Marie and Pierre Curie and the Discovery of Polonium and Radium

by Nanny Fröman

Introduction

Marie and Pierre Curie's pioneering research was again brought to mind when on April 20 1995, their bodies were taken from their place of burial at Sceaux, just outside Paris, and in a solemn ceremony were laid to rest under the mighty dome of the Panthéon. Marie Curie thus became the first woman to be accorded this mark of honour on her own merit. One woman, Sophie Berthelot, admittedly already rested there but in the capacity of wife of the chemist Marcelin Berthelot (1827-1907).

It was François Mitterrand who, before ending his fourteen-year-long presidency, took this initiative, as he said “in order to finally respect the equality of women and men before the law and in reality” (“pour respecter enfin…l’égalité des femmes et des hommes dans le droit comme dans les faits”). In point of fact – as the press pointed out – this initiative was symbolic three times over. Marie Curie was a woman, she was an immigrant and she had to a high degree helped increase the prestige of France in the scientific world.

At the end of the 19th century, a number of discoveries were made in physics which paved the way for the breakthrough of modern physics and led to the revolutionary technical development that is continually changing our daily lives.

Around 1886, Heinrich Hertz demonstrated experimentally the existence of radio waves. It is said that Hertz only smiled incredulously when anyone predicted that his waves would one day be sent round the earth. Hertz died in 1894 at the early age of 37. In September 1895, Guglielmo Marconi sent the first radio signal over a distance of 1.5 km. In 1901 he spanned the Atlantic. Hertz did not live long enough to experience the far-reaching positive effects of his great discovery, nor of course did he have to see it abused in bad television programs. It is hard to predict the consequences of new discoveries in physics.

On November 8, 1895, Wilhelm Conrad Röntgen at the University of Würzburg, discovered a new kind of radiation which he called X-rays. It could in time be identified as the short-wave, high frequency counterpart of Hertz’s waves. The ability of the radiation to pass through opaque material that was impenetrable to ordinary light, naturally created a great sensation. Röntgen himself wrote to a friend that initially, he told no one except his wife about what he was doing. People would say, “Röntgen is out of his mind”. On January 1, 1896, he mailed his first announcement of the discovery to his colleagues. “….und nun ging der Teufel los” (“and now the Devil was let loose”) he wrote. His discovery very soon made an impact on practical medicine. In physics it led to a chain of new and sensational findings. When Henri Becquerel was exposing salts of uranium to sunlight to study whether the new radiation could have a connection with luminescence, he found out by chance – thanks to a few days of cloudy weather – that another new type of radiation was being spontaneously emanated without the salts of uranium having to be illuminated – a radiation that could pass through metal foil and darken a photographic plate. The two researchers who were to play a major role in the continued study of this new radiation were Marie and Pierre Curie.

Marie
Marie Curie

Marie Sklodowska, as she was called before marriage, was born in Warsaw in 1867. Both her parents were teachers who believed deeply in the importance of education. Marie had her first lessons in physics and chemistry from her father. She had a brilliant aptitude for study and a great thirst for knowledge; however, advanced study was not possible for women in Poland. Marie dreamed of being able to study at the Sorbonne in Paris, but this was beyond the means of her family. To solve the problem, Marie and her elder sister, Bronya, came to an arrangement: Marie should go to work as a governess and help her sister with the money she managed to save so that Bronya could study medicine at the Sorbonne. When Bronya had taken her degree she, in her turn, would contribute to the cost of Marie’s studies.

So it was not until she was 24 that Marie came to Paris to study mathematics and physics. Bronya was now married to a doctor of Polish origin, and it was at Bronya’s urgent invitation to come and live with them that Marie took the step of leaving for Paris. By then she had been away from her studies for six years, nor had she had any training in understanding rapidly spoken French. But her keen interest in studying and her joy at being at the Sorbonne with all its opportunities helped her surmount all difficulties. To save herself a two-hours journey, she rented a little attic in the Quartier Latin. There the cold was so intense that at night she had to pile on everything she had in the way of clothing so as to be able to sleep. But as compensation for all her privations she had total freedom to be able to devote herself wholly to her studies. “It was like a new world opened to me, the world of science, which I was at last permitted to know in all liberty,” she writes. And it was France’s leading mathematicians and physicists whom she was able to go to hear, people with names we now encounter in the history of science: Marcel Brillouin, Paul Painlevé, Gabriel Lippmann, and Paul Appell. After two years, when she took her degree in physics in 1893, she headed the list of candidates and, in the following year, she came second in a degree in mathematics. After three years she had brilliantly passed examinations in physics and mathematics. Her goal was to take a teacher’s diploma and then to return to Poland.

Pierre
Now, however, there occurred an event that was to be of decisive importance in her life. She met Pierre Curie. He was 35 years, eight years older, and an internationally known physicist, but an outsider in the French scientific community – a serious idealist and dreamer whose greatest wish was to be able to devote his life to scientific work. He was completely indifferent to outward distinctions and a career. He earned a living as the head of a laboratory at the School of Industrial Physics and Chemistry where engineers were trained and he lived for his research into crystals and into the magnetic properties of bodies at different temperatures. He had not attended one of the French elite schools but had been taught by his father, who was a physician, and by a private teacher. He passed his baccalaureat at the early age of 16 and at 21, with his brother Jacques, he had discovered piezoelectricity, which means that a difference in electrical potential is seen when mechanical stresses are applied on certain crystals, including quartz. Such crystals are now used in microphones, electronic apparatus and clocks.

Marie, too, was an idealist; though outwardly shy and retiring, she was in reality energetic and single-minded. Pierre and Marie immediately discovered an intellectual affinity, which was very soon transformed into deeper feelings. In July 1895, they were married at the town hall at Sceaux, where Pierre’s parents lived. They were given money as a wedding present which they used to buy a bicycle for each of them, and long, sometimes adventurous, cycle rides became their way of relaxing. Their life was otherwise quietly monotonous, a life filled with work and study.

