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Marie and Pierre Curie and radium: History, mystery, and discovery

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Commencing with Marie Curie's early life in Poland and the discovery of radium in the rue l'Homond ''shed'' in Paris in 1898, this paper includes some little known facts. It ends with some unusual uses of and claims for radium, and finally, because *Medical Physics* is an American journal, details are included of Marie Curie's two visits to the USA. © *1999 American Association of Physicists in Medicine.* [S0094-2405(99)02709-1]

I. INTRODUCTION

Marie Curie, or Maria Sklodowska-Curie as she is more correctly known, using the original spelling of her first Christian name Maria (her second was Salome), as she actually wrote Marya according to the old Polish spelling, really needs no introduction. Three biographies have been written[1–3] including that by her daughter Eve[1] and Maria also wrote a short autobiography in the 1920s at the request of her American friend ''Missy'' but it is still a mystery as to where the original is located and all that is available is a 1959 Polish translation by her brother Józef and her sister Helena.[4] Payment by the publishers for this autobiography was used for the provision of radium sources for the Warsaw Radium Institute.

Her daughter Irene also published[5] a small booklet (in French) entitled *Marie Curie My Mother*. In addition there have been many book chapters and other literature references to the famous discovery of radium undertaken in the most basic of experimental circumstances, of which the following are but a few.[6–11]

II. EARLY LIFE IN WARSAW

Maria's parents were Bronislawa Boguska, a headmistress of a private school for girls in Freta Street, which now houses the Maria Sklodowska-Curie Museum of the Polish Chemical Society. Her father was Wladyslaw Sklodowski, who was a teacher of physics and mathematics at another school. They had four daughters, Bronislawa (who was to become the major force in setting up the Polish Radium Institute), Sophia, Helena, and Maria, and a son Józef who was to become a well respected doctor in Warsaw. Figure 1 shows the two sisters Helena and Maria and Fig. 2 is a page from Maria's 1885 private notebook with the German text of a poem of Heine's and a drawing of her dog Lancet.

> ''Our father loved literature, he was a connoisseur of Polish and foreign poetry. He used to translate foreign poems into Polish .... On Saturdays we gathered to listen to him reading the masterpieces of Polish poetry and prose: we enjoyed these evenings immensely.''[4]

In order to obtain money for her planned studies in Paris, Maria worked as a governess for a family in Szczuki during 1886–1889 and finally in 1891 began as a student at the age of 24 at the Sorbonne. She was helped in this by her elder sister Bronya who had preceded her to Paris.

III. DIPLOMAS

Maria showed early promise as a student and in 1872 at the age of 15 was awarded a gold medal of merit when leaving her secondary school. Her high school diploma was obtained in 1883 and was written in Russian rather than in Polish, as Poland was annexed into the Russian empire from the end of the 18th century until World War I. Maria's comments on this period of life appear in her autobiography.[4]

> ''Warsaw was by then, under Russian oppression .... I belonged to those young Poles who believed that the only hope for our nation was in a great effort to develop our intellectual and moral strength.''

She never lost her love of Poland but even today some people consider that she was a French woman; not a welcome attitude in the Warsaw of the 1990s. Indeed, as well as France and most of the rest of the world referring to her as Marie Curie, it is noted that on her tombstone in the Pantheon her name is carved as Marie Curie-Sklodowska, with her hyphenated surname the wrong way around; see also a Medical Physics journal paper![9]

In 1893 Maria received from the Sorbonne her Diplôme de Licencié ès Sciences physiques. This was later followed by her doctorate thesis ''Research on radioactive substances'' in 1903. She had chosen in 1897 to study what were then known as Becquerel rays and could have obtained her doctorate much earlier, but she was always putting off the examination because of the work involved in the discovery of polonium and radium.[1] Figure 3 shows Maria, with Pierre, at this period of her life in 1904.

IV. PIERRE CURIE

Pierre Curie first met Maria in 1894 when he was 35 years old. They were introduced by a fellow Polish scientist of Maria's, a Professor Kovalski working in the University of Freiburg but then in Paris on his honeymoon; his bride having met Maria previously in Szczuki. Maria at this time had needed more laboratory space for her analysis of minerals (her first research paper was on the magnetic properties of

FIG. 1. Maria (left) and Helena (right) circa 1887/1888, Warsaw.

