

Lise Meitner's escape from Germany

Ruth Lewin Sime

Sacramento City College, Sacramento, California 95822

(Received 29 September 1988; accepted for publication 12 April 1989)

Lise Meitner (1878–1968) achieved prominence as a nuclear physicist in Germany; although of Jewish origin, her Austrian citizenship exempted her from Nazi racial laws until the annexation of Austria in 1938 precipitated her dismissal. Forbidden to emigrate, she narrowly escaped to the Netherlands with the help of concerned friends in the international physics community.

In July 1938 Lise Meitner fled Germany, in secrecy and fear, never to return. She was fortunate, for while others in Germany and Austria were searching desperately for a way out and a place to go, she had friends, well-known physicists in many countries, who came to her rescue. This is the story of Lise Meitner's escape, pieced together from the documents¹ that survive: personal diaries, coded telegrams, smuggled messages, and above all the massive correspondence of two devoted friends, Dirk Coster and Adriaan Fokker, who made possible her illegal flight and brought her to the safety of Holland.

Germany had been Lise Meitner's professional home for more than 30 years. She had come to Berlin in 1907, the second woman to earn a physics doctorate in her native Vienna, painfully shy, yet determined to learn more physics. In Berlin, despite the exclusion of women from Prussian universities, she found acceptance and success. Max Planck became her mentor and friend; Otto Hahn, a young radiochemist her own age, her "colleague-brother"; a group of brilliant young physicists—James Franck, Gustav Hertz, Max von Laue, Otto Stern, Max Born, Bohr, Schrödinger, Einstein, and many others—her lifelong friends. With Hahn she studied beta radiation and spectra, identified several new radioactive species, moved into the Kaiser Wilhelm Institute (KWI) for Chemistry in Berlin-Dahlem, and in 1918 discovered the element protactinium. In the 1920s their scientific paths diverged, Hahn to the refinement of radiochemical techniques, Meitner to the forefront of experimental nuclear physics. Her studies of the beta-gamma decay sequence and the continuous primary beta spectrum were crucial to the development of nuclear theory, bringing recognition to herself and distinction to her institute.² It was her happiest time. Physics brought "light and fullness" to her life, surrounded her with people who were "great and lovable personalities."³

When Hitler came to power, Lise Meitner was shielded by the nongovernment status of the KWI and by her Austrian citizenship—unlike other "non-Aryans" she was not dismissed. She considered emigration, but it seemed wrong to take a job abroad from someone else, foolish to abandon Germany when—as many thought in 1933—the Nazis would soon be gone. More compelling, perhaps, were the scars of her early struggles—she was afraid of being an outsider again, unwelcome in a foreign land, of losing her institute, work, colleagues, and friends.

And so she stayed. Life in Germany grew meaner and more isolated, but physics sustained her. With the discoveries of the neutron and the positron in 1932, nuclear physics surged ahead: In 1933 Meitner used neutron-induced nuclear reactions to determine neutron mass, and was one of the first to observe noncosmic positrons and pair formation from gamma rays; in 1934, fascinated by artificial radioactivity and Fermi's neutron bombardment experi-

ments, she persuaded Hahn to join her for their first collaboration in many years: a study of the exciting new "transuranium elements" and the nuclear reactions that produced them. For 4 years Meitner led the increasingly complex and puzzling uranium investigation; it would culminate a few months after she fled Berlin in the discovery of nuclear fission, which she and O. R. Frisch would be the first to interpret.⁴

When Germany annexed Austria in March 1938, Lise Meitner lost the thin protection of her Austrian citizenship. The KWI for Chemistry, long a despised oasis of tolerance, immediately came under attack. Whispers reached Otto Hahn: "The Jewess endangers the institute." As institute director, Hahn was himself vulnerable for his anti-Nazi views; he panicked and rushed to see Heinrich Hörlein, head of the Emil Fischer Gesellschaft, a sponsor organization for the KWI.⁵ Hörlein's verdict: Meitner must go. "Hahn says I must not come to the institute any more," she wrote in her diary that day, stunned that her best friend and closest colleague would preemptively dismiss her to protect himself and his institute. Hahn was repentant, particularly when Hörlein changed his mind a few days later, and Carl Bosch, president of the Kaiser Wilhelm Gesellschaft (KWG), insisted she stay.⁶ By then, Meitner was unable to assess how seriously her position was threatened. If dismissed, she must leave, but emigration required preparation—contacts, letters, visas, setting her scientific and personal affairs in order—activities sure to jeopardize the position she still hoped to salvage. For weeks she was paralyzed with indecision, endlessly sifting the meager information available, seeking out visitors from abroad for reliable news, and working as before so as not to arouse suspicion among the many Party members in the institute.⁷

Friends outside understood that she was in trouble. Two days after the *Anschluss*, physicist Paul Scherrer wrote from Zurich, asking her to give a talk in April, to attend a congress that summer; Niels Bohr invited her to lecture in Copenhagen, any time, preferably soon, all expenses paid.⁸ At once urgent and open-ended, these "invitations" were, as Meitner knew, fabrications to get her out, offers of temporary havens. She was unwilling to leave without the assurance of a permanent position abroad.

