

Marie Curie

Marie Skłodowska-Curie (7 November 1867 – 4 July 1934) was a physicist and chemist famous for her pioneering research on radioactivity. She was the first person honored with two Nobel Prizes[1]—in physics and chemistry. She was the first female professor at the University of Paris, and in 1995 became the first woman to be entombed on her own merits in the Panthéon in Paris.[2]

She was born Maria Salomea Skłodowska ([ˈmarja salɔˈmɛa skwɔˈdɔfska]) in Warsaw, in what was then the Kingdom of Poland. She studied at Warsaw's clandestine Floating University and began her practical scientific training in Warsaw. In 1891, aged 24, she followed her older sister Bronisława to study in Paris, where she earned her higher degrees and conducted her subsequent scientific work. She shared her 1903 Nobel Prize in Physics with her husband Pierre Curie and with the physicist Henri Becquerel. Her daughter Irène Joliot-Curie and son-in-law, Frédéric Joliot-Curie, would similarly share a Nobel Prize. She was the sole winner of the 1911 Nobel Prize in Chemistry. Skłodowska-Curie was the first woman to win a Nobel Prize, the only woman to date to win in two fields, and the only person to win in multiple sciences.

Her achievements included a theory of radioactivity (a term that she coined[3]), techniques for isolating radioactive isotopes, and the discovery of two elements, polonium and radium. Under her direction, the world's first studies were conducted into the treatment of neoplasms, using radioactive isotopes. She founded the Curie Institutes in Paris and Warsaw, which remain major centres of medical research today.

While an actively loyal French citizen, Skłodowska-Curie (she used both surnames) never lost her sense of Polish identity. She taught her daughters the Polish language and took them on visits to Poland. She named the first chemical element that she discovered – polonium, which she first isolated in 1898 – after her native country.[4] During World War I she became a member of the Committee for a Free Poland (Komitet Wolnej Polski).[5] In 1932, she founded a Radium Institute (now the Maria Skłodowska–Curie Institute of Oncology) in her home town, Warsaw, headed by her physician-sister Bronisława. Curie died in 1934 of aplastic anemia brought on by her years of exposure to radiation.[6]

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Biography

Early life

Maria Skłodowska at 15

Birthplace on ulica Freta in Warsaw's "New Town" – now home to the Maria Skłodowska-Curie Museum

Władysław Skłodowski with daughters (from left) Maria, Bronisława, Helena, 1890

Maria Skłodowska was born in Warsaw, in the Russian partition of Poland, on 7 November 1867, the fifth and youngest child of well-known teachers Bronisława and Władysław Skłodowski. Maria's older siblings were Zofia (born 1862), Józef (1863), Bronisława (1865) and Helena (1866).

Maria's paternal grandfather Józef Skłodowski had been a respected teacher in Lublin, where he taught the young Bolesław Prus.[7] Her father Władysław Skłodowski taught mathematics and physics, subjects that Maria was to pursue, and was also director of two Warsaw gymnasia for boys, in addition to lodging boys in the family home. Maria's mother Bronisława operated a prestigious Warsaw boarding school for girls; she suffered from tuberculosis and died when Maria was twelve.

Maria's father was an atheist; her mother—a devout Catholic.[8] Two years earlier Maria's oldest sibling, Zofia, had died of typhus. The deaths of her mother and sister, according to Robert William Reid, caused Maria to give up Catholicism and become agnostic.[9]

When she was ten years old, Maria began attending the boarding school that her mother had operated while she was well; next Maria attended a gymnasium for girls, from which she graduated on 12 June 1883. She spent the following year in the countryside with relatives of her father's, and the next with her father in Warsaw, where she did some tutoring.

On both the paternal and maternal sides, the family had lost their property and fortunes through patriotic involvements in Polish national uprisings aiming at the restoration of Poland's independence (most recent of which was the January Uprising). This condemned each subsequent generation,

including that of Maria, her elder sisters and her brother, to a difficult struggle to get ahead in life.[10]

Elderly Żorawski

At a Warsaw lab, in 1890–91, Skłodowska did her first scientific work.

