



**Birthday Celebration of Marie Curie
International Day of Medical Physics
November 7, 2013**



Marie Sklodowska-Curie (1867-1934)
A Scientist Ahead of Her Time
Historical Overview, Tribute
and her Contributions to:
Physics, Medicine, Cancer Treatment



“Nothing in life is to be feared, it is only to be understood”, Marie Curie

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Krakow, Poland, November 7, 2013



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Childhood Life in Poland

- **Nov. 7, 1867**, Manya (Marie), was the fifth (**Zosia (7)**, **Joseph (6)**, **Bronya (4)**, and **Hela (1)**) and youngest child of well-known teachers. She was born to Sklodowaska family who were living in this **school building on Freta Street, Warsaw, (Apt. 255 – currently Apt 66) in the Russian Portion of Poland** - Mrs. Sklodowaska was the principal of a girl's boarding school.
- But when Maria was an infant, her mother got sick (tuberculosis), had to stop working, were forced to move.
- They moved to another school building where her father had a good job teaching math.
- **Basically Marie's parents were educated and valued education even though they had very limited income.**





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1870's: Childhood Life in Poland (Cont.)

- As a child, Marie could not kiss/hog her mother. The older sister, **Zosia (11 yrs)**, took care of **Maria (4 yrs)**.
- As a **4-yr**s old child Marie showed sign of interest and **special gift to learn quickly**.
- When she saw **her 8-yr**s older sister, **Bronya**, was struggling to read a book to her parents, she grabbed the book and read it aloud. Her parents were pleased but stunned – not knowing how to react... Suddenly **Marie (4 yrs)** burst into tears saying “it is not my fault, it is **Bronya's** fault it's only because it was so easy.
- Marie's parent wanted her to have a normal childhood but her astonishing memory, avid curiosity, passion to learn, and intense ability to concentrate could not stay hidden for long.
- Life in Poland was not easy for many people. There were two uprisings against Russian – The 2nd one launched 5 yrs before Marie's birth. Over 10,000 were killed and were sent to Siberia. Small minority, including Marie's uncle, escaped to Paris.
- Marie's parents were also revolutionaries, but they believed in revolution through ideas.
- Russian had strict rules for Polish:
Children had to learn their lessons in Russian and were forbidden to speak Polish at school.
- When Russian said Polish children should not be thought much science, Maria's father had to take all his scientific equipment to his home and put them in a glass case in his study.
- **Marie (5 yrs)** was fascinated with pretty, shiny things called “**physics apparatus**”.



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1870's: Childhood Tragedies

- Marie was **6 yrs (1873)**, her father was demoted and his salary was cut by Russian authorities.
 - They had to move to much smaller apartment and had to take in 10 students to board with them to earn some money to survive.
 - They had to do chores, sleep on couches/cots in dinning area, get up early to prepare breakfast for the students. The best food had to go to the students who paid the rent.
- Marie was **8 yrs (1876)**, Zosia (15) and Bronya (12) became sick with typhus – most likely due to poor hygiene living in a crowded small apartment with boys boarding there.
 - Zosia (15), who had been like a mother to Marie (8) died but Bronya (12) survived.
 - For the first time she was dressed in black and dark cloths were to remain with her for the rest of her life.
 - For the first time she questioned if God was just – a belief that has been instilled in her by her Catholic mother. Although her father was skeptic, he believed in “God, Honor, and Country”. Faith was the base of Polish patriotism.
- Marie was **11 years**, her mother died of tuberculoses on May 1878 despite her daily prayer in church repeatedly asking God “**Let me die so that she will live**”.
 - She was devastated, mourned longest, would sit in a corner cry bitterly, not allowing herself to be comforted.



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1880's: Teenage Life in Poland

- **Feeling lonely and depressed, she escaped from her sorrow by burying herself in books.**
 - **She read everything: books written in Polish, Russian, French, and German including poetry, novels, textbooks, and her father's scientific journals.**
- **Marie had an unusual gift to remember every word she read. Also, had an unusual ability to concentrate and shut out all the sounds around her when she was reading.**
 - **Years later, this ability to keep her mind locked on what she was doing helped her to become one of the world's greatest scientists.**
- **Marie's love of reading and her great memory made her a "prize student" at her school.**
- **At Polish school, classes were supposed to be taught in Russian but Poles refused to give up their own language.**
 - **In secret, they held classes in Polish history, which were taught in Polish.**
 - **When Russian inspectors went to Marie's school unannounced, they made all Polish books to disappear. The teacher used to call on Marie to recite page after page of the Russian history to please the inspector.**
 - **Marie loved her country and her language so she "hated" having to do this to please Russian inspectors. She would cry after the inspectors were gone – being ashamed of having to play this role.**



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1880's: Dream of University

- **On June 1883, Marie (15 yrs) graduated at the top of her class at the best girl's high school in Warsaw – called Gymnasium – a high school attended by only the brightest.**
 - **Math and sciences were her favorite subjects but every year she did well in all subjects.**
 - **At graduation she received “Gold Medal” that was the highest prize a student could receive.**
- **Marie wanted to go to college to study math and science but women were not allowed to go to college in Poland.**
 - **Marie was so upset – lost interest in everything around her – did not want to eat – cried when her family tried to cheer her up. She was sent to the country to get some rest.**
- **When Marie felt better, during day she gave lessons to children to save money and at night attended “**Floating (Flying) University**” with a group of people who met in secret. Some were women who were not allowed to go to college and some were men who could not afford to go to college. Teachers were Polish patriots who did not want their people to be ignorant.**
 - **Marie studied math, physics, chemistry, literature, natural history, anatomy.**
 - **She taught literature and Polish history to working women who met at night in secret.**
 - **This was the only way women could get any education in Poland at that time.**



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1890's: Dream of University (Cont)

- **When Marie turned 18, she and Bronya thought of a new plan. So the sisters agreed to help each other. Bronya who wanted to become a doctor, would take their savings to study at Sorbonne in Paris while Marie would get a job as governess and send her earnings to her.**
- **The 1st live-in job (Warsaw) was disaster. She was treated like a servant by spoiled children.**
- **The 2nd live-in job (country) was heart breaking but the pay was good.**
- **The family was wealthy and “educated” - but they did not allow their son to marry Marie whose family was not as “noble”.**
- **Crushed with disappointment, Marie lost her self-stem and hope of ever becoming anybody. But she continued working hard to save money to make sure Bronya accomplish her goal.**
- **In 1890, Bronya married a fellow medical student from Poland, and asked Maria to join her in Paris.**
- **At long last Marie rediscovered her sense of self-worth and purpose in life as though she had recovered from a long illness.**
- **At last, in Oct. 1891, Marie (24 yrs) went to Paris to study at Sorbonne where science was attracting money and outstanding prof.**





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1890's: College Life in Paris

- **In Nov. 1991**, on her registration card Maria (Manya) firmly wrote the French version of her name “Marie Sklodowska”. College life was full of challenges for Marie as a “foreigner” .
 - Classes were taught in French that was far from conventional French that she knew.
 - Her classmate were way ahead of her in their scientific education and there were not that many women in her classes.
 - She lived in a bare room in an attic near university. Every bite of her saving went for school and books. Every moments were spent studying or attending classes.
 - But her heart and mind was set on one goal:
 - a life dedicated to science and no obstacle was too great for her to overcome.
- **In 1893**, she received an advanced degree (MS in physics and was valedictorian of her class.
- **In 1894**, she received an advanced degree in math and was salutatorian (2nd) of her class.
- Her education was not over. She continued to do lab research at Sorbonne.
- Her 1st research job was to study magnetic properties of steel. But the lab was too crowded and equipment were too large.
- But in **winter of 1894**, Marie met **Prof. Kovalski** who was giving a few lectures at the Physics Society while he was in his honeymoon from Poland. She asked if he knew of a lab / scientist she can work. He **introduced Marie (28 yrs) to Pierre Curie (35 yrs)** who was a well established scientist at the School of Industrial Physics and Chemistry – less esteemed than Sorbonne. He had not yet acquired his doctorate degree and his salary was that of specialized factory worker.



