Marie Skłodowska Curie (1867-1934)

by **Koo Yi Xian**

"Life is not easy for any of us. But what of that? We must have perseverance and above all confidence in ourselves. We must believe that we are gifted for something and that this thing must be attained."

– Marie Curie[1]

INTRODUCTION

Maria Salomea Skłodowska, later known as Marie Skłodowska Curie is well known for her contributions towards radioactivity, which is extensively used in medicine even today. She is the first and only woman to be awarded two Nobel Prizes and the only person to be awarded two Nobel prizes in two different sciences.[2] Her act of selflessness was evidently seen throughout her life, as she believed in using science for the betterment of humanity, rather than for personal profit.

HARDSHIP DURING EDUCATION & ADOLESCENCE

Maria was born on 7th November, 1867, in Warsaw, currently known as Poland, which was then under the rule of Russia. Both Maria's parents, Władysław Skłodowski and Bronisława Boguska were teachers and she was their youngest child.

At the age of 10, Maria attended the boarding school of J. Sikorska, followed by a gymnasium for girls, where she graduated on the 12th June, 1883 with a gold medal. Throughout Marie's early education, Marie was consistently the star pupil in her class.

Obtaining an advanced degree was the next goal for Maria. However, Maria was not able to enrol for public universities as higher education was not available for girls during that time in Poland. Together with her sister, Bronisława, who also had the same problem, they decided to come up with financial plans, to assist each other in attaining their goals. Maria offered a bold suggestion—to subsidise Bronisława's study fees by working, as the main hurdle in their lives at that point, was the lack of money. Bronisława studied in a medical school in Paris, which spanned a total of five years, financially supported by Maria. Once Bronisława had completed her studies, she would returned the favour by working to support Maria's educational needs.

In November 1891, Maria was finally able to live the dream that

she had for several years, which was to pursue her desired course of study at the University of Paris. It was then that Maria decided to call herself Marie. Marie lived a tough life—she scrimped and restricted her finances as much as she could. With her meagre wardrobe, she barely kept herself warm during the winter months. Fainting spells were common because she was too engrossed in her studies to eat.

Through due diligence, Marie completed her master's degree in Physics in the summer of 1893. A degree in Mathematics soon followed.

Before the completion of her Mathematics degree, the Society for the Encouragement of National Industry had commissioned Marie to conduct a study on the magnetic properties of different steel. In order to conduct the study, Marie had to first find a laboratory where she can carry out her work. This led Marie to new beginnings, leading the life of a scientist, working with a colleague who would later become her husband.

NEW BEGINNINGS & WORK LIFE

In the spring of 1894, Marie raised her need for a laboratory to a fellow physicist. Through this, Marie was then introduced to Pierre Curie, who was a pioneering physicist specialising in magnetism and was also a laboratory chief at the Municipal School of Industrial Physics and Chemistry in Paris.

Marie was eventually able to find a laboratory space at the Municipal School that had limited capabilities. After working together for some time, their relationship grew and they were married in July 1895, after a simple ceremony. In September 1897, the Curies' welcomed the arrival of their first child, Irene.

BREAKTHROUGH & DISCOVERY

Marie was always intrigued by the works of two other scientists, Wilhelm Roentgen, and Henri Becquerel. Roentgen discovered X-rays, while Becquerel discovered the Becquerel rays.[3] The scientific community focused their efforts on X-rays, neglecting the Becquerel's rays. The latter had always fascinated Marie Curie. Furthermore, as little research was done, data was limited but Marie was able to carry out experimental work on her own.

Radioactivity

In April 1898, her study revealed that Becquerel Rays were emitted by thorium compounds, like those of uranium. To describe this occurrence, she coined this phenomenon 'radioactivity'.[4]

Discovery of Polonium and Radium

Pierre Curie became so interested in Marie's work, that he decided to drop his work on crystals and work alongside her on the same research. From her research, she discovered that two uranium ores, pitchblende and chalcolite, were much more radioactive than pure uranium itself. Hence, she hypothesised that there is a potentiality for the two minerals to contain small amounts of other elements that may be much more radioactive than uranium.

To extract the radioactive compound, a series of fractionating was done.[5] In July 1898, the Curies reached the conclusion that the uranium ores contained an element that were more radioactive than the known elements. They named this potentially new element 'polonium', in honour of Marie's country of birth. Later in December 1898, another discovery was made in the compound, which they named 'radium'.[6]

At that time, the Curies were very close to accomplishing the greatest feat in a scientist's career, that of placing a new element in the Periodic Table.[7] However, the biggest task—to isolate the miniscule amount of polonium and radium—was still ahead of them. This was a crucial point, as

it would provide evidence of the existence of polonium and radium, as well as for the identification and properties of the elements.