Maria made an agreement with her sister, Bronisława, that she would give her financial assistance during Bronisława's medical studies in Paris, in exchange for similar assistance two years later.[11] In connection with this, Maria took a position as governess: first with a lawyer's family in Kraków; then for two years in Ciechanów with a landed family, the Żorawskis, who were relatives of her father. While working for the latter family, she fell in love with their son, Kazimierz Żorawski, which was reciprocated by this future eminent mathematician. His parents, however, rejected the idea of his marrying the penniless relative, and Kazimierz was unable to oppose them. Maria lost her position as governess.[12] She found another with the Fuchs family in Sopot, on the Baltic Sea coast, where she spent the next year, all the while financially assisting her sister.

At the beginning of 1890, Bronisława, a few months after she married Kazimierz Dłuski, invited Maria to join them in Paris. Maria declined because she could not afford the university tuition and was still counting on marrying Kazimierz Żorawski. She returned home to her father in Warsaw, where she remained till the fall of 1891. She tutored, studied at the clandestine Floating University,[13] and began her practical scientific training (1890–91) in a laboratory at the Museum of Industry and Agriculture at Krakowskie Przedmieście 66, near Warsaw's Old Town.[14] The laboratory was run by her cousin Józef Boguski, who had been assistant in Saint Petersburg to the great Russian chemist Dmitri Mendeleev.[15]

In October 1891, at her sister's insistence and after receiving a letter from Żorawski, in which he definitively broke his relationship with her, she decided to go to France after all.[8]

Maria's loss of the relationship with Żorawski was tragic for both. He soon earned a doctorate and pursued an academic career as a mathematician, becoming a professor and rector of Kraków University and president of the Warsaw Society of Learning. Still, as an old man and a mathematics professor at the Warsaw Polytechnic, he would sit contemplatively before the statue of Maria Skłodowska which had been erected in 1935 before the Radium Institute that she had founded in 1932.[16]

In Paris, Maria briefly found shelter with her sister and brother-in-law before renting a primitive garret[17] and proceeding with her studies of physics, chemistry, and mathematics at the Sorbonne (the University of Paris).

Pierre Curie

Pierre Curie

Skłodowska studied during the day and tutored evenings, barely earning her keep. In 1893, she was awarded a degree in physics and began work in an industrial laboratory at Lippman's. Meanwhile she continued studying at the Sorbonne, and in 1894, earned a degree in mathematics.

That same year, Pierre Curie entered her life. He was an instructor at the School of Physics and Chemistry, the *École supérieure de physique et de chimie industrielles de la ville de Paris* (ESPCI). Skłodowska had begun her scientific career in Paris with an investigation of the magnetic properties of various steels; it was their mutual interest in magnetism that drew Skłodowska and Curie together.[18]

Her departure for the summer to Warsaw only enhanced their mutual feelings for each other. She still was laboring under the illusion that she would be able to return to Poland and work in her chosen field of study. When she was denied a place at Kraków University merely because she was a woman, she returned to Paris.[19] Almost a year later, in July 1895, she and Pierre Curie married, and thereafter the two physicists hardly ever left their laboratory. They shared two hobbies, long bicycle trips and journeys abroad, which brought them even closer. Maria had found a new love, a partner, and a scientific collaborator upon whom she could depend.[19]

New elements

In 1896 Henri Becquerel discovered that uranium salts emitted rays that resembled X-rays in their penetrating power. He demonstrated that this radiation, unlike phosphorescence, did not depend on an external source of energy, but seemed to arise spontaneously from uranium itself. Becquerel had, in fact, discovered radioactivity.

Curie decided to look into uranium rays as a possible field of research for a thesis. She used a clever technique to investigate samples. Fifteen years earlier, her husband and his brother had invented the electrometer, a sensitive device for measuring electrical charge. Using the Curie electrometer, she discovered that uranium rays caused the air around a sample to conduct electricity.[20] Using this technique, her first result was the finding that the activity of the uranium compounds depended only on the quantity of uranium present. She had shown that the radiation was not the outcome of some interaction of molecules, but must come from the atom itself. In scientific terms, this was the most important single piece of work that she conducted.[21]