Persuaded by his father and by Marie, Pierre submitted his doctoral thesis in 1895. It concerned various types of magnetism, and contained a presentation of the connection between temperature and magnetism that is now known as Curie’s Law. In 1896, Marie passed her teacher’s diploma, coming first in her group. Their daughter Irène was born in September 1897. Pierre had managed to arrange that Marie should be allowed to work in the school’s laboratory, and in 1897, she concluded a number of investigations into the magnetic properties of steel on behalf of an industrial association. Deciding after a time to go on doing research, Marie looked around for a subject for a doctoral thesis.

Becquerel’s discovery had not aroused very much attention. When, just a day or so after his discovery, he informed the Monday meeting of l’Académie des Sciences, his colleagues listened politely, then went on to the next item on the agenda. It was Röntgen’s discovery and the possibilities it provided that were the focus of the interest and enthusiasm of researchers. Becquerel himself made certain important observations, for instance that gases through which the rays passed become able to conduct electricity, but he was soon to leave this field. Marie decided to make a systematic investigation of the mysterious “uranium rays”. She had an excellent aid at her disposal – an electrometer for the measurement of weak electrical currents, which was constructed by Pierre and his brother, and was based on the piezoelectric effect.

**Surprising Results**

Results were not long in coming. Just after a few days, Marie discovered that thorium gives off the same rays as uranium. Her continued systematic studies of the various chemical compounds gave the surprising result that the strength of the radiation did not depend on the compound that was being studied. It depended only on the amount of uranium or thorium. Chemical compounds of the same element generally have very different chemical and physical properties: one uranium compound is a dark powder, another is a transparent yellow crystal, but what was decisive for the radiation they gave off was only the amount of uranium they contained. Marie drew the conclusion that the ability to radiate did not depend on the arrangement of the atoms in a molecule, it must be linked to the interior of the atom itself. This discovery was absolutely revolutionary. *From a conceptual point of view it is her most important contribution to the development of physics.* She now went through the whole periodic system. Her findings were that only uranium and thorium gave off this radiation.
Marie’s next idea, seemingly simple but brilliant, was to study the natural ores that contain uranium and thorium. She obtained samples from geological museums and found that of these ores, pitchblende was four to five times more active than was motivated by the amount of uranium. It was her hypothesis that a new element that was considerably more active than uranium was present in small amounts in the ore.

Marie and Pierre – A Fruitful Collaboration

Fascinating new vistas were opening up. Pierre gave up his research into crystals and symmetry in nature which he was deeply involved in and joined Marie in her project. They found that the strong activity came with the fractions containing bismuth or barium. When Marie continued her analysis of the bismuth fractions, she found that every time she managed to take away an amount of bismuth, a residue with greater activity was left. At the end of June 1898, they had a substance that was about 300 times more strongly active than uranium. In the work they published in July 1898, they write, “We thus believe that the substance that we have extracted from pitchblende contains a metal never known before, akin to bismuth in its analytic properties. If the existence of this new metal is confirmed, we suggest that it should be called polonium after the name of the country of origin of one of us.” It was also in this work that they used the term radioactivity for the first time. After another few months of work, the Curies informed the Académie des Sciences, on December 26, 1898, that they had demonstrated strong grounds for having come upon an additional very active substance that behaved chemically almost like pure barium. They suggested the name of radium for the new element.

Arduous Work

In order to be certain of showing that it was a matter of new elements, the Curies would have to produce them in demonstrable amounts, determine their atomic weight and preferably isolate them. To do so, the Curies would need tons of the costly pitchblende. However, it was known that at the Joachimsthal mine in Bohemia large slag-heaps had been left in the surrounding forests. Marie considered that radium ought to be left in the residue. A sample was sent to them from Bohemia and the slag was found to be even more active than the original mineral. Several tons of pitchblende was later put at their disposal through the good offices of the Austrian Academy of Sciences.

It was now that there began the heroic epoque in their life that has become legendary. At this stage they needed more room, and the principal of the school where Pierre worked once again came to their aid. They could use a large shed which was not occupied. There the very laborious work of separation and analysis began. Marie carried out the chemical separations, Pierre undertook the measurements after each successive step. Physically it was heavy work for Marie. She processed 20 kilos of raw material at a time. First of all she had to clear away pine needles and any perceptible debris, then she had to undertake the work of separation. “Sometimes I had to spend a whole day stirring a boiling mass with a heavy iron rod nearly as big as myself. I would be broken with fatigue at day’s end,” she writes.

In a preface to Pierre Curie’s collected works, Marie describes the shed as having a bituminous floor, and a glass roof which provided incomplete protection against the rain, and where it was like a hothouse in the summer, draughty and cold in the winter; yet it was in that shed that they spent the best and happiest years of their lives. There they could devote themselves to work the livelong day. Sometimes they could not do their processing outdoors, so the noxious gases had to be let out through the open windows. The only furniture were old, worn pine tables where Marie worked with her costly radium fractions. Since they did not have any shelter in which to store their precious products the latter were arranged on tables and boards. Marie could remember the joy they felt when they came into the shed at night, seeing “from all sides the feebly luminous silhouettes” of the products of their work. The dangerous gases of which Marie speaks contained, among other things, radon – the radioactive gas which is a matter of concern to us today since small amounts are emitted from certain kinds of building materials. Wilhelm Ostwald, the highly respected German chemist, who was one of the first to realize the importance of the Curies’ research, traveled from Berlin to Paris to see how they worked. Neither Pierre nor Marie was at home. He wrote: “At my earnest request, I was shown the laboratory where radium had been discovered shortly before…. It was a cross between a stable and a potato shed, and if I had not seen the worktable and items of chemical apparatus, I would have thought that I was been played a practical joke.”