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1890's: Pierre Curie - Love at First Sight

- In 1880, Pierre and his older brother Jacques, discovered that when a certain kind of crystal was squeezed, an electric charge would build up on its surface. This effect known as **“piezoelectricity”**, gave scientists a way to measure very small electric charges. Its 1st practical use in industry was in WWI to detect underwater submarines. Today in honor of his work, the term **“Curie point”** refers to the temperature at which these changes take place.
- Although Pierre was recognized as a scientific genius abroad, due to his scientific publications, but he was almost unknown in his own country. Four years **earlier (1890)**, Pierre had begun some very original work studying the effect of heat on magnetic materials, but had not presented his thesis to his Prof. at Sorbonne, the final step to earn a doctorate.
- If there is love at first sight, this was it for Pierre who had decided not to marry after disappointment with his 1st love. “Are you going to stay in France?”. “No” she replied.
- Several days after Marie left, Pierre wrote **“... Nothing makes me happier than news from you and I hope you relax and come back to us in October”**. **"It would be fine thing ... to pass our lives near to each other, hypnotized by our dreams; your patriotic dream, our humanitarian dream, and our scientific dream."** Pierre to Marie, in a letter, 1894”
- When Marie returned, she wanted to return to Poland after one year to live with her aging father. Pierre being terrified to lose her suggested to share an apt. with him that was divided into two separate units. Marie said “No”.

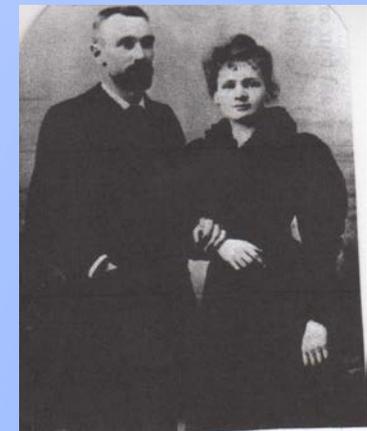


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1890's: Marie Curie's Life with Pierre Curie

- To show Marie that he was serious about science and their life together, in March 1895 he presented his research thesis at Sorbonne and invited Marie to attend. She was greatly impressed and thought he is a great scientist with passion for humanity as well.
- Marie's family had met Pierre's family and they thought they will be happy together.
- But stubborn Marie hesitated for most of the school year and **Pierre offered to move to Poland, if only she would marry him. He would teach French and do experiments on the side.**
- After one year persuasion, Marie agreed to marry, become French citizen and continue her study / research in France but they should visit Poland the following year.
- **On July 1895 they got married** in Paris. She asked a friend not to make a traditional wedding dress but instead to be dark and practical so she can wear it to the Lab.





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Birth of a New Era

- First around **1886, Hertz** demonstrated experimentally **the existence of radio waves** and expanded Maxwell theory of electromagnetic light. It was thought that someday was thought one day it could be sent around the earth. In **Sept 1901**, the **first radio signal was sent** over a distance of 1.5 km. But **he died in 1927 at 37** and did not see the result of his invention. The unit of **frequency (cycles/sec) was named HZ in his honor.**
- Then in **Mendeleev (1869)** based on their atomic weight and their typical properties with many gaps and uncertainties of about **60 elements.**
- Mendeleev was bold enough to suggest that **new elements not yet discovered would be found** to fill the blank places. Mendeleev even **predicted the properties of the missing elements.** He thought elements in the same column have similar chemical properties.
- Although many scientists were skeptic, **the discovery of gallium in 1875, of scandium in 1879, and of germanium in 1886** supported his idea. Each of the new elements displayed properties that had been predicted by Mendeleev.. The three new elements were respectively discovered by a **French, a Scandinavian, and a German scientist**, each of whom named the element in honor of his country - Gallia is Latin for France.
- Discovery of a new element had become a matter of national pride--the rare kind of science that people could read about and even politicians would mention.



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Birth of Atomic Age

- **Nov. 1895** the German physicist, **Roentgen**, discovered **X-rays** but did not know what it was. Two weeks later he took the very first picture using **X-rays of his wife Anna Bertha's** hand. When she saw her skeleton she exclaimed "**I have seen my death**".
- The next month he gave a lecture on his discovery. Soon his experiment was reproduced and for the first time doctors could locate bullet in a man's leg.
- Within a year many books and articles were written for "**Roentgen rays**".
- For the first time the ancient Greek idea of atoms being solid was overthrown and new "**atomic age**" was born. Today he is considered to be the father of diagnostic radiology.
- **In 1901** he was awarded **the very first Nobel Prize in Physics**. He died in **1923 (77)** from carcinoma of the intestine.
- Everyone in scientific world including **Becquerel** rushed to learn and understand X-rays. He was interested in uranium salt crystals and thought when exposed to sun light will emit X-rays.
- **In Feb 1896**, **Becquerel discovered** that the salts had emitted rays onto photographic plate even though they were kept in dark. Thus he discovered some rays but did not know where they were coming from. His discovery did not generate much enthusiasm by many scientist because they could not understand it.

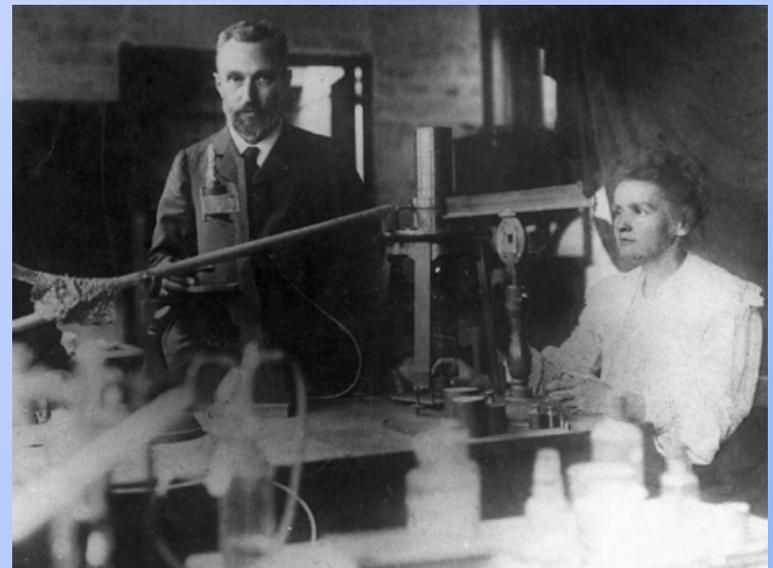


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Birth of Nuclear Age

- **In 1896** Marie and Pierre read Becquerel's papers. But Marie decided to adopt Becquerel's idea as the basis for her doctoral thesis. She started to work at Pierre's teaching lab at the School of Physics and Chemistry where Pierre had worked for 15 years.
- Marie's plan was to see if this "radiation" property existed in other elements on the Periodic Table.
- In **Dec. 1897** Marie began her research while she was pregnant. On **Sept. 1897**, their first child, **Irene, was born**. She followed her mother's footsteps and later on she became an accomplished physicist herself.
- Pierre helped Marie by giving her complete access to his quartz piezo-electrometer, to measure the electric charge that was being emitted from uranium salts.
- Marie tested all the known elements and minerals over and over until she found thorium which generated electrical activity.
- Marie used different compounds of uranium and thorium and found out what mattered was the amount of uranium, not whether it was wet or dry, powdered or solid.



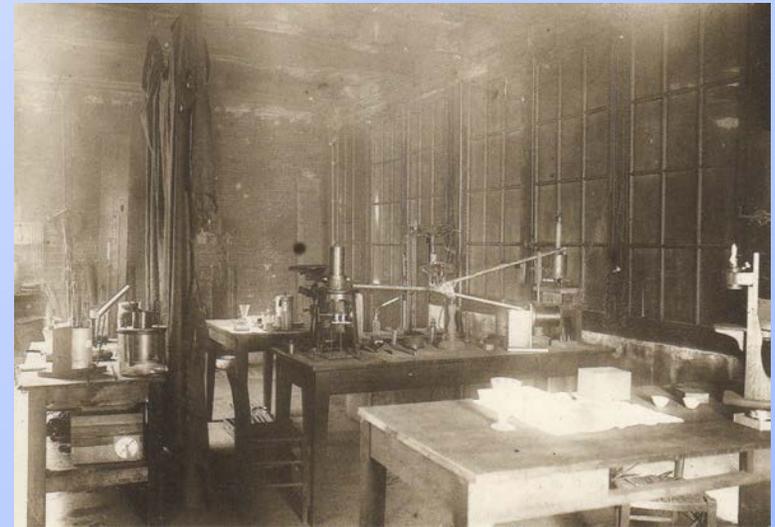


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1897-1900: The Years of Great Discoveries

- **The process of extracting radioactive elements in their pure chemical form was highly time-consuming, labor intensive and required large lab resources that they did not have.**
- **She wrote that radiation energy must come from the atom itself and not from chemical properties or chemical interaction of molecules.**
- **Marie measured electrical conductivity of pitchblende ore that was composed of almost 30 elements. She saw that electrical conductivity was 4 times greater than uranium itself.**
- **How could this be possible, since there was no uranium and no thorium present?**
- **This is what drove Marie to her bold hypothesis; namely it is possible that these substances contain a small quantity of strongly radioactive body, differing from uranium and thorium.**
- **She thought if this were the case she hoped to extract them from ore by chemical analysis.**
- **Marie and Pierre initially thought that it could be 1% but after 4 years of labor and careful measurement they found it was 1/1000,000 of 1 %.**





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1897-1900: The Years of Great Discoveries (Cont.)