At the end of April, however, Meitner learned that her case had come to the attention of the Ministry of Education—an ominous sign. Bosch wanted to ask the Ministry for clarification, but Meitner was losing hope. "Promises are not kept," she noted tersely in her diary, "possibilities are narrowing." On 9 May she reached a decision: She would leave for Copenhagen.¹⁰ There she could look for a new position and still be close to Niels and Margrethe Bohr, his institute, and her favorite nephew, physicist Otto Robert Frisch, who was working there.

But at the Danish consulate the next day, she was refused a travel visa: The *Anschluss*, she was told, had rendered her Austrian passport invalid.¹¹ Very worried, she turned to Carl Bosch. After a series of unsuccessful discreet inquiries,¹² he openly appealed to the Minister of the Interior on 20 May, asking that Meitner be issued the travel documents she needed.

“Honorable Herr Reichsminister! Frau Meitner is non-Aryan... With the return of Austria she has become a [German] citizen, and it may be assumed that the question of her dismissal will sooner or later become acute... Frau Meitner is prepared to leave at any time to assume a scientific position in another country... It is only a question of obtaining for Frau Meitner, who has an Austrian passport, notice that she may return to Germany, otherwise travel abroad for purposes of employment is impossible, or that Frau Meitner be issued a German passport... Heil Hitler! C. Bosch.”¹³

Weeks passed. Dirk Coster wrote from Holland, inviting Meitner to spend the summer with his family in Groningen. In a letter smuggled out of Germany, she replied, “At present I can not travel at all... It may never be possible.”¹⁴ Paul Scherrer wrote again from Zurich, this time more forcefully. “Now gather yourself together and come this week, by airplane it is only a short hop. You can give your lecture Wednesday or Friday, 5–7 pm.”¹⁵ But even the most insistent “invitations” were of no use; Meitner could not enter Switzerland or any other country without valid travel papers.

On 6 June Niels and Margrethe Bohr passed through Berlin. After dinner, Meitner and Bohr went to see Peter Debye. “D[eb]y[e] told B[oh]r there was time, there is no great hurry [for me to leave].”¹⁶ Debye’s assurances notwithstanding, Bohr was alarmed and returned to Copenhagen determined to find a position for Meitner in one of the Scandinavian countries. He also asked H. A. Kramers in Leiden to notify physicists in the Netherlands that she was in urgent need of help. Kramers immediately contacted Dirk Coster, who informed Adriaan Fokker on 11 June: “Lise Meitner will probably be thrown out of Berlin–Dahlem shortly.” Coster thought “it would be splendid if she could work in Holland for a time”; but since most university positions were not open to foreigners, he suggested, “Perhaps we can tap colleagues for regular contributions. I am prepared to commit myself for 5 years to an amount between f.50 and f.100 per year. If Lise Meitner could work in Groningen, there would also be a grant of about f.500 per year out of [University] funds... I would like her to come here, but would not make my personal commitment dependent upon that.” It was essential; Coster added, that they move quickly. “I have given my word that if I should get the impression that there is nothing for L.M. in Holland I shall let Bohr know in a week so that he can seek help in Denmark or Sweden. But I would regret it very much if we couldn’t get her to Holland.”¹⁷

Meitner first met Dirk Coster and his wife Miep in Sweden in 1921, when Coster was a rising young x-ray spectroscopist and Miep a student of Indonesian languages and culture. From the start Meitner had been attracted to their warmth, their concern for others, and their commitment—unusual among academics—to social equality. Coster went on to discover the element hafnium in 1922 (with George von Hevesy in Copenhagen) and later became professor at the University of Groningen in northern Holland. In 1923 he arranged Lise Meitner’s first lecture tour in the

Netherlands; she had returned often, becoming friends with many Dutch physicists.¹⁸

One of them was Adriaan Fokker of Haarlem. When he received Coster’s letter of 11 June, he set a goal of f.20 000 for 5 years’ support for Meitner and immediately began contacting colleagues for advice and donations.¹⁹ The response from individuals was encouraging—within days Fokker received pledges of f.3000—but the prospects for institutional help were not. “The Rockefeller Foundation has taken the stand... that it will not support refugee scientists... The budget committee of the International Federation of University Women [in London has] 30 applications... for support from Austria alone, and ... 100 pounds in their account.”²⁰ “One week is not enough time,” Fokker realized, “to definitely tell Bohr what we can do.”²¹ He began to wonder just how serious Meitner’s problems were. On 21 June he asked Bohr “whether it is certain that Lise Meitner will be dismissed, and whether she is living badly or in fear. I would write to Otto Hahn about this... but I don’t know whether his letters are opened; if it became known that he is trying to find work for her abroad she might be dismissed at once. I think if the Nazis let her keep her position, then we should not try to get her here.” Fokker had heard that biochemist Otto Warburg, a Jew, was allowed to work undisturbed in Germany; “to be sure that our attempts to get L.M. are really needed” he wanted to know whether or not the Nazis would “leave her be.”²²

