Marie Sklodowska-Curie

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INTRODUCTION

Nothing in life is to be feared - it is only to be understood.

I believe that Science has great beauty. A scientist in his laboratory is not a mere technician; he is also a child confronting natural phenomena that impress him as thought they were fairy tales.

We should not allow it to be believed that all scientific progress can be reduced to mechanisms, machines, gearings, even though such machinery also has its beauty.
Neither do I believe that the spirit of adventure runs any risk of disappearing in our world. If I see anything vital around me, it is precisely that spirit of adventure, which seems indestructible and is akin to curiosity.

Our society, in which reigns an eager desire for riches and luxury, does not understand the value of science. It does not realize that science is a most precious part of its moral patrimony. Nor does it take sufficient cognizance of the fact that science is at the base of all the progress that lightens the burden of life and lessens its suffering. Neither public powers nor private generosity actually accord to science and to scientists the support and the subsidies indispensable to fully effective work.

MARIE SKLODOWSKA-CURIE

7 NOVEMBER 1867 - 4JULY 1934

Marie Sklodowska-Curie (7 November 1867 - 4July 1934) was one of the greatest scientific minds who brought a fundamental contribution in science opening the door to the understanding/knowledge of the structure of the atom in the 20th century.

Marie Sklodowska-Curie's hypothesis that the spontaneous emission of powerful rays by some chemical elements - emission that she called *radioactivity* - is an *atomic property* of those elements, transformed forever how man would view the atom.

Marie Sklodowska-Curie is best known for her pioneering research of the uranium, developing the theory of radioactivity, devising isotope isolation/purification methods and for the *discovery* of *chemical elements radium* and *polonium*.

Marie Sklodowska-Curie's life is a life filled with self-sacrifice, curiosity and creativity.

Marie Skłodowska-Curie, known better as Marie Curie or Madame Curie, was a Polish physicist and chemist working mainly in France and a professor at the University of Paris (La Sorbonne).

Marie Sklodowska-Curie's entire life's work is the story of the passion to discover scientific truth for the betterment of mankind.

Marie Sklodowska-Curie is the first and only person to win Nobel Prizes for two different fields of science, Physics and Chemistry; she shared the 1903 Nobel Prize in Physics with physicist Antoine Henri Becquerel and physicist Pierre Currie and was the sole winner of the 1911 Nobel Prize in Chemistry.

YOUTH & STUDY YEARS

Marie Curie was Polish, born Maria Salomea Sklodowska in the Nowe Miasto district of Warszawa on November 7, 1867 year in the Russian Empire, Poland having been divided up amongst various European nations due to war and subsequent treaties. The Sklodowska family descended from nobility. Although they had lost their lands and position, the family members maintained their dignity by placing a high value on intellectual pursuits. Her father, Wladislaw Sklodowski, physics teacher and sub-inspector at Warszawa gymnasium studied at university in Petersburg, Russia. Was an erudite man, knew classical languages Latin and Greek and from modern languages Polish, Russian, French, German and English. He translated in Polish, prose and poetry from the most beautiful works of the foreign literature. Her mother, Bronislawa Boguska Sklodowska, was an intelligent, cultivated person, teacher and director of school. She died when Maria was ten years old.
Maria was the last child of five, four girls and a boy.

Known by the nickname Manya, Maria was gifted with a surprising memory; she was a precocious learner, demonstrating genius at age four when she learnt to read. In 1873 year, the six years old Maria begins the school at the private school of Jadwiga Sikorska. Maria was an excellent student, the star pupil in her class, with a strong taste for poetry and willingly learned by heart long passages from great poets, the favourite ones being Mickiewecz, Krasinski and Slowacki. This taste was even more developed when she became acquainted with foreign literatures; her early studies included the knowledge of French, German and Russian, becoming familiar with the fine works written in these languages. Later she felt the need of knowing English and succeeded in acquiring the knowledge of that language and its literature. She learned easily mathematics and physics as far as these sciences were taken in consideration in school. Always having held first rank in class, Maria completed the III National Women's Middle School in Warszawa on 12 June 1883, at the age of fifteen, with gold medal (the third medal in family).

In the family household religion and success in school were emphasized; however, embittered by the deaths of her sister Zosia of typhus (1876) and her mother of tuberculosis (1878), Maria rejected the religious beliefs of her childhood. One of Maria's biographers, Barbara Goldsmith, gives a passage written by the 16-year-old Manya which reveals her unwillingness to accept such tragedies as “God's will” as many Christians would do but in the same time shows her respect for sincere faith and distaste for hypocrisy: *Let everybody keep his own faith so long as it is sincere. Only hypocrisy irritates me—and it is as widespread as true faith is rare… I hate hypocrisy.*
After graduation, at her father’s urging, Maria took a vacation for one year at her uncle’s home at country, to recover after the strain of academic achievement; there she learnt to ride, to row, to swim and also wrote poetry for different anniversaries.
A merry round of dances and other festivities, it would be the only carefree year of her life.

Maria hoped, like her siblings, to study further for an advanced degree. Although her brother Joseph was able to enrol in the medical school at the University of Warszawa, women were not welcome there. Maria and her sister Bronya joined other friends in attending the Floating University, an illegal night school which got its name from the fact that its classes met in changing locations to evade the watchful eyes of the czarist authorities. Its students' lofty goal went beyond mere self-improvement. They hoped their grass roots educational movement would raise the likelihood of eventual Polish liberation. Later Marie Curie wrote: *It was one of those groups of Polish youths who believed that the hope of their country lay in a great effort to develop the intellectual and moral strength of the nation....we agreed among ourselves to give evening courses, each one teaching what knew best.*

I have a bright remembrance of the sympathetic intellectual and social companionship which I enjoyed at that time. Truly the means of action were poor and the results obtained could not be considerable; yet I still believe that the ideas which inspired us then are the only way to real social progress. You cannot hope to build a better world without improving the individuals. To that end each of us must work for his own improvement and at the same time share a general responsibility for all humanity…

It was at this time of her life, in the Floating University, that Manya fell in love with science and experimental work and made the decision to become a scientist:

during these years of isolated work, trying little by little to find my real preferences, I finally turned towards mathematics and physics and resolutely undertook a serious preparation for future work.

Maria's father, professor Sklodowsky, became aged, tired, needed rest and his fortune was very modest (he had lost his savings through bad investments). Maria began to teach private lessons. Followed years of sacrifices, anxiety, humility, exhausting work for her. Only evenings had time to study for herself, the physics of Alfred Daniell, the sociology of Herbert Spencer, lessons of anatomy and physiology by Paul Bert. When she became tired, Maria began to solve difficult exercises of algebra and trigonometry, which forced her to concentrate and so to work further. The works of Louis Pasteur, Charles Darwin, Claude Bernard directed her attention to exact sciences. The chemistry, the biology, in general the sciences became more important for her than literature; with the time the cult of writers was replaced by the cult of savants for her. Because in then Poland the women had no right to university studies, Maria spared money thinking to go in Paris, France to study mathematics, physics and chemistry.

