The career of Marie Skłodowska-Curie

An Inspired Scientist

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Marie Skłodowska-Curie's extraordinary talent and ability were obvious from her earliest days. However, her true genius revealed itself when she took up scientific research

Marie Skłodowska graduated top of her class from the gymnasium she attended in Warsaw, and two years after her arrival in Paris she was awarded a degree in physics from the Sorbonne (1893), once again coming top in her year. She also received the best results in her 1896 exam permitting her to teach at middle school level.

The young scientist's *tempus mirabile*

Henri Becquerel discovered the radioactivity of uranium by accident in late February 1896, when he was studying changes to photographic plates exposed to radiation. This subjective and highly unreliable method led Becquerel to the mistaken conclusion that the radiation emitted by uranium is subject to reflection, refraction and polarization - that it exhibits the same properties as light, even though it is invisible to the naked eye. As a result, uranium radiation became widely regarded as a type of penetrating invisible light, not dissimilar to UV and infrared light - also invisible to the naked eye - both of which were already known by then. As far as physicists were concerned, studying the mysterious X-rays discovered by Wilhelm Roentgen was of far greater interest than uranium. Becquerel himself abandoned his research in mid-1896, and spent the next two years studying the Zeeman effect.

Skłodowska-Curie was a young aspiring scientist at the time; she gave birth to her first daughter, Irène, on 12 August 1897, and celebrated her own 30th birthday on 7 November the same year. 27 December saw the publication of her first scientific paper on the magnetic properties of hardened steel. It was a standard work commissioned by the industry; however, the results were of sufficient interest to be presented at the meeting of the French Academy of Sciences and published in its proceedings (*Comptes Rendus*).

This inspired Skłodowska-Curie to continue with her research career on top of her new family responsibilities. "I finally decided on the topic of my doctoral dissertation. I became intrigued by the fascinating results of Henri Becquerel's research into the salts of the rare metal uranium," she later wrote in her autobiography.

She started getting significant results after just a few months of intensive work. Skłodowska-Curie's article, presented by Gabriel Lippmann at the Academy of

Collections of the Marie Skłodowska-Curie Museum

Marie Skłodowska-Curie with her daughters Irène and Eve, their English governess, and Albert Einstein with his son Hans in the Swiss Alps, 1913

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Marie Mattingly Meloney, Irène Curie, Marie Curie and Eve Curie arrive in the US, 1921

Sciences on 12 April 1898 and published the same day, was of crucial importance in the development of research into radioactivity. Carefully thought-out and written, it continues to set an excellent standard for research papers. Although it is only 3 pages long, it contains many extremely important results.

✔ Skłodowska-Curie used a good qualitative method for detecting radioactivity. The sensitive electrometer she used allowed her to take measurements of very weak electrical currents in the picoampere range. The device was built by the brothers Pierre and Jacques Curie for their studies of piezoelectricity. Becquerel used only photographic plates, and estimated the degree of their exposure visually; this led him to commit serious errors in the interpretation of his results.

✔ Skłodowska-Curie's inspired concept was to examine a high variety of substances in her search for radioactive properties. This allowed her to discover the radioactivity of another element – thorium – and confirm that in all but two of the investigated substances containing uranium, the intensity of radiation is proportional to the content of this element; she therefore drew the conclusion that radioactivity is an inherent property of uranium atoms.

✔ She also discovered that two of the substances under investigation – chalcolite and pitchblende – emit more powerful radiation than pure uranium. She had the inspired idea of producing chalcolite synthetically from its known components. She discovered that the radioactivity emitted by the synthetic chalcolite corresponded to its uranium content; therefore the secret was in the natural mineral.

✔ This allowed Skłodowska-Curie to pose a bold hypothesis, stating that chalcolite and pitchblende contained a hitherto unknown, even more radioactive element.

✔ She analyzed the rate of absorption of radiation emitted by uranium and thorium by various materials, and compared the effects of their radiation with X-rays.