Lise Meitner already knew the answer to that question. On 14 June she learned of new restrictions on emigration from Germany. Hurriedly she noted, “Go for information. Hear that technical and academic [people] will not be permitted to get out. [Max von] Laue hears the same from the legal faculty.” The next day, 15 June, “the same from Bosch.”²³

Since she had already applied to leave, Meitner hoped she, at least, might still get out, but on 16 June Bosch received a response from the Ministry of Interior:

“Political considerations are in effect that prevent the issuance of a passport for Frau Meitner to travel abroad. It is considered undesirable that well-known Jews leave Germany to travel abroad where they appear to be representatives of German science or with their names and their corresponding experience may even demonstrate their inner attitude against Germany. Surely the KWG can find a way for Frau Meitner to remain in Germany even after she resigns, and if circumstances permit she can work privately in the interests of the KWG. This statement represents in particular the view of the Reichsführer-SS and Chief of the German Police in the Reichsministry of the Interior.”²⁴

Here, distilled into a single letter, was everything Meitner feared. Her “resignation” was a foregone conclusion. She was trapped, imprisoned in Germany. And she had lost anonymity—her case had come to the attention of the Reichsführer of the SS, Heinrich Himmler. Bosch prepared a direct appeal to Himmler, but Meitner knew she must get out—illegally, and at once. She turned to Paul Rosbaud, an old friend and staunch anti-Nazi, whose position as physics consultant to the publisher Springer-Verlag and its journal *Naturwissenschaften* permitted him contacts of many sorts. A forged passport was a possibility.²⁵ Meanwhile, Rosbaud telephoned Paul Scherrer, who sent a telegram on 17 June:

ARE YOU COMING FOR A “PHYSICS WEEK”? 29 JUNE TO 1 JULY²⁶

But without a passport, she could never get into Switzerland. Holland and Sweden were considered more lenient.

At this point Peter Debye became Lise Meitner's critical contact to friends outside. Born in the Netherlands, Debye had spent most of his professional life in Germany and had recently been appointed director of the Kaiser Wilhelm Institute for Physics. As a foreigner and head of a major institute, he was unlikely to attract attention with his extensive international correspondence.

Even so, when Debye wrote to Bohr on 16 June he described Lise Meitner's situation with the utmost caution, never once mentioning her name. "When I last saw you [on 6 June]... I thought everything was all right, but in the meantime it has become clear to me that circumstances have substantially changed." Trusting Bohr to read between the lines, Debye went on, "I now believe it would be good if something could happen as soon as possible. Even a very modest offer would be considered and followed up if only it provided the possibility to work and to live. That is how the situation was represented to me, and it was emphasized that a poorer but earlier offer would be preferred over one that is better but later. I have taken the responsibility for writing all this myself, so that you can see that I too concur with the opinion of the concerned party." To be sure Bohr understood that Meitner's dismissal was no longer conjecture, but about to be forced, Debye stressed that "even the most dispassionate observer of the situation would not come to a different conclusion."²⁷

Bohr understood. On 21 June he sent a copy of Debye's letter to Fokker. He thought, "it may even be necessary for her safety to leave Germany at the earliest opportunity," and asked for a reply by return post "exactly how the matter stands in Holland and what proposal you and Coster are able to make at the moment." Bohr regretted that he himself had nothing to offer Meitner in Copenhagen, it being "quite impossible to obtain the necessary permission of the authorities on account of the great number of foreigners working already in this institute," but he believed "a person with her unique qualifications should hardly [have] difficulties to find some... solution for the long run, if only she can get out of her for [the] present most precarious situation."²⁸

Bohr's letter reached Fokker and Coster just as they had become quite discouraged. After 10 days of constant effort, they had netted only f.4000,²⁹ far short of their goal of f.20 000. Moreover, Fokker had just learned from an Amsterdam colleague, Professor D. Cohen, that getting Meitner into the Netherlands would "not be entirely easy."²² Like many countries, the Netherlands had erected major barriers to immigration: "Only those are admitted for whom it can be shown that their presence delivers important benefits to the Netherlands. The way to go about it is to direct a request to the Minister of Justice for the admission of Mevr[ouw] Meitner. The letter will go to [the Ministry of] Education for advice, and you should at the same time inform Education, preferably in person, and convince them that her presence in the Netherlands is of great importance. I fear that even then there will be difficulty, in that the regulations in fact apply to Germany and not to Austria. But if you and your friends push hard enough it seems to me you can show that this is a very special... I hope from my heart that you succeed."³⁰