Wladislav Sklodowsky and his daughters Maria, Bronislawa, Helena

Her elder sister Bronislawa (Bronya) wanted also to study in Paris medicine but had no means of subsistence for that. Followed a deal between sisters: Maria would work to support Bronya while she was in the school of medicine and Bronya would return the favour after she completed her studies. In spite of enormous family suffering, due in part to their patriotic activities, the family supported one another to such an extent that two of the sisters, Bronya and Maria, rose above their poverty and entered professions normally reserved for men - Bronya in medicine and Maria as a scientist. Maria worked first as a home tutor at a barrister family in Warszawa, then in 1885 year she accepts a work position as governess at a country side family (in Ciechanow county) for three and half years, where also teaches peasant children to read and write. The work was hard but people appreciated it and Maria was pleased. She used her spare time to study about physics, chemistry, math.

Maria Sklodowska and her sister Bronislawa 1886

Impressed by Maria's intellectual and moral qualities, beside beauty, the eldest son of her landlord asked her to marry him, but his parents opposed to that vigorously: "A gentleman does not marry a governess".
Remembering about that time she confessed to a friend: *… I was barely over eighteen when I first arrived and went through many trials. I count some of those moments as the worst in my life… However I made it through and my strong nature won out, freeing me from this nightmare…Rule number one: never let people or situations take control over you.*
After the three and half years she returned to Warszawa, where a position, similar to the one she had left was awaiting for her. She kept this new place for only a year and then went back to her father, who had retired some time before and was living alone. Together they passed an excellent time, he occupying himself with some literary work, while she increased their funds by giving private lessons. She also continued her efforts to educate herself.

She began her practical scientific training between 1890 -1891 years in a chemical laboratory; she use to go to the Museum of Industry and Agriculture at Krakowskie Przedmieście 66, near Warszawa's Old Town, which in reality was a cover for a scientific laboratory, run by Manya's cousin, Josef Boguska. Educated in St. Petersburg under the great Russian scientist Dmitri Mendeleev, Boguska had also worked as a laboratory assistant for Mendeleev. Dmitri Mendeleev, the father of the Periodic Table of chemical elements, was one of the most advanced intellectuals in the world at that time. More than 10 years later, when Manya Sklodowska had become the great scientist Madame Marie Curie, she would write often to Josef, sharing with him her discoveries.
Laboratories were banned in then Poland. Professor Sklodowski, during his entire life as a teacher of science, had never access to a laboratory. About this period in Warszawa she wrote: *I had little time for work in this laboratory. I could generally get there only in the evening,*

after dinner or on Sunday and I was left to myself. I tried to reproduce various experiments described in the treatises on physics chemistry and the results were sometimes unexpected. From time to time a little unhoped-for success would come to encourage me and at other times I sank into despair because of the accidents or failures due to my inexperience. But on the whole, even though I learned to my cost that progress in such matters is neither rapid nor easy, I developed my taste for experimental research in the fields of physics and chemistry.

Very important was the method of epistemology - branch of philosophy concerned with the nature and scope of knowledge - that she learned from her cousin.

Dmitri Mendeleev had predicted the appearance of many new elements, describing in detail where they would appear on the Periodic Table. The ideas of Mendeleev, in particular the idea that there were many elements yet to be discovered, were planted then in her fertile mind.

Krakowskie Przedmiescie 66, Warsaw
At a lab here, Maria Sklodowska-Curie did her first scientific work
1890-91

In the period of time when her intellect developed from girlhood to young womanhood, Maria turned toward “positivism”, a concept popularized and systematized by the French philosopher August Comte. Positivism stressed the empirical as opposed to the theoretical approach to solving problems and improving society. Polish positivists took this foundation and built upon it while promoting equal rights for women and a nonviolent approach to social change, emphasizing education as the means to achieve lasting progress. Positivism integrated with the scientific spirit of Curie's time as prevailing thinking emerged from the darkness of dogmatic religious assertions. The profound influence of the philosophy of positivism which demanded that assertions and conclusions be supported by verifiable evidence, left its hallmark on the thinking of the young Maria. Insistence on measurable data and verifiable proofs were hallmarks of Marie Curie's success in the field of science.
These beliefs replaced religion for Marie Curie and became a driving force for her achievements in life.

Meanwhile Bronya completed her medical studies in Paris, married a classmate Polish exile Kazimierz Dluski, started a medical practice in Paris. She offered hospitality to Maria in 1890 year. Finally in 1891 year Maria made her way to Paris, happy that although 24 years old begins to study in France. Manya was rename Marie when she enrolled at the University of Paris, La Sorbonne, at the Faculty of Science. At Sorbonne, Marie attended the physics and mathematics courses greedily. She would have wanted to attend all the courses, to listen to all professors, 23 in number! Her ideal was a degree in science. After few months living at her sister, Marie moved close to university in the Latin Quarter where lived artists and students. She threw herself into her studies, working until 10pm at public library and from 10pm to 2am home, but this dedication had a personal cost; with little money, she survived on buttered bread and tea, her health suffering because of her poor diet. Her student years were years of fight, could say heroic fight against hunger, freezing conditions and other difficulties. The holydays she spent with her family in Warszawa.

In the summer of 1893 year, after two years from her arrival in Paris, she had the satisfaction of graduating in first rank as *licenciée es sciences physiques* and after was awarded a scholarship earmarked for an outstanding Polish student graduated in second rank as *licenciée es sciences mathématiques* in 1894 year, extraordinary things for a foreign. Marie had planned to return to Poland after she received her formal education, but before completing the math degree she was commissioned by the "Society for the Encouragement of National Industry" to do a study, relating magnetic properties of different steels to their chemical composition. To accomplish the work she needed a laboratory. The Polish professor Jozef Wierusz-Kowalski from the University of Fribourg recommended her to his friend, the French physicist Pierre Curie, known for his studies in the properties of different types of crystals and laboratory director at Municipal School for Industrial Physics and Chemistry in Paris.

The laboratory facilities were poor, but the presence of a man of Pierre's calibre provided an intellectual ambience for research. The two soon discovered that they share a common passion for science and advanced research. Pierre had dedicated his life to the dream of science; he just found a companion who could live the dream with him. This was the beginning of a partnership that changed not only Marie's course of life, but also the face of the modern science in the twentieth century; the two reshaped the landscape of modern physical understanding and built the foundation for many of major discoveries that followed. Eventually Pierre proposed marriage, but Marie did not accept as she - always Polish at heart - was still planning to go back to her native country. For the 1894 year summer break, Marie returned to Warszawa to visit her family and to find work in her field but she was denied a place at Kraków University because she was a woman. A letter from Pierre convinced her to return to Paris to pursue a doctorate.

French physicist Pierre Curie and Marie Curie, his brilliant student

At Marie's insistence, Pierre had written up his research on magnetism and received for that his Doctor in Science degree in March 1895 year; he was also promoted as professor at the Municipal School in Paris.
On 26 July same year 1895, they married in a civil union in Sceaux, Pierre’s hometown. Their honeymoon consisted of a bike ride around the French village.
In their life together they shared two pastimes, long bicycle trips and journeys abroad. In Pierre, Marie had found not only a partner but also a scientific collaborator.
To obtain a teaching post to support the family, she passed (first) the examination for the aggregation of young women in 1896 year. In the next year 1897, Marie completed and published her work on the investigation of the magnetic properties of the steel and Pierre resumed his investigation on the growth of the crystals.
After the birth of their first daughter Irene in September 1897 year, Marie resumed her laboratory work with the intention of preparing a doctor's thesis.