In 1902, one decigramme of pure radium chloride was finally extracted from a tonne of pitchblende.[8] However, polonium was never successfully isolated as it has a relatively short half-life. Furthermore, the concept of radioactive decay was not developed at that time. With this discovery being made known to the public, the radium industry blossomed, and the Curies conscientiously published the processes they used to isolate radium, without patenting any of them, as it would require money and time which they barely had enough of. Furthermore, the Curies were set on dedicating their lives to scientific research alone, for the benefit of all humanity. Little did they know that radium would later become a big money maker.

Having a family, as well as an expensive research project to conduct, Pierre sought a job with better pay. However, he was not welcomed at the French universities, due to his unusual educational background.[9] This would soon change, when the University of Geneva made an offer that provided both Curies with a good salary, as well as a personal laboratory in which Marie could work as well. Fearing to lose Pierre to Switzerland, French mathematician Henri Poincaré intervened and Pierre was given a position in a Sorbonne programme, that educated medical students on the fundamentals of physics, chemistry and natural history.

This new position was not without cost, as no laboratory was provided and hence, the Curies continued to work at an old shed. Pierre's teaching load doubled too, as he retained his position at the Municipal School as well, albeit with a salary increment. Marie too, was appointed as a lecturer at France's best teachers' training institution for women, the Sèvres school. Their health too, deteriorated due to the long-term exposure to radiation, of which the dangers were not known then.[10]

RECOGNITION AND DISAPPOINTMENT

Nobel Prize

In December 1903, Henri Becquerel and both Curies, were awarded the Nobel Prize for physics, for their joint efforts. However, the Curies were too ill and busy to travel to the award ceremony that December. Nobel laureates were also required to present a lecture describing the significance of their work. In June 1905, the Curies finally made the trip and Pierre delivered the lectures. The award came with a sum of prize money, some of which, they used to cover the expenses of treating pitchblende and a paid laboratory assistant. Pierre's contribution to science was finally acknowledged, when he was appointed to a professorship alongside a laboratory—a complaint raised by Pierre—that would be completed in 1906, at the Sorbonne.

TRAGEDY AND CHANGE

Unfortunately, on 19th April, 1906, Pierre was killed in an accident while crossing a road in a rainstorm. The French government offered to support Marie and her children with a state pension, but Marie turned this down as she felt that she was capable of supporting herself and her children.

On May 1906, the University of Paris offered Marie an unexpected proposal—to take up Pierre's academic post. One of Pierre's wishes was to own a state of the art laboratory. By taking up Pierre's academic post, she hoped that she could one day fulfil one of his wishes, as a tribute to his memory. To achieve this, Marie had to be more than just a teacher and researcher. She would have to learn how to create a scientific institution.

At that time, being able to build an entirely new institution from scratch independently, was a rare feat. Marie assembled a research staff, by using a generous grant from an American philanthropist in 1907. After some persuasion, the government-funded University of Paris joined the private Pasteur foundation to fund a Radium Institute. However, Marie's new appointment at the Sorbonne and the laboratory was so laborious, she relinquished her position at the Sèvres school, which was taken over by her friend and colleague, Paul Langevin.

Marie successfully isolated pure radium metal in year 1910. Following this was the publication of her comprehensive textbook, as well as securing the authority to set an international standard for radium emissions. This standard was recognised by the international scientific community, which named it the Curie.

For her discovery of radium and polonium, Marie was awarded a second Nobel Prize in chemistry on 10th December, 1911. During that time, she was the world's first and only person to receive two Nobel Prizes.

WORLD WAR I

When Germany declared war on France, on 2nd September, 1914. Marie felt the need to serve her country. However, being a middle-aged woman, her physical capabilities were limited. She in turn, served by utilising her expertise in radioactivity to help in the war efforts.

She realised that bullets and shrapnel embedded in the wounded soldiers' bodies as well as broken bones, can be detected by electromagnetic radiation of X-rays, which could aid doctors during removal or procedures involving the bones. Marie persuaded the government to authorise her to set up France's first military radiology centre. Being the Director of the Red Cross Radiology Service, she cajoled money and cars out of wealthy acquaintances.

Many hospitals in France already had X-ray equipment. However, those machines are often far from the battlefield and when soldiers were transported for treatment, the soldier's condition would have deteriorated. To enable swift and efficient treatment of the soldiers, technology had to be brought closer to the soldiers. By late October 1914, Marie developed the first mobile radiology units. These units transported X-ray equipment to the wounded at the war front, and they were called 'Petites Curies.'

