

II. Marie Sklodowska Curie

“...polonium, du nom du pays d'origine de l'un de nous!”¹⁴⁵

Maria Salome Sklodowska was born on 7 November 1867, in Warsaw, in partitioned Poland, under foreign subjugation. She was the youngest of five children in the Ulica Freta household of Vladislav Sklodowski, a teacher of mathematics and physics, and of his wife, née Boguska, also a school teacher. Manusia grew within sight of the Vistula; she was small, timid, nervous, and beloved of her brother Josef and her sisters Zosia, Bronislava, and Helena. At an age when most children are blissfully oblivious of their surroundings, she witnessed the demotion of her respected father by the imperial establishment, suffered the death of her eldest sister (1876) and endured the apparent disaffection of her consumptive mother. In the painful aftermath of her mother's death (1878), Maria renounced her Catholic faith (“...I respect religious feelings...the more I recognize how lucky they are, the less I can understand their faith”); the exaggerated mourning, black curtains, dresses and veils, unconscionably protracted the pain and clung to the sensitive girl for the rest of her life.

From her mother, Maria adopted kindness and uncompromising sense of duty; from her father, she acquired introspection, preciseness, and an addiction to self-education. Both parents contributed the concept of culture as an educated refinement of taste, the learned ability to enjoy beauty in its various manifestations. Their home became a schoolhouse as their father sought to earn a living through private tutoring. At sixteen (1883) Maria finished school, earning a gold medal. Her father decided that she should spend a prolonged rest at the stock farm of one of her uncles, in Zawieprzyce, northeast of Lublin. The mountain footpaths and cottages, the lakes, the snowy peaks, the horseback riding, the country music and dances awoke her youthful lyricism: “*I have gone to a kulig. You can't imagine how delightful it is. My costume was very pretty...many handsome boys who danced so well! At eight in the morning we danced the last dance, a white ma-*

zurka.” Half a century later her daughter Eve tenderly wrote: “*I thanked the destiny which, before it dictated this woman's austere and inexorable summons, had allowed her to follow by sleigh after the wildest kuligs, and to wear out her shoes of russet leather in one night of dancing.*”

Under tzarist domination, Polish women were denied higher education. Manya and her sister Bronya sought to obtain a liberal education in the “floating



Fig. II-1. Manya and Bronya Sklodowska, the two “positivists” (1886).

university," a clandestine organization of intellectuals and political activists. With innate dignity and moderate enthusiasm they embraced the lofty aspirations of their surreptitious confederates: equality for women, education for all, abolition of class distinctions, anticlericalism, and a better future for all mankind. The girls called themselves *positive idealists* and cut their hair short! (Fig. II-1.) Self-renunciation offered itself to them, as a substitute for lost faith. Maria lectured to laborers and started a library for women; she annotated books by Heine, Dostoevski, and translated poetry from French and German into Polish ("...*the ideas that guided us were the only ones which can lead to true social progress: one cannot build a better world without improving the individual*"). An understanding of dissenters and a tolerance of libertarians were to remain in her character. But she also learned that the vanity of the unselfish might be boundless and that the millennial component, the need for a faith in the future, could be satisfied without erasing the self.

In 1885, Bronya decided to study medicine in Paris. Maria conceived and proposed a pact: she would work as a governess and send half of her earnings to help support her sister; later she might expect help herself. She took her first salaried position with a Warsaw family ("...*where they speak French—a chimney sweep kind of French—when there is company...*") the experience discouraged her ("...*one must not enter into contact with people who have been demoralized by wealth*"). She carefully chose another position as governess, in the country near Przasnysz (three hours by train plus four hours by sleigh from Warsaw), with a cultured, as well as affluent, family. Her zest for the adventure of life was stimulated by the countryside and its people. In addition to her contracted duties, and with the consent of her employers, she taught ten peasant children in her own room; this was against the law. Gradually, she also discovered the excitement of mathematics, physics, and chemistry, which she studied alone ("*Think of it, I am learning chemistry from a book*").