Marie Presents Her Doctoral Thesis

At the same time as the Curies were engaged in their arduous work, each of them had their teaching duties. From 1900 Marie had had a part-time teaching post at the École Normale Supérieure de Sèvres for girls. After thousands of
crystallizations, Marie finally – from several tons of the original material – isolated one decigram of almost pure radium chloride and had determined radium’s atomic weight as 225. She presented the findings of this work in her doctoral thesis on June 25, 1903. Of the three members of the examination committee, two were to receive the Nobel Prize a few years later: Lippmann, her former teacher, in 1908 for physics, and Moissan, in 1906 for chemistry. The committee expressed the opinion that the findings represented the greatest scientific contribution ever made in a doctoral thesis.

A little celebration in Marie’s honour, was arranged in the evening by a research colleague, Paul Langevin. The guests included Jean Perrin, a prominent professor at the Sorbonne, and Ernest Rutherford, who was then working in Canada but temporarily in Paris and anxious to meet Marie Curie. He had good reason. His study of the deflection of radiation in magnetic fields had not met with success until he had been sent a strongly radioactive preparation by the Curies. By that time he was already famous and was soon to be considered as the greatest experimental physicist of the day. It was a warmish evening and the group went out into the garden. Pierre had prepared an effective finale to the day. When they had all sat down, he drew from his waistcoat pocket a little tube, partly coated with zinc sulfide, which contained a quantity of radium salt in solution. Suddenly the tube became luminous, lighting up the darkness, and the group stared at the display in wonder, quietly and solemnly. But in the light from the tube, Rutherford saw that Pierre’s fingers were scarred and inflamed and that he was finding it hard to hold the tube.

Serious Health Problems

A week earlier Marie and Pierre had been invited to the Royal Institution in London where Pierre gave a lecture. Before the crowded auditorium he showed how radium rapidly affected photographic plates wrapped in paper, how the substance gave off heat; in the semi-darkness he demonstrated the spectacular light effect. He described the medical tests he had tried out on himself. He had wrapped a sample of radium salts in a thin rubber covering and bound it to his arm for ten hours, then had studied the wound, which resembled a burn, day by day. After 52 days a permanent grey scar remained. In that connection Pierre mentioned the possibility of radium being able to be used in the treatment of cancer. But Pierre’s scarred hands shook so that once he happened to spill a little of the costly preparation. Fifty years afterwards the presence of radioactivity was discovered on the premises and certain surfaces had to be cleaned.

In actual fact Pierre was ill. His legs shook so that at times he found it hard to stand upright. He was in much pain. He consulted a doctor who diagnosed neurasthenia and prescribed strychnine. And the skin on Marie’s fingers was cracked and scarred. Both of them constantly suffered from fatigue. They evidently had no idea that radiation could have a detrimental effect on their general state of health. Pierre, who liked to say that radium had a million times stronger radioactivity than uranium, often carried a sample in his waistcoat pocket to show his friends. Marie liked to have a little radium salt by her bed that shone in the darkness. The papers they left behind them give off pronounced radioactivity. If today at the Bibliothèque Nationale you want to consult the three black notebooks in which their work from December 1897 and the three following years is recorded, you have to sign a certificate that you do so at your own risk. People will have to do this for a long time to come. In fact it takes 1,620 years before the activity of radium is reduced to a half.

Rutherford was just as unsuspecting in regard to the hazards as were the Curies. When it turned out that one of his colleagues who had worked with radioactive substances for several months was able to discharge an electroscope by exhaling, Rutherford expressed his delight. This confirmed his theory of the existence of airborne emanations.

In view of the potential for the use of radium in medicine, factories began to be built in the USA for its large-scale production. The question came up of whether or not Marie and Pierre should apply for a patent for the production process. They were both against doing so. Pure research should be carried out for its own sake and must not become mixed up with industry’s profit motive. Researchers should be disinterested and make their findings available to everyone. Marie and Pierre were generous in supplying their fellow researchers, Rutherford included, with the preparations they had so laboriously produced. They furnished industry with descriptions of the production process.

Nobel Prize

In 1903, Marie and Pierre Curie were awarded half the Nobel Prize in Physics. The citation was, “in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel.” Henri Becquerel was awarded the other half for his discovery of spontaneous
radioactivity. In a letter to the Swedish Academy of Sciences, Pierre explains that neither of them is able to come to Stockholm to receive the prize. They could not get away because of their teaching obligations. He adds, “Mme Curie has been ill this summer and is not yet completely recovered.” That was certainly true but his own health was no better. Not until June 1905 did they go to Stockholm, where Pierre gave a Nobel lecture.

At the prize award ceremony, the president of the Swedish Academy referred in his speech to the old proverb: “union gives strength.” He went on to quote from the Book of Genesis, “It is not good that the man should be alone; I will make him an help meet for him.”

Although the Nobel Prize alleviated their financial worries, the Curies now suddenly found themselves the focus of the interest of the public and the press. Their seemingly romantic story, their labours in intolerable conditions, the remarkable new element which could disintegrate and give off heat from what was apparently an inexhaustible source, all these things made the reports into fairy-tales. At the center was Marie, a frail woman who with a gigantic wand had ground down tons of pitchblende in order to extract a tiny amount of a magical element. Even Le Figaro, otherwise a sensible newspaper, began with “Once upon a time...” They were pursued by journalists from the whole world – a situation they could not deal with. Marie wrote, “The shattering of our voluntary isolation was a cause of real suffering for us and had all the effects of disaster.” Pierre wrote in July 1905, “A whole year has passed since I was able to do any work.... evidently I have not found the way of defending us against frittering away our time, and yet it is very necessary. It is a question of life or death from the intellectual point of view.”