SCIENTIFIC WORK YEARS

In searching for the subject of her doctoral thesis, the main attraction for Marie Curie was the phenomenon discovered by serendipity in 1896 year by the French physicist Antoine Henri Becquerel. The particular phenomenon discovered by Becquerel was: uranium compound placed on a photographic plate covered with black paper produces on that plate an impression analogous to that which light would make. Henri Becquerel assured himself that that happens even when the uranium compound is kept in darkness for several months. The explanation was that the impression is due to “uranium rays” (radiated by uranium compound) that traverse the black paper. These rays, like X-rays or Roentgen-rays discovered in the previous year, discharge an electroscope, an instrument for detecting and measuring electric charge, because they ionize the air around it. The next step was to ask whence came this minute quantity energy, constantly given off by uranium compounds under the form of radiations.

In 1897 year Marie decided to undertake an investigation on that matter because was entirely new and nothing yet had been written upon it. Her own words: *It was at the close of the year 1897 that I began to study the compounds of uranium, the properties of which had greatly attracted my interest. Here was a substance emitting spontaneously and continuously radiations similar to Roentgen rays, whereas ordinarily Roentgen rays can be produced only in a vacuum-tube with the expenditure of energy. By what process can uranium furnish the same rays without expenditure of energy and without undergoing apparent modification? Is uranium the only body whose compounds emit similar rays? Such were the questions I asked myself, and it was while seeking to answer them that I entered into the researches which have led to the discovery of radium. First of all, I studied the radiation of the compounds of uranium.* She determined the intensity of uranium compounds radiation with the same method used for measuring the X-ray intensity, by measuring the ionization of the air exposed to the action of the rays

not by making these bodies act upon photographic plates. Her words: *experiments proved that the radiation of uranium compounds can be measured with precision under determined conditions and that this radiation is an atomic property of the uranium element, something built into the very structure of its atoms; the intensity of radiation is proportional to the quantity of uranium contained in the compound and depends neither on conditions of chemical combination nor on external circumstances, such as light or temperature*. Next she tried to discover if there were also other elements possessing the same property and with this aim she examined all the elements then known, either in their pure state or in compounds, founding that among those thorium compounds emit rays similar to those of uranium. Her words: *The radiation of thorium has an intensity of the same order as that of uranium and is, as in the case of uranium, an atomic property of the element. It was necessary at this point to find a new term to define this new property of matter manifested by the elements of uranium and thorium.*

Marie Sklodowska-Curie proposed the word *radioactivity* which has since become generally adopted; the radioactive elements have been called *radio elements*.
During the course of research, Marie had occasion to examine not only simple compounds, salts and oxides, but also a great number of minerals. Certain ones proved radioactive; these were those containing uranium and thorium; but their radioactivity seemed abnormal, for it was much greater than that of uranium and thorium. This abnormality was greatly surprising.
When Marie had assured herself that it was not due to an error in the experiment, it became necessary to find an explanation. She then made the hypothesis that the ores uranium and thorium contain in small quantity a substance much more strongly radioactive than either uranium or thorium. This substance could not be one of the known elements, because these had already been examined; it must therefore be a new chemical element. She had a passionate desire to verify this hypothesis as soon as possible.

At this point, Pierre Curie interested and challenged by Marie's comments, abandoned - provisionally he thought- his investigation on crystals' physical properties to join the search for this unknown substance. For work, was used the ore pitchblende, an uranium ore which in its pure state is about four times more active than the oxide of uranium. Pitchblende is highly complex, made of combinations of up to 30 different elements. Since the composition of this ore was known through very careful chemical analysis, was expected to find at a maximum 1% of the new substance. The result of the experiment proved that there were in reality new radioactive elements in pitchblende, but that their proportion did not reach even a millionth per cent! Marie tried a tedious technique called fractional crystallization to separate the different substances from a solution of pitchblende. This procedure depends on the fact that different substances in the same solution vaporize and form crystals at different temperatures. Those with lower atomic weights vaporize and crystallize first.

Marie first boiled the pitchblende solution, then gradually cooled it and finally tested the formed crystals for radioactivity with the electrometer. She discarded the crystals that were not radioactive or only slightly. She repeated this technique over and over again on the solution, retaining the more radioactive fraction and discarding the less active crystals. With each fractional crystallization the crystals became increasingly radioactive. With this method, soon became recognized that the radioactivity was concentrated principally in two different chemical fractions, indicating the presence in pitchblende of at least two new radioactive elements, considered *polonium* and *radium*; so Marie and Pierre Curie announced at the French Academy of Sciences the existence of the element *polonium* in July 1898 year, when the statement used the term *radioactivity* for the first time and of the element *radium* in December of the same year.

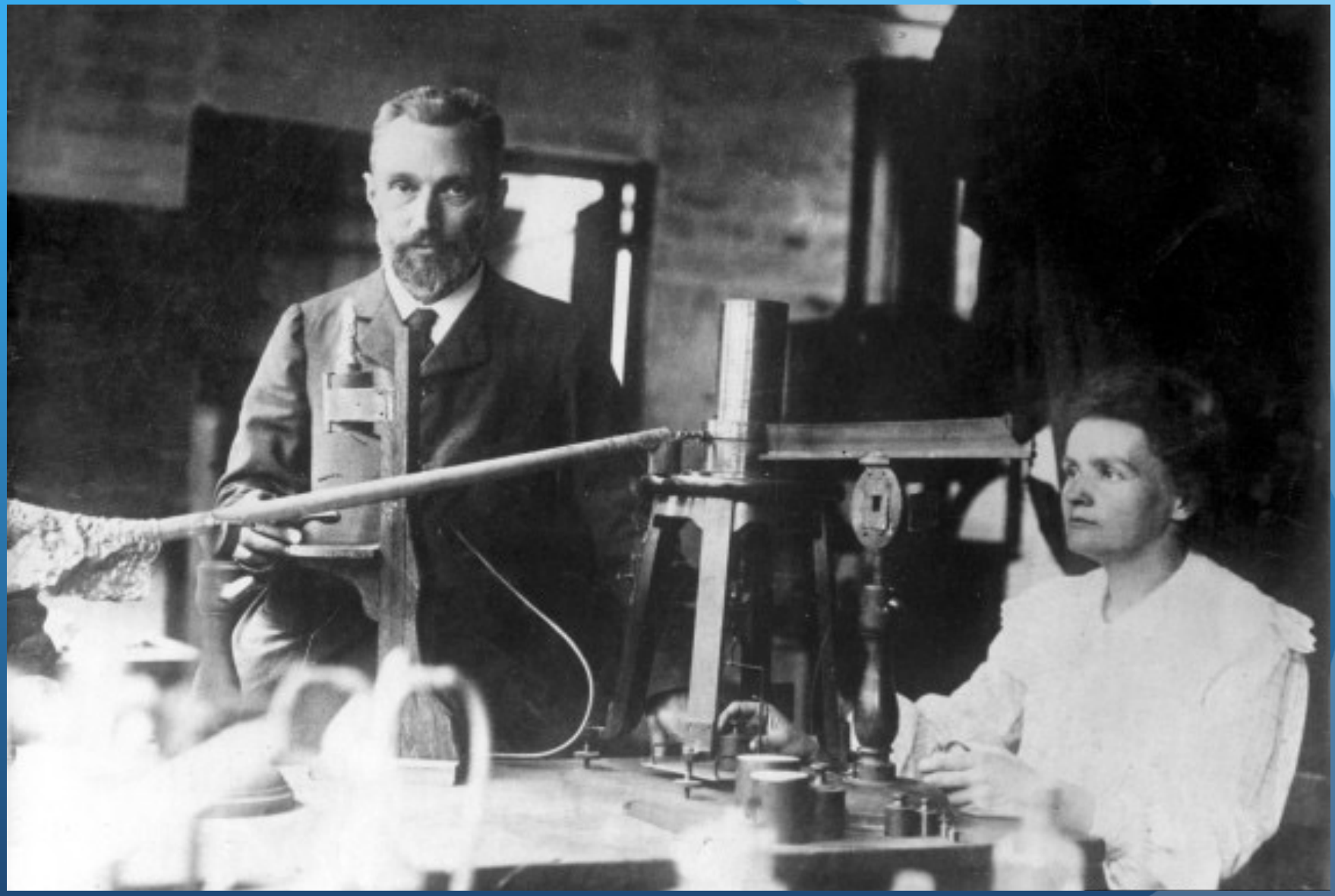
Polonium was named after Marie Curie's native land of

