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ANNIVERSARY MEMORIAL

MARIA SKŁODOWSKA-CURIE, HER LIFE AND WORK - THE 150 ANNIVERSARY OF HER BIRTHDAY

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ABSTRACT

Maria Skłodowska was born on November 7, 1867 in Warsaw (Poland). Her parents were teachers. Maria's mother has died in 1878 of tuberculosis. In 1893 and 1894, respectively, Maria was awarded master's degrees in physics and in mathematics from the Sorbonne University. In 1895 Maria married Pierre Curie. In 1897 their daughter Irene was born. Maria investigated rays emitted by uranium salts. She hypothesized that the radiation come from atom and called this phenomenon "radioactivity". In 1898, Maria and Pierre discovered new radioactive elements polonium and radium. In 1902 she isolated pure radium chloride and defined radium atomic mass. In June 1903, Maria supervised by Professor Lippmann was awarded her doctorate in physics from the Sorbonne University of Paris after presentation of the thesis "Investigation of radioactive bodies". In December 1903, Maria was awarded the Nobel Prize in Physics, along with her husband Pierre and Henri Becquerel, for their work on radioactivity. In 1904, the daughter Eve was born. On 19 April 1906, Pierre was killed in a road accident in Paris.

In 1910 Maria isolated radium as a pure metal. She also defined an international standard for radioactive emissions (curie), published her fundamental results on radioactivity and textbook of radiology. She also defined the international pattern of radium. In 1911, she won her second Nobel Prize, this time in Chemistry, for her discovery of radium and polonium.

In 1914 she was appointed director in the Radium Institute in Paris. During World War I, Maria became the director of the Red Cross Radiology Service and set up France's first military radiology centre. In May 1932 she has attended the official opening ceremony of the Radium Institute in Warsaw. On 4 July 1934, Maria Skłodowska-Curie has died aged 66 years in Sancellemoz sanatorium (France) of aplastic anemia.

STRESZCZENIE

Maria Skłodowska urodziła się 7 listopada 1867 r. w Warszawie (Polska). Jej rodzice byli nauczycielami. Matka Marii zmarła na gruźlicę w 1878 r. W latach 1893-1894 Maria uzyskała magisteria z fizyki i matematyki na uniwersytecie Sorbona w Paryżu. W 1895 r. poślubiła Piotra Curie, a w 1897 r. urodziła się ich córka Irena. Maria badała promieniowanie emitowane przez sole uranowe. Postawiła hipotezę, że promieniowanie pochodzi z atomu i nazwała to zjawisko radioaktywnością. W 1898 r., Maria i Piotr odkryli nowe pierwiastki promieniotwórcze polon i rad. W 1902 r. Maria wyizolowała czysty chlorek radu i określiła masę atomową radu. W czerwcu 1903 r. Maria obroniła na Uniwersytecie Sorbona pracę doktorską w dziedzinie fizyki pt. "Badania ciał radioaktywnych", której promotorem był Profesor Lippmann. W grudniu 1903 r. wraz z mężem Piotrem Curie i Henri Becquerelem uzyskała Nagrodę Nobla w dziedzinie fizyki za prace nad radioaktywnością. W 1904 r. urodziła córkę Ewę. W kwietniu 1906r., Piotr Curie zginął tragicznie w wypadku drogowym w Paryżu.

W 1910 r. Maria wyizolowała metaliczny rad, zdefiniowała międzynarodową jednostkę aktywności promieniotwórczej (curie), opublikowała najważniejsze wyniki prac nad radioaktywnością oraz podręcznik radiologii. Zdefiniowała także międzynarodowy wzorzec radu. W 1911 r., otrzymała drugą Nagrodę Nobla, tym razem w dziedzinie chemii, za odkrycie polonu i radu. W 1914 została powołana na stanowisko dyrektora w Instytucie Radowym w Paryżu. Podczas I wojny światowej, kierowała sekcją Radiologiczną Czerwonego Krzyża oraz utworzyła we Francji pierwsze wojskowe centrum radiologiczne. W maju 1932 r. wzięła udział w ceremonii otwarcia Instytutu Radowego w Warszawie. Maria Skłodowska-Curie zmarła w wieku 66 lat 4 lipca 1934r. w sanatorium Sancellemoz (Francja) z powodu anemii aplastycznej.