But as Elisabeth Crawford emphasizes in her book The Beginnings of the Nobel Institution, from the latter’s viewpoint, the awarding of the 1903 Prize for Physics was masterly. Formerly, only the Prize for Literature and the Peace Prize had obtained wide press coverage; the Prizes for scientific subjects had been considered all too esoteric to be able to interest the general public. The commotion centered on the award of the Prize to the Curies, especially Marie Curie, aroused once and for all the curiosity of the press and the public. The work of researchers was exciting, their findings fascinating.

The health of both Marie and Pierre Curie gave rise to concern. Their friends tried to make them work less. All their symptoms were ascribed to the drafty shed and to overexertion. Their dearest wish was to have a new laboratory but no such laboratory was in prospect. When Paul Appell, the dean of the faculty of sciences, appealed to Pierre to let his name be put forward as a recipient for the prestigious Legion of Honor on July 14,1903, Pierre replied, “....I do not feel the slightest need of being decorated, but I am in the greatest need of a laboratory.” Although Pierre was given a chair at the Sorbonne in 1904 with the promise of a laboratory, as late as 1906 it had still not begun to be built. Pierre was given access to some rooms in a building used for study by young medical students. Pierre Curie never obtained a real laboratory.

Dreadful Catastrophe

On April 19, 1906, Pierre Curie was run over by a horse-drawn wagon near the Pont Neuf in Paris and killed. Now Marie was left alone with two daughters, Irène aged 9 and Ève aged 2. Shock broke her down totally to begin with. But even now she could draw on the toughness and perseverance that were fundamental aspects of her character. When she was offered a pension, she refused it: I am 38 and able to support myself, was her answer. She was appointed to succeed Pierre as the head of the laboratory, being undoubtedly most suitable, and to be responsible for his teaching duties. She thus became the first woman ever appointed to teach at the Sorbonne. After some months, in November 1906, she gave her first lecture. The large amphitheater was packed. As well as students, her audience included people from far and near, journalists and photographers were in attendance. Many people had expected something unusual to occur. Perhaps some manifestation of the historic occasion. When Marie entered, thin, pale and tense, she was met by an ovation. However the expectations of something other than a clear and factual lecture on physics were not fulfilled. But Marie's personality, her aura of simplicity and competence made a great impression.

Irène was now 9 years old. Marie had definite ideas about the upbringing and education of children that she now wanted to put into practice. Her circle of friends consisted of a small group of professors with children of school age. Marie organized a private school with the parents themselves acting as teachers. A group of some ten children were accordingly taught only by prominent professors: Jean Perrin, Paul Langevin, Édouard Chavannes, a professor of Chinese, Henri Mouton from the Pasteur Institute, a sculptor was engaged for modeling and drawing. Marie took the view that scientific subjects should be taught at an early age but not according to a too rigid curriculum. It was important for children to be able to develop freely. Games and physical activities took up much of the time. Quite a
lot of time was taken for travel, too, for the children had to travel to the homes of their teachers, to Marie at Sceaux or to Langevin's lessons in one of the Paris suburbs. The little group became a kind of school for the elite with a great emphasis on science. The children involved say that they have happy memories of that time. For Irène it was in those years that the foundation of her development into a researcher was laid. The educational experiment lasted two years. Subsequently the pupils had to prepare for their forthcoming **baccalauréat** exam and to follow the traditional educational programs.

### A Second Nobel Prize

In 1908 Marie, as the first woman ever, was appointed to become a professor at the Sorbonne. She went on to produce several decigrams of very pure radium chloride before finally, in collaboration with André Debierne, she was able to isolate radium in metallic form. André Debierne, who began as a laboratory assistant, became her faithful collaborator until her death and then succeeded her as head of the laboratory. In 1911 she was awarded the **Nobel Prize in Chemistry**. The citation by the Nobel Committee was, “in recognition of her services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element.”

Now that the archives have been made available to the public, it is possible to study in detail the events surrounding the awarding of the two Prizes, in 1903 and 1911. In a letter in 1903, several members of the *l'Académie des Sciences*, including Henri Poincaré and Gaston Darboux, had nominated Becquerel and Pierre Curie for the Prize in Physics. Marie’s name was not mentioned. This caused Gösta Mittag-Leffler, a professor of mathematics at Stockholm University College, to write to Pierre Curie. That letter has never survived but Pierre Curie’s answer, dated August 6, 1903, has been preserved. He wrote, “If it is true that one is seriously thinking about me (for the Prize), I very much wish to be considered together with Madame Curie with respect to our research on radioactive bodies.” Drawing attention to the role she played in the discovery of radium and polonium, he added, “Do you not think that it would be more satisfying from the artistic point of view, if we were to be associated in this manner?” (plus joli d’un point de vue artistique).

Some biographers have questioned whether Marie deserved the Prize for Chemistry in 1911. They have claimed that the discoveries of radium and polonium were part of the reason for the Prize in 1903, even though this was not stated explicitly. Marie was said to have been awarded the Prize again for the same discovery, the award possibly being an expression of sympathy for reasons that will be mentioned below. Actually, however, the citation for the Prize in 1903 was worded deliberately with a view to a future Prize in Chemistry. Chemists considered that the discovery and isolation of radium was the greatest event in chemistry since the discovery of oxygen. That for the first time in history it could be shown that an element could be transmuted into another element, revolutionized chemistry and signified a new epoch.