To help Fokker with the difficult and unfamiliar task of petitioning the government, Coster traveled to Haarlem on Friday, 24 June.³¹ As required, their request to the Minis-

ter of Justice took the form of a highly stylized resolution. They appealed to national honor: "Whereas the measures of the German government have already forced the expulsion of many scientific scholars and others of the first rank, who have found positions in France, England, Belgium, Denmark, and America, and whereas the same misfortune now awaits Mevrouw Prof. Dr. Lise Meitner..." They appealed to the Dutch reputation for scientific excellence: "Whereas it would be of great value and also esteem to the development of physics in the Netherlands if a scientist of the quality of Mevrouw Meitner could work in this country..." They indicated that Lise Meitner would be welcome in Holland: "Whereas this proposal has the consent of the Royal Academy of Sciences in Amsterdam... Whereas she is prepared to work in laboratories in Haarlem as well as Groningen..." Perhaps most important, they explained that Meitner's presence would not create economic distress for a single Dutch scientist: "Whereas the money [for Meitner's support] has been donated thus far by private parties... she would not deprive any Dutch scientist of employment opportunities." After testifying to her mental and political stability—"Whereas Mevrouw Meitner has never been mentally ill, nor taken part in political actions or propaganda"—Coster and Fokker concluded, "These reasons commend themselves to your Excellency with the respectful request that Mevrouw Meitner be granted her request to be admitted to the Netherlands."³²

On 28 June the petition went to the Ministry of Justice; a less formal but more detailed appeal went to the Ministry of Education.³³ Education, they were told,³⁴ would view the matter most favorably if the request came from a university with a definite position for Lise Meitner. As foreigners were not permitted to work for pay,³⁵ the unsalaried position of *privaat-docente* (lecturer) was the only option. This required faculty consent, normally a lengthy process. It happened that a meeting of the Leiden faculty was scheduled for 28 June; physicist W. J. de Haas and chemist A. E. van Arkel saw to it that the position was quickly approved.³⁶ After assuring Education that Groningen, too, would be honored to have Lise Meitner, Coster requested that Meitner be admitted into the Netherlands as a *privaat-docente* who would maintain "close contact with physics and chemistry students... in Groningen and Leiden... directly supervising their research and giving lectures in the universities."³⁷

There was still the problem of money. University physicists were supportive, but had little to spare.³⁸ Coster obtained the addresses of four Jewish industrialists whom he asked for f.1000 each. Gilles Holst, director of research at N. V. Philips in Eindhoven, pledged personal support and thought the company might contribute—Coster suggested f.500 a year—if Meitner would lecture there each year.³⁵ Fokker appealed to A. F. Philips directly, referring to Lise Meitner as "one of the pioneers in radioactivity," whose work in "our land, with our students" would be a "strong inspiration," and reminding him that Meitner had in the past lectured all over Holland, "including your physics laboratory in Eindhoven."³⁹

It was to little avail. The number of refugees was rising sharply; resources were spread thin. "We understand the unhappy circumstances of so many unfortunate people," one industrialist wrote to Fokker, "but we have so many responsibilities to fulfill that it is no longer possible to take part in your fund."⁴⁰ Another regretted that "owing to the dire circumstances of relatives and friends in Germany and

now also in Austria, the demands on me are such that I am no longer free to offer philanthropic help to people outside my own circle."⁴¹ P. F. S. Otten, director of Philips, responded coolly: "internal budgetary considerations as well as considerations of a political sort"⁴² made it impossible for him to help.

Even colleagues who knew Meitner well and liked her very much found it hard to believe her situation was truly desperate. G. J. Sizoo of Amsterdam thought he was acting in her best interests by warning Coster: "Since Lise Meitner will lose her pension rights upon leaving Germany, the responsibility one assumes by offering her a position here is very great."⁴³ Another friend of Meitner's, H. R. Kruyt of Utrecht, declared himself "of course gladly willing" to use his influence with the government, but only "if the question really becomes acute"—and then cautioned Fokker and Coster to "think ahead carefully about what one is doing, especially since [the loss of pension rights] apparently can not be reversed."⁴⁴ Clearly, it was difficult for people to comprehend the injustice of life without work, to understand that Meitner could not remain in Germany a despised outcast, even if she did receive a pension from her forced "retirement." And almost no one, including Meitner herself, was able to truly "think ahead carefully" and foresee what lay ahead for the Jews of Europe.