Poland (Latin: *Polonia*). Poland at that time was under Russian, Prussian and Austrian partition and did not exist as an independent country, so may be polonium was the first element named to highlight a political controversy. *Radium* was named after the Latin word “radius” for ray, called for its power of emitting energy in the form of rays. In 1898 year Marie Curie, then thirty-one years of age, received the **Gegner Prize** from the French Academy of Sciences, nominally “for her extensive researches relating to the magnetic properties of iron and steel, but also alludes to the researches in radio-activity which she had already begun in co-operation with her husband and to their recent discovery of the radio-active element which Mme. Curie named Polonium, in honour of her native country”. She received word of this through her husband, because the members of the Academy did not think it is proper to inform a female laureate directly.
The **Gegner Prize** was awarded to Marie Curie again by the French Academy of Sciences in the year 1900 and a third time in the year 1902 together with the **Berthelot Medal**.

In spite of this relatively rapid progress, the work was far from finished. In Curies' opinion, there could be no doubt of the existence of these new elements, but to make chemists admit their existence, it was necessary to isolate them. Now, in the most strongly radioactive products (several hundred times more active than uranium), the polonium and radium were present only as traces. The polonium occurred associated with bismuth extracted from pitchblende and radium accompanied the barium extracted from the same ore. Was already known by what methods might hope to separate polonium from bismuth and radium from barium; but for that separation was necessary to have much larger quantities of the primary ore. During this period the research was extremely handicapped by inadequate conditions, lack of a proper place to work in, lack of money, lack of personnel. Pitchblende was an expensive mineral, the principal source of this mineral was the silver mines at St. Joachimsthal, Bohemia in the Austrian Empire. The uranium ore was only a by-product of the mining activities.

The Curies believed that would find the radium and the polonium in the unused residues of this mine and thanks to the influence of the Academy of Sciences of Vienna, they secured several tons of these residues at an advantageous price as primary material. In the beginning they used their private resources to pay the costs of experiment; later they had a few subventions and some help from outside sources. So the work started in an abandoned storeroom, a wooden shed with a bituminous floor and a glass roof which did not keep the rain out and no interior arrangements. The only objects it contained were some worn pine tables, a cast-iron stove, which worked badly and a blackboard. There were no hoods to carry away the poisonous gases thrown off in the chemical treatments, so that it was necessary to carry them on outside in the court, but when the weather was unfavourable they went on with them inside, leaving the windows open. In this makeshift laboratory they worked practically unaided during two years, occupying themselves as much with the chemical research as with the study of radiation of the increasingly active obtained products.

Marie did all the chemical experiments with the objective of preparation of pure radium salts. Pierre did investigate the physical properties of radium. Marie had to work with as much as twenty kilograms of material at a time, so the hangar was filled with big vessels full of precipitates and of liquids. It was an exhausting work to move the containers about, to transfer the liquids and to stir for hours, with an iron bar, the boiling material in the cast-iron basin. Marie extracted from the mineral the radium-bearing barium in the state of chloride and submitted it to a fractional crystallization. The radium accumulated in the least soluble parts and was believed that this process must lead to the separation of the chloride of radium. The very delicate operations of the last crystallizations were exceedingly difficult to carry out in that laboratory, where it was impossible to find protection from iron and coal dust. After a year the results indicated clearly that it would be easier to separate radium than polonium, so the efforts went in that direction. Were examined the radium salts obtained with the aim of discovering their powers and were loaned samples.



MARIE AND PIERRE IN LABORATORY

The Curies observed/discovered also that solid substances which are placed in the vicinity of radioactive substances, themselves become temporarily radioactive, naming the phenomenon *induced radioactivity*. In 1899 year the French chemist André-Louis Debierne, close friend of Pierre and Marie Curie and associated with their work, discovered the third radioactive element, *actinium*, as a result of continuing the work with pitchblende that the Curies had initiated. In the same year followed the discovery of other new radioactive elements by other physicists.
Was observed also that several radioactive substances such as radium, actinium and thorium act on the surrounding air which becomes radioactive. In 1900 year the New Zeeland physicist and chemist Ernest Rutherford assumes that each of these substances emits an unstable radioactive gas which he calls *emanation* and which spreads in the air surrounding the radioactive substance. The *induced radioactivity* and the *emanation* were equally unstable and destroyed spontaneously according to exponential laws characteristic for each.

During the years 1899 and 1900, Marie and Pierre Curie published:

Memoir on the discovery of the radioactivity produced by radium by Marie and Pierre Curie

Paper on the effects of the rays - the luminous effects, the chemical effects, etc by Marie and Pierre Curie

Paper on the electric charge carried by certain of the rays by Marie and Pierre Curie

Study of the action of a magnetic field on radium rays by Pierre Curie

Final general report on the new radioactive substances and their radiations for the Congress of Physics which met in Paris in 1900 year by Marie and Pierre Curie

The 1900 Congress of Physics offered the opportunity to make known to foreign scientists, the new radioactive bodies. This was one of the points on which the interest of this Congress chiefly centred.

Marie and Pierre had an especial joy in observing that their products containing concentrated radium were all spontaneously luminous (material containing radium spontaneously emitted light). Radium was soon seen as a magical substance whose rays could cure all ills, power wondrous machines or destroy a city at one blow.