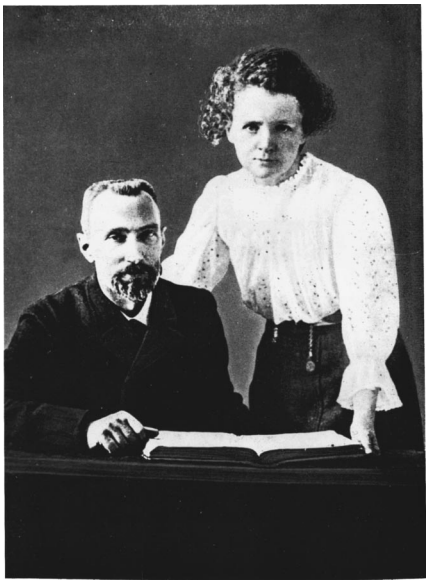


FIG. 3. Maria and Pierre in 1904.

iron alloys, and was conducted in the laboratory of Professor Gabriel Lippman[10]) and it was for this reason that Pierre, then working in the rue l'Homond was introduced to her.

He was born in Paris in the rue Cuvier, the second son of a physician, and for some time had been working in the laboratory of the Museum of Natural History. This museum still exists in the rue Geoffroy-Saint-Hilaire, just around the corner from the rue Cuvier, and is the site of a special 1996–1998 centennial exhibition[12] in Paris on the discovery of radioactivity by Becquerel and the discovery of radium by the Curies. He had obtained his Licencié es physiques (equivalent to a Master's degree) at the early age of 18 and collaborated with his brother Jacques in physics research which led them to the discovery of piezoelectricity. Their piezoelectrometer was to be used later in the study of radium.

However, in 1883 the brothers parted with Paul-Jacques becoming a professor of physics at Montpelier and Pierre the chief of the physics laboratory (Chef de traveaux pratique and Professeur de physique generale et electricite theorie) at the School of Physics and Chemistry of the city of Paris (Ecole Municipale de Physique et de Chimie Industrielles is the title on the outside of the building) based in the rue l'Homond, Fig. 4.

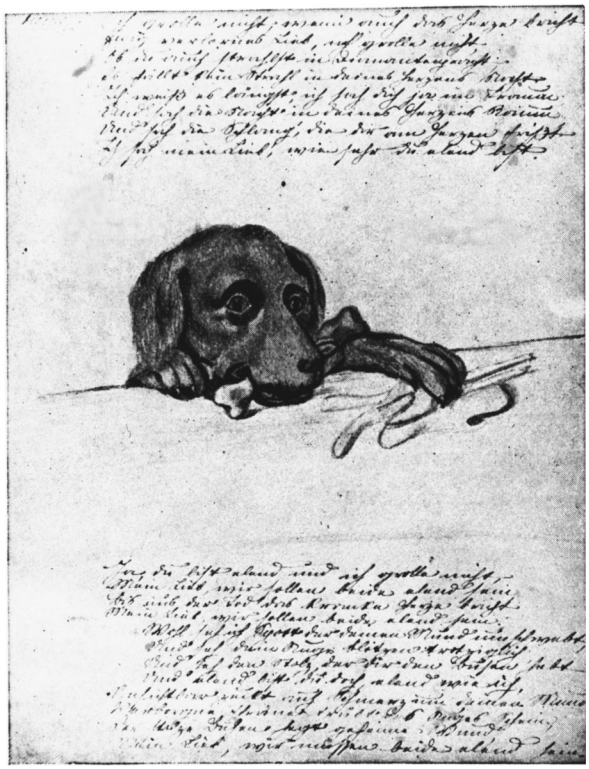


FIG. 2. A page from Maria's private notebook in 1885 when she was 18. The sketch is of her pet dog Lancet and the text is from a poem by Heine.

