A DEVOTION TO THEIR SCIENCE

Pioneer Women of Radioactivity

Marelene F. Rayner-Canham and
Geoffrey W. Rayner-Canham

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When the subject of women in atomic science is mentioned, Marie Curie's name immediately leaps to mind. Many other women also worked in the field, but their names have been forgotten. *A Devotion to Their Science* reclaims this first generation of women researchers in radioactivity, providing new insights into the contribution of women to atomic science and dispelling the myth that this field was essentially a male preserve.

A Devotion to Their Science includes biographical essays on twenty-three women who worked in atomic science during the first two decades of the twentieth century, including Marie Curie, Lise Meitner, Irène Joliot-Curie, and a host of lesser-known women scientists whose life stories have never before been told. The biographies highlight the lives and work of these women, noting their contributions and the challenges they faced and overcame. Taken together the essays record their collective experiences, highlighting the support network that developed among them and the reasons women were more predominant in this field than in other sciences in the early part of this century.

By recovering and recording individual and collective histories of the many eminent women in radioactivity whose work had a major impact on the scientific discoveries of the twentieth century, a more complete, gender-integrated view of the history of this fascinating field emerges.

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Preface

This compilation contains seventeen full biographies and six briefer accounts of most of the early women pioneers in the study of radioactivity. The fascinating stories of most of these women have never before been told and it is important that their lives be brought to light. It is only just to do so, since most of them contributed to the progress of science without any recognition during their lifetimes or since. We also need to kill the myth that Marie Curie was the one and only woman working in the field – a sort of gender aberration. Just as important, this collection is more than the sum of the essays because it shows, for the first time, that many of the women did not work in isolation but interacted throughout their lives, forming a support network, or "invisible college." In part, the support network resulted from the fact that the researchers, with few exceptions, belonged to one of the three major research schools in radioactivity, and we have organized the book around these three groups rather than dealing with the subjects in alphabetical order.

The difficult part was to decide on some sort of cut-off point, for women entered and left research into radioactivity on a continual basis. For this reason, we chose to include only women born before 1900. This division encompasses what might be referred to as the first generation of women researchers (it could be argued that Marie Curie, having started her research work in the 1890s, actually belonged to the zero generation). However, in the closing chapter, we mention a few of the second generation, such as Marguerite Perey, the discoverer of the element francium, to illustrate that women did not vanish from the field, though they did become more marginalized.

It was our original intent to write the whole of this work ourselves. Yet we wanted this compilation to become the definitive work on the lives of these women, containing the fullest and most comprehensive account possible. However, as we surveyed the quantity of material available on Curie and Meitner, it became apparent that we could not do them justice and that their life histories were best recounted by individuals who had spent years in their study. For some of the women from non-English-speaking countries, such as Gleditsch, we also believed that a thorough account could only be provided by someone fluent in their native language. We were fortunate to find enthusiastic and competent contributors for this purpose. Finally, we were able in two cases (Blau and Noddack) to obtain accounts written by people who had known the women as friends and who could present oral histories to substitute for the lack of biographical material. From our own research, we have edited and added to these solicited contributions to try to provide a consistent style and depth of treatment.

Marelene F. Rayner-Canham
Geoffrey W. Rayner-Canham

Acknowledgments

Apart from Meitner and the Curies, there are no formal archives of the women whose lives are discussed here. They regarded their contributions to science as minimal or even "worthless" and, as a result, kept no record of their lives. In most cases, the only way to piece together their stories has been to obtain copies of their academic records and filed résumés, copies of their publications, obituaries in parochial newspapers, letters to more famous scientists, letters of reference, comments about them in letters between other scientists, and in a few cases, biographical notes from surviving friends and relatives. The research has covered archives in eighteen countries. Through a travel grant from the Canadian Social Sciences and Humanities Research Council, it was possible to search archives at Cambridge University, Oxford University, the Royal Society, the Royal Institution, and the Institut Curie. For all the other archives (more than fifty) we relied upon the dedication of librarians and archivists in those locations to find the particular items for us. Each librarian and archivist is acknowledged in the appropriate chapter, but we wish to mention their efforts at the outset of the book as well. Without their collective contributions, it would have been impossible to assemble these accounts.

