, September 22, 2001, Göteborg, Sweden.

Note 84: Hess, "Persönliche Erinnerungen aus dem ersten Jahrzehnt des Instituts für Radiumforschung" (1950), 45.

Note 85: Karlik to Pettersson, February 3, 1938, GUB.

Note 86: Bischof, *Physikerinnen* (1998), 13; Hittner, *Geschichte des Studienfaches Physik* (1949), 243.

Note 87: *Vorlesungen an der k. k. Universität zu Wien*, especially for the summer semester of 1935, AÖAW.

Note 88: At the end of 1938, Mattauch moved to Berlin as director of the Kaiser Wilhelm Chemistry Institute. Hittner, *Geschichte des Studienfaches Physik* (1949), 241–4. See also Vorlesungen an der k. k. Universität zu Wien, winter semester 1937/38, AÖAW.

Note 89: Karlik to Pettersson, July 26, 1933, GUB.