V. THE RUE L'HOMOND LABORATORY

In 1897 Maria started her own investigations with Becquerel as her supervisor, on the new uranium ''radiations'' with her first task being the development of an accurate method of measurement which would enable the uranium

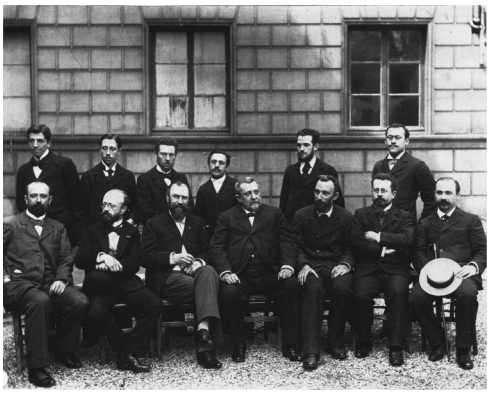


FIG. 4. Senior staff of the Ecole Supérieure de Physique et de Chimie Industrielles, circa 1894. Pierre is seen seated third from the right.

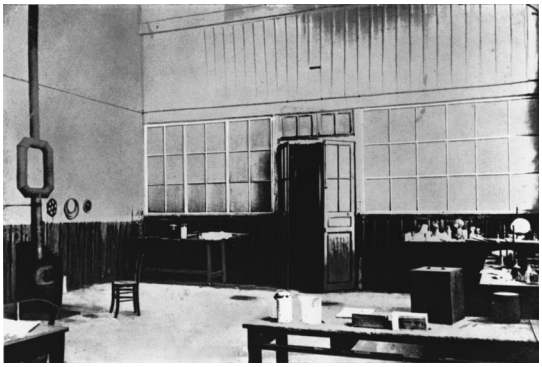


FIG. 5. View of the laboratory ''shed'' in the rue l'Homond where polonium and radium were discovered in 1898.

radiations to be studied at length. She used a quadrant electrometer, piezoelectric quartz, and a flat condenser as an ionization chamber; the powdered substances being in the form of a thin layer on a metallic substrate placed inside the ionization chamber on one of its flat electrodes.

The ''zero'' method of measurement was used in which the saturated current in the ionization chamber was compensated for by the current appearing in the piezoelectric quartz crystal.[10] Pierre was instrumental in helping Maria master the piezoelectrical method of measurement and in 1897/98 he stopped his own research on the properties of crystals to work full time with Maria.

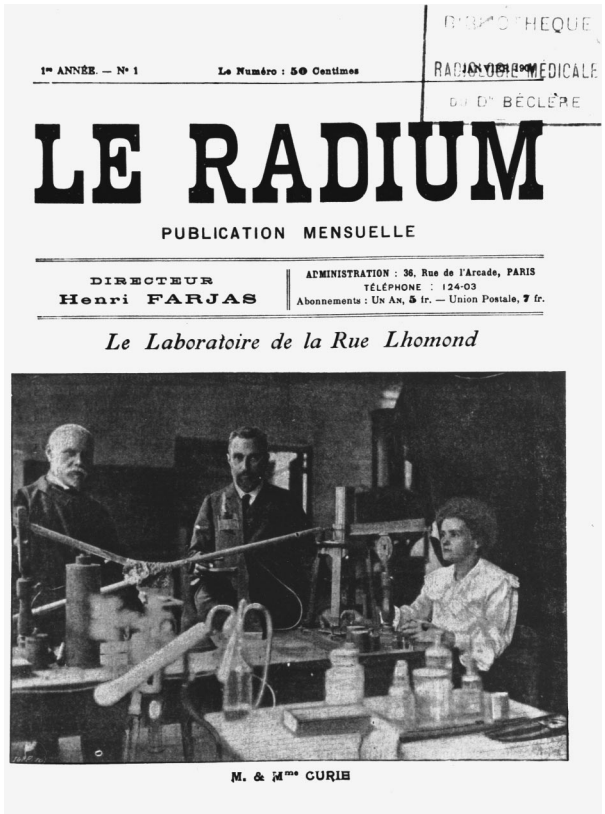
They investigated many minerals, including pitchblende which was found to be four times as active as metallic uranium. Their studies were rewarded in July 1898 by the discovery of the radioactive element polonium which was associated with the bismuth extract of the ore and finally in December 1898 by the discovery of radium, associated with the barium extract of the ore, Figs. 5 and 6.