„Trzeba mieć wytrwałość i wiarę w siebie. Trzeba wierzyć, że człowiek jest do czegoś zdolny i osiągnąć to za wszelką cenę."

Maria Skłodowska-Curie

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Maria Salomea Skłodowska, famous Polish and international scientist, was born on November 7, 1867 in Warsaw (then the Kingdom of Poland, part of the Russian Empaire) as the youngest, fifth child of Władysław Skłodowski and Bronisława *de domo* Boguska. At a moment of her birth Maria had the brother Józef (4 years old) and 3 sisters Zofia (6), Bronisława (2) and Helena (1). Parents of Maria came from nobleman's families, but had lost their property and fortunes through patriotic involvements in Polish national uprisings. Both her parents were teachers. Maria's father taught mathematics and physics, and was also director of schools for boys. Later, due to pro-Polish sentiments, he has lost his job and official apartment, and forced to take lower-paying posts. In order to earn more, he set up dormitory for boys in the family flat. Maria's mother operated a prestigious Warsaw boarding school for girls, but she resigned from the position after Maria was born. Soon she has fallen ill on tuberculosis, which was then incurable. From fear before infecting, she did not display children of affection. The lack of close contact with mother was the most unpleasant to the youngest child, Maria. Her the oldest sister Zofia tried to substitute mother in custody over Maria. Unfortunately, in 1876 Zofia had died at the age of 15 of typhus. Two years later Maria's mother past away of tuberculosis.

When Maria was 10 she was taken together with her sister Helena to the boarding school of Jadwiga Sikorska and then she attended the 3rd Governmental Gymnasium for Girls in Warsaw. At the age of 15 years, she graduated with a gold medal. Then due to health problems, she spent the following year in the countryside with relatives of her father. After returning to Warsaw, she joined of Polish patriotic institution Flying University, and also participated in organization of secret educational trainings for workers. Maria and her sister Bronisława wanted to study, but it was impossible in the Kingdom of Poland for women. They both made an agreement that Maria would give Bronisława financial assistance during her medical studies in Paris, in exchange for similar assistance to Maria later. Firstly, Maria did some tutoring in Warsaw, and then for two years she took a position as governess in Szczuki with a aristocratic family Żurawski. Maria fell in love with mutuality to their oldest son Kazimierz, who was a student of University, but unfortunately his parents have disagreed on their marriage. In 1889 she took a position as governess in Sopot with a family Fuchs. Finally she returned to Warsaw and continued working as a governess, and educated herself. Her first independent laboratory investigations Maria started in Physical Laboratory of her cousin *Józef Jerzy Boguski*, which was located at Museum of Industry and Agriculture in Warsaw.

In 1891 Bronisława, who graduated and married Polish physician Kazimierz Dłuski, invited Maria to Paris, where Maria started her study of physics and mathematics at the Sorbonne University. In 1893, she was awarded a master's degree in physics with first place, and earned another degree in mathematics with second place the following year. After graduated of physics she began work in an industrial laboratory of Professor *Gabriel Lippmann*, where she has investigated the magnetic properties of various steels. In 1894 Maria has meet *Pierre Curie*, who was already famous scientist working at the School of Physics and Chemistry in Paris. On 26 Jul 1895 they have married. Maria became a French civilize and has legally changed her surname on Curie, but in Poland she is known as *Skłodowska-Curie* to underline her Polish nationality. Next year she has gotten entitlement of teacher in high schools. In September 1897 their daughter Irene was born. Shortly after that, Maria started laboratory experiments leading to her doctoral thesis. She investigated rays emitted by uranium salts, discovered in 1896 by *Henry Becquerel*. Using electrometer, developed by Pierre and his brother, she discovered that uranium rays caused the air around a sample to conduct electricity. Maria and her husband worked in very hard conditions. They did not have proper laboratory, but adapted the shed, formerly a medical school dissecting room, which was next to the School of Physics and Chemistry. Maria's research, was sponsored only by metallurgical and mining companies and from various organizations and governments, but not by University. *Maria Sklodowska-Curie* observed that the activity of the uranium compounds depended on its quantity. She hypothesized that the radiation come from atom. She studied two uranium minerals, pitchblende and chalcolite, which occurred four times, and twice as active as uranium, respectively, and she concluded that above minerals must contain additional compound which emit radiation. In 1898 *Maria Skłodowska-Curie* discovered that the element, thorium had similar properties. Maria called this phenomenon "radioactivity". This year is considered as beginning of the new branch of science, radiobiology. At that time, Pierre, who was extremely interested in Maria's discovery, put aside his own work to help his wife with her exploration of radioactivity.