Most of the book was written at Sir Wilfred Grenfell College (SWGC) of the Memorial University of Newfoundland. We acknowledge the support and encouragement of SWGC faculty and administrators. In particular, we wish to thank James Greenlee and Dennis and Alice Bartels for critical comments on chapter 2. The remainder of the book was written at New College, University of South Florida (NC), where one of us has had a continuing appointment as visiting research scholar for the summer months.

Elizabeth Behrens, associate university librarian (SWGC), deserves a special thanks for her tireless efforts over the years to track down arcane material and copies of the research papers of these pioneer women. We also acknowledge the similar contribution of Holly Barone, interlibrary loans department (NC), during a half-sabbatical at that institution.

We are most grateful to the Subvention Fund of the Memorial University of Newfoundland and to the Chemical Heritage Foundation, Philadelphia, for their support of this work.

Foreword

For the better part of a decade I have played a game with students in the "women and science" course I teach at Concordia University. During the first class, I ask them to identify three Canadian women scientists and three from other parts of the world, write the six names on a piece of paper, and put the paper into a envelope. I keep the sealed envelopes until two weeks before the end of term; then I read them out for the class and a student writes the names on a board. Unfortunately, the list is brief and repetitious, "Marie Curie" being cited most frequently.

By the second stage of this exercise, students have heard about many other women scientists, including the Canadian Harriet Brooks and the Norwegian Ellen Gleditch. More importantly, they have learned about the factors that have influenced women's scientific opportunities in the Western industrialized world, such as systemic discrimination and the stereotypes of women and science. Readings and discussions have aroused their curiosity about women who have contributed to science at different times in many parts of the world, and who, for a variety of complicated historical reasons, have been overshadowed by the two-time Nobel Prize winner Marie Curie. They want to read about scientists, women and men, to understand gender roles and gender relations in science. From the response of my students it is evident that, in spite of the growing literature on women scientists, there is a great need for books such as *A Devotion to their Science: Pioneer Women of Radioactivity.*

What was the science of radioactivity and who were its forgotten pioneers? What were the factors that shaped their lives? When and for what reasons did the women in this volume decide to enter the new profession, science? How were they treated at various universities as students? Were they encouraged in their endeavours or were they prohibited from pursuing their studies in science? Were there any national and generational variations in their opportunities and experiences? To what extent did they fulfil their potential? How did they deal with obstacles and discrimination? How did they, if they were able to at all, combine a career with a conventional family life – like most of their male colleagues?

These questions need to be answered in order to understand the many similarities and differences in the "careers" of the first generation of women atomic scientists. The essays in this volume show how supportive environments at home, school, and work can encourage creativity and scientific excellence. Many of the authors deal with the challenges women faced because of discrimination based on their ethnic/religious backgrounds as well as on gender. They also deal with the impact of the women's discoveries and contributions to the emerging field of radioactivity.

The Rayner-Canhams have been researching and writing about women in chemistry and physics for well over a decade. Their scientific expertise, their sensitivity to gender issues in science, and their prodigious industry in lecturing and writing about women scientists have enabled them to disseminate information on many previously overlooked women scientists. This collection, with its variety of biographies – some detailed, others (for want of adequate documentation) far less so – will enhance the growing literature on women and science.

The feminist biographical approach of this book will lead to changes in the conventional story of radioactivity. By recovering forgotten women and presenting them as active, creative agents whose work had a major impact on the scientific discoveries of the last century, the authors give us a different, much more complete story that will help in reinterpreting the history of science. This, in turn, should affect the way science is taught in school, lead to fresh insights into the functioning of modern science, and prompt new research into gender relations in what has been known until recently as a largely masculine field. *A Devotion to Their Science* will open the readers' eyes and stimulate their minds. It will answer many questions and raise others. By analyzing the lives of eminent women in radioactivity, this book presents a more realistic, gender-integrated view of the history of this fascinating science.