The paper[13] announcing the discovery of radium was presented at the French Academy of Sciences in December 1898 by Henri Becquerel on behalf of Maria, Pierre, and their colleague G. Bémont (who passes into obscurity after this one citation and becomes somewhat of a mystery). It is also interesting to record that in 1997 when obtaining a photocopy of this paper,[13] I was told by the archivist that I should read the following paper[14] by Eugene Demarçay since in 1898 the Curies had been told that their paper would not be accepted unless spectrometry confirmed the existence of this new element radium. Demarçay's presentation ended with the following conclusion;

> ''La présence de la raie 3814,8 confirme l'existence, en petite quantité, d'un nouvelle élément dans le chlorure de baryum de M. et Mme Curie.''

Figure 7 also shows a spectrum,[15] but this is from 1997 and not 1898 and is of the contamination on some of Pierre's apparatus which is still retained in a display cabinet in the Physics Department at the Ecole Supérieure de Physique et de Chimie Industrielles.

Also of interest in this small historical collection are some lecture notes of Pierre when he worked in the rue l'Homond.



1re ANNÉE. — N° 1 Le Numéro : 50 Centimes

LE RADIUM

PUBLICATION MENSUELLE

DIRECTEUR Henri FARJAS

ADMINISTRATION : 36, Rue de l'Arcade, PARIS
TÉLÉPHONE : 124-03
Abonnements : Un An, 5 fr. — Union Postale, 7 fr.

Le Laboratoire de la Rue Lhomond

M. & Mme CURIE

FIG. 6. Front cover of the first issue, January 1904, of the journal Le Radium showing in the photograph Gustave Bémont, Pierre, and Maria in the measurement laboratory at the rue l'Homond, circa 1898.

Purely by chance the page on display dated 29 November and 4 December (without any year) gave Pierre's measurement of 0.394 g radium sulphate in a rubber covered capsule for one Danlos. This must have been Dr. Henri Danlos of St. Louis Hospital, Paris, to whom Pierre gave a radium source for the treatment of the first patient in Paris. This was following Pierre's self-inflicted radium burn on his forearm in 1901. Figure 8 shows a typical radium source[16] for medical use in this era, variously described as a button or capsule.

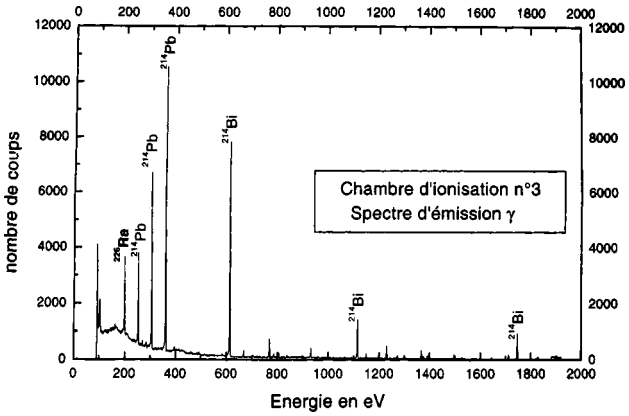


FIG. 7. Spectrum of contamination of apparatus such as the ionization chambers and the piezoelectrometer used by Pierre and Maria in the rue l'Homond.

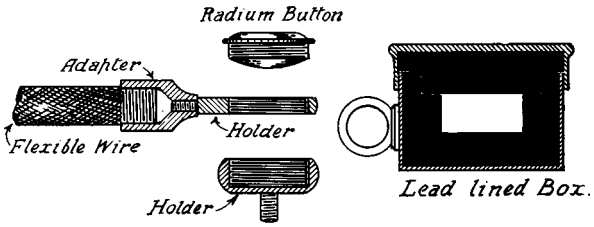


PLATE XXI. -DETAILS OF MEDICAL APPARATUS.

FIG. 8. Details of an early form of radium therapy apparatus, 1904.