### A Terrible Year

**Rejected by the Academy**

Despite the second Nobel Prize and an invitation to the first Solvay Conference with the world's leading physicists, including Einstein, Poincaré and Planck, 1911 became a dark year in Marie’s life. In two smear campaigns she was to experience the inconstancy of the French press. The first was started on 16 November 1910, when, by an article in *Le Figaro*, it became known that she was willing to be nominated for election to *l'Académie des Sciences*. Examples of factors other than merit deciding an election did exist, but Marie herself and her eminent research colleagues seemed to have considered that with her exceptionally brilliant scientific merits, her election was self-evident. Notwithstanding, it turned out that it was not merit that was decisive. The dark underlying currents of anti-Semitism, prejudice against women, xenophobia and even anti-science attitudes that existed in French society came welling up to the surface. Normally the election was of no interest to the press. The most rabid paper was the ultra-nationalistic and anti-Semitic *L'Action Française*, which was led by Léon Daudet, the son of the writer Alphonse Daudet. Dreyfus had got redress for his wrongs in 1906 and had been decorated with the Legion of Honour, but in the eyes of the groups who had been against him during his trial, he was still guilty, was still “the Jewish traitor.” The pro-Dreyfus groups who had supported his cause were suspect and the scientists who were supporting Marie were among them. Jokes in bad taste alternated with outrageous accusations. It was said that in her career, Pierre’s research had given her a free ride. She came from Poland, though admittedly she was formally a Catholic but her name Sklodowska indicated that she might be of Jewish origin, and so on. A week before the election, an opposing
a thorough scratch on his opponent for the duel to be considered decided. But fatal accidents did in fact occur.

in this dispute had already fought duels. Swords were generally used and a duellist was usually content with inflicting

France at that time, although scarcely in academic circles. Newspaper publishers who had come up against each other

editor of the newspaper that printed the letters, to a duel. Fighting a duel was a usual way of obtaining satisfaction in

Marie did not take place. Langevin who had been repeatedly insulted, then felt forced to challenge Gustave Téry, the

Appell, who was in the process of putting on his shoes, threw one of them to hit the door – but the interview with

in to that idiotic nationalist movement and insist that Marie should leave France, you will never see me any more."

her candidature to the

request her to leave France: her situation in Paris was impossible. “I have done everything for her, I have supported

the matter. He revealed that with several other influential people he was planning an interview with Marie in order to

father, Paul Appell, then dean of the faculty at the Sorbonne. He was furious that the Borels have gotten mixed up in

would cast a shadow on the

le ministre de l’Instruction publique) who informed him that he had no right to let Marie Curie stay in his home. It

owned by the

and Ève were installed in two rooms in the Borels’ home. Henriette Perrin looks after Irène. But the Borels’ home was

throughout their journey. Marguerite wanted to take her hand, but did not venture to do so. On their return, Marie

outside Marie’s home. Someone shouted, “Go home to Poland.” A stone hit the house. Having managed to persuade

over. Marguerite and André Debierne went out to Sceaux where they found a hostile and angry crowd gathered

extremely indignant and acted quickly. Marie had to be fetched from Sceaux and live with them until the storm was

The drama culminated on the morning of 23 November when extracts from the letters were published in the

newspaper

The Langevin Affair

However, Marie’s tribulations were not at an end. When, at the beginning of November 1911, Marie went to Belgium,

being invited with the world’s most eminent physicists to attend the first Solvay Conference, she received a message

that a new campaign had started in the press. Now it was a matter of her private life and her relations with her

colleague Paul Langevin, who had also been invited to the conference. He had had marital problems for several years

and had moved from his suburban home to a small apartment in Paris. Marie was depicted as the reason. Both were

described in slanderous terms. The scandal developed dramatically. Marie stands up in her own defence and

managed to force an apology from the newspaper Le Temps. The same day she received word from Stockholm that

she had been awarded the Nobel Prize in Chemistry. However, the very newspapers that made her a legend when she

received the Nobel Prize in Physics in 1903, now completely ignored the fact that she had been awarded the Prize in

Chemistry or merely reported it in a few words on an inside page. The Langevin scandal escalated into a serious

affair that shook the university world in Paris and the French government at the highest level. Madame Langevin was

preparing legal action to obtain custody of the four children. With a burglary in Langevin’s apartment certain letters

were stolen and delivered to the press. Léon Daudet made the whole thing into a new Dreyfus affair. Day after day

Marie had to run the gauntlet in the newspapers: an alien, a Polish woman, a researcher supported by our French

scientists, had come and stolen an honest French woman’s husband. Daudet quoted Fouquier-Tinville’s notorious

words that during the Revolution had sent the chemist Lavoisier to the guillotine: “The Republic does not need any

scientists.” Marie’s friends immediately backed her up. Jean Perrin, Henri Poincaré and Émile Borel appealed to the

publishers of the newspapers. Henri Poincaré’s cousin, Raymond Poincaré, a senior lawyer who was to become

President of France in a few years time, was engaged as advisor. But the scandal kept up its impetus with headlines

on the first pages such as “Madame Curie, can she still remain a professor at the Sorbonne?” With her children Marie

stayed at Sceaux where she was practically a prisoner in her own home. Her friends feared that she would collapse.

The drama culminated on the morning of 23 November when extracts from the letters were published in the

newspaper L’Oeuvre. There was no proof of the accusations made against Marie and the authenticity of the letters

could be questioned but in the heated atmosphere there were few who thought clearly.

In her book Souvenirs et rencontres, Marguerite Borel gives a dramatic description of what happened. Émile Borel was

extremely indignant and acted quickly. Marie had to be fetched from Sceaux and live with them until the storm was

over. Marguerite and André Debierne went out to Sceaux where they found a hostile and angry crowd gathered

outside Marie’s home. Someone shouted, “Go home to Poland.” A stone hit the house. Having managed to persuade

Marie to go with them, they guided her, holding Ève by the hand, through the crowd. Marie sat stiff and deathly pale

throughout their journey. Marguerite wanted to take her hand, but did not venture to do so. On their return, Marie

and Ève were installed in two rooms in the Borels’ home. Henriette Perrin looks after Irène. But the Borels’ home was

owned by the École Normale Supérieure and Émile Borel was called up to the Minister of Education (Théodore Steeg,

le ministre de l’Instruction publique) who informed him that he had no right to let Marie Curie stay in his home. It

would cast a shadow on the École Normale. If Borel persisted in keeping his guest, he would be dismissed. “So be it

then, I shall persist,” was Borel’s answer. For Marguerite Borel’s part, she had to endure a stormy battle with her

father, Paul Appell, then dean of the faculty at the Sorbonne. He was furious that the Borels have gotten mixed up in

the matter. He revealed that with several other influential people he was planning an interview with Marie in order to

request her to leave France: her situation in Paris was impossible. “I have done everything for her, I have supported

her candidature to the Académie, but I cannot hold back the flood now engulfing her.” Marguerite replied, “If you give

in to that idiotic nationalist movement and insist that Marie should leave France, you will never see me any more.”