In 1900 year Pierre obtained a position as a professor in the Faculty of Sciences in Rue Cuvier (annex of Sorbonne) and Marie obtained a position as a professor in the Higher Normal School for Girls at Sevres near Versailles.
In 1902 year Marie Curie succeeded to prepare a decigram of chloride of radium $RaCl_2$ solution and could determine the atomic weight of radium; the atomic weight increased with the solution enrichment in radium. So a new element, Radium with symbol Ra, appears in **Mendeleev Table**, group 2/period 7. In 1903 year under the doctoral supervision of Henri Becquerel, Marie Sklodowska-Curie sustains her doctor thesis (dissertation) with the subject *Recherchés sur les substances radioactives* (*Research of radioactive substances*). 40,000 words French text was reprinted and revised four times over the next twelve months; translated in English appeared in Britain in year 1903 and in America in 1904 and appeared in German and Polish editions too. Based on her doctoral thesis outlining the success of her experiments, Marie was awarded a **Doctor in Science** degree from the University of Paris,

La Sorbonne, in June 1903 year. After the standard formula: “The University awards the title of doctor in physics sciences with the mention of very well with distinction” the president of the examining committee added: “In the name of the jury and my I express all our congratulations”. That month, she and Pierre were invited to the Royal Institution in London to give a speech on radioactivity; being female, she was prevented from speaking and Pierre alone was allowed to.
Years of toil, autumn 1897-spring 1903, led in 1903 year to the award of the prestigious **Davy Medal** of Royal Society of London and of the **Nobel Prize for Physics**.
The Davy Medal is awarded by the Royal Society of London "for an outstandingly important recent discovery in any branch of chemistry”.
The Nobel Prize (Swedish: “Nobelpriset”; Norwegian: “Nobelprisen”) is a set of annual international awards bestowed in a number of categories by Scandinavian committees in recognition of cultural and/or scientific advances. The will of the Swedish philanthropist inventor Alfred Nobel established the prizes in 1895 year. The prizes in Physics, Chemistry, Physiology or Medicine, Literature and Peace were first awarded in the year 1901.

The 1903 Nobel Prize in Physics was divided, one half awarded to Antoine Henri Becquerel “in recognition of the extraordinary services he has rendered by his discovery of spontaneous radioactivity”, the other half jointly to Pierre Curie and Marie Curie, née Sklodowska, “in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel”.
Marie was not really nominated for the Nobel Prize. In 1903 year the French Academy of Sciences nominated Henri Becquerel and Pierre -- but not Marie -- Curie as candidates for the physics prize. If not for the intervention of a member of the nominating committee, Swedish mathematician Magnus Goesta Mittag-Leffler, Marie might have been denied recognition for her work. But Mittag-Leffler, an advocate of women scientists, wrote Pierre advising him of the situation. In his reply Pierre made clear that a Nobel Prize for research in radioactivity that failed to acknowledge Marie's pivotal role would be a travesty.

Pierre wrote: “If it is true that one is seriously thinking about me for the Nobel Prize, I very much wish to be considered together with Madame Curie with respect to our research on radioactive bodies.”
Radioactivity, born in France, rapidly conquered in foreign countries. From 1900 onwards, the Curies received letters signed by the greatest names in science with requests for information. The “parents” of radium were lavish of explanations and technical advice to their colleagues.
In more countries the researchers rushed into search for unknown radioactive elements, hopping for new discoveries. It was a fruitful pursuit, to which the mankind owes mesothorium, radio-thorium, ionium, protactinium and radio-lead. When Henri Becquerel discovered “his” uranium rays in 1896 and when Marie Curie began to study them in 1897, there was no knowledge about the origin of X-rays or uranium rays and in the physical science was given that the atom was indivisible and unchangeable. But the work of Becquerel and Curie led scientists to suspect that this theory of the atom was untenable.

Diploma of Nobel Prize in Physics, awarded in December 1903 to Pierre and Marie Curie

Both shared this distinction with Henri Becquerel, whose name is mentioned on the document

HENRI BECQUEREL PIERRE CURIE MARIE CURIE

1903 PHYSICS NOBEL PRIZE RECIPIENTS

In 1903 year two English scientists, William Ramsay and Frederick Soddy, experimented that radium continually disengaged a small quantity of gas, helium, the first recognized example of transformation of atoms/elements - was detected spectroscopically the formation of helium from radium emanation. Later, in 1906 Rutherford taking up a hypothesis considered by Marie Curie as early as 1900, published the striking “Radioactive Transformations”, affirming that radioelements are in a state of spontaneous evolution/transformation. Meanwhile, a new industry began developing based on radium. The Curies did not patent their discovery and benefited little from this increasingly profitable business. They deliberately filled no patents, reaped no fees for technical advice, but aided the industrialist Armet de L’Isle to set up a radium factory on the outskirts of Paris and the American mining engineers when they started radium extraction in Buffalo, New York. Also it was becoming apparent that radium had a potential and lucrative commercial future in medicine but both Marie & Pierre were opposed to profiting from scientific research and believed all their work should be freely available.

From 1899 year to 1904 year, Marie Curie and Pierre Curie published separately, together or in collaboration with their colleagues thirty two scientific communications. Each of them represents a victory. Some of the most important reports are:

On the chemical effects of radium rays by Marie Curie & Pierre Curie 1899
On the Atomic Weight of Radi-ferous Barium by Marie Curie 1900
The new radioactive substances and rays they emit by Marie Curie & Pierre Curie 1900
On induced radioactivity provoked by radium salts by Pierre Curie & Andre Debierne 1901
The physiological action of radium rays by Pierre Curie & Henry Becquerel 1901
On radioactive bodies by Marie Curie & Pierre Curie 1901
On the atomic weight of radium by Marie Curie 1902
On the absolute measure of time by Pierre Curie 1902
On induced radioactivity and on emanation of radium by Pierre Curie 1903
On the heat spontaneously disengaged by radium salts by Pierre Curie & A. Laborde 1903
Researches on radioactive substances by Marie Curie 1903
On the radioactivity of gases freed by the water of thermal springs by Pierre Curie & A. Laborde 1904
The physiological action of the emanation of radium by Pierre Curie, Charles Bouchard & V. Balthazard 1904

In 1904 year the Curies received the **Matteucci Medal**. The Matteucci Medal was established to award physicists for their fundamental contributions, by an Italian Royal Decree dated July 10 1870 year when the Italian Society of Sciences was authorized to accept the donation from Carlo Matteucci for establishment of a Prize.
Marie and her husband declined to go to Stockholm to receive the 1903 Physics Nobel Prize in person; they were too busy with their work and Pierre, who disliked public ceremonies, was feeling increasingly ill. After the birth of their second daughter Eve Denise on 6th December 1904, the Curies finally decided to undertook the trip to Stockholm. As Nobel laureates they were required to deliver a lecture, so on June 6th, 1905 in the name of his wife and himself, Pierre Curie spoke about radium before the Academy of Science of Stockholm. He evoked the consequences of the discovery of radium:
“ - In physics it profoundly modified the fundamental principles of mechanics.

- In chemistry it stirred up bold hypotheses on the source of energy which supplied the radioactive phenomena
- In geology and meteorology it was the key to phenomena never explained before.
- In biology the action of radium on cancerous cells had proved efficacious.

Radium had enriched Knowledge and served the God. But could it also serve the Evil? One may also imagine that in criminal hands radium might become very dangerous…
I am among those who think, with Nobel, that humanity will obtain more good than evil from the new discoveries."
Following the award of the Nobel Prize and galvanized by the offer from the University of Geneva, which offered Pierre a position, La Sorbonne gave Pierre a professorship and the chair of physics, but without a proper laboratory. Upon Pierre's complaint, La Sorbonne relented and agreed to furnish a new laboratory, but it would not be ready until 1906 year.