Those of you in 1998 hoping to find where the rue l'Homond ''shed'' once stood would be disappointed if you walked along today's rue l'Homond since this street has been altered in the last 100 years and the entrance to the Ecole Supérieure is not at 10, rue Vauquelin. There is a small plaque outside recording the discovery of radium and inside the gateway there is a car park with four concrete pillars blocking off a space and another plaque describing the discovery of radium. This is all that is left of the site of the famous ''shed,'' a car park!

Returning to the mysterious Gustave Bémont there is a third person on the far left of the photograph of Fig. 6 standing next to Pierre. In many published copies of this photograph[3] he is ''cut off'' leaving only Pierre and Maria and in others[9,12] this person is stated to be M. Petit a laboratory assistant. However, the truth lies in the archives of the Ecole Supérieure where there is a passport size photograph of Bémont, Fig. 9, and a photograph similar to Fig. 6 but only with Pierre and another man. That man was Petit and the person in Fig. 6 is Bémont (the French got it wrong[9,12] and the Poles got it right[10]). This was confirmed by enlarging the faces and particularly noting the ears, eyes, mouth, and beard! Bémont was the chief chemist at the Ecole and as such was indispensable to the Curies in their initial research. Bémont remained at the Ecole and did not follow the Curies to their later laboratories in the rue Cuvier and finally at the Radium Institute, and therefore passes from the history of radioactivity.

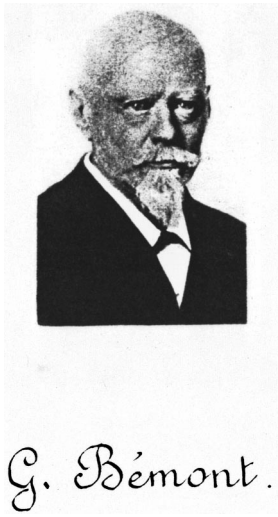


FIG. 9. Gustave Bémont.

FIG. 10. Zoe atomic soda.

Finally, to end this section we have Maria's own comments on the discovery.

> ''...The various reasons we have just enumerated lead us to believe that the new radioactive substance contains a new element to which we propose to give the name radium. The new radioactive substance certainly contains a very strong proportion of barium; in spite of that its radioactivity is considerable. The radioactivity of radium must therefore be enormous.'' [4,11]
>
> ''It is easy to understand how important for me is the conviction that our discovery is a blessing for humankind not only by its scientific importance but also because it permits to reduce human suffering and treat a terrible disease. This is indeed a great reward for the years of our enormous effort.'' [4,11]
>
> ''We did not conceal the smallest detail and only thanks to the precision of our publications could the radium-making industry develop so quickly.'' [4,11]

VI. UNUSUAL USES AND CLAIMS FOR RADIUM

Apart from ''borrowing'' the name of radium, atoms or nuclear for what are obviously nonradioactive items, such as Zoe Atomic Soda which ''gives you infinite energy as with an atomic pile,'' Fig. 10, the hot pepper sauce called Nuclear Hell which is described as ''great taste with a blast,'' and Atomic Fire Ball candies with the ''red hot flavor,'' certain unusual radioactive items have also existed. Radium drinking (and bathing) water is well known, but what is more exotic is the radium impregnated electric blanket from which supposedly electric heat and photons keep you warm at night, and the radioactive corset designed to cure rheumatism, Fig. 11.

Many ailments were supposedly cured with radium preparations in the early years of this century, Table I, but the most bizarre was the cure for impotence (an early Viagra?) apparently consisting of monkey glands and radium. This

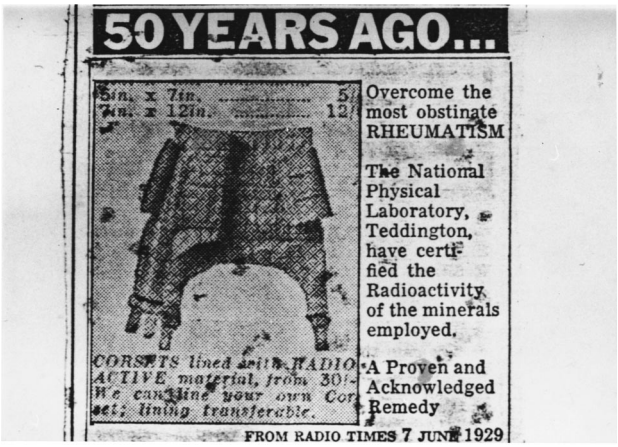


FIG. 11. Cure for rheumatism as advertised in the BBC Radio Times of June 1929.