Curie's systematic studies had included two uranium minerals, pitchblende and torbernite (also known as chalcocite). Her electrometer showed that pitchblende was four times as active as uranium itself, and chalcocite twice as active. She concluded that, if her earlier results relating the quantity of uranium to its activity were correct, then these two minerals must contain small quantities of some other substance that was far more active than uranium itself.[22]

The idea [writes Reid] was her own; no one helped her formulate it, and although she took it to her husband for his opinion she clearly established her ownership of it. She later recorded the fact twice in her biography of her husband to ensure there was no chance whatever of any ambiguity. It [is] likely that already at this early stage of her career [she] realized that... many scientists would find it difficult to believe that a woman could be capable of the original work in which she was involved.[23]

In her systematic search for other substances beside uranium salts that emitted radiation, Curie had

found that the element thorium likewise, was radioactive.

Pierre and Marie Curie in their Paris laboratory, before 1907

She was acutely aware of the importance of promptly publishing her discoveries and thus establishing her priority. Had not Becquerel, two years earlier, presented his discovery to the Académie des Sciences the day after he made it, credit for the discovery of radioactivity, and even a Nobel Prize, would have gone to Silvanus Thompson instead. Curie chose the same rapid means of publication. Her paper, giving a brief and simple account of her work, was presented for her to the Académie on 12 April 1898 by her former professor, Gabriel Lippmann.[24]

Even so, just as Thompson had been beaten by Becquerel, so Curie was beaten in the race to tell of her discovery that thorium gives off rays in the same way as uranium. Two months earlier, Gerhard Schmidt had published his own finding in Berlin.[25]

At that time, however, no one else in the world of physics had noticed what Curie recorded in a sentence of her paper, describing how much greater were the activities of pitchblende and chalcocite than uranium itself: "The fact is very remarkable, and leads to the belief that these minerals may contain an element which is much more active than uranium." She later would recall how she felt "a passionate desire to verify this hypothesis as rapidly as possible." [26]

Pierre Curie was sure that what she had discovered was not a spurious effect. He was so intrigued that he decided to drop his work on crystals temporarily and to join her. On 14 April 1898, they optimistically weighed out a 100-gram sample of pitchblende and ground it with a pestle and mortar. They did not realize at the time that what they were searching for was present in such minute quantities that they eventually would have to process tons of the ore.[26]

As they were unaware of the deleterious effects of radiation exposure attendant on their chronic unprotected work with radioactive substances, Curie and her husband had no idea what price they would pay for the effect of their research upon their health.[19]

Pierre, Irène, Marie Curie

In July 1898, Curie and her husband published a paper together, announcing the existence of an element which they named "polonium", in honor of her native Poland, which would for another twenty years remain partitioned among three empires. On 26 December 1898, the Curies announced the existence of a second element, which they named "radium" for its intense radioactivity — a word that they coined.

Pitchblende is a complex mineral. The chemical separation of its constituents was an arduous task. The discovery of polonium had been relatively easy; chemically it resembles the element bismuth, and polonium was the only bismuth-like substance in the ore. Radium, however, was more elusive. It is closely related, chemically, to barium, and pitchblende contains both elements. By 1898, the Curies had

obtained traces of radium, but appreciable quantities, uncontaminated with barium, still were beyond reach.[27]

The Curies undertook the arduous task of separating out radium salt by differential crystallization. From a ton of pitchblende, one-tenth of a gram of radium chloride was separated in 1902. By 1910, Curie, working on without her husband, who had been killed accidentally by a horse drawn vehicle[28] in 1906, had isolated the pure radium metal.[29]

In an unusual decision, Marie Curie intentionally refrained from patenting the radium-isolation process, so that the scientific community could do research unhindered.[30]

In 1903, under the supervision of Henri Becquerel,[31] Marie was awarded her DSc from the University of Paris.

Nobel Prizes

1903

1911, awarded second Nobel Prize

In 1903 the Royal Swedish Academy of Sciences awarded Pierre Curie, Marie Curie and Henri Becquerel the Nobel Prize in Physics, "in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel."

Curie and her husband were unable to go to Stockholm to receive the prize in person, but they shared its financial proceeds with needy acquaintances, including students.[19]

On receiving the Nobel Prize, Marie and Pierre Curie suddenly became very famous. The Sorbonne gave Pierre a professorship and permitted him to establish his own laboratory, in which Curie became the director of research.