Then she caught the "*kind of fever*" to which she had thought to be immune: she and Kazimierz, the eldest son of her employer, fell in love with each other. But Mr. and Mrs. Sorawski, a former governess herself, did not approve of their son's choice. Maria was badly shaken and humiliated ("*To gain my independence again, I would give half my life...If only I did not have to think of Bronya*"). Her obligation terminated (1889), she returned to live with her father ("*I want to give him a little happiness in his old age*"). An encounter with Kazimierz broke the last threads between them.

In the private laboratory of a cousin, Maria taught herself, at night, the simple operations of elementary science, the use of thermometers, electroscopes, pipettes ("*Although I learned...that progress is neither swift nor easy, I developed a taste for experimental research during these first trials*"). Her vocation flashed

into life: at 24, intellectual achievement as an aim in itself became her ambition. Bronya, now Mme. Dluska and a mother-to-be, had been urging her trip to Paris ("*I dreamed of Paris as a redemption, but the hope of going there left me long ago*"). Finally, in the autumn of 1891, Maria made the 1200-mile train trip, crouched in a folding chair, to the city where she was to live for the rest of her life.

The Dluski's lived near the Buttes-Chaumont, over an hour by horse-drawn omnibus from the University. Maria found most of her classmates advantageously prepared by seven years of *Licée*; the curriculum was challenging and tough. By contrast, the students' ambit, the Latin Quarter, was gay, frivolous, libertarian, eccentric. Within a short time, Maria found a room of her own, twenty minutes walk from the Sorbonne. Her *seventh heaven* had a skylight window, no water or heat, but it was all her own and made her feel independent; Paris had that ineffable quality that made so many feel vibrant and confident, one dared to think and to hope. In Paris, one could feel both at home and abroad ("*...the best memories of my life... If sometimes I felt lonely, my usual state of mind was one of calm and of great moral satisfaction*"). She spent long hours reading by her oil lamp.

After two years of hard work, Marie Skłodowska finished first in her class and obtained the *Licence ès Sciences Physiques* (1893). She went to Warsaw for a visit to her lonely father but she returned to France: her intellectual ambitions had already overtaken her family attachments. She engaged in a study of the magnetic properties of various minerals for which laboratory space was needed: a visiting friend proposed consultation with the Chief of Laboratories at the Industrial School of Physics and Chemistry, Professor Pierre Curie: an interview was arranged at a private party ("*A conversation began between us and we became friendly*").

Pierre Curie was eight years her senior. He was tall, slender, with an undefinable, careless elegance; his reddish hair was cut *en brosse* and he wore well-trimmed beard and mustache. He had serene eyes, a soft voice, a kind smile, and a powerful and noble mind. Of a Protestant family, he had become an agnostic and also had vowed to remain a bachelor. An unusually reserved and complex man, he would walk alone in the woods for hours, sometimes in the middle of the night, without notion of time ("*One must make of life a dream—he wrote—and of that dream a reality*"). His contemplative character was accompanied by a rare conceptual sense and an ability to express complex situations. With his brother, Jacques, Pierre had done notable original research and had invented the *quarz piezoélectrique* for the measurement of small electric currents; although the brothers Curie were hardly known in France, their work had brought them fame abroad.

Marie and Pierre's initial conversation was followed by others at the regular sessions of the Physics

Society. He was impressed by her courage and her amazing love of work and fascinated by her lucidity, her challenging questions, her reflective answers. He was gradually attracted to her; his gentle tenacity won over her timidity and she accepted his companionship. He was allowed to visit her in the barren garret where she now lived, rue Feullantines, not far from his laboratory and from the Luxembourg Gardens. He was surprised by her patriotic feelings and social interests and was disgruntled to learn that she had no intention to remain in France. Their friendship grew, but within a few months (1894) she finished second in her class, obtained another Masters Degree in mathematical sciences and went again to Poland. Pièrre asked her to become his wife but Warsaw was still humming in her ear (“...fate has made us deeply attached to each other,” she admitted).