Appell, who was in the process of putting on his shoes, threw one of them to hit the door – but the interview with

Marie did not take place. Langevin who had been repeatedly insulted, then felt forced to challenge Gustave Téry, the

editor of the newspaper that printed the letters, to a duel. Fighting a duel was a usual way of obtaining satisfaction in

France at that time, although scarcely in academic circles. Newspaper publishers who had come up against each other

in this dispute had already fought duels. Swords were generally used and a duellist was usually content with inflicting

a thorough scratch on his opponent for the duel to be considered decided. But fatal accidents did in fact occur.
Langevin found it hard to find seconds, but managed to persuade Paul Painlevé, a mathematician and later Prime Minister, and the director of the School of Physics and Chemistry. The duel, with pistols at a distance of 25 meters, was to take place on the morning of November 25. Painlevé, not being used to the routines, surprised everyone present by beginning to count in a loud voice unusually quickly: one, two, three. Téry did not raise his pistol. Langevin, who had first raised his, then lowered it. No shot was fired. The journalists wrote about the silence and about the pigeons quietly feeding on the field. In the midst of all its gravity, the duel had turned into a farce.

However, the publication of the letters and the duel were too much for those responsible at the Swedish Academy of Sciences in Stockholm. Marie received a letter from a member, Svante Arrhenius, in which he said that the duel had given the impression that the published correspondence had not been falsified. He asked her to cable that she would not be coming to the prize award ceremony and to write him a letter to the effect that she did not want to accept the Prize until the Langevin court proceedings had shown that the accusations against her were absolutely without foundation. Of those most closely affected, the person who remained level-headed despite the enormous strain of the critical situation was in fact Marie herself. In a well-formulated and matter-of-fact reply, she pointed out that she had been awarded the Prize for her discovery of radium and polonium, and that she could not accept the principle that appreciation of the value of scientific work should be influenced by slander concerning a researcher’s private life. On December 6, Langevin wrote a long letter to Svante Arrhenius, whom he had met previously. He described the whole situation, explained what circles were behind the smear campaign. He appealed to the Nobel Committee not to let it be influenced by a campaign which was fundamentally unjust. Nor, in fact, was it so influenced.

Marie gathered all her strength and gave her Nobel lecture on December 11 in Stockholm. The lecture should be read in the light of what she had gone through. She made clear by her choice of words what were unequivocally her contributions in the collaboration with Pierre. She spoke of the field of research which “I have called radioactivity” and “my hypothesis that radioactivity is an atomic property,” but without detracting from his contributions. She declared that she also regarded this Prize as a tribute to Pierre Curie.

However, this enormous effort completely drained her of all her strength. She sank into a depressed state. On December 29, she was taken to a hospital whose location was kept secret for her protection. When she had recovered to some extent, she traveled to England, where a friend, the physicist Hertha Ayrton, looked after her and saw that the press was kept away. A whole year passed before she could work as she had done before.

In her book, Marguerite Borel quotes Jean Perrin's words, ‘But for the five of us who stood up for Marie Curie against a whole world when a landslide of filth engulfed her, Marie would have returned to Poland and we would have been marked by eternal shame.’ The five were Jean and Henriette Perrin, Émile and Marguerite Borel and André Debierne.

Legal proceedings were never taken. Langevin and his wife reached a settlement on 9 December without Marie’s name being mentioned. We shall never know with any certainty what was the nature of the relationship between Marie Curie and Paul Langevin. It is referred to by Paul Langevin's son, André Langevin, in his biography of his father, which was published in 1971. He writes, “Is it not rather natural that friendship and mutual admiration several years after Pierre’s death could develop step by step into a passion and a relationship?” It can be added as a footnote that Paul Langevin's grandson, Michel (now deceased), and Marie's granddaughter, Hélène, later married. Hélène Langevin-Joliot is a nuclear physicist and has made a close study of Marie and Pierre Curie's notebooks so as to obtain a picture of how their collaboration functioned.

Marie had opened up a completely new field of research: radioactivity. Various aspects of it were being studied all over the world. In Uppsala Daniel Strömholm, professor of chemistry, and The Svedberg, then associate professor, investigated the chemistry of the radioactive elements. In 1909 they were close to the discovery of isotopes. However it was the British physicist Frederick Soddy who in the following year, finally clarified the concept of isotopes. Marie’s laboratory became the Mecca for radium research. Eva Ramstedt, who took a doctorate in physics in Uppsala in 1910, studied with Marie Curie in 1910-11 and was later associate professor in radiology at Stockholm University College in 1915-32. The Norwegian chemist Ellen Gleditsch worked with Marie Curie in 1907-12.

Marie opened up a completely new field of research: radioactivity. Various aspects of it were being studied all over the world. In Uppsala Daniel Strömholm, professor of chemistry, and The Svedberg, then associate professor, investigated the chemistry of the radioactive elements. In 1909 they were close to the discovery of isotopes. However it was the British physicist Frederick Soddy who in the following year, finally clarified the concept of isotopes. Marie’s laboratory became the Mecca for radium research. Eva Ramstedt, who took a doctorate in physics in Uppsala in 1910, studied with Marie Curie in 1910-11 and was later associate professor in radiology at Stockholm University College in 1915-32. The Norwegian chemist Ellen Gleditsch worked with Marie Curie in 1907-12.