After 3 weeks of intense effort, Coster and Fokker had collected only enough to support Lise Meitner for 1 year; at times even they thought she might be better off in Berlin. Late in June Coster decided to go to Berlin, see for himself how things were and, if necessary, bring Meitner back with him.³⁵ Before he left, Fokker offered some ambivalent advice. "Don't panic! Don't let your presence in Berlin... make L. M. leave too hastily. Let her calmly conclude her business and pack her suitcase; remember she cannot travel alone as well as with you. Forgive me for saying this, but don't fall victim to the masculine protective instinct... Think of Warburg, who says he is left undisturbed and makes no trouble. There is no axiom that says you must bring L.M. to me. Also you must let her calmly make the decision *herself*." Fokker's ambivalence reflected his fear: "It is always possible that the two of us will *not* get the money!"⁴⁵

On Monday, 27 June, Coster sent Debye a short coded message: He was coming to Berlin to look for an "assistant" (Meitner) whom he could offer a 1-year appointment. That day, Dr. Rasmussen, a member of the Swedish Academy of Sciences, arrived in Berlin⁴⁶ with a similar offer: a 1-year position in Stockholm with Manne Siegbahn, whose new institute, still under construction, would be devoted to nuclear research. This was Meitner's first offer, and she took it. She knew Sweden lagged behind in nuclear physics and believed she could be of use there. When Coster's message arrived 2 days later, she did not change her mind.

"Dr. Rasmussen was here already on Monday [27 June]," Debye wrote to Coster, "seeking an assistant to Siegbahn's new laboratory. I regret, actually, that I must write that in the end Stockholm won. I would have preferred that it be Groningen, but I let myself be persuaded by the assistant himself [Meitner], who thinks he will be able to accomplish more in Stockholm... Of course I still let him know this morning what was in your letter... I believed its contents would have a good effect on his spirits... What a pleasure it is for me to see what a couple of splendid Dutch fellows like you and Fokker can do!"⁴⁷

Satisfied that Lise Meitner was in good hands, Fokker immediately notified the various donors that their contributions would not be needed after all.²⁹ A day or two later, however, he received an unsettling letter from Bohr: The Swedish offer, it seemed, was not entirely firm. "All formalities regarding her invitation and her permission to [enter] Sweden are... not yet in order, and in case unforeseen difficulties should arise I shall of course let you know."⁴⁸

Difficulties arose at once. On 4 July Carl Bosch learned that the policy prohibiting scientists from leaving Germany would soon be strictly enforced. Meitner and Debye agreed: She must leave immediately.⁴⁹ Sweden was inaccessible, Holland the only possibility. Urgently, Debye wrote to Coster:

"The assistant we talked about, who had made what seemed like a firm decision, sought me out once again... He is now completely convinced (this has happened in the last few days) that he would rather go to Groningen, indeed that this is the only avenue open to him. He intends to keep his agreement with Rasmussen, but that is only in the future; under no circumstances can he start there right away. I believe he is right and therefore I want to ask whether you can still do anything for him. Perhaps I may now have the pleasure of showing you my laboratory. If you come to Berlin may I ask you to be sure to stay with us, and (providing of course that the circumstances are still favorable) if you were to come rather soon—as if you received an SOS—that would give my wife and me even greater pleasure."⁵⁰

Debye's SOS went out on Wednesday, 6 July. It did not reach Groningen until the afternoon of Saturday, 9 July. Coster understood immediately and sent a telegram: "I am coming to look over the assistant; if he suits me I will take him back with me."⁵¹ But Coster could not say when—he had not received permission for Meitner to enter the Netherlands. By the time Fokker telephoned the Hague that Saturday afternoon, government officials had left. He did reach the head of the border guard, who promised him an answer on Monday morning. Sunday they could do nothing but wait. On Monday they heard: Lise Meitner would be admitted.⁵² Coster immediately set off for Berlin.²⁹

In Dahlem, meanwhile, Monday morning came and went without a word from Coster. At noon Debye sent Fokker a frantic telegram: WITHOUT ANSWER FROM COSTER CLARIFICATION URGENTLY REQUESTED.⁵³ Fokker telegraphed back: DIRK WITH YOU THIS EVENING IN BEST CONDITION. "In best condition" was Fokker's attempt to reassure Meitner and Debye. "It was really rotten," he wrote to Kramers later, "that I could not even telegraph that we had official permission for her to enter."²⁹

In Berlin only a handful of people were informed of Meitner's plans. Coster arrived late Monday evening and stayed with Debye and his family. He planned to leave on Wednesday, 13 July, taking Meitner on a lightly traveled train route which crossed the border at the small station of Nieuweschans. One of Coster's Groningen neighbors, E. H. Ebels, was an influential politician from a large farming family near the border. On Monday morning, just before Coster left for Berlin, Ebels had driven him to Nieuweschans, where they both talked to immigration officers and showed them Lise Meitner's entrance permit from the Hague. Coster hoped that the Dutch border guards, who were on good terms with their German counterparts, would persuade them to let Lise Meitner pass through undisturbed.⁵⁴