Marie returned to Paris but matrimony was not in her plans. Pièrre renewed his entreaties, without re-

sults; he suggested that they take neighboring apartments on rue Mouffetard, in order to remain close if not united (“*It would be a fine thing...to spend our lives near each other hypnotized by...your patriotic dream, our humanitarian dream and our scientific dream. Of all of these...the last is, I believe, the only legitimate one*”). He even offered to move with her to Poland. Finally she agreed to marry Pièrre and on 26 July 1895, they faced the simple civil ceremony. At 28, Marie had lost her earlier embonpoint: her high forehead, curly blond hair, and ash-gray eyes gave her a very pretty appearance in her dark blue dress. (Fig. II-2.) “*Since she came into the world she has never caused me pain*”, said Mr. Sklodowski to his new son-in-law (“*You are right to follow your heart—wrote her brother—may you find with him all the happiness and joy you deserve...you shall remain Polish*”). The newlyweds got two bicycles as a present and went off on a wedding tramp. Pièrre was a dedicated observer of the order and beau-



Fig. II-2. Pièrre and Madame Curie at their marriage ceremony (1895).

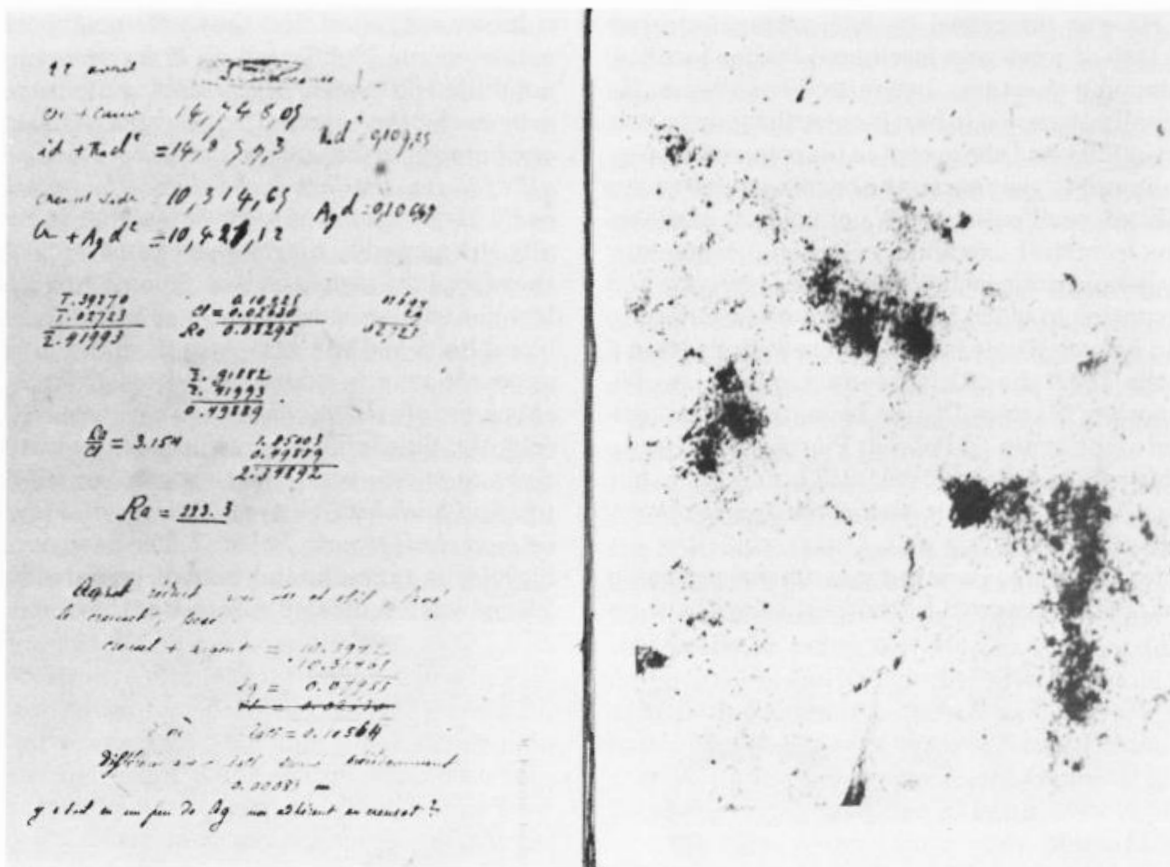


Fig. II-3. Page of the Curie's laboratory log (left) and its radioautograph (right) taken 50 years later,^{242b} showing radioactive contamination.

ty of nature and Marie had long loved the open country; they spent their youthful energy pedaling in the windy plains and up to the high plateaus, they admired the green fields and loitered at dusk listening to distant folk singing. Upon their return, they rented a flat at 24 rue de la Glacière.