At the turn of the twentieth century the discovery of radium was considered one of the most important scientific discoveries in the human history. The Curies continued to experiment with radium salts they had distilled from hundreds of pounds of pitchblende, refining the distillation process. Eventually, in 1905 year Pierre Curie was elected to the Academy of Sciences. Their work progressed until 19th April 1906 when Pierre was killed in a fatal carriage accident on the streets of Paris.

Marie became a widow with two young children at the age of 38 years. The Sorbonne physics department decided to offer the professor chair of Pierre to Marie. On 13th May 1906 she became the first woman professor at La Sorbonne and on 4th November 1906 the journals announce the opening of Madam Curie course. For the first time a woman speaks at La Sorbonne, a woman who is in the same time a genius and a desperate wife. Her courses are at the level of those sustained by professors who inspired and captivated Maria Sklodowska once. In the same year she received the **MERIT Award** from the French Foundation for Science.

In 1910 year her *Treatise on Radioactivity* was published. Marie Curie continued the research into radium and radioactivity. She wanted to separate radium into its purest form because the distillation process she developed left it as part of a chloride salt compound, radium chloride $RaCl_2$. In 1910 year her experiments proved successful when was passed a current through pure radium chloride solution(electrolysis of radium chloride with a mercury cathode) reducing the material to an amalgam that further processed became pure Radium, a radio element, a silvery-white, shiny metal. Résumé: Radium is found in nature in uranium ores in trace amounts as small as a seventh of a gram per ton of uraninite (uranium-rich mineral and ore); Radium was discovered by Marie Skłodowska-Curie and Pierre Curie in 1898 year; they extracted the radium compound from uraninite and published the discovery at the French Academy of Sciences five days later; Radium was isolated in its metallic state by Marie Sklodowska-Curie and André-Louis Debierne through the electrolysis of radium chloride in 1910 year.

After the break-through of pure radium Marie was awarded the **1911 Nobel Prize for Chemistry** making her the first person to receive two Nobel prizes for scientific endeavours. The Nobel Prize in Chemistry 1911 was awarded to Marie Curie “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”.
Rumors and gossip surrounded the award; many jealous scientists sniped that she had been awarded the Nobel Prize only out of pity since her husband, Pierre, has recently died, while others alleged that she is "morally unfit" to receive the prize; the Swedish Academy which inform her early 1911 that she would receive again the Nobel Prize, told her later that they did not want her to come to the public ceremony in Stockholm. Marie defied their wishes and went to the ceremony. Curie's second Nobel Prize enabled her to talk to the French government into supporting a Radium Institute for research in chemistry, physics and medicine. It will be built in 1914.
Marie was participating at international conferences aimed to physics and chemistry as were the **Solvay Conferences**.

MARIE CURIE
1911 CHEMISTRY NOBEL PRIZE RECIPIENT

MARIE SKLODOWSKA CURIE
1911 NOBEL PRIZE DIPLOMA

After the fame of Curie couple, the personal fame of Madame Curie mounted and spread like a rocket. **Diplomas** of **Doctor Honoris Causa** or of **Corresponding Member of Foreign Academies** arrived by dozen, though the laureate never dreamed to make a show of them or even drawing up a list of them. France has only two ways of honoring her great men during their lifetime: the Legion of Honor and the Academy. The cross of chevalier was offered to Marie in 1910, but inspired by the attitude of Pierre she refused it. Early in 1911 year, however Marie Curie was denied election to the French Academy of Sciences by one vote, 28/29. The French physicist Emile Hilaire Amagat member of Academy said : "Women cannot be part of the Institute of France."
Marie Curie refused to have her name resubmitted for nomination and refused to allow the Academy to publish any of her work for ten years.
Marie Curie was appointed director of the Institute for Radioactivity in Warszawa that year 1911.

FIRST SOLVEY CONFERENCE 1911

The **Solvay Conferences** (*Conseils Solvay)* were very important; after the initial success in 1911 year with subject about the theory of radiation and quanta, they have been devoted to outstanding preeminent open problems in both physics and chemistry with an usual schedule at every three years.
In 1914 year Marie Sklodowska-Curie was named director of the Sorbonne's Radium Institute in Paris, established in her and her husband's honour. The institute made significant advancements in the use of X-ray technology and its medical applications during World War I (1914-1918) and Marie worked feverishly to make the medicinal benefits of radium also available to soldiers in combat. After the start of World War I Marie donated Roentgen machines to hospitals, establishing two hundred permanent X-ray installations in France and Belgium and from September 1914, serving as director of radiology for the French Red Cross, she organized moving "Roentgen points" along the front with donated cars converted as ambulances.

In total Marie compiled 20 radiology vehicles as ambulances. Marie worked as ambulance driver, driving the vehicles to the front lines; the ambulances equipped with portable X-ray equipment for medical purposes, were popularly known as “little Curies”. She also recruited and trained 150 young women as radiologic equipment operators to treat wounded soldiers; among them was her own daughter Irene Curie. Thanks to Marie’s determination and her 20 vehicles, which she gathered and equipped, over 1,000,000 soldiers were screened, saving the lives of thousands. Her daughter Irene showed herself to be useful and brave in the roles of helper and chief of radiology staff in various military hospitals. A grateful French government decorated Irene with a medal. Marie Curie received nothing.

Her wartime experiences were summarised in the book *Radiology in War* (1919, published in 1921) presenting scientific lessons learned from war.

MARIE CURIE IN A MOBILE X-RAY VEHICLE

In the Curie laboratory of the Radium Institute in Paris, Marie worked from 1919 to 1934, coordinating the research of the scientists who published 483 works including 31 papers and books by Marie Curie. In 1917 year, the National Institute of France appointed her as advisor in the Physics Research Review Committee. In 1918 year after Poland won its independence, Maria took the first steps to create Radium Institute in Poland. Curie Foundation was established in 1920 year to work on medical applications for radium.
Marie Curie took an important trip to the United States in 1921 year to accept the generous gift of a gram of pure radium for research. Comments: “On May 27, 1921 Marie Curie, Nobel Laureate, visited the Standard Chemical Company works in Canonsburg, Pennsylvania, USA. The visit was part of a six-week tour of the United States that earlier included a reception at the White House where President Harding presented a gift of a gram of radium that had cost $100,000. The radium was produced by the Standard Chemical Company. For much of her visit to Western Pennsylvania, Mme. Curie was not in the best of health, which resulted in postponements and curtailments of scheduled activities. However, she seemed energized during her visits in Pittsburgh and Canonsburg.”

Was no corner of world where her name was not known.
On 7th February, 1922 Marie was inducted into the Paris Medical Academy, breaking a 224 years old tradition of excluding women. Her candidacy was submitted by 35 members of the Academy and 65 members from other academies supported her. The academy's president praised Marie for being a great scientist and patriot: "Your presence here brings us the moral benefit of your example and the glory of your name. You are the first woman of France to enter an academy but what other woman could have been so worthy?"
On 15th May 1922, Marie was named member of the International committee on Intellectual Cooperation of the League of Nations. In that quality she protected researchers' ownership of intellectual rights for their discoveries (although she avoided material profit for herself) and developed standards for international scientific scholarships. It was to be her only infidelity to scientific research.