- Pierre was very impressed with Marie and said *“Women of genius are rare”*
- Pierre gave up his research in crystals to help Marie with her project. While Pierre was studying the physics behind the new substances, Marie spend most of time extracting elements from the pitchblende. Each 50 kg of raw pitchblende had to be prepared precisely the same way.
- The Curies had another problem. The Lab in which they worked was contaminated with radon. Although Rn was not yet understood, nor even classified as an element, they knew that emission of rays from radium were making their work increasingly difficult.
- After each extraction, Marie devised an elegant chemical process known as “fractional crystallization”. When a solution is boiled and then cools, it causes the formation of pure crystals.
- After each element was crystallized, the Curies used the quartz piezo-electroscope to see if there was an electrical charge, which would tell them if they had radioactivity in their batch.
- One element after another was eliminated in this fashion. One thing was not known to Curies was that there were 3 radioactive substance in the pitchblende instead of one.
- In **July 1898** the Curies published their **1st conclusion**: the **bismuth** fraction contained a new element. Chemically it acted almost exactly like bismuth, but since it was **“radioactive”**, it had to be something new. They named it **“polonium” (element 84)** in honor of the Marie's birth country.

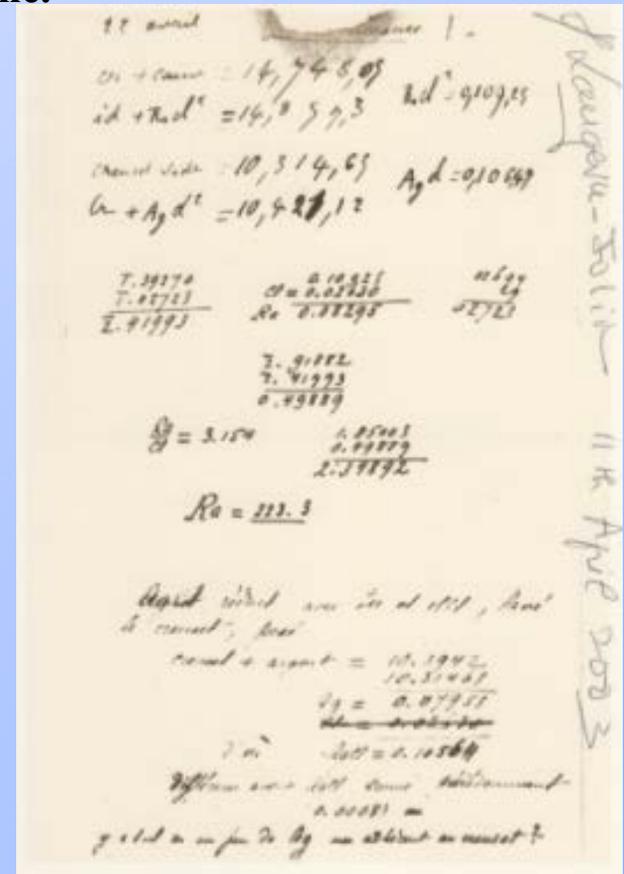


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1897-1900: The Years of Great Discoveries (Cont.)

- With her first great discovery, Polonium, Marie paid homage to her native land, with an irony that Poland did not exist on any world map of that time.
- In **Dec. 1898**, the Curies published their **2nd conclusion**:
- the **barium** had a fraction of new element, which they named **“radium”** from the Latin word for ray.
- In this article Marie wrote “... while the chemical properties of these two new elements were completely different, they both had strong **radioactivity**” a term that was coined by her.
- Marie was the major spokesperson for her discoveries of Polonium, Radium, and actinium (the latter with the help of fellow scientist, Andre Debierne). All 3 elements were found in more than 4 tons of pitchblende.
- By the **end of 19th century**, the Curies had **reached one of the highest goals that a scientist of the time could hope to achieve: Placing two new elements in the Periodic Table.** They called Ra = **223.3**





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Kelvin and British Operation Against Curies

- **William Kelvin (1824-1907) was a respected member in the British Royal Society.**
- **In early 1890s there were some correspondence between him and Pierre Curie.**
- **Pierre Curie was a humble scientist with a few inventions and discoveries. But he was an unknown scientist inside France. He was underpaid and overworked.**
- **Lord Kelvin was an arrogant man in his correspondence with Curies . He worshipped Newtonian Laws of Physics. He said such things as:**
 - **“There is nothing new to be discovered in physics now. All that remains is more and more precise measurements”.**
 - **He also made predictions such as “Radio has no future” and “wireless telegraphy is all very well, but I would rather send a message by a boy on a pony”**
 - **“I can state flatly that heavier than air flying machines are impossible”**
 - **He also declared that the Earth was not more than 10 million years old.**
- **The discovery of radioactivity demolished Kelvin’s claim. In fact as late as 1906 he insisted that atoms are indestructible and the radium gets its energy by absorbing mysterious ethereal waves.**
- **In 1906 Kelvin attacked Marie in the Times of London, by saying that “Radium was not an element” and he tried to ruin Marie’s scientific reputation and deliberately blocked publications of her articles.**



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1900-1903: Rewards and Outcomes

- In 1901 the Nobel Nominating Committee, did NOT include Marie Curie for Nobel Prize for discovery of Ra. A Swedish mathematician, Mittag-Leffler, an advocate of women scientists, informed Pierre of this situation.
- In reply, Pierre made it clear that a *Nobel Prize for research in radium that failed to acknowledge Marie's pivotal role would be a shame*. He 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 Madam Curie with respect to our research on radioactive bodies."*
- Some strings were pulled, and Marie's nominating in 1902 was validated for 1903.
- Thus Marie became the 1st female scientist to receive such honor.

MARIE WAS NOT REALLY NOMINATED for her first Nobel Prize. From the inception of the award in 1901, the Nobel Prizes have been made after a lengthy evaluation of the merits of nominees. In 1903 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. Some strings were pulled, and a nomination of Marie Curie in 1902 was validated for 1903.



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1900-1903: Rewards and Outcomes (Cont.)

- Money was always a problem for the Curies. Marie was working in the shed and Pierre scraped an income from part-time teaching and tutoring.
- In summer 1900, Pierre was offered a professorship at the Univ. of Geneva that included a well-equipped physics lab and a job for Marie. But he turned it down because Marie was so far along in her research for her doctorate and a move would delay her progress.
- Soon, Henri Poincare, a brilliant French mathematician, came to the rescue. He helped Pierre get a teaching position at the Univ. of Paris and got Marie a teaching job at a government boarding school for teenage girls in nearby Paris. She was the 1st woman to teach there. Both Marie and Pierre were inspiring teachers and their students became very devoted to them. Meanwhile Marie continued her research on properties of Ra.
- In 1902, she measured the atomic weight of Ra=225.93. She found that Ra gave off α , β , γ .
- She confirmed Rutherford's theory that α rays were heavy with + q, and β rays were like cathode rays, and γ rays were like X-rays but they could travel in air and in vacuum and were very penetrating and only thick-walled lead containers could stop all of them.
- Rutherford used Ra as an α source to probe the atomic structure of gold. His experiment led to the Rutherford Model of the atom that revolutionized the nuclear physics.
- Marie and Pierre also found that many chemicals that were not originally radioactive became radioactive after being exposed to Ra. They called this phenomenon "induced radioactivity".



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Curies: Benefits and Damages (Patent?)