✔ Finally, she posed the first bold hypothesis on the potential energy source of uranium and thorium radiation. She wrote, "It is possible that the whole of space is constantly being bombarded by radiation similar to X-rays, albeit more penetrating, which can only be absorbed by certain elements with a high atomic mass, such as uranium and thorium."

All this was achieved by a researcher placing her early steps along her scientific career, while nursing her

first-born infant. It was a truly superhuman effort and a tempus mirabile; a time of wonder for the soon-to-be-great scientist.

Simple questions

Skłodowska-Curie made a momentous discovery while seeking answers to very simple questions. Her genius is best assessed by comparing her activities with those of her contemporary physicists working on radioactivity. In Naples, Emilio Villari studied the discharging of leaf electroscopes by pitchblende; however, he did not think to conduct quantitative measurements. In Erlangen in Germany, Gerhard Schmidt had the idea to look for other radioactive substances, and discovered thorium radiation independently of Skłodowska-Curie. And yet he clearly decided that studying the intensity of radiation of various uranium minerals was a waste of time. Finally, as already mentioned, Becquerel also did not attempt to take such measurements.

Collections of the Marie Skłodowska-Curie Museum

Marie Skłodowska-Curie with her daughter Irène, son-in-law Frédéric Joliot-Curie, and grandchildren Helene and Pierre, 1932

"It turned out that the results I obtained through my work reveal such fascinating visions that Mr. Curie, temporarily abandoning his own ongoing work, joined me in my research; from then on we focused our efforts jointly on discovering and studying new radioactive materials," Skłodowska-Curie wrote in her doctoral dissertation (1903). From then on, the Curies worked together to identify this new radioactive element. On 18 June 1898 - baby Irène was just 10 months old - they announced the discovery of the new element, which they named polonium. This was a clear political statement and a reminder to the rest of the world of the partitioned Poland. A few months later, on 26 December, they published the announcement on the discovery of another element - radium. And so the study of radioactivity became an exciting new branch of physics in a short space of a few months.

Becquerel was mightily embarrassed that he managed to miss such a major discovery. He returned to his work on radioactivity, and in 1899 he recalled his incorrect results from early 1896. He tried to make up for lost time, and frequently spent time in the Curies' laboratory; Pierre wrote that Becquerel tended to be rather insistent. In 1903 he was awarded half the Nobel Prize for physics, with the other half going to the Curies; not something one might call a very fair split.

Wrongful myths

Plenty of myths abound about Skłodowska-Curie. One states that her husband - supposedly a doctoral student of Becquerel's - recommended that the latter take Marie into his laboratory to allow her to work on her own doctorate in his laboratory and under his guidance. The myth is propagated in the book "Marie Skłodowska-Curie: The Significance of Her Discoveries for Medicine", published by Prof. Marek Krawczyk (Warsaw, 2011). However, it is sufficient to review the aforementioned article from 12 April 1898 to see that Skłodowska-Curie conducted her research at the School of Physics and Chemistry (where her husband also worked), and that this had nothing whatsoever to do with Becquerel. Another myth, once popular among the French, was that all the discoveries in the field of radioactivity were supposedly achieved by Pierre Curie, while Marie was simply his competent research assistant.

Skłodowska-Curie's greatness continued to shine throughout her future achievements. Following Pierre's tragic death in 1906, she was entrusted with full authority over his laboratory at Sorbonne, and became the first woman professor in its history. She isolated metallic radium and precisely measured its atomic mass, earning her the second Nobel Prize in 1911, this time in chemistry. She was the only woman personally invited to participate in Solvay Conferences, each gathering around 20 of the world's most outstanding physicists and chemists. She was also the first woman to become director of a major research institution (the Radium Institute in Paris). The institute was home to many more major discoveries; Marie's daughter Irène and her husband Frédéric Joliot were the joint discoverers of artificial radioactivity, for which they were awarded the Nobel Prize in chemistry in 1935. ■