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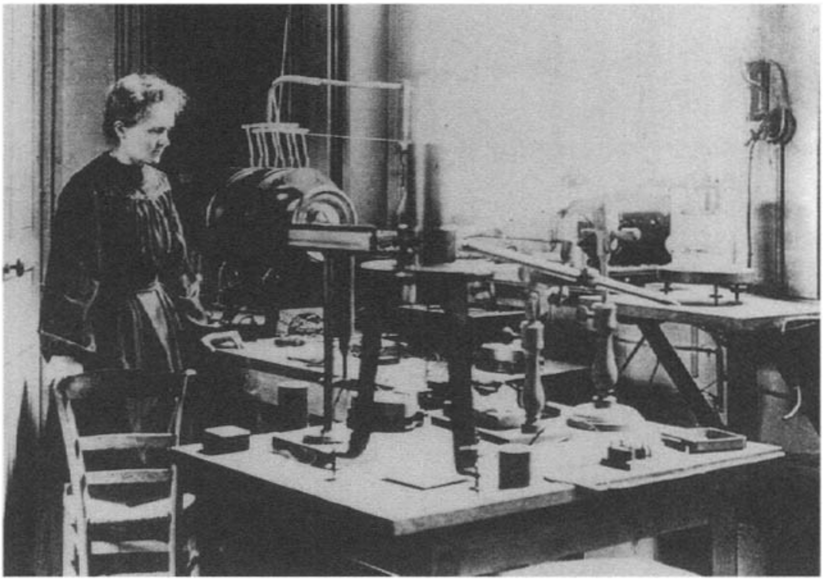


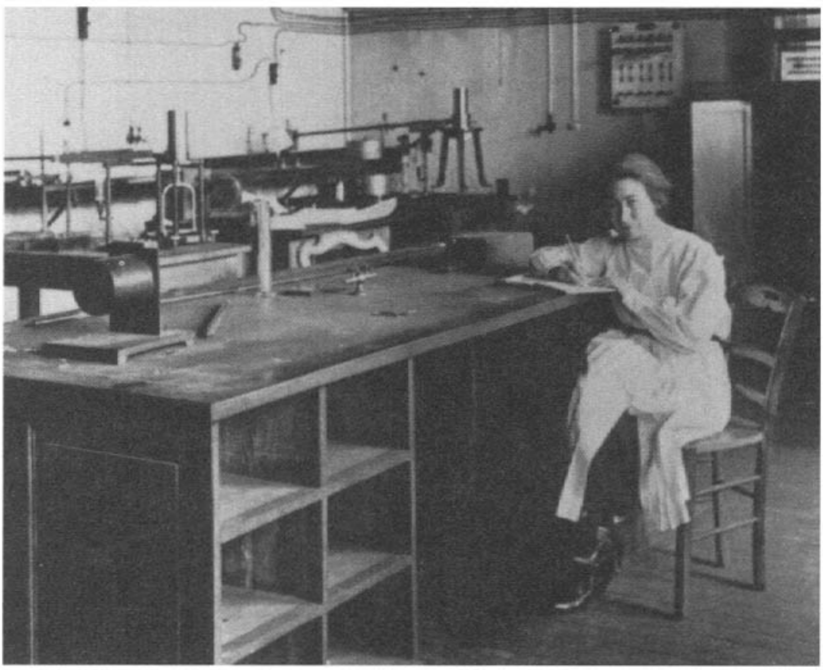
Marie Curie in her laboratory. (Archives Pierre et Marie Curie)

Ellen Gleditsch, her graduation photo. (T. Kronnen and A.C. Pappas)

May Sybil Leslie.
(University of Leeds Archives)

Catherine Chamié (right) in the Curie laboratory with Sonia Cotelle.
(Archives Curie et Joliot-Curie)

Harriet Brooks, her graduation photo.
(Notman Collection, McGill University Archives)



Stefania Maracineanu in the Curie laboratory.
(Archives Curie et Joliot-Curie)


Fanny Cook Gates. (Goucher College Archives)

Jadwiga Szmidt (*rear right*). This is possibly a photo of the Ioffe research group. (M. Golonka)