- Over 30 scientific papers were published by Curies including one that announced diseased, tumor-forming cells were destroyed faster than healthy cells when exposed to Ra.
- Early on some of the biological effects of Ra were apparent. The first case of so-called “**radium dermatitis**” was reported in **1900**, only 2 yrs after discovery of Ra. Becquerel had carried vials of radium salts in his waistcoat pocket for 6 hrs and reported that his skin became ulcerated.
- Marie also kept tiny sample of Ra in contact with her skin for 10 hrs, and noted that an ulcer appeared several days later and caused an ulcerated burn that took 4 months to heal. A radiation burns starts with redness to the skin and sores can develop that takes months to heal.
- In **June 1903**, **Marie** was the 1st female scientist to defend her dissertation at Sorbonne. This was a history-making event. She passed with very high honors and her thesis advisor, **Prof. Lippmann (Nobel Laureate in 1908)** was 1st to congratulate her on behalf on The Univ. of Paris.
- Despite their great need for money to continue their lab research, they decided not to patent their method of purifying Ra. **Marie said “It may be easily understood how deeply I appreciated the privilege of realizing that our discovery had become a benefit to mankind, not only through its great scientific importance but also by its power of efficient action against human suffering and terrible diseases. She also said that “Physicists always publish their research completely, and if our discovery in future has a commercial value, it is an accident by which we should not profit,.. Ra is going to be used in treating disease, it seems to me impossible to take advantage of that”. If Ra can destroy healthy tissue, could it kill unhealthy tissue, e.g. cancer?**

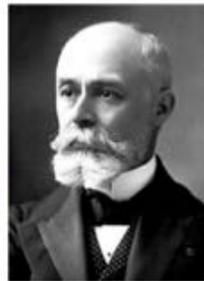


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The Nobel Prize in Physics 1903
 Henri Becquerel, Pierre Curie, Marie Curie

- In a letter to the Swedish Academy of Sciences, Pierre explains that neither of them is able to come to Stockholm to receive the prize. They could not get away because of their teaching obligations. He adds, "Mme Curie has been ill this summer and is not yet completely recovered." That was certainly true but his own health was no better. The medal was accepted in their name by the French Minister Jean-Baptiste Marchando. **Not until June 1905 did they go to Stockholm, where Pierre gave a Nobel lecture. In accepting Nobel Prize, Pierre Said "I am among those who think with Nobel the humanity will drive more good than bad from new discoveries"**



Antoine Henri Becquerel



Pierre Curie



Marie Curie, née Skłodowska

The Nobel Prize in Physics 1903 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 Skłodowska "in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel".





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The French Academy of Sciences

- **In 1966**, the French Academy of Sciences was founded to encourage and celebrate French scientists.
- Existing members evaluate the scientific work of prospective members and since membership depends on merit, it is very prestigious to be elected.
- Before 1903 Nobel Award, Academy awarded Marie Gegner Prize and 3800 francs in recognition of her research. She heard this through her husband, because members of Academy did not think it was proper to inform a female laureate directly.
- Before 1903, Pierre was nominated to the Academy but had been rejected. He did not care for the tedious procedure set by the elites.
- **In 1905**, Pierre was finally admitted although he never understood the point of it. He wrote to the colleagues “I have not yet discovered what is the use of the Academy”. **Marie was not eligible for membership because it was for men only.**
- No woman was elected into academy **until 1979** (Irene’s Student).



The French Academy of Sciences

The French Academy of Sciences was founded in 1666 to encourage and celebrate French scientists. Existing members evaluate the scientific work of prospective members and then vote on those they wish to admit to membership. Since membership depends on merit, it is very prestigious to be elected. Marie Curie was defeated for membership two years in a row because she was female. No woman was elected into the academy until 1979.



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1906 Tragedy: Pierre Curie (1859-1906)

- Curies got married in 1895 and had two daughters, Irene and Eve. **Irene Joliot-Curie (1897 – 1956)** was first child of Curies. This photo is from 1904 at their home. **Eve Denise Curie (1904 – 2007)** was their second child. Kids were not baptized. Marie had lost her faith long time ago and Pierre was atheist, while the grandfather was anticlerical.
- In 1905 Marie told her sister, Helena that she is worried by Pierre's condition, who was spending sleepless nights because of the increasing intense pain in his back.
- April 19, 1906 was a gloomy day. It was raining and cold. While Marie was dressing Irene and Eve, Pierre went downstairs, called to Marie if she is coming. She said I don't know – don't bother me now. Pierre grabbed his huge umbrella and headed for the Lab.
- Deep in thought, he walked along the edge of the sidewalk, stepped out onto the road to avoid the crowd.
- He did not see the 6-tons cart drawn by 2 horses that was approaching. Suddenly decided to cross the street, he fell down. He tried to grab the shaft but on a slippery surface he fell under the horses. Somehow the horses jumped over him but the back left wheel ran over his head and died immediately.





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1906: New Challenges after Pierre's Death

- The day after the funeral, government offered to pay annual pension, as they did to Pasteur's widow. Marie refused and said I am 38 yrs old, healthy, and can work.
- Marie went to the Lab **11 days after the tragedy** and started to keep an unusual diary, full of despair, in which for over a year, she talked to Pierre. Full content of diary was disclosed by the family in 1990. She wrote: *"This lab provides me with the illusion that I am holding to a piece of your life"*
- The authorities at the Sorbonne decided to retain the Univ. Dept. of General Physics, as set up for Pierre, and hand it over to Marie. Marie gave her first lecture **in Nov. 1906**. She started exactly from the same place where Pierre's notes ended. The lecture hall, corridors, and even the square in front crowded. Marie became the first professor at the Sorbonne in French history. Never before a woman been allowed to be a university lecturer.
- Marie wrote in her diary: *"Dear Pierre, I want to tell you I was appointed to your position at the university and that there were fools who congratulated me for that. And that I'm still in despair and do not know what will become of me.."* *"I made the final offering of my entire life and I promise that I will never give the position to anyone else"*





Birthday Celebration of Marie Curie International Day of Medical Physics November 7, 2013



The Nobel Prize in Chemistry 1911
Marie Curie

- In 1911, Marie received her second Nobel Prize – This time in Chemistry – for the
- Separation and tests on polonium and radium.
- She remained the only female scientist Laureate of the Nobel Prize until 1935, when the prize was awarded to her daughter, Irene, for discovery of artificial radioactivity.
- In 1911 there was scandal in the newspapers about Marie's friendship with Prof. Paul Langevin, a former student of Pierre and long time family friend.
- Marie was regarded as a liberal who mocked French traditions and conspired against the French women.
- A member of the Swedish Academy of Sciences advised Marie not to accept the prize until she is clear of the charges against her. Marie, agitated, replied: "I was awarded the Nobel Prize for discovering Po and Ra. I believe there is no correlation between my scientific work and my private life". She wrote that she plans on attending the prize ceremony.



Marie Curie, née Skłodowska

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*".

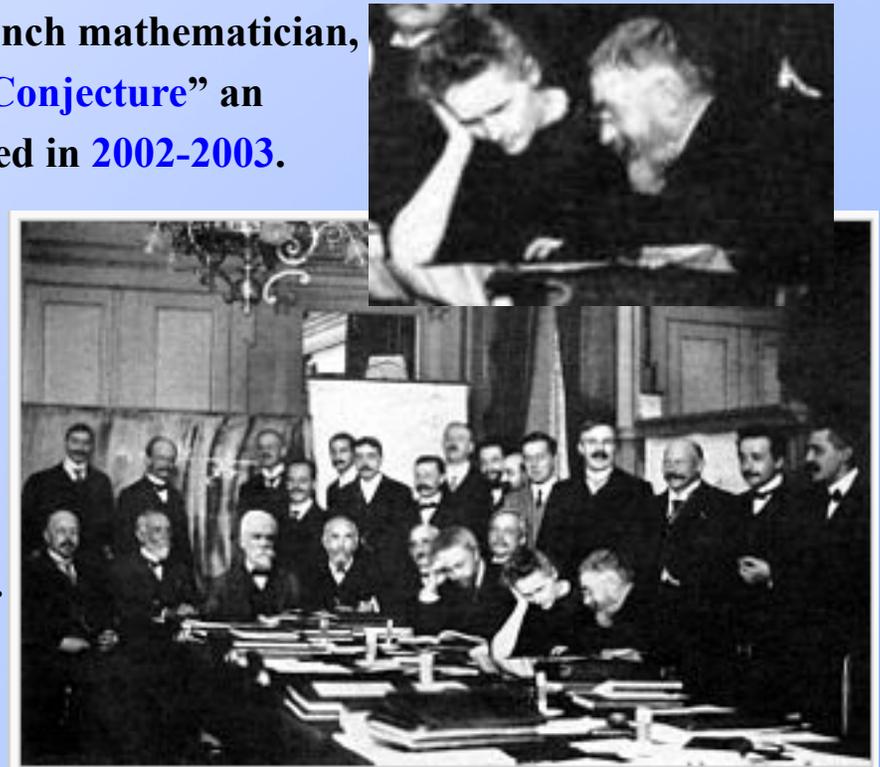


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Marie Curie and Albert Einstein