In July 1898, *Maria* and *Pierre Curie* published a joint paper announcing the existence of an new radioactive element which they named polonium in honor of Maria's homeland. On 26 December 1898, they announced the existence of a second unknown radioactive element, radium. They observed that radioactive agents shine, salts of radium give off warm, and color porcelain and glass. Moreover, they noted that radiation penetrates by air and some bodies, and may transform oxygen to ozone. Thus, in 1900, Maria became the first woman faculty member at the École Normale Supérieure. In 1902 she isolated

pure radium chloride and defined radium atomic mass. Between 1898 and 1902, Maria and Pierre published over 30 scientific papers. In recognition of their discovery, Curies have obtained several awards like Plante, Lacaze, Gegner, Osiris, Davy Medal. In June 1903, Maria *Skłodowska-Curie* supervised by Professor Gabriel Lippmann was awarded her doctorate in Physics from the Sorbonne University of Paris after presentation of the thesis "Investigation of radioactive bodies". Soon after that, Maria and Pierre were invited to the Royal Society in London to give a speech on radioactivity. Unfortunately, they have survived tragedy in their personal life. In August 1903, their baby-girl has died just after her birth.

In December 1903, *Maria Skłodowska-Curie* became the first woman awarded the Nobel Prize by Royal Swedish Academy of Sciences. She won the prestigious honor in Physics along with her husband Pierre and Henri Becquerel, for their work on radioactivity. In the beginning in the nomination letter submitted by the group of scientists, including Maria's doctorate supervisor, the name of Maria was omitted. Fortunately, one of the committee members and an advocate of women scientists, Magnus Goesta Mittag-Leffler informed Pierre about this. Pierre stated that he did not agree to be honored without Maria. Also, Charles Bouchard, who nominated Maria for Nobel Prize in 1901 and in 1902 supported her in 1903. Finally her name was added to the nomination, however Curies got together only a half of money award, instead of two third. Maria and Pierre received the prize personally in the middle of 1905 after presentation of Nobel laureates lecture by Pierre on behalf of Maria and himsef. After that, the University of Paris gave Pierre a Professorship and the Chair of Physics, and agreed to organize a new laboratory for Curies. In December of 1904, the daughter of Maria and Pierre Curie, Eve was born. Unfortunately, family luck of Curies did not last long. On 19 April 1906, Pierre was killed by horse-drawn wagon in a road accident in Paris. Maria heavily survived the sudden death of her husband and co-worker.

In May 1906 *Maria Sklodowska-Curie* became the first woman to teach in the Sorbonne University in Paris. She took the position as Professor of General Physics in the Faculty of Sciences that had been left vacant after her husband's death. In 1908 she became a titular Professor. In 1910 *Maria Skłodowska-Curie* succeeded in isolating radium as a pure metal. She also defined an international standard for radioactive emissions that was named for Pierre and her honor, the curie. In the same year she published her fundamental results on radioactivity and textbook of radiology. She also defined the international pattern of radium. Nevertheless, in 1911 the French Academy of Sciences did not elected her to be a member. After Pierre's death, his former student physicist Paul Langevin, a married man, assisted her in investigations and helped in preparation of lectures. For about one year, Maria had conducted an affair with him. This resulted in a press scandal in 1911, which her academic opponents wanted to take advantage against her and make impossible getting the second Nobel Prize by her.