Lise Meitner at a colloquium in Berlin, 1920. (Archiv zur Geschichte der Max-Planck-Gesellschaft, Berlin)

Marietta Blau.
(L. Halpern)

Ida Noddack. (Fo Habashi)

PART ONE

The Overview

It is crucial to place our biographical and scientific accounts in context, and this is provided in the first two chapters. They deal in part, of course, with the advances in knowledge of the atom and of subatomic particles that took place in the early decades of the twentieth century. But equally important are the individuals involved in the quest for knowledge. Progress in scientific knowledge is intimately involved with human relations and all advances reflect the preconceptions and prejudices of their era. Hence we will be examining some of the beliefs concerning the atom as well as the relationships between scientists and their research groups. Many of the individual biographies in this book overlap and this is one of its major strengths; for as we show conclusively in chapter 2 – and reiterate in later chapters – the "accepted" historical view that many of these women were "loners" is wrong: they communicated with one another both professionally and socially. It is also crucial to realize that the women researchers belonged to that unique period in history when women were being admitted for the first time to universities. Thus, we review contemporary beliefs concerning women's education and address the question why so many women were attracted into this particular field.

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1 Early Years of Radioactivity

MARELENE F. RAYNER-CANHAM
and
GEOFFREY W. RAYNER-CANHAM

In this introductory chapter we summarize the immense progress in our understanding of matter and radiation between about 1880 and the 1940s. This period in scientific history marked the transition in emphasis from individual professional and amateur scientists to the research schools that we recognize today. As well, research was no longer a simple striving for knowledge but a need for priority in discovery, reflecting the intense nationalism of the age.

At the outset of this period the vision of matter was very simple. Ernest Rutherford, who became one of the leading researchers in the field, summarized the situation well: "I was brought up to look at the atom as a nice, hard fellow, red or grey in colour according to taste."[1] The change in our view of matter was brought about by two factors: advances in the knowledge of electricity, light, magnetism, and other physical phenomena and changes in the nature of scientific research. Traditionally, scientific research had been the preserve of the individual professional or amateur scientist, usually employing simple items of equipment. Between the 1860s and the First World War the hierarchical research group appeared, and though important discoveries were still being made by individuals, the work of these groups came more and more to dominate the major advances in science.[2] The formation of groups reflected the increasing complexity of the work, which drew on the combined skills and abilities of scientists of different backgrounds, while the enormous amount of research needed to follow up discoveries in the field required many hands at the research bench. Indeed, the discovery of the phenomenon of radioactivity marked one of the most explosive growths in the history of science; by 1907 more than twelve hundred papers had been published in the field.[3]

Radioactivity was becoming a topic of daily conversation as people became aware that scientific discoveries were changing their lives.[4] Following from this, personal and national prestige became a driving force in the development of the field as well as scientific curiosity. In the study of atomic science and the phenomenon of radioactivity, we find that there were three major groups of researchers. These we will call research schools,[5] though in many ways it is more accurate to refer to them as invisible colleges, a term used to describe groupings of scientists who correspond with each other and exchange results.[6]

THE RESEARCH SCHOOLS OF ATOMIC SCIENCE

Those who worked in this field can be roughly categorized into three sets of collaborators: the French school, the British school, and the Austro-German school.[7] These schools represented not only location of focus but also the style of research. There was a strong perception, embedded in reality, that the approaches of the groups were different. In his discussion of the national differences, Alex Keller notes: "Yet a young Hungarian colleague of Rutherford's wrote to him in 1913 on the contrast between the British Association meeting at Birmingham that September, and a similar congress held at Vienna straight after: 'altogether it was more knowledge in Vienna but far more ingenuity at Birmingham.' A few months later another young colleague, Henry Moseley, described a visit from the eminent French chemist Urbain from whom he learnt that 'the French point of view is essentially different from the English – where we try to find models or analogies, they are quite content with laws.'"[8] Keller comments on the French view of their own science as "the spirit of synthesis, simplicity and clear precision," in contrast to "the haphazard fact-finding sorties of the British, who wanted to turn everything into wheels within wheels, or to the grandiose woolly theorizing, and niggling accumulations of useless data piled up in German theses and treatises."[9] There did seem to be a basis in reality for different scientific styles, Marie Curie, and, later, Irène Joliot-Curie, for example, were often among the first to perform a crucial experiment but, through conceptual conservatism, rarely recognized the paradigm shift[10] necessary for its correct interpretation.