- **1911** was considered to be a turning point in the world of physics. A Belgian industrialist, Earnest Solvay arranged the first historic conference “*Radiation and Quanta*” devoted to open problems in physics, namely classical physics and quantum physics and chemistry. Lorentz was the Chair. **Einstein was 32, the 2nd youngest physicist** (1st was Lindemann).
- Marie is next to **Henri Poincare (1852-1912)**, French mathematician, theoretical physicist who formulated “**Poincare Conjecture**” an unsolved math problem that was eventually solved in **2002-2003**.
- While these scientists carried out their research independently but were aware of each other ideas.
- Einstein had a great regard for Marie Curie, *Calling her one of the only people he knew who had not been corrupted by fame.*
- **Einstein had already postulated $E=MC^2$ in 1905.**
- Marie wrote recommendation letter for Einstein when applied to teach at the **Univ. of Prague.**



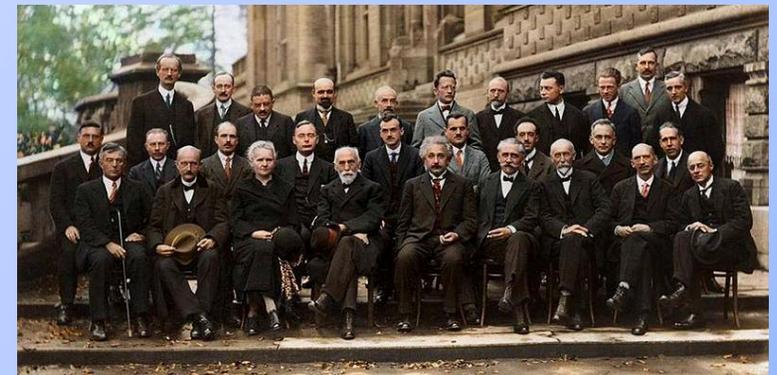


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Marie Curie and Albert Einstein (Cont.)

- Following 1911 Solvay Conf., The International Solvay Institute for Physics and Chemistry was founded by Solvay in Belgium in 1912.
- In 1913, 2nd Solvay Conf. was on *“Structure of Matter”*.
- in 1927, the 5th Solvay Conf. of *“Electrons and Photons”*
- This was the most famous Conf. where (17/29) scientists were or became Nobel Laureate.
- Einstein, disenchanted with Heisenberg’s uncertainty principle said *“God does not play dice”*. Bohr replied, *“Einstein, stop telling God what to do”*.
- In 1930, the 6th Solvay Conf. was on *“Magnesium”*



in Geneva, 1925 (private family visit)



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1909-1914: The Radium Institute, Curie Pavilion

- **In 1909, Marie's dream of having a brand new laboratory for research became a reality.**
- **A physician, Emile Roux, a champion of Marie, proposed creation of a Lab under the auspices of the Pasteur Institute, of which he was the head.**
- **Sorbonne also decided to support funding it.**
- **The Radium Institute was completed in 1914 with one section for biology and cancer research and one section for physics & chemistry of radioactive substances.**
- **She took direct part in every aspect of the Institute: design including planting a garden of roses, light, lab space, equipments, hiring researches and accepting students. She made sure qualified women and foreigners were hired/accepted. She personally provided the money for scholarship to poor Polish students.**
- **With intense personal interest in biology and medicine, Marie fulfilled her humanitarian wishes by founding Radium Institute.**
- **Emile Roux saw the great tradition of Pasteur, a physicist& chemist, who made a revolution in medicine. He saw a breakthrough in cancer treatment soon after discovery of Ra.**





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1914-1919: Mission to Save Lives

- **WWI started right after completion of Radium Institute. In Aug. 1914 Marie was in vacation with her children when Germany declared war on France. She decided to return to Paris when others were leaving. At stake was the precious one single (1 g) Ra in the Institute's Lab.**
- **In Sept three German bombs fell on Paris and Curie's researchers were drafted like other men. Unlike many, Marie sensed that the war would be long and brutal.**
- **Marie put the Ra in a heavy lead box and with help from the government staff, took a train to Bordeaux and secured it in a bank-deposit box and returned to Paris.**
- **Marie used the earnings from her 2nd Nobel Prize, which was in a Swedish bank account, and bought war bonds to help her adopted country. She also offered to give all of her gold medals to the government to melt them, but the Bank of France refused to do so.**
- **Marie soon realized that X-ray can save soldiers' lives. She was determined to make mobile X-ray units. She convinced the government to set up France's first military radiology centers.**
- **Marie did some hospital work and learned X-ray examination from radiologist, Dr. Beclere.**
- **She visited Red Cross hospitals and saw lack of equipment and personnel.**
- **She convinced auto body shops to transform the cars into vans with several glass vacuum tubes thru which electrical charge could be fired to produce X-ray, light wt table to lay the pt, photographic plates, screen for radioscopy, curtain to make darkroom, apron to protect operators and few other tools,... and also the van should not be too heavy..**
- **Marie got a driver's license and learned how to fix a car, maintain and fix X-ray equipment.**



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1914-1919: Mission to Save Lives (Cont.)

- Marie told Irene *“If you cannot work for France just now, work for her future. Many people will be gone after this war and their places must be taken. Do your Math & physics as best as you can”*
- Irene, 17, who was Marie’s lab partner, insisted to be trained at a military hospital and joined her mother in battlefields with “Petite Curie” Van.
- **After war**, the French government awarded military medal to Irene for her war services **but not to Marie.**
- After war Marie wrote *“The use of the X-rays during the war saved the lives of many wounded men; it also saved many from suffering and lasting infirmity”*.



Curie in a mobile x-ray vehicle



Irene Curie with her mother Marie during World War I, 1915.



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Physics After WWI

- **By the time war was over, physics had advanced greatly. Physicists had a new understanding of the structure of atom and radiation.**
- **In 1913, Danish physicist, Neil Bohr proposed his atomic model based on simple H atom. With an atomic weight of one, H had a + nucleus and a – electron orbiting nucleus. He was able to explain why elements were arranged so neatly on the Periodic Table. He was considered **the father of modern atomic theory.****
- **By this time Rutherford had also proposed a new theory of radioactivity: When an atom gives out α particles, it changes to a new element. The decay process was complicated since sometimes β and γ (not α) were emitted. He calculated half life of the atoms and found for **U** it was **4.5 billion yrs, Ra was 1600 yrs and Rn gas was 4 dys.****
- **After the war Marie was anxious to get back to her Lab to resume her Ra research. But the Institute was in bad shape. Most equipment had disappeared and many students did not come back from the war. Even though government offered to help she knew that it will take a long time for government assistance given their other priorities.**
- **On May 1920, Marie was introduced to Mrs. Melony, Chief Editor of a respected women' magazine in US. The two became friend and when Mrs. Melony asked what you want the most in the world, Marie immediately said **"A gram of Ra"**. The cost was a lot (**\$100 K**).**
- **Mrs Melony thought she could use Marie's fame and her appealing case to raise money from wealthy American but Marie had to go to US to claim the radium. Marie agreed.**



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1921: Marie Curie's 1st Trip to US

- After one year nationwide campaign, Missy collected money for **the Marie Curie Radium Fund** to purchase one gr of Ra.
- On **May 11, 1921**, Marie and her two **daughters (23 and 16)** sailed to NYC to tour US for six week. Marie was overwhelmed by the reception. Her shy nature was not prepared for so many enthusiastic crowds and press. Having fragile health, the daughters protected her.
- On **May 12**, The NY Times on a Front-Page article wrote **“Mme Curie plans to End All Cancers”**. This was retracted the stating **“Ra NOT a Cure for Every Cancer”**.
- **In NYC**, Marie was honored at NYC American Museum of History and Carnegie Hall and many scientists and college educated women including Smith, Vassar, Bryn Mawr, Radcliffe, Wellesley,... Women's Medical College in Philadelphia.
- She received 9 **honorary degrees** from universities of Columbia, Yale, PA, Chicago, Northwestern. In Pittsburg, Marie visited the Standard Chemical Co., where Ra were extracted from carnotite sands in Colorado using Marie's technique. By 1921, this Co. had produced more than $\frac{1}{2}$ of world's Ra (74 -87 gr). But in 1923 this Co. was “closed” since it could not compete with Ra produced in Belgian Congo with higher concentration and lesser cost.