Marie continued the testing of minerals in her husband's laboratory. She had decided to face all of her obligations equally, without neglecting any of them. During the first part of 1897, she was frequently hampered by her pregnancy, but in the fall of that year, she completed her report and first publication. Her daughter, Irène, was born 12 September 1897.

A key point in Röntgen's discovery had been his observation of the fluorescence of platinocyanide salts. In 1896, in successive communications made in Paris, Antoine Henri Becquerel (1852–1908) reported that the "phosphorescence" of uranium could be elicited without benefit of sun exposure, that in roentgen-ray fashion, it was capable of fogging photographic plates through a thickness of aluminum and, also, of discharging electrified bodies. Interest in these phenomena had declined but Madame Curie, who had been working with minerals, chose the subject for her doctor's thesis. She decided to use the conductivity of air for a *quantitative* test of radiant activity. The piezoelectrometer of the brothers Curie was to play its most important role yet.



Fig. II-4. Widow Curie and her daughters, Eve and Irène (1908).

In December 1897, she was already at work. She verified that the radiant activity of various compounds was directly related to the amount of uranium present, irrespective of its solid, powdered, or wet state. She assayed innumerable metals, salts, minerals. Working with pitchblende and charcolite she discovered that some compounds of *thorium* were even more active than uranium. Her findings were reported to the Academie des Sciences on 12 April 1898.³⁷¹ It turned out that Gerhard Schmidt, working in Berlin, had preceded her in reporting the radiant activity of thorium. But she emphasized that both, uranium and thorium, had high atomic weights and suggested that the radiant activity was an atomic property, for it was independent of the physical or chemical state of the radioactive element. Moreover, she presaged the existence of additional yet undiscovered radiant elements (*"Ce fait est très remaquable et porte à croire que ces minéraux peuvent contenir un élément beaucoup plus actif que l'uranium"*). The study of what she now called *radioactivity* was to enter a more distinct and important phase. Pierre Curie and his laboratory assistant, Gustave Bemont, joined in her work. The search for new elements on the basis of radioactivity required new methods, which Marie and Pierre developed. She remained responsible for the chemical procedures and



Fig. II-5. Double Nobel Prize winner Marie Curie in her laboratory (1912).



Fig. II-6. Madame Curie in the driving seat of one of her ambulances during World War I (1917).

separations. By July 1898, having separated away, by dilution, the uranium and thorium in pitchblende, they reported their discovery of a new radioactive element, akin to bismuth: *"If the existence of this new metal is confirmed, we propose to call it polonium from the name of the country of origin of one of us"*.¹⁴⁵

During 1898, little Irène had started to walk; the details of her development, the eruption of her teeth, her feedings were lovingly noted by her mother in her home records. The Curies had already observed that they were also dealing with another even more radioactive element. They eventually succeeded in precipitating polonium and obtained a very radioactive chloride of a new element, akin to barium, 900 times more radioactive than uranium. The spectroscopic study by Eugène Demarçay revealed a characteristic line in its spectrum; in their report of December 1898, they proposed to call the new element: *radium*.¹⁴⁶

Having discovered it, the Curies felt obligated to produce a sample of their new element. Thus, they initiated a four-year odyssey of hard work in the uncomfortable shed, rue Lhomond (*"...a lamentable enclosure which had endured the worst insults of time"*—wrote a journalist). Large quantities of ore were needed and there was no money; the Austrian government offered the first ton of residue ore and they paid for the transportation charges. But more than time and toil was needed to the task: they gave themselves, day and night, and finally brought forth one-tenth of a gram of radium (*"...it was in this miserable old shed—wrote Marie—that the best and happiest years of our lives were spent"*). To this day, the jealously kept pages of



Fig. II-7. Irène Curie, age 20, at her mother's laboratory.

their laboratory log-book show their radioactive finger marks!^{242b} (Fig. II-3.) The Curies acquired an associate, André Debierne (1874–1940), who was to discover *actinium* and became a faithful friend of the family.