In the year 1923 Curie foundation and the university celebrated 25 years from the discovery of radium. Students, teachers, friends, politicians, fellow scientists came in droves at celebration. Marie's sisters Helena and Bronia and her brother Jozef came to share Marie's moment in the spotlight in France. The president of France Alexandre Millerand presided over the festivities with her close friend scientist Andre Debierne reading the 1898 year report titled *On a New and Strongly Radioactive Substance Contained in Pitchblende* by Pierre Curie, Madam Curie and M.G. Bemont. To celebrate the occasion the French government passed through parliament by unanimous vote a law granting Marie, as national recompense (reward), an annual pension of 40,000 francs. After her death her daughters Irene and Eve would inherit the money.
In 1924 year, Marie published the biography of her husband.
In 1925 year, Maria Sklodowska-Curie laid the first stone at the site of construction for the Warszawa Radium Institute.

In 1926 year the Lublin Medical Society unanimously elected Maria as a honorary member and the Faculty of Physics of Warszawa University of Technology awarded her the title of **Doctor Honoris Causa**.
In 1927 year she participated again at the famous **Solvay Conference** in Brussels (the fifth) with the subject about electrons and photons, where the world's most notable physicists met to discuss the newly formulated quantum theory. She lectured extensively, participated in numerous scientific congresses, assemblies, ceremonies, symposia and visits to laboratories, published in her specialty, participated in the formation of numerous scientific institutions, helped shaped the nature of research for next generations. Always she tried to make herself useful.
A second visit in USA in the year 1929 facilitated the meeting with president Herbert Hoover offering the funds to purchase another gram of radium. She stockpiled radium at Paris Radium Institute for scientific use, for advance medical applications and enable other scientists to conduct seminal research on their own.

In 1931 year, the Radiological Society in Paris presented her with the **Gold Medal** for her work in Science.
On 29th May 1932 Marie visited Poland for the last time when she participated in the opening ceremony of the Radium Institute, where the treatment of cancer patients had already begun using radium from USA.

But the health of Marie Curie was weakening.
The work of Marie Curie, her husband and colleagues with radioactivity was done in ignorance of its effect on human health. At the time of their research, the dangers of ionising radiation were unknown; Marie did not wear protective clothing or employ any other safety practices in her research, working in what was essentially a shed and even carrying test tubes of radioactive material in her pockets. The notebooks of Marie Curie are still so radioactive that they cannot be handled. The long manipulating of radium transforms that in her own killer.

Her spinal marrow was not reacting more because of the long exposure to radiations. Cataracts contributed to failing vision. She developed aplastic anaemia later identified as leukaemia as a result of her prolonged exposure to radiation and died on 4th July 1934 in the sanatorium Sancellemoz, Passy, France. Marie Curie's life ended by the element she discovered, radium.
The news spread fast. All people went into mourning. Marie Curie was never a Polish citizen, though her family were Polish nationalists. At the time of her departure from Warszawa, the Polish state simply did not exist. Also she was rejected by the Russian-Polish scientific establishment because of her gender. By necessity she became educated in France, joined the French scientific community, married a French citizen, became a French citizen, spent her entire adult life in France and was buried in French cemetery in Sceaux near her husband Pierre. 60 years later, in April 1995 their remains were dug up and re-interred with honours, enshrined in the crypt of the Panthéon in Paris.

When the ashes of scientist *Marie Curie* were entombed in Paris' *Panthéon*, the memorial dedicated to the "great men" of France like Voltaire, Jean-Jacques Rousseau, Victor Hugo, Emile Zola, the words of the France president, François Mitterrand, at ceremony were: “the first lady so honoured in our history for her own merits”. The president Lech Walesa of Poland joined Mr. Mitterrand at the ceremony.
Marie Curie’s last book with her lecture course of Sorbonne was published posthumously in 1935 year.
In addition to have a spectacular career Marie raised two daughters largely as a single mother and saw that they were well educated, physically strong and independent. Her first daughter Irene Curie continued family tradition at Radium Institute. Irene Curie and her husband Frederic Joliot received the 1935 Nobel Prize in Chemistry for the discovery of artificial radioactivity; they became prominent scientists. Her second daughter Eve Denise Curie became a talented writer and pianist.

Schools, universities and institutes around the world have been named in Marie Curie's honour celebrating the scientist who put learning and discovery above everything. Marie Curie's Warszawa birthplace is now a museum documenting her life.

The life of Marie Curie is the most beautiful example of lack of interest work pushed to heroism. Her work is everlasting; generation of people after generation of people uses her research, her guidance, her publications. Marie once said:
You must not forget that when radium was discovered no one knew it would prove useful in hospitals. The work was one of pure science and this is a proof that scientific work must not be considered from the point of view of the direct usefulness of it. It must be done for itself, for the beauty of science and then there is always the chance that a scientific discovery may become like the radium, a benefit for humanity.

MARIE SKLODOWSKA-CURIE
LUBLIN POLAND MONUMENT

PRIZES

MEDALS

DECORATIONS

HONORARY TITLES

PRIZES

Prix Gegner Academie des Sciences, Paris
12th December 1898, 11th December 1900, 14th December 1902

Nobel Prize for Physics 1903 with Henry Becquerel & Pierre Curie

Prix Osiris with M. Branly, Syndicat de la Presse Parisienne,4th Jan 1904

Actonian Prize Royal Institution of Great Brtain, 6th May 1907

Nobel Prize for Chemistry 1911

Ellen Richards Research Prize 23rd April 1921

Grand Prize du Marquis d'Argenteuil 1923 with bronze medal
Societe d'Encouragement pour l'Industrie Nationale, 15th March 1924

Cameron Prize University of Edinburgh, 1931

MEDALS & DECORATIONS

Berthelot Medal 1903 with Pierre Curie

Medal of Honour of the City of Paris 1903 with Pierre Curie

Davy Medal with Pierre Curie, Royal Society of London 5th Nov 1903

Matteucci Medal with Pierre Curie, Italian Society of Sciences, 8th Aug1904

Kuhlmann Gold Medal Society of Industry of Lille, 19th Jan 1908

Elliott Cresson Gold Medal Franklin Institute, 6th January 1909

Albert Medal Royal Society of Arts, London, 4th July 1910

Grand Cross of the Civil Order of Alphonse XII of Spain
28th April 1919

Benjamin Franklin Medal American Philosophical Society
Pholadelphia, 1921

John Scott Medal American Philosophical Society, Philadelphia, 13th April 1921

Gold Medal of the National Institute of Social Sciences
New York 1921

Willard Gibbs Medal American Chemical Society, Chicago, 1921

Order of Merit of Roumania, first class, with warrant and gold medal 4th August 1924

Gold Medal of the Radiological Society of North America
8th December 1922

Medal of the New York City Federation of Women's Clubs
1929

Medal of the American College of Radiology 16th April 1931

HONORARY TITLES

Honorary Member of the Societe Imperiale des Amis des Sciences Naturelles d'Anthropologie et d'Ethnographie, 1st December 1904