In 1897 and 1904, respectively, Curie gave birth to their daughters, Irène and Ève Curie. She later hired Polish governesses to teach her daughters her native language, and sent or took them on visits to Poland.[32]

Curie was the first woman to be awarded a Nobel Prize. Eight years later, in 1911, she received the Nobel Prize in Chemistry, "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."

1911 Nobel Prize

A month after accepting her 1911 Nobel Prize, she was hospitalized with depression and a kidney ailment.

Curie was the first person to win or share two Nobel Prizes. She is one of only two people who have been awarded a Nobel Prize in two different fields, the other person being Linus Pauling (for chemistry and for peace). Nevertheless, in 1911 the French Academy of Sciences did not elect her to be a member by two votes. Elected instead was Édouard Branly, an inventor who had helped Guglielmo Marconi develop the wireless telegraph.[33] It would be a doctoral student of Curie, Marguerite Perey, who would become the first woman elected to membership in the Academy – over half a century later, in 1962.

Pierre's death

On 19 April 1906 Pierre was killed in a street accident. Walking across the Rue Dauphine in heavy rain, he was struck by a horse-drawn vehicle and fell under its wheels; his skull was fractured.[28] While it has been speculated that previously he may have been weakened by prolonged radiation exposure, there are no indications that this contributed to the accident.

Curie was devastated by the death of her husband. She noted that, as of that moment she suddenly had become "an incurably and wretchedly lonely person". On 13 May 1906, the Sorbonne physics department decided to retain the chair that had been created for Pierre Curie and they entrusted it to Curie together with full authority over the laboratory. This allowed her to emerge from Pierre's shadow. She became the first woman to become a professor at the Sorbonne, and in her exhausting work regime she sought a meaning for her life.

At First Solvay Conference (1911), Curie (seated, 2nd from right) confers with Henri Poincaré. Standing, 4th from right, is Rutherford; 2nd from right, Einstein; far right, Paul Langevin. Recognition for her work grew to new heights, and in 1911 the Royal Swedish Academy of Sciences awarded her a second Nobel Prize, this time for Chemistry. A delegation of celebrated Polish men of learning, headed by world-famous novelist Henryk Sienkiewicz, encouraged her to return to Poland and continue her research in her native country.[19]

In 1911 it was revealed that in 1910–11 Curie had conducted an affair of about a year's duration with physicist Paul Langevin, a former student of Pierre Curie's.[34] He was a married man who was estranged from his wife. This resulted in a press scandal that was exploited by her academic opponents. Despite her fame as a scientist working for France, the public's attitude tended toward xenophobia—the same that had led to the Dreyfus affair—which also fueled false speculation that Curie was Jewish. She was five years older than Langevin and was portrayed in the tabloids as a home-wrecker.[35] Later, Curie's granddaughter, Héléne Joliot, married Langevin's grandson, Michel Langevin.

Curie's second Nobel Prize, in 1911, enabled her to talk the French government into funding the building of a private Radium Institute (Institut du radium, now the Institut Curie), which was built in 1914 and at which research was conducted in chemistry, physics, and medicine. The Institute became a

crucible of Nobel Prize winners, producing four more, including her daughter Irène Joliot-Curie and her son-in-law, Frédéric Joliot-Curie.

World War I

Curie in a World War I mobile X-ray vehicle

During World War I, Curie pushed for the use of mobile radiography units, which came to be popularly known as *petites Curies* ("Little Curies"), for the treatment of wounded soldiers. These units were powered using tubes of radium emanation, a colorless, radioactive gas given off by radium, later identified as radon. Curie provided the tubes of radium, derived from the material she purified. Also, promptly after the war started, she donated the gold Nobel Prize medals she and her husband had been awarded, to the war effort. She was also active member in committees of Polish Polonia in France dedicated to Polish cause.[36]

Post-war years

In 1921 Curie was welcomed triumphantly when she toured the United States to raise funds for research on radium. Mrs. William Brown Meloney, after interviewing Curie, raised money to buy 1 gram of radium and publicized the trip.[37] President Warren Harding received her at the White House. [38]

Her second American tour, in 1929, succeeded in equipping the Warsaw Radium Institute, founded in 1925 with her sister Bronisława as director.[39]

These distractions from her scientific labors and the attendant publicity caused her much discomfort but provided resources needed for her work.