Once sufficient amounts of radium became available, radiophysiologic effects were observed and reported. Becquerel and Mme. Curie both noted accidental effects on their skin. Pierre Curie applied radium to his forearm and described in detail the various phases of a moist radio-epidermitis and his recovery from it. He initiated animal studies and gave tubes containing radium emanation (radon) to clinicians who carried out human trials: Henry A. Danlos (1844–1912), Henri Dominici (1867–1927), Louis F. Wickham (1861–1913), Paul Degrais (1874–?).

In June 1903, Madame Curie presented her thesis at the Sorbonne and obtained her diploma of *Docteur ès Sciences Physiques*.³⁷² Her historical text summarized the scientific episodes of their discovery; she painstakingly detailed the credit due to others and carefully also, her own role in the discovery. In August, Marie delivered, prematurely, a baby girl who died shortly afterwards. In November, the Royal Society of London conferred on the Curies the Davy Medal and, immediately following, the Swedish Academy of Science announced that the Nobel Prize for Physics had been awarded to Becquerel “for his discovery of spontaneous radioactivity” and to the Curies “for their work on radiation phenomena.” The numerous other honors, the international acclaim, invitations, solicitations, etc.

deprived them of their prized independence and threatened their happiness (“We have been pursued by journalists and photographers—wrote Pierre—they have gone so far as to report the conversations between my daughter and her nurse.” “Our life has been spoiled by honor and fame—wrote Marie—One would like to dig in the ground somewhere to find a little peace”).

The University of Paris created a chair of physics and offered it to Pierre Curie; Marie was appointed Chief of Laboratories in the same chair in November 1904. On 6 December 1904, Marie delivered another baby girl, Eve, who was to write a remarkable biography of her mother. Mme. Curie resumed her lectures at a school for young women at Sèvres. (“In the afternoons, I am at the laboratory and in the mornings at home, except for two mornings a week at Sèvres...with the housekeeping, the children, the teaching and laboratory, I don't know how I shall manage...”). Dr. Albert Laborde²⁵⁵ and an American professor of physics, Dr. William Duane,³²⁶ became her enthusiastic collaborators at the University laboratories, rue Cuvier. They worked persistently on means to measure the emanation of radon although Pierre preferred more adventurous work. “My husband—wrote Marie—made a habit of engaging in the pursuit of phenomena, often without great hope of success, just for love of the unexpected.” In June 1905, the Curies went to Stockholm to fulfill their obligation to the Swedish Academy (“I am among those who think with Nobel—said Pierre—that humanity will obtain more good than evil from the new discoveries”). On 3 July 1905, after the customary round of solicitations, Pierre was elected a member of the French Academy of Sciences.

Then, on 19 April 1906, as lightning on a clear sky, tragedy came into their midst. After a luncheon, Pierre walked towards the Institut de France; absent-mindedly he attempted to cross rue Dauphine at the Quai, when a heavy horse-drawn wagon, emerging from Pont Neuf, rushed past the intersection; as he saw the fuming horses upon him, he tried to hang on to one of them but he slipped on the wet pavement and was trampled to death. Grief-stricken, Marie froze and became silent; gradually, she gave in to sobs (“*Mon Pierre—enfermé dans un rêve dont tu ne peut sortir...tes lèvres que jadis j'appelais gourmandes, sont blêmes et decolorées*”). She drew strength from her father-in-law, a retired physician, from André Debierne, her faithful associate, and from Henriette (Mme. Jean) Perrin, her next-door neighbor. The University of Paris promoted her to the chair left vacant by her husband and she pursued her work on the mathematics of radioactivity. Concerned with quality education for her daughter, Irène, and in concert with her closest colleagues, she organized a cooperative: a series of lectures and demonstrations given to a group of their own children by Jean Perrin (1870–1942), Paul Langevin (1872–1946)† and others, on science, literature, art, history; the project lasted only two years. A widow at 38, she was yet to suffer more.