War

When, in 1914, Marie was in the process of beginning to lead one of the departments in the Radium Institute established jointly by the University of Paris and the Pasteur Institute, the First World War broke out. Marie placed her two daughters, Irène aged 17 and Ève aged 10, in safety in Brittany. She herself took a train to Bordeaux, a train
overloaded with people leaving Paris for a safer refuge. But Marie had a different reason for her journey. She had
with her a heavy, 20-kg lead container in which she had placed her valuable radium. Once in Bordeaux the other
passengers rushed away to their various destinations. She remained standing there with her heavy bag which she did
not have the strength to carry without assistance. Some official finally helped her find a room where she slept with
her heavy bag by her bed. The next day, having had the bag taken to a bank vault, she took a train back to Paris. It
was now crowded to bursting point with soldiers. Throughout the war she was engaged intensively in equipping
more than 20 vans that acted as mobile field hospitals and about 200 fixed installations with X-ray apparatus.

Marie driving one of the radiology cars in 1917.
© Marie Skłodowska Curie Museum

She trained young women in simple X-ray technology, she herself drove one of the vans and took an active part in
locating metal splinters. Sometimes she found she had to give the doctors lessons in elementary geometry. Irène,
when 18, became involved, and in the primitive conditions both of them were exposed to large doses of radiation.

After the Peace Treaty in 1918, her Radium Institute, which had been completed in 1914, could now be opened. It
became France’s most internationally celebrated research institute in the inter-war years. Even so, as her French
biographer Françoise Giroud points out, the French state did not do much in the way of supporting her. In the USA
radium was manufactured industrially but at a price which Marie could not afford. She had to devote a lot of time to
fund-raising for her Institute. She also became deeply involved when she had become a member of the Commission
for Intellectual Cooperation of the League of Nations and served as its vice-president for a time. She frequently took
part in its meetings in Geneva, where she also met the Swedish delegate, Anna Wicksell.

Missy

Marie regularly refused all those who wanted to interview her. However, a prominent American female journalist,
Marie Maloney, known as Missy, who for a long time had admired Marie, managed to meet her. This meeting became
of great importance to them both. Marie told Missy that researchers in the USA had some 50 grams of radium at their
disposal. “And in France, then?” asked Missy. “My laboratory has scarcely more than one gram,” was Marie’s answer.
“But you ought to have all the resources in the world to continue with your research. Someone must see to that,”

Missy, like Marie herself, had an enormous strength and strong inner stamina under a frail exterior. She now
arranged one of the largest and most successful research-funding campaigns the world has seen. First of all she got
the New York papers to promise not to print a word on the Langevin affair and – so as to feel safe – unbelievably
enough managed to take over all their material on the Langevin affair. Due to the press, Marie became enormously
popular in America, and everyone seemed to want to meet her – the great Madame Curie. Missy had to struggle hard
to get Marie to accept a program for her visit on a par with the campaign. Finally, she had to turn to Paul Appell, now
the university chancellor, to persuade Marie. In spite of her diffidence and distaste for publicity, Marie agreed to go to
America to receive the gift – a single gram of radium – from the hand of President Warren Harding. “I understand
that it will be of the greatest value for my Institute,” she wrote to Missy. When all this became known in France, the
paper Je sais tout arranged a gala performance at the Paris Opera. It was attended by the most prominent
personalities in France, including Aristide Briand, then Foreign Minister, who was later, in 1926, to receive the Nobel
Peace Prize. Jean Perrin made a speech about Marie’s contribution and the promises for the future that her
discoveries gave. The great Sarah Bernhardt read an “Ode to Madame Curie” with allusions to her as the sister of
Prometheus. After being dragged through the mud ten years before, she had become a modern Jeanne d’Arc.
Missy Maloney, Irène, Marie and Ève Curie in the USA.
Photo kindly provided by William Brown Maloney Papers, Rare Book and Manuscript Library, Columbia University, USA.

Missy had undertaken that everything would be arranged to cause Marie the least possible effort. In spite of this Marie had to attend innumerable receptions and do a round of American universities. Outwardly the trip was one great triumphal procession. She became the recipient of some twenty distinctions in the form of honorary doctorates, medals and membership in academies. Great crowds paid homage to her. But for Marie herself, this was torment. Where possible, she had her two daughters represent her.

Marie and Missy became close friends. The inexhaustible Missy organized further collections for one gram of radium for an institute which Marie had helped found in Warsaw. Marie’s second journey to America ended only a few days before the great stock exchange crash in 1929.

In the last ten years of her life, Marie had the joy of seeing her daughter Irène and her son-in-law Frédéric Joliot do successful research in the laboratory. She lived to see their discovery of artificial radioactivity, but not to hear that they had been awarded the Nobel Prize in Chemistry for it in 1935. Marie Curie died of leukemia on July 4, 1934.

Epilogue

It is worth mentioning that the new discoveries at the end of the nineteenth century became of importance also for the breakthrough of modern art. X-ray photography focused art on the invisible. The human body became dissolved in a shimmering mist. Wassily Kandinsky, one of the pioneers of abstract painting, wrote about radioactivity in his autobiographical notes from 1901-13. He claimed that in his soul the decay of the atom was synonymous with the decay of the whole world. The thickest walls had suddenly collapsed. Everything had become uncertain, unsteady and fluid. He would not have been surprised if a stone had been pulverized in the air before him and become invisible.

For the physicists of Marie Curie’s day, the new discoveries were no less revolutionary. Although admittedly the world did not decay, what nevertheless did was the classical, deterministic view of the world. Radioactive decay, that heat is given off from an invisible and apparently inexhaustible source, that radioactive elements are transformed into new elements just as in the ancient dreams of alchemists of the possibility of making gold, all these things contravened the most entrenched principles of classical physics. For radioactivity to be understood, the development of quantum mechanics was required. But it should be noted that the birth of quantum mechanics was not initiated by the study of radioactivity but by Max Planck’s study of radiation from a black body in 1900. It was an old field that was not the object of the same interest and publicity as the new spectacular discoveries. It was not until 1928, more than a quarter of a century later, that the type of radioactivity that is called alpha-decay obtained its theoretical explanation. It is an example of the tunnel effect in quantum mechanics.