Despite having theoretical knowledge of X-rays at the Sorbonne, practical knowledge was absent. Hence, Marie taught herself and picked up knowledge in anatomy, operating and mechanics of a vehicle and learned how to operate the Petite Curies herself, if required. Her first radiological assistant, was no other than her own daughter, Irene, who was well educated in the fields of science.

During 1915, it became clear that the Germans could not take Paris. Marie then proceeded to retrieve the gramme of radium from Bordeaux, and by using a technique to collect radon, she sealed the radioactive product in a thin glass tube, and delivered them to military and civilian hospitals, which were then encased in platinum needles, and carefully positioned within the patient's body, so that it would most efficiently destroy diseased tissue.[11] While collecting these radioactive vapours, Marie used minimal protection to shield herself.

Multiple mobile x-ray stations and stationary units were present, and so as to staff these stations, Marie trained more personnel, and by 1916, she started training women as radiological assistants in the operation of X-ray machines at the Radium Institute.

Unaware of the effects of long term exposure to x-rays, both mother and daughter were inadequately shielded from the radiation, while saving the lives of countless soldiers.

Simultaneously, Marie also tried to sell her two Nobel medals as well as other medals that were awarded over the years for her contributions in Science to assist in war efforts. However, her offer was declined by the French National Bank. To contribute to the war financially, Marie utilised most of her Nobel prize money to buy war bonds.

On 11th November, 1918, the war ended. However, Marie's war efforts did not stop there. During the spring of 1919, radiology courses were offered to a group of American soldiers who remained in France, while waiting for their transport home. And by the fall of 1919, her laboratory at the Radium Institute was finally ready.

POST-WAR PERIOD

Marie too knew that laboratories and therapy centres in the United States had much more radium than what she had currently. Hence, it was her wish to be able to obtain a second gramme of radium for her laboratory. Soon after, this sparked a campaign, known as the Marie Curie Radium Campaign.

In 1920, Curie alongside her colleagues, created the Curie Foundation, whose mission was to provide resources for the scientific and medical divisions of the Radium Institute. Over the next two decades, the Curie Foundation became a major international force in the treatment of cancer.

The Institute also became an international centre for the measurement of radium content in various products. Marie believed that it was her personal responsibility to provide this service, which was necessary for doctors and others who used radium.

Directing the Curie Institute became the central task of her life. Since science was becoming specialised, she restructured the Radium Institute to function as an entire major laboratory, committed to a single subject.

DETERIORATING HEALTH

Due to the prolonged exposure to radiation without adequate protection, her health deteriorated. Despite the attempts of specialists to diagnose Marie's condition, the root cause was not discovered then. After undergoing a review of a medical expert from Geneva, she was diagnosed with a terminal illness, aplastic anaemia. She passed away at Sancellemoz, a sanatorium, on 4th July, 1934. Two days after her passing, she was laid to rest in Sceaux, alongside Pierre and her in-laws.

In 1995, the remains of both Curies, were moved. She became the first woman, to be entombed on her own merits, alongside her husband, in France's national mausoleum, the Pantheon.

CONCLUSION

Marie Curie was a woman who devoted her life to Science, despite undergoing immense adversity and hardships. She endured through the hardest of times, even if it meant going against the world. She was never a person to put herself first but, instead was a selfless woman, who devoted herself to Science for the betterment of mankind.

ENDNOTES

1. Brainy Quotes, "Marie Curie Quotes", https://www.brainyquote.com/quotes/marie_curie_126077.html
2. A shared Nobel Prize in Physics, followed by a Nobel Prize in Chemistry
3. A ray emitted by a radioactive substance — used before radioactive emissions were

classified as alpha and beta particles and gamma-ray photons. Meriam-webster. https://www.merriam-webster.com/medical/Becquerel%20ray

4. Radioactivity is the emission of ionising radiation or particles caused by the spontaneous disintegration of atomic nuclei.

5. Fractionation is a procedure whereby a mixture/compound is separated into its individual components. In this case, fractionation is carried out by dissolving the pitchblende in acid. This is possible due to the various solubility of individual components to different acids.

6. The name Radium originated from the Latin Word Radius, which meant ray

7. A table illustrating the periodic system, in which the chemical elements, formerly arranged in the order of their atomic weights and now according to their atomic numbers, are shown in related groups. Dictionary.com. http://www.dictionary.com/browse/periodic-table

8. One decigramme is equivalent to 0.1 gramme

9. Pierre's early education was taught by private tutors which was then deem unorthodox

10. Some effects of radiation include: increased risk of cancer, cataracts and potentially harmful genetic changes

11. Radon is a radioactive gas produced by radioactive decay of radium