Around 1910, Marie appeared beautifully dressed in white at a party of friends: a keen observer guessed that she was in love.²⁷² Paul Langevin, Pierre's genial student was five years her junior; he had studied at Cambridge and had replaced Curie at the *Ecole de Physique et Chimie*. Langevin was a brilliant mathematician who also taught at Sèvres; he often sought Marie's advice. Her maternal concern gradually turned to affection for the young man and they became lovers. The trouble was that he was already married.³⁵⁵

Madame Curie decided to present her name for a vacancy at the Academy of Sciences; she was the first woman scientist to do so. The publicity given to the unprecedented event brought the customarily reserved contest into the open: she was defeated by one vote. Then came the scandal. A journalist got hold of Marie's love letters to Langevin and the Parisians were given daily, the prurient details of their love affair. The publicity was spiced by a duel between Langevin and a journalist: the public was aroused. Madame Curie, who had brought great scientific credit to France, seriously considered returning to Poland.

She was among the few notable scientists invited to attend the first Solvay Conference, in Brussels (1911), to which Paul Langevin was also invited (see Fig. III-4, page 29). They were missed in Paris, in the midst of the scandalous publicity of their "affaire"; *Le Journal* implied that they had eloped. In the wake of the sordid publicity, the Swedish Academy announced

that she had received the Nobel Prize for Chemistry "for the discovery of radium," the first person to receive it twice. Accompanied by Bronya and Irène, she went to Stockholm and gave her own well-pointed acceptance speech. Upon her return to Paris, her energy and emotions at a low ebb, she needed rest. It took several months away from Paris for her to renounce her love and to regain her moral and physical strength. She gradually modeled her hidden grace, and restrained tenderness, into melancholy courage that was to become her self.

Madame Curie's yearning for a special research institution devoted to the study of radioactivity and its medical applications started to achieve reality in 1911: under the joint auspices of the Pasteur Institute and of the University of Paris the *Institut du Radium* was founded. The construction of twin buildings was planned: the *Curie Pavillion* for the laboratories of Mme. Curie and her collaborators in physics and mathematics; the *Pasteur Pavillion*, for the medical associates of Claudius Regaud (1870-1940)† in radiophysiology and radiotherapy.^{323b} But the first World War postponed the work that had just begun. Mme. Curie gave herself to the efficient organization and operation of a fleet of radiologic ambulances, and the training of the necessary technologists, carrying the possibility of fluoroscopy and radiography to the various fronts. (Fig. II-6.) She travelled incessantly from Amiens to Dunkerque to Verdun, to assure the proper



Fig. II-8. Marie and Irène Curie with a group of radiologists of the AEF (1919).

† See Biographical Notes on page 171.



Fig. II-9. Madame Curie descending the White House "scalinata" on the arm of President Harding (1921).

operation of her units; her daughter Irène was the able technologist of a unit of Montereau and another one was operated by Dr. Henri Coutard.³¹⁹

In 1919, Regaud gathered from the war ranks a fine corps of collaborators: Antoine M. Lacassagne (1884–1971), Octave Monod (1877–1934), Jean L. Roux-Berger (1880–1957), Henri Coutard (1876–1950). This original contingent was later augmented by Jean Pierquin, Georges Richard, and Juliette Baud. It was at the Radium Institute, financially aided by the Foundation Curie that they made their momentous radiobiologic contributions and that their work established the basis of modern clinical radiotherapy. Meanwhile Mme. Curie reassembled her collaborators just out of uniform: André Debierne, Fernand Holweck (1890–1941). Irène Curie (1897–1956) achieved her ambition to do research work close to her beloved mother ("Douce Mé"). (Fig. II-7.) On 7 February 1922, the National Academy of Medicine of France elected Madame Curie to its

membership without the customary application and interviews of the candidate: rather than an election it was a belated homage proposed by the Academicians led by Antoine Béclère.²⁵⁷

In 1925, Mme. Curie accepted a new assistant, a highly recommended young scientist, Frédéric Joliot (1900–1957): he was a protege and life-time admirer of Paul Langevin. In 1926, Frédéric and Irène were married. Within a few paces of the scene of the discovery of radium, this admirable second couple of devoted researchers discovered *artificial radioactivity* and opened the doors to a new world of nuclear medicine and brought them a well deserved Nobel Prize. (See Joliot, Chap. VIII.)