For most of the period in question, the French group was identified exclusively with the name of its leader, Marie Curie.[11] Initially, the "school" consisted essentially of Marie Curie and her husband, Pierre. Following Pierre's death, Marie Curie's research group grew rapidly to the point where there were more applicants than space to house them. Though most of the researchers came and went, André Debierne seemed to have been the day-to-day manager of the research effort with Irène Joliot-Curie, Marie's daughter, taking over in later years. Throughout the continuous history of the French group, it was always Paris-focused.

The British effort largely revolved around Ernest Rutherford. Rutherford had been a student of the famous nineteenth-century physicist J.J. Thomson, at the Cavendish Laboratory, Cambridge University.[12] Enticed by the excellent research facilities at Canada's McGill University, he moved to Montreal in 1898. Chemist Frederick Soddy joined him later and some of Rutherford's major conceptual advances were joint efforts between the two. Rutherford returned to England, first to the University of Manchester and then back to the Cavendish Laboratory. Though many researchers worked with him wherever he was located, he also had a more diffuse network of collaborators and associates. When Rutherford returned to England from Montreal, the study of radioactivity died in North America. Pyenson has shown that research in the field collapsed at McGill with Rutherford's departure,[13] while Badash has commented upon the sterile scene in the United States: "There were no charismatic leaders, and no laboratory seems to have created a vital environment sufficient to establish a tradition with the weak exceptions of Yale and Minnesota."[14]

The situation in Vienna where the Austro-German school originated could more correctly be described as a research circle rather than a research school, as the head of the Institute, Franz S. Exner, favoured collaboration, not a master-student style.[15] Nevertheless, for research into atomic science it was Stefan Meyer who was considered the overall leader. Following the collapse of the Austro-Hungarian Empire, the focus moved to Berlin and the work of Hahn and Meitner, among others. There was still interesting work being done in Vienna, but it was never in the forefront of the major discoveries.

The researchers in Vienna were almost exclusively physics-oriented at a time when interest centred on aspects of radioactivity in the middle ground between chemistry and physics, such as the discovery of new elements and the undertanding of atomic structure. This is, perhaps, part of the reason why the Vienna workers have been little acknowledged in the history of atomic science. By contrast, the Curie group always contained chemists as well as physicists (Marie Curie having had a chemistry background) and Rutherford collaborated with the chemist Soddy for many years. Even though Rutherford thought of himself as a physicist, he was awarded the Nobel Prize in chemistry for his work on radioactivity. Of relevance to this hypothesis, the greatest claim to fame of the Austro-German group was the collaboration between the chemist Otto Hahn and physicist Lise Meitner. Only later did the interdisciplinary science of radioactivity become replaced by that of atomic physics.[16]

Throughout this saga, competition seemed to be a strong driving force between the different groups. Inititially, the principal competition was between the British (Rutherford) and French (Curie) groups, then later between the Austro-German (Hahn and Meitner) and French (Joliot-Curie) groups. The perceived arrogance of the French group antagonized other scientists. Such anti-French views were reinforced by Curie's insistence that the unit of radioactivity be called the curie and that the standard sample be lodged in Paris. Though the First World War severely disrupted scientific relations[17] in general, relations between the British and Austro-German workers in radioactivity seemed to be more amicable, perhaps in part because Otto Hahn had worked with Rutherford in the early days in Montreal. Even so, the superficial congeniality covered a competitive attitude. Otto Frisch, Lise Meitner's later collaborator, remarked of his early years in Vienna that hasty (and erroneous) research was being done for the sake of "beating the English at their own game."[18]