Honorary Member of the Royal Institution of Great Britain, 9th May 1904

Foreign Member of the Chemical Society of London, 18th May 1904

Corresponding Member of Batavian Philosophical Society, 15th Sept 1904

Honorary Member of the Mexican Society of Physics 1904

Honorary Member of the Mexican Academy of Sciences, 4th May 1904

Honorarty Member of the Warsaw Society for the Encouragement of Industry and Commerce 1904

Corresponding Member of the Argentine Society of Sciences, 6th Nov 1906

Foreign Member of the Dutch Society of Sciences, 25th May 1907

Doctor of Laws, University of Edinburgh, 2nd February 1907

Corresponding Member of the Imperial Academy of Sciences, St. Petersburg, 20th January 1908

Honorary Member of the Society of Natural Sciences, Brunswick 10th March 1908

Doctor of Medicine, University of Geneva 1909

Corresponding Member of the Academy of Sciences, Bologne 31st March 1909

Associate Foreign Member of the Czechish Academy of Sciences, Arts and Letters 1909

Active Foreign Member of the Academy of Sciences, Cracow 1909

Honorary Member of the Philadelphia College of Pharmacy 27th September 1909

Corresponding Member of the Scientific Society of Chili 19th December 1910

Member of the American Philosophical Society, 23rd April 1910

Foreign Member of the Swedish Royal Academy of Sciences 1910

Honorary Member of the American Chemical Society, 1st March 1910

Honorary Member of the London Society of Physics 1910

Honorary Member of the Society for Psychical Research of London 1st February 1911

Foreign Corresponding Member of the Portuguese Academy of Sciences 19th April 1911

Doctor of Sciences, University of Manchester, 24th November 1911

Honorary Member of the Belgian Chemical Society, 16th April 1912

Collaborating Member of the Imperial Institution of Experimental Medicine, St Petersburg, 12th April 1912

Member of the Scientific Society of Warsaw 1912

Honorary Member in Philosophy of the University of Lemberg 1912

Member of Warsaw Photographic Society 1912

Doctor of the Polytechnic School, Lemberg 1912

Honorary Member of the Vilna Society of the Friends of Sciences 20th July 1912

Member Extraordinary of the Royal Academy of Sciences (mathematics and Physics Section) Amsterdam, 21st May 1913

Doctor, University of Birmingham 1913

Honorary Member of the Association of Arts and Sciences of Edinburgh 15th January 1913

Honorary Member of the Physico-Medical Society of the University of Moscow, March 1914

Honorary Member of the Philosophical Society of Cambridge 30th May 1914

Honorary Member of the Scientific Institution of Moscow, March 1914

Honorary Member of the Institution of Hygiene, London, 15th April 1914

Corresponding Member of the Philadelphia Academy of Natural Sciences, 22nd April 1914

Honorary Member of the Royal Spanish Society of Medical Electrology and Radiology, 1st April 1918

Honorary President of the Royal Spanish Society of Medical Electrology and Radiology, 25th April 1919

Honorary Director of the Radium Institute of Madrid, 5th July 1919

Honorary Professor of the Warsaw University 1919

Member of Polish Chemical Society 1919

Ordinary Member of the Danish Royal Academy of Sciences and Letters 1920

Doctor of Sciences of Yale University, 10th June 1921

Doctor of Sciences of the University of Chicago, 18th July 1921

Doctor of Sciences of the North-western University, 15th June 1921

Doctor of Sciences of Smith College, 13th May 1921

Doctor of Sciences of Wellesley College, 12July 1921

Doctor of the Women's Medical College of Pennsylvania 23rd May 1921

Doctor of Sciences of Columbia University, 1st June 1921

Doctor of Laws of Pittsburgh University, 7th June 1921

Doctor of Laws of University of Pennsylvania, 23rd May 1921

Honorary Member of the Buffalo Society of Natural Sciences
16th June 1921

Honorary Member of the Mineralogical Club of New York
20th April 1921

Honorary Member of the North American Radiological Society 1921

Honorary Member of the New England Association of Chemistry Teachers
14th April 1921

Honorary Member of the American Museum of Natural History
20th April 1921

Honorary Member of the New Jersey Chemical Society
16th May 1921

Honorary Member of the Industrial Chemistry Society
13th July 1921

Member of the Christiania Academy, 18th March 1921

Honorary Life Member of the Knox Academy of Arts and Sciences 18th June 1921

Honorary Member of the American Radium Society, 29th July 1921

Honorary Member of the Norwegian Society for Medical Radiology 15th October 1921

Honorary Member of Alliance Francaise of New York, 10th June 1921

Associate Member, Academie de Medecine Paris, 7th February 1922

Membre Honoraire du Groupe Academique Russe de Belgique 22nd January 1922

Honorary Member of the Romania Society of Medical Hydrology and Climatology, 10th January 1923

Doctor of Laws of the University of Edinburgh, 9th July 1923

Honorary Member of the Czechoslovakian Union of Mathematicians and Physicists, 20th January 1923

Honorary Citizen of the City of Warsaw 1924

Honorary Member of the Polish Chemical Society of Warsaw 1924

Doctor of Medicine of the University of Cracow, 25th Febr 1924

Doctor of Philosophy of the University of Cracow, 25th Febr 1924

Honorary Citizen of the City of Riga 1924

Honorary Member of the Society of Psychic Research of Athens 15th December 1924

Honorary Member of the Medical Society of Lublin, Poland, 4th July 1925

Member of the "Pontifica Tiberina" of Rome, 31st March 1926

Honorary Member of the Chemical Society of Sao Paulo Brazil 12th August 1926

Corresponding Member of the Brazilian Academy of Sciences 24th August 1926

Honorary Member of the Society of Pharmacy and Chemistry of Sao Paulo Brazil, 17th July 1926

Honorary Member of the Brazilian Association of Pharmacists 23rd July 1926

Doctor of the Chemical Section of the Polytechnic School of Warsaw 1926

Honorary Member of the Academy of Sciences of Moscow 4th January 1927

Foreign Member of the Bohemian Society of Letters and Sciences 12th January 1927

Honorary Member of the Academy of Sciences of USSR 2nd February 1927

Honorary Member of the Interstate Postgraduate Medical Association of North America 1927

Honorary Member of New Zealand Institute, 8th February 1927

Honorary Member of the Society of the Friends and Sciences of Poznan, Poland, 6th March 1929

Doctor of Law of the University of Glasgow 1929

Honorary Citizen of the City of Glasgow 1929

Doctor of Sciences of the University of St. Laurent, 26th October 1929

Honorary Member of the New York Academy of Medicine, 7th January 1930

Honorary Member of the Polish Medical and Dental Association of America, October 1929

Honorary Member of the Societe Francaise des Inventeurs et Savants, 5th March 1930

Honorary President of the Societe Francaise des Inventeurs et Savants, 16th June 1930

Honorary Member of the World League for Peace, Geneva 1931

Honorary Member of the American College of Radiology 16th April 1931

Foreign Corresponding Member of the Madrid Academy of Exact Natural Physical Sciences, 25th April 1931

Member of the Imperial German Academy of Natural Sciences, Halle, 18th March 1932

Honorary Member of the Society of Medicine of Warsaw, 28th June 1932

Honorary Member of the Czechoslovakian Chemistry Society 24th September 1932

Honorary Member of the British Institute of Radiology and Roentgen Society, London 1933