Busy in her laboratory, Madame Curie also spent time in the company of her family and close friends. She had difficulty relating to the variety of colorful friends of her younger daughter, Eve: musicians, theater folks, playwrights, journalists. Eve aspired to



M. Curie

Fig. II-10. Marie Curie (1925)—signature.



Fig. II-11. Madame Curie thanking Dr. Albert Soiland after the presentation to her of the Gold Medal of the American College of Radiology, in Paris (1931).



Fig. II-12. Marie Curie in the winter of her life at her laboratories (1932).



Fig. II-13. Postage stamp of the French Republic honoring Pierre and Madame Curie.

become a concert pianist. Later, she translated Shakespeare to French; eventually, she turned a peripatetic reporter, author, and lecturer.*

In 1921, she travelled to the United States to accept the gift of one gram of radium, a contribution of American women.* She added her prestigious name to the list of those who pleaded in vain for the life of Sacco and Vanzetti. She returned to the United States in 1929, this time to receive a monetary gift from President Herbert Hoover.

After the day's work at her laboratories, she would walk, alone or in the unassumingly protective company of one of her "laborantines," through the quieter streets of the Latin Quarter, to her modest apartment, 36 Quai Bethune. In the tranquil beauty of the legendary Isle Saint Louis, she could see from her window the majestic silhouette of the Pantheon rising above the city's skyline; she could also admire the beautiful vine-covered high walls of the left bank of the Seine. A few steps from her door, at the eastern end of the island, there is a charmingly secluded garden, a most romantic spot, traditional rendezvous of lovers, from which one can see the Seine divide to bathe both sides of the island.

She was active in the planning of the Institute of Radium of Warsaw, today the Marie Sklodowska-Curie Institute of Oncology. In 1931 Mme. Curie accepted an invitation to appear in Paris before the assembled Chancellors of the American College of Radiology to receive the Gold Medal of the College.³²² (Fig. II-11.) In the summers, she frequently vacationed in Switzerland: in the valley of the Engadine or on the borders of Lake Geneva, she often met a respected and congenial colleague, Dr. Albert Einstein. Another favorite vacation spot, where she built a house for her children and herself, was l'Arcouest on the north coast of Brittany near Paimpol, whence the "*pêcheurs d'Islande*" once made sail for the arctic, in pursuit of codfish, and did not always return. At l'Arcouest, the families Perrin, Curie, Langevin, Joliot, Gricoureff and others, grew in an atmosphere of respect for learning and admiration for each other.*



Fig. II-14. Statue of Marie Curie in the gardens of the Institute of Oncology, in Warsaw, the city of her birth (1936).

In the spring of 1932, while working in her laboratory (Fig. II-12), she sustained a Colle's fracture. She died in Paris on 6 July 1934 of aplastic anemia, the result of long exposure to radiations.

Workers of the Radium Institute were occasionally rewarded by a glimpse at the taciturn countenance of this most exceptional human being. A few would later remember her slim figure, in ankle-length black dress, pacing her meditations, and perhaps her memories, in the small patio between her two pavillions: she held her right hand under her chin, supporting the el-

bow with her left hand. This is the attitude captured by Ludwika Nitsh in the sculpture that graces the garden of the Institute of Oncology, in Warsaw. (Fig. II-14.)

This frail, sensitive, loving woman, who spoke timidly, was a portent of prodigious powers: her uncompromising devotion and obstinate efforts brought forth an understanding of the historical evolution of matter in the cosmos; her discoveries led man to pry into the secrets of the atom, to witness its tragic collisions, divorces, and brought him into possession of the forces of his own destruction.