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1921: Marie Curie's 1st Trip to US (Cont.)

- On **May 20, 1921**, the White House was filled with more than 100 scientists and diplomats from US, France, and Poland. **President Harding** had the honor of presenting Marie with a key inscribed **“From the Women of America”**. The key was to open a ribbon-draped cabinet which contained one gr of Ra. His **inspiring speech** paid great homage to Madam Curie as foremost among scientists, and respect for her adopted nation and the newly-established nation, Poland.... He said:
“It has been your fortune to accomplish an immortal work of humanity. We bring to you the honor due to pre-eminence in science, scholarship, research, humanitarianism, ... love of man to bestow upon the noble woman, the unselfish wife and the devoted mother”.
- Marie also received a **“Certificate for Radioactive Material”** stating:
“To you we owe our knowledge and possession of it, and so to you we give it, confident that in your possession it will be the means further to unveil the fascinating secrets of nature, to widen the field of useful knowledge, to alleviate suffering among the children of man”
- Marie's response to President Harding and to the American people who treated her with great respect and admiration any where she visited were emotional as well.





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US Champion of the Curies: Dr. Robert Abbe

- **Dr. Abbe (1851-1928) was a renowned American surgeon, born in NYC. He died of anemia, possibly due to his work handling Ra. He was **founder of radiation therapy in US**. He was also a pioneer radiologist in NYC. He was one of the few American doctors who very early on was convinced of the wonders of Ra in treating patients.**
- **In 1903 he reported on his **first patient treated Ra**. He also reported on other patients who had developed cancer with Roentgen rays. He stated that Ra emits α and β rays which are good for cancer treatment but the output of Roentgen tube is heavy penetrating γ .**
- **Dr. Abbe was very found of Curies, especially Marie. In 1904 he visited Curies Lab in Paris and raised lots of money from the US physician for Mari's Radium Fund.**
 - He was against use of tobacco which he considered to be cause of cancer and reported over 100 cases of smoker's cancer.
 - He was also interested to collect artifacts, instrument and tubes used by Pasteur.
- **In March 1921 Marie wrote to Dr. Abbe *"It gives me great pleasure to present this quartz piezo-electrometer for such purpose as its historical interest will serve. It was designed by Pierre and used by us in our early research work for measuring the radioactivity of Ra"*.**
- **He donated the "homesick" instrument along with his other collection to the American College of Physicians" in Philadelphia where it is kept as a center piece of all his collections.**





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The New York Times
Published: May 29, 1921
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**MEMORIAL HOSPITAL
GREET'S MME. CURIE**

Visit, Intended to Be Quiet, Is
Turned Into an Ovation for
Woman Scientist.

WARNED BY HER DOCTORS

Told That She Must Not Overtax
Her Strength—Social Plans
to Be Curtailed.

Mme. Curie tried to pay a surprise visit to the Memorial Hospital, at Central Park West and 106th Street, yesterday, where only cancer patients are received and where \$400,000 worth of radium is used in treating them. But it didn't work. Word of her coming preceded her, and when she arrived there was a small reception committee, and the preliminaries to her inspection of radium were handshaking and introductions, which are beginning to bore the French scientist.

It was probably one of the most interesting afternoons Mme. Curie has had since she arrived here, for the four grams of radium in the big steel vault of the hospital are the largest amount of the precious element gathered in any one place in the world. A little more than three grams were the gift to the hospital of Dr. James Douglas, a former member of the Board of Trustees, and three-quarters of a gram belongs to the United States Government and was lent to the hospital on condition that they treat soldiers free.



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Mme. Curie arrived yesterday from Pittsburgh, exhausted by her travels and the receptions in her honor, and went to the home of Mrs. William B. Meloney to rest. It was announced that because of her weariness all social plans on her coming tour to the West would be canceled and that her trip would be somewhat curtailed. Her physician told her she must not do anything to overtax her strength.

So when Dr. Francis Carter Wood, Chairman of the medical committee in charge of Mme. Curie's program, called up the Memorial Hospital yesterday afternoon he gave only a few hours' notice of her visit. She hoped that she would find only the staff there and that she would be able to make a quick visit and go home. But when the hospital authorities heard she was coming they felt that it would be discourteous not to pay the distinguished Frenchwoman every mark of attention, and they organized a reception committee.

She arrived at the hospital at 4 o'clock and was received by Dr. William S. Stone, Dr. Burton J. Lee, Dr. Douglas Quick, Archibald Douglas, Secretary of the Board of Managers, and George Holmes, the superintendent. She was accompanied by her daughter Anne and a publicity man, who for once in his life had tried to keep away from publicity.

Dr. Stone escorted Mme. Curie to the room where the four little jars of radium are kept, each one of them worth \$100,000. They are in a vault, the radium being dissolved in water and the emanations from it used, which is possible only when so large an amount can be had as the source. They are linked up by a tube with another room, to the apparatus by which the emanations are controlled and placed in tubes.

Mme. Curie examined the jars and the apparatus with great interest, asking short, quick questions, and understanding apparently in a moment the use of any piece of apparatus that was new to her. It gave her pleasure that the one who explained the working of the tubes and valves to her was a former pupil of hers in Paris, Dr. Gioacchino Failla. She was also shown the measuring room, where the radium emanations are first measured so that their strength may be determined before being used on a patient. Then she was shown X-ray plates of cancer patients before and after radium treatment, and pathological slides also illustrating the treatment.



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She was told that although the hospital was the fortunate possessor of so much of the element she gave to the world, and had used it with some apparent success in treating cancer, conditions were such that unless the hospital succeeds in raising \$2,000,000, a part of its work would have to be stopped.

Dr. E. H. Rogers, who has been attending Mme. Curie with Dr. Samuel Lambert, denied yesterday a report that her health had been injured by the use of radium.

"There is not a word of truth in it," he said. "There is nothing the matter with Mme. Curie at all except that she has been trying to do too much. She had been confined most of her life to work in the laboratory. She is a woman of 53 years. With a delicate physique and unaccustomed to outdoor life, she has been attempting to put through a strenuous program in this country and it has tired her."

"But she is better today than she was a week ago. I was yesterday in Pittsburgh when she spent four hours going through the plant of the Standard Laboratories Company, climbing up and down stairs in old buildings and inspecting apparatus. After that she went to the country place of Mrs. Henry Rea and spent some time swimming in a private pool."

"There is no case on record of any one being injured in health by radium. It causes slight burns, of course—that was the way it was discovered—but these have never had any after effects. Mme. Curie has now been working with radium twenty years. Many others have handled it constantly for about the same period. If it had any deleterious effects, they would have been noted long ago. Even those who have in the past opposed its use have not asserted that it was injurious. Mme. Curie is somewhat anemic, as nearly all persons of confined, studious pursuits are. About half of the people are more or less so. She will in all probability go as far west as the Grand Canyon. Both Dr. Lambert and myself have told her that there was no reason on earth why she should not

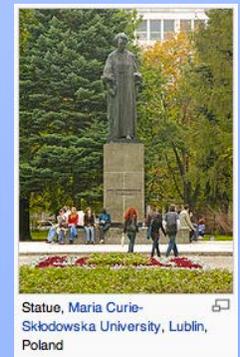


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Marie Curie and Scientific Communities