In her later years Curie headed the Curie Pavilion, a radioactivity laboratory created for her by the Pasteur Institute and the University of Paris. It was one of four major radioactivity-research laboratories, the others being the Cavendish Laboratory, with Ernest Rutherford; the Institute for Radium Research, Vienna, with Stefan Meyer; and the Kaiser Wilhelm Institute for Chemistry, with Otto Hahn and Lise Meitner. [40]

Death

1935 statue, facing the Radium Institute, Warsaw

Curie visited Poland for the last time in the spring of 1934.[19] Only a few months later, on 4 July 1934, Curie died at the Sancellemoz Sanatorium in Passy, in Haute-Savoie, eastern France, from aplastic anemia contracted from her long-term exposure to radiation.[6] The damaging effects of ionizing radiation were not then known, and much of her work had been carried out in a shed, without proper safety measures. She had carried test tubes containing radioactive isotopes in her pocket and

stored them in her desk drawer, remarking on the pretty blue-green light that the substances gave off in the dark.[41]

She was interred at the cemetery in Sceaux, alongside her husband Pierre. Sixty years later, in 1995, in honor of their achievements, the remains of both were transferred to the Panthéon, Paris. She became the first – and so far the only – woman to be honored with interment in the Panthéon on her own merits.

Her laboratory is preserved at the Musée Curie.

Because of their levels of radioactivity, her papers from the 1890s are considered too dangerous to handle. Even her cookbook is highly radioactive. They are kept in lead-lined boxes, and those who wish to consult them must wear protective clothing.[42]

Legacy

Statue, Maria Curie-Skłodowska University, Lublin, Poland

The physical and societal aspects of the work of the Curies contributed substantially to shaping the world of the twentieth and twenty-first centuries. Cornell University professor L. Pearce Williams observes:

The result of the Curies' work was epoch-making. Radium's radioactivity was so great that it could not be ignored. It seemed to contradict the principle of the conservation of energy and therefore forced a reconsideration of the foundations of physics. On the experimental level the discovery of radium provided men like Ernest Rutherford with sources of radioactivity with which they could probe the structure of the atom. As a result of Rutherford's experiments with alpha radiation, the nuclear atom was first postulated. In medicine, the radioactivity of radium appeared to offer a means by which cancer could be successfully attacked.[29]

(See physics, conservation of energy, Ernest Rutherford, atom, alpha decay, atomic nucleus.)

If the work of Marie Curie helped overturn established ideas in physics and chemistry, it has had an equally profound effect in the societal sphere. To attain her scientific achievements, she had to overcome barriers that were placed in her way because she was a woman, in both her native and her adoptive country. This aspect of her life and career is highlighted in Françoise Giroud's *Marie Curie: A Life*, which emphasizes Curie's role as a feminist precursor. She was ahead of her time, emancipated, independent, and in addition uncorrupted. Albert Einstein is reported to have remarked that she was probably the only person who was not corrupted by the fame that she had won.[43]

Awards

Marie Curie was the first woman to win a Nobel prize and the first person to win two Nobel Prizes.
Nobel Prize in Physics (1903)
Davy Medal (1903)
Matteucci Medal (1904)

Elliott Cresson Medal (1909)
Nobel Prize in Chemistry (1911)
Franklin Medal of the American Philosophical Society (1921)[44]

The Curies reportedly used part of their award money to replace wallpaper in their Parisian home and install modern plumbing into a bathroom.[45]

Honors

Madame Curie was decorated with the French Legion of Honor. In Poland, she had received honorary doctorates from the Lwów Polytechnic (1912), Poznań University (1922), Kraków's Jagiellonian University (1924), and the Warsaw Polytechnic (1926).

Their elder daughter, Irène Joliot-Curie, won a Nobel Prize for Chemistry in 1935 for discovering that aluminum could be made radioactive and emit neutrons when bombarded with alpha rays. Their younger daughter, Ève Curie, later wrote a biography of her mother.