RADIOACTIVITY AND ATOMIC STRUCTURE

If one can possibly place a date on the beginning of the Age of Radioactivity, then it would be the discovery in 1896 that radiation was emitted by a compound of uranium. The discovery that uranium salts darkened photographic plates is associated with the name of the French chemist Henri Becquerel, who observed the phenomenon in 1896.[19] However, Becquerel's research depended upon Konrad Röntgen's discovery of x-rays in 1895[20] and the even earlier discovery of cathode rays. At the time, few scientists pursued investigations into so-called hyperphosphorescence, or Becquerel rays from uranium. Interest rose in 1898 with the simultaneous discovery by Marie Curie in France and G.C. Schmidt in Germany that thorium also emitted Becquerel rays.[21] And so the search was on for the nature of the rays and for evidence of radioactivity among other elements. It was the French group that pursued the isolation of radioactive elements, the Curies extracting polonium and radium from pitchblende in 1898 and Debierne isolating actinium in 1899. Rutherford, on the other hand, was more interested in radiation, showing in 1898 that there were two types of rays, which he called alpha (α) and beta (β), and that they behaved as particles. Later, the French scientist P. Villard reported a third type of radiation. Rutherford suggested that this was very short wavelength electromagnetic radiation, which he named the gamma (γ) ray.[22]

Atomic Transmutation

The long-discredited field of alchemy had claimed that one substance could be transmuted into another, such as lead into gold. Hence the "real" science of chemistry had identified the immutability of chemical elements as one of the cornerstones of its philosophy. J.J. Thomson, one of the orthodox physicists, was convinced that radioactivity was only a simple chemical process and he expended considerable (and fruitless) effort in his laboratory trying to prove this.[23] Even in 1900, the Curies agonized over the apparently unlimited amount of energy being radiated from the radioactive elements without any obvious source and in apparent violation of the laws of thermodynamics.[24]

Thus, it was extremely difficult for atomic scientists to reconcile what was then a fundamental principle of chemistry with the discovery that elements *did* change identity during the release of radiation – the phenomenon that we now call radioactive decay.[25] Rutherford, together with Harriet Brooks, had worked on the identity of "emanation," which was produced from the element thorium. Brooks concluded that emanation was in fact a gaseous element of different atomic weight (what we now call radon). Following from this, Soddy and Rutherford took the bold and somewhat blasphemous step of announcing that one element had been produced from another.[26] The Curies and Debierne had made the same laboratory observations earlier, but they had tried to explain radioactivity purely in terms of energy release. As Marjorie Malley has commented: "Curie's theory was hesitant, conservative, vague, and abstract; Rutherford's hypotheses were bold, ultimately revolutionary, specific, and concrete."[27]

The Concept of Isotopes

Another established principle of chemistry was that of atomic weight: that each chemical element had a unique and fixed value.

Here again philosophical principle was to fall in the face of overwhelming facts. Having recognized that radioactive decay led to the formation of different elements, the identity of those elements came into question. Each of these radioactive products had been given a name, such as thoron or ionium, or the name of its parent followed by a letter, such as thorium X and radium G. In 1906 Bertram Boltwood found it chemically impossible to separate ionium from thorium, while the Hungarian scientist Geörgy Hevesy was unsuccessful in separating radium D from lead. It was Soddy and Kasimir Fajans who simultaneously and independently proposed the group displacement laws: that emission of an alpha particle produced an element two places lower in the periodic table, while emission of a beta particle produced an element one place higher. This proposal meant that it was not previously unknown elements that were being produced but forms of existing elements. The atoms of these elements produced by radioactive decay were predicted to have different atomic masses to atoms of the "ordinary" element. To support this proposal, studies were made of the atomic weight of lead from radioactive ores against the accepted value for "normal" lead. The first major differences were found by Otto Hönigschmid and Stefanie Horovitz, while the most conclusive differences were produced by the Harvard chemist Theodore Richards, based primarily on samples provided by Ellen Gleditsch. As a result of these reports, the existence of isotopes (as Soddy called them) became accepted.[28]