On Tuesday, 12 July, Meitner arrived early in the institute. "Hahn tells me what Coster-Debye propose. Meet Coster in the morning with Hahn."⁵⁵ Coster kept a low profile in Dahlem that day.⁵⁶ Meitner was careful too. "So as not to arouse suspicion, I spent the last day of my life in Germany in the institute until 8 at night correcting a paper to be published by a young associate. Then I had exactly 1½ hours to pack two small suitcases with a few necessary things."⁵⁷

Hahn and Paul Rosbaud helped her pack. "Hahn very nervous," she noted. "At 10:30 Rosbaud comes, we drive to Hahn's."⁵⁵ At Rosbaud's suggestion Meitner called Paul Scherrer "so that if I couldn't get into Holland there might be the possibility of Switzerland. Scherrer understood immediately why I called and said he was waiting for my lecture."⁵¹

Meitner spent Tuesday night at Hahn's house. He remembered, "We agreed on a code-telegram in which we would be let known whether the journey ended in success or failure...The danger consisted of the SS's repeated passport control of trains crossing the frontier. People trying to leave Germany were always being arrested on the train and brought back"⁵⁸ ... We were shaking with fear, whether she would get through or not."⁵⁹

In 1907 Lise Meitner had come to Berlin with nothing but her desire to learn physics. Thirty-one years later, "I left Germany forever— with 10 marks in my purse."⁵⁷ And one thing more: Hahn gave her a diamond ring he had inherited from his mother. "I wanted her to be provided for in an emergency."⁵⁸

On Wednesday morning Rosbaud drove Meitner to the station. At the last minute, overwhelmed by fear, she begged him to turn around.⁶⁰ But Coster was waiting, and they greeted each other, as if by chance. The trip was uneventful. As they neared the border, Meitner became very nervous. To help her feel unobtrusive, Coster asked her to remove the diamond ring and slipped it into his waistcoat pocket. They crossed the border without incident.⁶¹ In her diary she wrote: "July 13. Said good-bye early to Hahn. Ring. Met Coster at the station. In Nieuweschans the customs officer was informed. 6 p.m. Groningen."⁶²

It was over. Lise was out. The prearranged telegram went to Hahn: The "baby" had arrived, all was well. Hahn sent "Heartiest congratulations," adding, "What will be the little daughter's name?"⁶³ Coster was deluged with congratulations, including a telegram from Wolfgang Pauli: "You have made yourself as famous for the abduction of Lise Meitner as for [the discovery of] hafnium!"⁶⁴

For the first time in months, Lise was free to think beyond the moment of escape. Relief turned to shock: She was, as Fokker sensed, "inwardly torn apart,"⁶⁵ uprooted from work, colleagues, income, and language, suspended between a past that was gone and a future that held nothing at all. How unbearable, Miep Coster thought, "to be forced at the age of 59 to leap into the void."⁶⁶ Meitner struggled for calm. "Things will develop,"⁶⁷ she told Scherrer, with a composure she did not feel. Immensely grateful to Coster and Fokker, she was unable to forget that people who lacked influential friends remained trapped in Germany. "I would consider myself fortunate," she told Coster, "if I did not know how bad things are for so many others. One dare not look back; one can not look forward."⁶⁸

In August, Lise Meitner made her way to Stockholm, where she prepared to begin her life anew.

ACKNOWLEDGMENT

I am indebted to Dr. L. K. ter Veld, Laboratorium voor Algemene Natuurkunde, Rijksuniversiteit Groningen, for his advice, insight, and letters of Dirk Coster; to Dr. Hans P. Coster, Bellaire, TX and Dr. Ada Klokke-Coster, Epse, Netherlands for sharing with me recollections of their parents and a number of their father's letters. I am grateful to the Museum Boerhaave, Leiden, for access to the papers of A. D. Fokker; to the Bibliothek und Archiv zur Geschichte der Max-Planck-Gesellschaft, Berlin-Dahlem; to Ulla Frisch and the late Professor Otto Frisch for permission to use the Meitner Collection, Churchill College, Cambridge; and to Eleanore Watrous, San Jose, CA for the translation of several letters from Dutch to English. Support by the National Science Foundation and the National Endowment for the Humanities is gratefully acknowledged.

¹ Nearly all primary sources cited here are from the Meitner Collection in Churchill College, Cambridge [CC]; the Bibliothek und Archiv zur Geschichte der Max-Planck-Gesellschaft, Berlin-Dahlem [MPG]; the A. D. Fokker papers, Museum Boerhaave, Leiden [MB]; or Dirk Coster's papers, University of Groningen [UG]. Unless otherwise indicated, the language of the Boerhaave and Groningen documents is Dutch, the remainder German. With the exceptions noted, all translations are by the author.