Michalina Mościcka, wife of Polish President Ignacy Mościcki, unveiled a 1935 statue of Marie Curie before Warsaw's Radium Institute, which had been founded by Marie Curie. Within a decade, during the 1944 Warsaw Uprising, the monument suffered damage from gunfire. After the war, when maintenance was done, it was decided to leave the bullet-inflicted scars on the statue.[19]

In 1967, a museum devoted to Curie was established in Warsaw's "New Town", in her birthplace on ulica Freta (Freta Street).[19]

The year 2011 was declared the Year of Marie Curie by France and Poland. "Madame Curie", which fills the Jacobs gallery at the Museum of Contemporary Art's downtown space, is an artistic installation celebrating the scientist.[46]

Rue Madame Curie is a street in Beirut, Lebanon that was named in her honor.

On 7th November 2011, Google celebrated her birthday with a special Google Doodle.[47]

On 10 December 2011, the New York Academy of Sciences celebrated the centenary of Marie Curie's second Nobel prize in the presence of Princess Madeleine of Sweden.[48]

Tributes

Panthéon, Paris

As one of the most famous female scientists to date, Marie Curie has become an icon in the scientific world and has received tributes from across the globe. In 1995, she became the first woman to be entombed on her own merits in the Panthéon, Paris, alongside her husband Pierre Curie. The curie (symbol Ci), a unit of radioactivity, is named in honour of her and Pierre,[49][50] as is the element with atomic number 96 – curium. Three radioactive minerals are also named after the Curies: curite, sklodowskite, and cuprosklodowskite.

Curie's likeness appeared on the Polish late-1980s inflationary 20,000-złoty banknote. Her likeness also has appeared on stamps and coins, as well as on the last French 500-franc note, before the franc was replaced by the euro. In a 2009 poll carried out by New Scientist, Marie Curie was voted the "most inspirational woman in science". Curie received 25.1 per cent of all votes cast, nearly twice as many as second-place Rosalind Franklin (14.2 per cent).[51][52]

Soviet postage stamp

Polish institutions named after Marie Curie include:

Maria Skłodowska–Curie Institute of Oncology, in Warsaw

Maria Curie-Skłodowska University, in Lublin, founded in 1944;

a private college in Warsaw (Uczelnia Warszawska im. Marii Skłodowskiej-Curie)

numerous schools of various levels in Poland.

French institutions named after Marie Curie include:

Pierre and Marie Curie University, the largest science, technology and medicine university in France, and successor to the faculty of science at the University of Paris, where Marie Curie taught. The university is home to the laboratory where the couple discovered radium.

The Curie Institute and Curie Museum, in Paris

In 2007, the Pierre Curie Paris Métro station was renamed the "Pierre et Marie Curie" station.

Maria Skłodowska-Curie Medallion, University at Buffalo

American institutions named after Marie Curie include:

Curie Community at the Loyola University Stritch School of Medicine, in Chicago, a memorial gathering room for students at the university

In Bayside, Queens, New York, another school named for her, Marie Curie M.S. 158, specializes in science and technology; as does Curie Metropolitan High School – located in Archer Heights, on Chicago's Southwest Side – which has a Technical, Performing Arts and IB program

The Maria Skłodowska-Curie Medallion, a stained-glass panel created by Jozef Mazur, may be found at the University at Buffalo Polish Room.

Greer Garson and Walter Pidgeon starred in the 1943 U.S. Oscar-nominated film, *Madame Curie*, based on her life. "Marie Curie" also is the name of a character in a 1988 comedy, *Young Einstein*, by Yahoo Serious.

More recently, in 1997, a French film about Pierre and Marie Curie was released, *Les Palmes de M. Schutz*. It was adapted from a play of the same name. In the film, Marie Curie was played by Isabelle Huppert. Unlike the 1943 drama, *Les Palmes de M. Schutz* is a light comedy.

A KLM McDonnell Douglas MD-11 (registration PH-KCC) is named in her honor.[53]

KVS is celebrating IYC 2011, and, under this programme, held a nationwide quiz in India, with the topic being "Life and Works of Madam Curie".[54]