- In **May 1912**, Marie received a delegation from **the Scientific Society of Warsaw**, who wished to convince her to return to Poland, where a Lab was being built for her. They said “Our nation admires you, and would like to see you working in the city where you were born.
- On **Feb 7, 1922**, Marie was inducted into the **Paris Medical Academy**, breaking a 224 yr old tradition of excluding women. When her candidacy was submitted by 35 members of the Academy, all other candidates for the open Academic seat resigned in favor of Marie.
- In **1925**, Marie laid the first corner stone of the **Radium Institute on Wawelska St, in Warsaw**.
- At the ceremony, the **Poland President, Stanislaw Wojciechowski**, (1st on the left) who had met Marie when he was in exile as a member of Polish Socialist Party, asked Marie if she remembered giving her a small pillow upon his return to Poland.
- Marie smiled and spontaneously replied: “I also remember that you forgot to return it to me”.
- On **July 1926**, the **Lublin Medical Society** unanimously elected Marie as an Honorary Member.
- **Maria Curie-Sklodowska University, Lublin, Poland.**



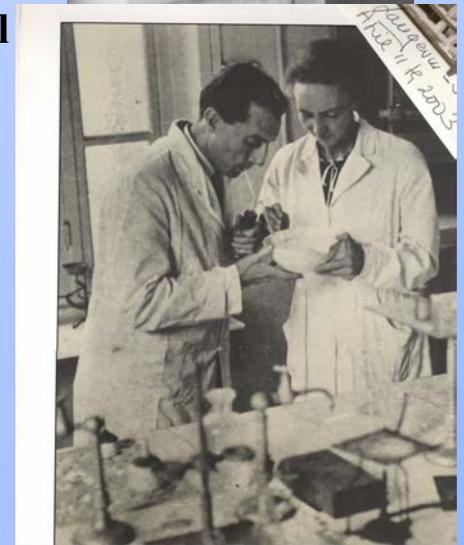


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Marie Curie and her Daughter Irene

- Irene was born in **Sept. 1897** when Marie had just started her Ra research and she was **9 yrs** old when Pierre died in 1906.
- Irene was destined to help her mother as lab assistant very early in her life. She became interested in physics and chemistry and followed her mother's footsteps to the WW1 for 5 yrs.
- **By 1925**, it was evident to Marie that a special department is essential to measure Ra and have control over radioactive substances used for research. So, when Irene received her doctorate degree in 1925, Marie hired her to assist her at the Radium Institute.
- Marie had also hired **Frederick Joliot** (24 yr) as a lab assistant on **Dec. 17, 1924**, following Paul Langevin's Recommendation.
- On Jan 1925 Frederick and Irene worked together, got married a year later (1926), had their 1st child **Helene in 1927** (**Nuclear Physicist**) and their 2nd child **Pierre in 1932** (**Biologist**).
- In 1935, they received **Nobel Prize** in Chemistry for their discovery of artificial radioactivity.



The Nobel Prize in Chemistry 1935
Frédéric Joliot, Irène Joliot-Curie



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1929: Marie Curie's 2nd Trip to US

- After WW1, the financial situation in newly established nation of Poland was disastrous.
- Marie, along with her sister Bronya, were raising money to build Radium Institute in Warsaw.
- Marie appealed directly to the Polish population to subscribe to buy a “brick” for the building.
- The greater problem was to secure Ra. Marie had used some of the money she received from US to “rent” some Ra to scientists in Warsaw. Once again she appealed to her friend Mrs. Missy Meloney in 1928. Missy explained some problems with this 2nd campaign that American had become politically “small-minded”, “isolationists” and “backward”. She asked her not to bring Bronya to US, since people will not be as generous to help Poland as they were in 1921.
- Economically, US was in deep recession that was handled later by Roosevelt after Hoover.
- She arranged for Marie to be an **“official” guest of the White House**, with an invitation from newly elected **President Hoover** who was an engineer and a member of the Marie Curie Radium Fund Committee of 1921. **His invitation to stay at White House was a “first” that no foreigner had ever been given such a privilege.** He presented a check \$50,000 on behalf of generous minded men / women under leadership of Mrs. Melony to purchase a gr of Ra for Radium Institute that bears her name in Warsaw.
- In Oct. 1929 Marie's health was worse than before. She had great difficulties with her sight. Her only public appearance was at the American Society for Control of Cancer. (latter called American Cancer Society). She enjoyed visiting General Electric in Schenectady, NY with Dr. Coolidge, inventor of the Coolidge X-ray Tube being her guide. She also accepted dedication of the Hepburn Science Building at St. Lawrence College in Canton, NY where the building was completed in 1926 but had been waiting for Marie's visit until 1929.





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1932: Radium Institute in Warsaw

- **In 1929 Irene documented Marie’s trip to US: “On the day of her birthday she is given many presents: flowers, books, various objects, checks for her laboratory.**
- **Many of these gifts are from people she has never met. From physicists she receives: a galvanometer, vials of radon, rare minerals. Before departing she tours St Lawrence University, guided by Owen D. Young, where she sees a sculpture dedicated to physics; it is her likeness. She takes part in Edison’s jubilee.”**
- **In 1930 Marie (63) underwent her fourth and final eye surgery.**
- **On May 29, 1932 Marie visited Poland for the last time. She participated in the opening ceremony of the Radium Institute, where the treatment of cancer patients had already begun, using Radium from the United States.**
- **After WW II, the Institute changed its name to “[Maria Skłodowska-Curie Institute of Oncology](#).”**
- **Today it is a specialized health institute of the Polish Ministry of Health.**
- **Today, it is the leading and most specialized cancer research and treatment center in Poland.**
- **It also has regional branches in Gliwice and Krakow which hopefully we can visit this afternoon.**





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1934: Passing of Marie Curie

- **July 4, 1934** Maria Sklodowska-Curie died at the age of 67 in Sancellemoz, France.
- In an official press release Dr. Tobe concluded: “Maria Curie died as a result of malignant anemia, with abrupt symptoms and fever. Her bone marrow did not react in the usual manner most likely due to changes caused by extended radiation.”
- The **New York Times** on July 5, 1934 ran the story on the front page: *“Mme. Curie Is Dead: Martyr to science- Mme. Marie Curie, whose individual and collaborative work on radium and radiology is one of the greatest accomplishments of modern science, died at six o’clock this morning. Her death, caused by anemia, was accelerated by what doctors called ‘long-term exposure to radiation, which affected her bone structure, and prevented a normal reaction to the disease. Eve Curie and Dr. Irene Curie Joliot along with her husband who are continuing family tradition at the Radium Institute were by her bed when the end came.”*
- On **July 6, 1934** the funeral was held at Sceaux. She was buried next to her husband Pierre.
- In 1935 Maria’s last work was published posthumously. It was titled “Radiation”.
- Eve Curie, who is a writer and pianist of great talent wrote her mothers biography “Marie Curie”, which became an international bestseller. The book was released in more than 60 countries. Based on the book, Metro Goldwyn Meyer filmed “Madame Curie”, which was released in 1943 and received seven Oscar nominations. In the coming years, more biographical movies were made, as well as television series about Marie.



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1995: Rest in Peace in Pantheon

- **Inscription on Pantheon: *“To the fatherland’s great men in gratitude”***
- **On April 20, 1995** Marie and Pierre’s ashes were interred in the Pantheon, among other distinguished people of France. Marie is the first foreign born person and first woman buried in the Pantheon for her own merit.
- **Along the way, the ashes of Pierre and Marie were accompanied by President Francois Mitterrand, President Lech Walesa, Eve Curie, Irena and Frederick Joliot Curie with their children, scientists, and others.**
- **President Mitterrand carried the ashes into the Pantheon and dedicated his farewell speech: *“Carrying the ashes of Pierre and Marie to our holiest place is not only an act of memory, but also one in which France shows its respect for those whom we consecrate here, for their greatness and for their lives. Today’s ceremony is a key step for us, to welcome the first woman in the history of the Pantheon. It is another symbol directing the awareness of our society-the battle of a woman, who chose to rise above society with her skills, and it was a society in which skill, research and public responsibility were reserved for men.”***
- **In April of 2005** viewers of channel 2 in France voted for the greatest French person of all time. The first was **Charles de Gaulle**, second was **Louis Pasteur**, third was monk **Abbe Pierre** who helped the poor and fourth was **Marie Curie**, the first woman to appear on this list, followed by **Victor Hugo** and **Moliere**.