FIG. 12. Radon bulbs for use with Sparklets syphons and Scotch whisky.

was advertised for ''weak discouraged men! Now bubble over with a joyous vitality through the use of glands and radium.''

One of the worst uses of small amounts of radium (and thorium) was in the cosmetic industry for face creams and suntan creams where presumably the skin erythema was equated to a suntan; which unknowingly could lead to skin cancer many years later if sufficient cream had been used.

A new drink was also available, Scotch whisky and radioactivity! This was produced by the Sparklets company which still today manufactures soda water syphons. However, this product Radon Bulbs, Fig. 12, contained a small amount of radon.

VII. MARIA IN THE USA

Maria visited America twice, once in 1921 and once in 1929, both times visiting the White House and meeting the then Presidents of the USA. On the 1921 visit, traveling on the White Star liner the Olympic, a sister ship of the Titanic, her main purpose was to receive the gift of 1 g of radium, worth $100 000 and raised from public subscription by American women, to be taken back to Paris for medical purposes, Fig. 13. The main organizer of this American campaign for the ''Marie Curie Memorial Fund'' was Maria's friend ''Missy,'' the journalist Mrs. Marie Mattingley Melony who had first met Maria on a visit to Paris in 1920.

This 1 g was processed in the chemical laboratories of the Standard Chemical Company of Pittsburgh and was a gift for the Radium Institute in Paris. In 1934 Maria bequeathed this 1 g to the University of Paris on the condition that her daughter Irene could use the sources during her lifetime.

On her second visit to the USA, Maria was given money to buy radium for the planned Warsaw Radium Institute in Wawelska Street, for which the opening of the Clinical Department by Maria was in May 1932, at which time the radium was gifted to the Institute. There is a fascinating story[11] with regard to this radium during World War II in the manner in which it was saved.

TABLE I. Some of the illnesses which purportedly could be efficiently treated using a radium preparation.

Anemia
Arteriosclerosis
Arthritis
Cold feet
Constipation
Gastroenteritis
Gout
Hemorrhoids
Impotency
Lumbago
Migraine
Neuralgia
Rheumatism
Toothache
Ulcers

FIG. 13. Newspaper cutting from the Illinois Examiner of June 1921. Lake Front refers to Chicago and the photograph was taken on the roof of the Blackstone Hotel, just before Maria and her two daughters left for a tour of the Grand Canyon.

The Director of the Institute, Dr. Franciszek Lukaszczyk, fearing that the Nazis might destroy the Institute during the siege of Warsaw took all the radium (1886 mg) to Józefów outside Warsaw, carrying it for many hours and burying it in the garden of his friend. The radium was brought back to the Institute shortly after the siege. Then in October 1939, Dr. Lukaszczyk, still not trusting the Nazi authorities, hid all the radium applicators donated by Maria. The remainder of the radium was seized by the Gestapo and they investigated the missing radium, but eventually accepted Lukaszczyk's explanation that it had been taken out of Warsaw by the withdrawing Polish Army. The hidden radium still continued to be used secretly but at the defeat of the Warsaw Uprising the Institute's work ceased.

Pure chance saved the Institute's personnel from the mass execution carried out as they had been herded into the refugee camp at Pruszków. To save the remaining radium Dr. Lukasczyk had to return to the Institute in Wawelska Street.

He achieved this with the help of one of his patients, the wife of a German officer, and bribed German soldiers by offering them his wife's jewelry and managed to get to the Institute inside a German tank, pretending that he only wanted to collect his personal belongings. When the attention of the soldiers was elsewhere, he retrieved the radium from the ventilation pipes where it had been hidden and at the same time put nonradioactive dummy copies of the sources in the Institute's radium safe to give the impression that they had been left there in the panic of leaving the Institute. Maria's radium was then transported in the German tank to Reguly where it was buried again.