Much has changed in the conditions under which researchers work since Marie and Pierre Curie worked in a drafty shed and refused to consider taking out a patent as being incompatible with their view of the role of researchers; a patent would nevertheless have facilitated their research and spared their health. But in one respect, the situation remains unchanged. Nature holds on just as hard to its really profound secrets, and it is just as difficult to predict where the answers to fundamental questions are to be found.
Names Mentioned in the Text

Appell, Paul (1855-1930), mathematician  
Arrhenius, Svante (1859-1927), Nobel Prize in Chemistry 1903  
Ayrton, Hertha (1854-1923), English physicist  
Becquerel, Henri (1852-1908), Nobel Prize in Physics 1903  
Borel, Émile (1871-1956), mathematician  
Borel, Marguerite, author, married to Émile Borel  
Branly, Édouard (1844-1940), physicist  
Briand, Aristide (1862-1932), eminent French statesman, Nobel Peace Prize 1926  
Brillouin, Marcel (1854-1948), theoretical physicist  
Darboux, Gaston (1842-1917), mathematician  
Daudet, Léon (1867-1942), editor of L'Action Française  
Debierne, André (1874-1949), Marie Curie's colleague for many years  
Einstein, Albert (1879-1955), Nobel Prize in Physics 1921  
Giroud, Françoise (1916- ), author, former minister  
Gleditsch, Ellen (1879-1968), chemist  
Hertz, Heinrich (1857-1894), physicist  
Langevin, Paul (1872-1946), physicist  
Lippmann, Gabriel (1845-1921), Nobel Prize in Physics 1908  
Marconi, Guglielmo (1874-1937), Nobel Prize in Physics 1909  
Mittag-Leffler, Gösta (1846-1927), mathematician  
Moissan, Henri (1852-1907), Nobel Prize in Chemistry 1906  
Ostwald, Wilhelm (1853-1932), Nobel Prize in Chemistry 1909  
Painlevé, Paul (1863-1933), mathematician  
Perrin, Jean (1870-1942) Nobel Prize in Physics 1926  
Planck, Max (1858-1947), Nobel Prize in Physics 1918  
Poincaré, Henri (1854-1912), mathematician, philosopher  
Poincaré, Raymond (1860-1934), lawyer (president 1913-1920)  
Ramstedt, Eva (1879-1974), physicist  
Röntgen, Wilhelm Conrad (1845-1923), Nobel Prize in Physics 1901  
Rutherford, Ernest (1871-1937), Nobel Prize in Chemistry 1908  
Soddy, Frederick (1877-1956), Nobel Prize in Chemistry 1921  
Strömholm, Daniel (1871-1961), chemist, professor at Uppsala University  
Svedberg, The (1884-1971), Nobel Prize in Chemistry 1926

Bibliography


Curie, Marie, Pierre Curie and Autobiographical Notes, The Macmillan Company, New York, 1923. Subsequently Marie Curie refused to authorize publication of her Autobiographical Notes in any other country.

Gleditsch, Ellen, Marie Skłodowska Curie (in Norwegian), Nordisk Tidsskrift, Årg. 35, 1959.


Other Sources

**Muzeum Marii Curie-Sklodowskiej**
(Polskie Towarzystwo Chemiczne)
00-227 Warsawa, ul. Freta 16
tel: 48-22-31 80 92
fax: 48-22-31 13 04
Contact person: Malgorzata Sobieszczak-Marciniak

Web site of L’Institut Curie et l’Histoire:
http://www.curie.u-psud.fr/Histoire1.html

* Originally delivered as a lecture at the Royal Swedish Academy of Sciences in Stockholm, Sweden, on February 28, 1996.

Translation from Swedish to English by Nancy Marshall-Lundén.

First published 1 December 1996

To cite this section
Marie and Pierre discovered not only polonium, but also radium, through their work with pitchblende. In 1903, Marie Curie and her husband won the Nobel Prize in physics for their work on radioactivity. She was the first woman ever to receive a Nobel Prize. Just three years after winning the Nobel Prize, Pierre was killed in an accident. Irene Curie studied in her parent's Radium Institute. She, as well as her husband, was later awarded a Nobel Prize in chemistry for the discovery for artificial radioactivity. © Mary Caballero. The author grants permission to copy, distribute and display this work in unaltered form, with attribution to the author, for noncommercial purposes only. All other rights, including commercial rights, are reserved to the author. References. Pierre Curie and Maria Sklodowska, both of whom loved science more than anything else, very soon became the closest friends. They worked together constantly and discussed many problems of their researches. After little more than a year they fell in love with each other, and in 1895 Maria Sklodowska became Mme. Curie. Theirs was not only to be a very happy marriage but also one of the greatest scientific partnerships. Marie had been the greatest woman-scientist of her day but she was a mother too, a very loving one. There were their two little girls, Irene and Eve. By this time Mme. Curie had o Marie and Pierre Curie's pioneering research was again brought to mind when on April 20 1995, their bodies were taken from their place of burial at Sceaux, just outside Paris, and in a solemn ceremony were laid to rest under the mighty dome of the Panthéon. Marie Curie thus became the first woman to be accorded this mark of honour on her own merit. His discovery very soon made an impact on practical medicine. In physics it led to a chain of new and sensational findings. Marie considered that radium ought to be left in the residue. A sample was sent to them from Bohemia and the slag was found to be even more active than the original mineral. Several tons of pitchblende was later put at their disposal through the good offices of the Austrian Academy of Sciences.