² References to Meitner's life and work include O. R. Frisch, "Lise Meitner 1878-1968," *Biogr. Mem. Fellows R. Soc.* **16**, 405-420 (1970); *Otto Hahn-Erlebnisse und Erkenntnisse*, edited by Dietrich Hahn (Econ, Düsseldorf, 1975), p. 43; Ruth L. Sime, "The discovery of protactinium," *J. Chem. Educ.* **63**, 653-657 (1986); Sallie A. Watkins, "Lise Meitner and the beta-ray controversy," *Am. J. Phys.* **51**, 551-553 (1983); Sallie A. Watkins, "Lise Meitner: The making of a physicist," *Phys. Teach.* **22**, 12-15 (1984); Fritz Krafft, "Lise Meitner, her life and times— On the centenary of the great scientist's birth," *Angew. Chem. (Int. Ed. in English)* **17**, 826-842 (1978).

³ Lise Meitner, "Looking back," *Bull. At. Sci.* **1964**, 2-7 (November 1964).

⁴ Lise Meitner, "Wege und Irrwege zur Kernenergie," *Naturwiss. Rundsch.* **16**, 167-169 (1963); Ruth L. Sime, "Lise Meitner and the discovery of fission," *J. Chem. Educ.* **66**, 373-376 (1989).

⁵ Lise Meitner Diary, 14 March 1938 [CC]; Otto Hahn Pocket Calendar, 17 March 1938 [MPG]; D. Hahn, p. 54 in Ref. 2.

⁶ Meitner Diary, 20-22 March 1938; Meitner Calendar, 21-23 March and 5 May 1938 [CC]; Hahn Calendar, 31 March 1938.

⁷ Meitner Diary and Calendar, March-April 1938.

⁸ Letters: Paul Scherrer to Lise Meitner, 14 March 1938; Niels Bohr to Meitner, 21 April 1938 [CC].

⁹ Meitner Diary, 22 April 1938.

¹⁰ Meitner Diary, 9 May 1938.

¹¹ Meitner Diary, 10 May 1938; Hahn Calendar, 10 May 1938.

¹² Meitner Diary, 11, 13, 16, 20 May 1938.

¹³ Fritz Krafft, *Im Schatten der Sensation: Leben und Wirken von Fritz Strassmann* (Verlag Chemie, Weinheim, 1981), p. 173.

¹⁴ Meitner to Coster, 6 June 1938, collection of Dr. Ada Klokke-Coster; the letter was probably taken out of Germany and mailed by Bohr.

¹⁵ Scherrer to Meitner, 2 June 1938 [CC].

¹⁶ Meitner Diary, 6 June 1938.

¹⁷ Dirk Coster to A. D. Fokker, 11 June 1938 [MB].

¹⁸ Meitner to Coster, sum 9 December 1949 [CC]; personal communication: Hans P. Coster, Bellaire, TX, 1 February 1986; Ada Klokke-Coster, Epse, Netherlands, 11 February 1986.

¹⁹ Fokker to Coster, 14 June 1938 [MB].

²⁰ Johanna v. Westerdijk to Fokker, 14 June 1938 [MB].

²¹ Fokker to Coster, 17 June 1938 [MB].

²² Fokker to Coster, 21 June 1938 [MB].

²³ Meitner Diary, 14 and 15 June 1938.

²⁴ Ernst Berninger, *Otto Hahn, Eine Bilddokumentation* (Heinz Moos, München, 1969), pp. 42-43.