Fortunately, the members of Royal Swedish Academy of Sciences ignored campaign against Maria and taken into consideration international recognition of her investigations. In 1911, *Maria Skłodowska-Curie* received another great honor, winning her second Nobel Prize, this time in Chemistry. She was selected for her discovery of radium and polonium, and became the first scientist to win two Nobel Prizes. This is interesting to note that on the second Nobel Prize Diploma her full name "*Maria Sklodowska-Curie*" is inscribed. Just after that, Warsaw Scientific Society nominated her honorable member.. In 1914 she was appointed Director of the Curie Laboratory in the Radium Institute of the University of Paris, where research in chemistry, physics, and medicine was conducted.

During World War I, *Maria Skłodowska-Curie* became the director of the Red Cross Radiology Service and set up France's first military radiology centre. She directed the installation of 20 mobile radiological vehicles and another 200 radiological units at field hospitals in the first year of the war. Then, she passed examination for driving license and personally droved the mobile vehicle. Her 17-year old daughter Irene assisted her. Maria produced hollow needles containing radon, a radioactive gas given off by radium, to be used for sterilizing infected tissue. Moreover, she trained technicians and nurses in the range of X-ray service. In 1918 the Radium Institute became a universal centre for nuclear physics and chemistry. Next year, she described her wartime experiences in a textbook, Radiology in War. In 1921 Maria and her daughters Irena and Eva were invited to United States of America. Maria presented there several lectures about the radioactivity. The President of USA gave her as a present 1 gram of radium bought as a result of collection money among American women. In 1922, she became a member of the newly created International Commission for Intellectual Cooperation by the Council of the League of Nations. In 1923 the 25th anniversary of radium discovery was celebrated. For this reason Maria received many aspects of recognition and estimate. As a gift of French nation, Maria received lifelong salary (40 000 French frank per annum). *Maria Skłodowska-Curie* came to Poland in 1925 to laid foundations for the Radium Institute in Warsaw. To equipped that new institute, she went in 1929 for her second tour to USA, where again received 1 gram of radium as a gift of American

nation. Next year she was elected to a member of the International Atomic Weights Committee, where she served until her death. At last, the construction of the Radium Institute in Warsaw was finished. Maria came for its official opening ceremony in May 1932. The first director of Radium Institute in Warsaw became *Bronisława Dłuska*, the sister of *Maria Skłodowska-Curie*.

Unfortunately, since several years Maria had health problems caused by her job. She proceeded seriously operation of kidney and four operations of cataract. In the spring of 1934 the condition of Maria's health has been considerably deteriorated. She felt tired, her temperature had gone up to 40ºC. She was transferred to Sancellemoz sanatorium. Unfortunately, on 4 July 1934, she has died aged 66 years from aplastic anemia caused by her long-term exposure to radiation. She was interred in Paris in the family tomb of Curies. In 1995, the French Government transferred her ashes, together with those of Pierre, to the Pantheon in Paris, making her the first woman to be recognized in this way for her own achievements.

Many institutions and foundations bear name of Maria *Skłodowska-Curie*, for example Institute of Oncology in Warsaw, Curie Institute in Paris, *Maria Skłodowska-Curie* University in Lublin. She is a patron of the Polish Radiation Research Society founded in June 1967, in the year of 100 anniversary of her birthday. This Society concedes medals of *Maria Skłodowska-Curie* name in recognition of desert in radiation research for polish and foreign scientists. Moreover, the *Maria Skłodowska-Curie* Action was established by European Union/European Commission to support young scientists.

Scientific work become tradition in the progeny of *Maria Skłodowska-Curie*. Her daughter, Irene *Joliot-Curie* jointly with her husband, Frederic, in 1935 were awarded the Nobel Prize in Chemistry for their discovery of artificial radioactivity. Moreover, both children of the Joliot-Curies, Helene, who married the grandson of Paul Langevin, and Pierre are also scientists.

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