The Modern Structure of the Atom

A whole book could be dedicated to a thorough historical account of the research in this field. For our brief summary we must simplify the history and eliminate the names of many participants and many of the experiments. The first proposal similar to our modern picture was made by the Japanese scientist H. Nagaoka, who had studied in Germany. In 1904 he proposed a "Saturnian model" of the atom in which the electrons swirled around a central core.[29] At the time, scientists were unable to find evidence for this proposal and the model fell into disfavour. In 1906 Rutherford observed that a beam of alpha particles would penetrate a very thin metal foil but the spot produced was highly diffuse. Hans Geiger and Ernest Marsden subsequently showed that the particles were either little deflected or massively deflected. This discovery suggested that the atom was mostly empty space with a "hard" core, leading Rutherford to propose the nuclear model of the atom in 1911.[30]

Nuclear Particles

At that point, to account for the mass and charge, the nucleus of any atom was considered to contain hydrogen nuclei and some electrons. For example, the helium nucleus was considered to contain four hydrogen nuclei *and* two electrons while two additional electrons "circled" the nucleus.[31] This proposal was reinforced by the first artificial synthesis of an element by Rutherford in 1917. He bombarded nitrogen atoms with alpha particles to produce oxygen atoms and hydrogen nuclei (named protons by Rutherford in 1920). The next advance was not to come until 1931 when Irène Joliot-Curie and her husband, Frédéric Joliot, studied the emission of a penetrating radiation when low atomic weight elements were bombarded with alpha particles. The radiation was undeflected by a magnetic field but they were unable to explain its nature. Upon seeing the report of these findings, James Chadwick showed that the radiation was in fact neutral particles, which he named neutrons. It was these neutrons that made up about half (or more) of an atom's mass, and the previous solution of proton-electron pairs was discarded.[32]

Nuclear Fission

Artificial syntheses of nuclei had, with few exceptions, resulted in the formation of a new nucleus higher in the periodic table. The research group formed in Rome and led by Enrico Fermi bombarded uranium atoms to produce new elements of higher atomic weight and atomic number. As they analyzed the results in 1934, they believed they had accomplished their goal.[33] They assumed that any new element would be one or two positions further in the periodic table and it was this belief that determined the tests that they and others used to identify the new elements. According to the periodic law, a chemical element should resemble in its properties the elements in the group above it. Since at that time the uranium series was believed to form a seventh row in the table, element 93 was expected to resemble the manganese group, and this is what Fermi and his colleagues claimed for their new element. Ida Noddack and a few others contested this conclusion, but most scientists accepted Fermi's claimed discovery of element 93. Two groups followed up on this work: Irène Joliot-Curie and Paul Savitch in Paris and Lise Meitner, Otto Hahn, and Fritz Strassmann in Berlin. The Meitner group claimed to identify several more new elements, while Joliot-Curie reported, in addition, a product element with a three-and-a-half-hour half life that behaved like one of the lanthanum-series elements, not like another transition metal. It was easier for the other research groups to dismiss the Joliot-Curie report than to question the whole basis on which new element status was being assigned. Hence it was not until Hahn and Strassman found one product element that behaved like barium that Meitner and her nephew, Otto Frisch, were forced to question the integrity of the nucleus. The liquid-drop model of the nucleus had been proposed a few years earlier, and Meitner and Frisch realized that it was the key to their conceptual problems – that a nucleus *could* break into two halves, just like a water drop.[34] In other words, the products were not new elements but simply isotopes of elements in the mid-part of the periodic table. So once again, the Paris group had found the evidence for a scientific breakthrough but failed to make the conceptual interpretation.[35]

Hazards of the Work

It is important to consider the health hazards that all of these men and women faced. It is amazing that most lived so long, for nearly all of them were exposed on a regular basis to high levels of radiation with few, if any, safety precautions. The severe skin damage that exposure to radiation could cause was reported as early as 1901,[36] but it was simply regarded as an occupational hazard. May Sybil Leslie had noted, during her time at the Institut Curie, the cavalier attitude towards radiation among the Curie workers.[37] In fact, Marie Curie's cookbooks were still radioactive fifty years later.[38] Rutherford, too, failed to recognize the hazards of radiation, the most vivid example involving a visit to Dartmouth College as part of a lecture tour of the United States. During his demonstrations, Rutherford discarded the paper that he had used to transfer some radium salt into a tube. This paper was saved by his host and used as a radioactive source for a period of forty years.[39]