- ²⁵ Ref. 13, p. 175.
- ²⁶ Scherrer to Meitner, 17 June 1938 [CC].
- ²⁷ Peter Debye to Bohr (in German) [MB].
- ²⁸ Bohr to Fokker (in English) 21 June 1938 [MB].
- ²⁹ Fokker to H. A. Kramers, 13 July 1938 [MB].
- ³⁰ D. Cohen to Fokker, 20 June 1938 [MB].
- ³¹ Fokker to Coster, 21 June 1938 [MB].
- ³² Fokker/Coster to Minister van Justitie, 28 June 1938 [MB].
- ³³ Fokker to Minister van Onderwijs, Kunsten, en Wetenschappen, 28 June 1938 [MB].
- ³⁴ W. J. de Haas to Fokker, 24 June 1938 [MB], translation by E. Watrous.
- ³⁵ Coster to Fokker, 27 June 1938 [MB].
- ³⁶ Fokker to Coster, 29 June 1938; A. E. van Arkel to Fokker, 1 July 1938 [MB].
- ³⁷ Coster to A. J. L. v. Baeck Calkoen, 29 June 1938 [UG].
- ³⁸ Paul Jaffe to Fokker, 24 June 1938; A. E. van Arkel to Fokker, 1 July 1938 [MB].
- ³⁹ Fokker to A. F. Philipps, 22 June 1938 [MB].
- ⁴⁰ W. van Beuningen to Fokker, 28 June 1938 [MB].
- ⁴¹ Robert May to Fokker, 24 June 1938 [MB].
- ⁴² P. F. S. Otten to Fokker, 28 June 1938; Fokker to P. F. S. Otten, 1 July 1938 [MB].
- ⁴³ Coster to G. J. Sizoo, 20 June 1938; Sizoo to Coster, 22 June 1938 [UG].
- ⁴⁴ H. R. Kruyt to Fokker, 24 June 1938 [MB].
- ⁴⁵ Fokker to Coster, 27 June 1938 [MB].
- ⁴⁶ Meitner Diary, 27 June 1938.
- ⁴⁷ Debye to Coster, 29 June 1938 [MB].
- ⁴⁸ Bohr to Fokker, 30 June 1938 (in English) [MB].
- ⁴⁹ Meitner Diary, 4 July 1938.
- ⁵⁰ Debye to Coster, 6 July 1938 [MB], assistance with translation from E. Watrous.
- ⁵¹ Meitner to Hahn, 13 May 1966 [CC].
- ⁵² The Ministry of Justice granted provisional admission in writing the next day: A. B. Calkoen to Fokker, 12 July 1938 [MB].
- ⁵³ Telegram, Debye to Fokker (in German) 11 July 1938 [MB].
- ⁵⁴ Personal communications: Dr. L. K. ter Veld, Groningen, 6 November 1985; H. Coster, A. Klokke-Coster, Ref. 18.
- ⁵⁵ Meitner Diary, 12 July 1938.
- ⁵⁶ Fokker to Bohr, 16 July 1938 [MB].
- ⁵⁷ Meitner to Gerda von Übisch, 1 July 1947 [CC].
- ⁵⁸ Otto Hahn, *My Life*, translated by E. Kaiser and E. Wilkins (Herder and Herder, New York, 1968), p. 149.
- ⁵⁹ D. Hahn, p. 55, in Ref. 2.
- ⁶⁰ Arnold Kramish, *The Griffin: The Greatest Untold Story of World War II* (Houghton-Mifflin, New York, 1986), p. 49.
- ⁶¹ Miep Coster thought the German border guards may have let Meitner through because they assumed "Frau Professor" was only a professor's wife; A. Klokke-Coster, Ref. 18.
- ⁶² Meitner Diary, 13 July 1938.
- ⁶³ Hahn to Coster family, 15 July 1938 [CC].
- ⁶⁴ A. Klokke-Coster, Ref. 18.
- ⁶⁵ Fokker to Miep Coster, 16 July 1938 [MB], assistance in translation from E. Watrous.
- ⁶⁶ Miep Coster to Fokker, 14 or 15 July 1938 [MB].
- ⁶⁷ Meitner to Scherrer, 20 July 1938 [CC].
- ⁶⁸ Meitner to Coster, 9 August 1938, collection of A. Klokke-Coster.

Random multiplicative processes: An elementary tutorial

S. Redner

Center for Polymer Studies and Department of Physics, Boston University, Boston, Massachusetts 02215

(Received 16 November 1988; accepted for publication 25 April 1989)

An elementary discussion of the statistical properties of the *product* of N independent random variables is given. The motivation is to emphasize the essential differences between the asymptotic $N \rightarrow \infty$ behavior of a random product and the asymptotic behavior of a *sum* of random variables—a random additive process. For this latter process, it is widely appreciated that the asymptotic behavior of the sum and its distribution is provided by the central limit theorem. However, no such universal principle exists for a random multiplicative process. In this case, the ratio between the average value of the product $\langle P \rangle$ and the most probable value P_{mp} diverges exponentially in N as $N \rightarrow \infty$. Within a continuum approximation, the classical log-normal form is often invoked to describe the distribution of the product. It is shown, however, that the log-normal provides a poor approximation for the asymptotic behavior of the average value and, also, for the higher moments of the product. A procedure for computing the correct leading asymptotic behavior of the moments is outlined. The implications of these results for simulations of random multiplicative processes are also discussed. For such a simulation, the numerically observed "average" value of the product is of the order of P_{mp} , and it is only when the simulation is large enough to sample a finite fraction of all the states in the system that a monotonic crossover to the true average value $\langle P \rangle$ occurs. An idealized, but quantitative account for this crossover is provided.

I. INTRODUCTION

An important component of an elementary statistical mechanics course is a discussion of the theory of random walks.¹ Usually, an initial treatment is based on a one-dimensional lattice random walk, which is a sequence of equal-length displacements whose direction is chosen randomly at each step. One of the basic goals in the study of

random walks is to find the average displacement of the probability distribution after a large number of steps N . This example is a realization of a *random additive process*, as the displacement r is the *sum* of random steps. For the one-dimensional random walk, the probability distribution for the displacement is the binomial function. In the limit as $N \rightarrow \infty$, the central limit theorem²⁻⁴ guarantees that this distribution approaches a Gaussian function, with the $2k$ th