On the next day the Nazis plundered and destroyed the Institute, murdered the patients and set fire to the buildings and also stole the dummy radium sources. The radium eventually returned to the rebuilt Institute, Fig. 14, after the end of the war and today there is still a single radium tube retained for historical remembrance.

FIG. 14. Bronze statue of Maria outside the Warsaw Radium Institute in Wawelska street. This was all that survived after World War II. The Nazis used this for bullet practice and there is a hole exactly over her heart. Because of this statue it is said in Warsaw that Maria died twice, once after the Warsaw Uprising and once for medical science when she died of aplastic anemia in 1934.

VIII. FINAL RESTING PLACE: THE PANTHÉON

On 20 April 1995 the coffins of Maria and Pierre were reinterred in the Panthéon, Paris, Fig. 15, from their initial resting place in Sceaux. Maria is the first woman ever to be honored by burial in the Panthéon and the ceremony was attended by the Presidents of France and Poland, François Mitterand and Lech Walewsa, together with the Mayor of Paris, Jacques Chirac, Eve Curie-Labouisse, and other dignitaries.

The Joliot-Curie family accompanied the coffins which were carried by soldiers of the Republic Guard. It was also appropriate that the ceremony closed with the playing of a nocturne by Poland's most famous composer, Frederic Chopin, and that the Panthéon is only a short walk from the rue l'Homond and from the original Radium Institute buildings in the rue Pierre et Marie Curie, and today's Institute Curie in the rue d'Ulm.

IX. AFTERWORD

No such short paper as this can do proper justice to the 20th century's most famous woman scientist; it would need a full biography. For example, no mention has been made of Maria's work with the X-Ray Ambulances, termed Little Curies, in World War I, and the establishments of Radium Institutes in both Paris and Warsaw. However, it is hoped that there is something new for readers in this paper which is based on my presentation at the 1998 AAPM Annual Meeting which included a Symposium *Legacy of Madame Curie: 100 Years of Radioactivity*.

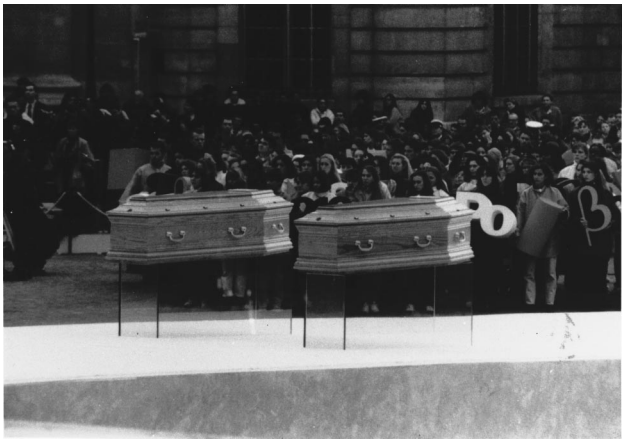


FIG. 15. The coffins of Maria and Pierre outside the Panthéon. The polystyrene cutout held by children symbolize their work. Po (for polonium) and β are clearly seen. Second from the right a cylinder is being held; this signifies an atom (the design was chosen by a librarian and not a scientist!).

ACKNOWLEDGMENTS

The research for this and my other publications[8,11] on Maria Sklodowska-Curie would have been impossible without a great deal of help from any persons. In particular I would like to mention the Museums at the Institute of Radium in Paris (Mme. Monique Bordry) and in Freta Street, Warsaw (Mme. Malgorzata Sobieszczak-Marciniak), and the permanent exhibition at the Ecole Supérieure in Paris (Professor A. P. Legrand). I am also particularly grateful to Professor Jean-Marc Cosset of the Institute Curie, Paris and to Professor Andrzej Kulakowski and Dr. Edward Towpik of the Maria Sklodowska-Curie Memorial Cancer Center and Institute of Oncology, Warsaw. I was also privileged to be invited by Mme. Eve Curie-Labouisse to her New York home to listen to her fascinating stories of her early years with her mother.

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