Though Hahn and Meitner were generally very careful about their exposure to radioactivity, they kept a crate of between 150 and 250 kilograms of radioactive salts under their workbench for many years.[40] Elizabeth Róna had two major accidents involving radioactive materials, one at Paris and the other at Vienna.[41] Perhaps as a result of those close escapes and her frequent exposure to radiation, the last paper that she published described some of the health problems at the institutes in Paris, Vienna, and Berlin. She commented that a number of the participants, such as Sonia Cotelle and Debierne, died from radiation-related diseases. She found it amazing that Marie Curie lived to the age of sixty-seven, considering her continuous exposure to radiation. Even more amazing were the ninety-seven ears that Róna herself lived. It is of particular note that, in her review of radiation-related health problems, Róna makes no mention of the potential effect of radiation on a woman's reproductive organs. It is as if she assumed that, for a woman, a life devoted to the study of radioactivity precluded any possibility of a family life. As we shall see, this was largely the case.

Yet it was not just through ignorance or carelessness that radioactive materials were handled in a cavalier fashion. With the burst of optimism at the start of the twentieth century, science was looked upon as the great saviour of humanity. The cancer-killing ability of these materials seemed to demonstrate that the rays of radioactive decay were another wonderful tool that would bring benefit to all.[42] In fact, the use of radium (and later, radon) to cure growths, tumours, and certain forms of cancer was called Curietherapy in France.[43] To admit that radiation had a darker side as a cause of illness and death was unacceptable.

All of the researchers seemed to have held this rosy view but none as firmly as Marie Curie. Even after the illness and subsequent death of Cotelle[44] in her laboratories, Curie still refused to recognize the seriousness of the problem.[45] In part, this was because both she and Irène had handled radioactive materials continually during their careers and had suffered only "minor" problems. Curie recommended plenty of exercise in the fresh air as her personal panacea for radiation-induced illness. Later, Florence Pfaltzgraph, an American journalist, described in a letter to Curie the sufferings of the workers who painted watch dials with radium to make them luminous.[46] Pfaltzgraph asked whether she had "discovered anything which might benefit these women." Curie expressed sympathy and advised the women to eat calves' liver. Irène Joliot-Curie, in turn, did not endear herself to the physicist Cécile DeWitt-Morette by asserting that anyone who was worried about radiation hazards was not a dedicated scientist.[47] It is ironic, then, that Irène, together with Catherine Chamié and another of Curie's later researchers, Marguerite Perey, definitely died of radiation-related causes.[48]

2 Pioneer Women of Radioactivity

MARELENE F. RAYNER-CANHAM
and
GEOFFREY W. RAYNER-CANHAM

Between 1900 and 1910 about thirty women were active researchers in the study of radioactive phenomena. In those days, for a woman to have graduated with a degree in science was a feat in itself. For these particular women, the focus of their lives became the study of the nature of the atom. Many of them depended on their supervisors, mentors, and colleagues for encouragement and support in their work.

When one reads about the history of research in radioactivity, women are rarely mentioned.[1] Yet many women participated in the venture to discover the secrets of the atom. In fact, they seemed to play a disproportionately large share in the research work in radioactivity compared to many other fields of physical science. So why have they been overlooked? As with other aspects of life, it was almost impossible for women to reach the upper ranks of academia to gain the authority, prestige, research workers, and research grants that were necessary to make a name in the scientific community. And it is the "great names" that are passed on from generation to generation in the simplified stories that we refer to as the history of science. As Hubbard commented: "Women have played a very large role in the production of science – as wives, sisters, secretaries, technicians, and students of 'great men' – though usually not as named scientists ... More important, we must understand and describe accurately the roles women have played all along in the process of making science."[2]

In radioactivity studies the research assistants, many of them women, played a particularly important role, as de Solla Price has