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The Curie Museum: History & Memory

- **The Curie Museum is on the ground floor of the Curie Pavilion, in one of the oldest buildings of the Institute Curie. This laboratory, erected a few streets away from the “shed” where the Curies discovered polonium and radium in 1898, was specially built for Marie by University of Paris and Institute Pasteur (1911-1914)**
- **Here she pursued her work for nigh on twenty years, and here too Irène and Frédéric Joliot-Curie discovered artificial radioactivity.**
- **The Curie Museum is the guardian of this institutional heritage, a place of memories and a repository of the history of science. It has a permanent exhibition and a center for historical resources. Museum was re-designed, it now presents a themed tour revealing the life and times of a family of unusual physicists and their huge contribution to science. The place may be modest in size, but it has immense historical and scientific value. Located in the 5th arrondissement of Paris, the Curie Museum, a national authority on Marie Curie, pays homage to this great French-Polish physicist who discovered radioactivity and her entire family, two generations of which won the Nobel Prize.**





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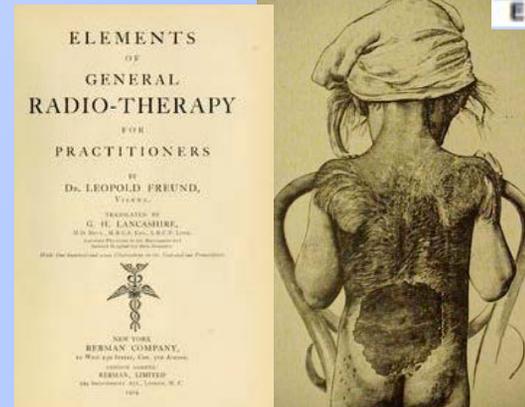


Radium Therapy of Cancer

- It is not easy to say who did what and what equipment was used over 100 yrs ago
 - (a) Due to lack of published claims in medical journals, and
 - (b) Distinction between the person who had the idea for radium therapy and the one who actually implemented radium therapy in clinic / hospital.
- An obvious precursor of radium therapy is X-ray therapy for skin conditions & diseases.
- On Jan. 12, 1896, 17 days after publication of X-ray discovery, Emil Grubbe, son of German immigrants in US and student at Medical College of Chicago, applied X-ray to a patient suffering from locally advanced breast cancer.
- But a yr after discovery of X-ray, in 1896, Prof. Leopold Freund (1868-1943), Dermatologist at Medical Univ. of Vienna, successfully treated a 5-yr old patient in Vienna suffering from hairy moles covering her whole back. This case was published in 1901. Thus he is considered to be founder of the medical radiology & radiotherapy.
- Subsequently in 1903, he published his first textbook on Radiation Therapy.



Emil Grubbe (1875-1960)



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Radium Therapy of Cancer (Cont.)

- **In 1900**, the **American Roentgen Ray Society**, a radiology society was established.
- Radium therapy started first accidentally by observing skin burn when Becquerel put radium in his jacket. Then by self-exposure experiments **in 1900** when two German **Walkoff and Giesel** described the results of strapping 270 mg of Ra salt to the inner forearm of Giesel for 2 hrs. They informed Pierre of the outcome.
- It is known that for many yrs, **Dr. Henri Danlos** of the Hospital St-Louis, Paris, was the first physician to whom Curies loaned a source of Ra and the 1st patient treated was for **lupus** rather than skin cancer. **In 1901** Danlos and Block reported on the result of Ra tx using a local surface applicator. **In 1905** a picture of this tx was published.
- But **in 1900 Dr. Williams** from Boston used Ra for the 1st time for cancer tx.
- **June 1901** Curies & Becquerel reported on **13 cases of self-exposure**.
- **In 1903, Herman Strebel** of Munich also used Ra for cancer tx. and he was the 1st person to suggest use of **afterloading tubes** for tx.
- **In 1904, Dr. Abbe (US)** published the results of his self-exposure experiments. He also correlated the degree of erythema and necrosis with amount of Ra and exposure time.





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Radium Therapy of Cancer (Cont.)

- **In 1906, The American Journal of Roentgenology, Radium Therapy and NM** with quarterly publication was funded. **In 1922, Volume IX** these results have been reported:
 - For Carcinoma of Thyroid, Pfahler, MD reported that:
“We feel that the effect of X-ray and Ra is practically the same. It is our custom to employ Ra therapy in cases requiring hospitalizations ... avoiding physical exertion of being taken to the X-ray room.”
 - For the Superficial Reaction of Radium, Newcomet, MD from Philadelphia reported that:
“If one possesses any amount of Ra, it is possible to employ it for almost any lesion., the reaction from Ra has not been considered as dangerous as that of X-ray... they give practically the same results under similar circumstances” He said the point of X-ray radiation and distance to pt is almost constant but with Ra therapy:
 - (1) amount of Ra,
 - (2) distribution of Ra,
 - (3) time, duration and interval,
 - (4) distance and
 - (5) style of container, filters, etc are important.
- Any modification will effect the outcome and it is best to **elevate Ra 1-2 cm (not more)** from the skin and to it is best to give it in few days... **but this is not practical.**



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Radium Therapy of Cancer (Cont.)

- **In 1916, American Radium Society** was established but the clinical cases were published in the **American Journal of Roentgenology, Radium Therapy and NM.**
- **By 1920s**, Curietherapy was practiced in leading cancer hospitals in Stockholm, Manchester, and Munich. **In 1921** the Holt Radium Institute in Manchester was established.
- **By 1923**, Institute du radium/ Institute de Curie de Indochine was established in Hanoi.
- **In 1925** Marie said *“Radiation therapy can be dangerous if applied in a careless way.. Radiation therapy must be based on the physical and chemical studies on the new radioactive bodies”*
- **By 1929**, Marie Curie Hospital was established in Hampstead, UK.
- **By 1932**, Marie Sklodowska-Curie Memorial Oncology Center was established in Warsaw.
- **In 1931** under **Dr. Ralston Paterson**, MD (1897-1981) the Holt Radium Institute became a leading cancer research center. He was particularly interested in Ra dosimetry. What puzzled him was that **in Paris** using weaker source, the Ra dosimetry was expressed in **mCi destroyed** whereas elsewhere with stronger sources it was expressed in **mg-hrs.** With the help of his research physicist, **Herbert Parker**, he developed a series of rules given the amount of Ra and distribution required for a **homogeneous irradiation.** He understood the importance of physicist in radiotherapy and insisted of giving Parker, Msc equal rank with his medical team. Among his team was his wife, **Dr. Edith Paterson**, who became a world renowned pioneer in biological dosimetry.



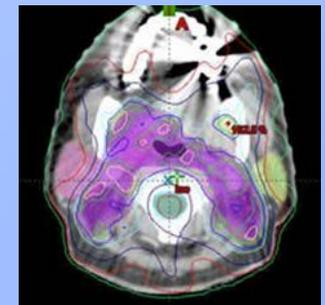
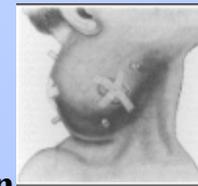
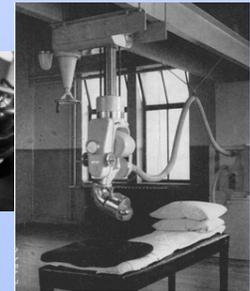


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Radium Therapy of Cancer (Cont.)

- This led to development of after loading equipment for Curietherapy.
- US-NCI (1926-1970), **Nasopharyngeal radium irradiation (NRI)** was used to Shrink swollen lymphoid tissue in head and neck.
- Ra Tx was then replaced by Cs-137 tx that is produced in nuclear reactors. In particular Cs-137 is often used **interstitially** for breast tx and **intra-cavity** for cervical tx.
- Even though “Radium Therapy” per se is no longer practiced in many parts of the world, but brachytherapy (treatment at short distance), continues to be an important mode of cancer treatment in US and elsewhere.
- However, with advent of teletherapy (treatment at long distance) in 1950’s, the epicenter of Cancer Therapy began to shift to US, partly due to the immigration of European radiotherapists after WWII.
- With advent and perfection of linear accelerators such as Cyberknife, Tomotherapy and other equipment with IMRT capabilities, many of past “brachtherapy” is now being treated effectively with “teletherapy” by using non-uniform radiation to save critical organs.
- This is an example of IMRT tx for tonsil cancer avoiding salivary glands.





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**International Day of Medical Physics
Dedicated to a Scientist Ahead of her Time
A Genius with Great Mind and Heart**

“Nothing in life is to be feared, it is only to be understood”, Marie Curie

Mind

- Passionate
- Methodical
- Bold



Heart

- Compassionate
- Committed
- Brave

