HARRIET BROOKS (1876-1933): CANADA'S FIRST WOMAN PHYSICIST

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DISCOVERING HARRIET BROOKS

When scientists are asked about women pioneers in the study of radioactivity, many are familiar with Marie Curie [1], a few with Lise Meitner [2], and even fewer with Irène Joliot-Curie [3]. Until recently, no-one would have heard of Harriet Brooks.

The 'discovery' of Brooks and of her contributions to the early days of radioactivity research was one of those serendipitous accidents which seem to drive so much of scientific discovery [4]. One of us (GRC) was perusing the classic chemistry work, Discovery of the Elements. In amongst the photos of aged males was a cameo portrait of a young woman, identified as Harriet Brooks (Mrs. Pitcher), a researcher with Ernest Rutherford [5]. Both of us had an interest in the history of women in science and we thought that delving into her life and work would make a summer research project. How wrong we were! It took about three years to unravel her convoluted saga.

Harriet Brooks was the first research student of Ernest Rutherford and she also undertook research with J.J. Thomson and Marie Curie. Her several contributions to the study of radioactivity have only recently been recognized.

The easy part was to obtain a list of her publications, some with her as sole author, others with Rutherford. McGill University Archives generously provided copies of obituary notices for Brooks. These documents indicated that she had been an outstanding student at McGill, that she had worked with Rutherford, that she had three children, and that she had died at the age of 56. From the Rutherford Archives at Cambridge University, we obtained copies of letters from Harriet Brooks to Rutherford at McGill. Some of the letters gave Brooks' address as Bryn Mawr College, Pennsylvania, others as Cambridge University, England. Finally, from the McGill Archives, we obtained a copy of a letter from McGill's Principal to Brooks at Barnard College.

We then made a fortunate connection with Margaret Gillette who was writing a compilation of biographies of women at McGill [6]. She had a phone number for a relative of Brooks. Through this contact, we were able to track down Brooks' surviving son, Paul Brooks Pitcher. Pitcher actually knew very little about his mother's life before she became an 'ordinary' Montreal housewife. He did have his mother's notecase and he forwarded the contents to us. The notecase had contained the following items which Brooks presumably saved as particularly important memorabilia of her life: letters from Mary Rutherford (spouse of Ernest); letters from a Prestonia Martin; an invitation to Summerbrook, Keene, New Hampshire; photos of Brooks with a group (one of whom is identified as M. Gorky); and a draft of a presentation given by Brooks on Marie Curie. The contents of the presentation indicated that Brooks had worked with Curie. In later communications with Brooks Pitcher, he revealed that he had a large number of love letters from his father to Brooks. He sent these valuable documents to us by regular Canada Post! Some of the letters were addressed to Brooks at a Capri, Italy, address.

We had now amassed a plethora of material that indicated Brooks life had been quite complex. There were many questions to be answered including: What was Brooks doing at Bryn Mawr College and Barnard College? What was she doing at Cambridge University? Who was Prestonia Martin? Why did Brooks have and value an invitation to Summerbrook? Why should Brooks know the famous author and revolutionary, Maxim Gorky? What was Brooks doing in Paris? It took us several years of work, visiting archives, tracking down obscure documents, and piecing together the information, before we had answers to most - but not all of the questions. We have recounted the details of this detective story elsewhere [7], so here we will summarise our findings which have been enough to fill a book [8]!

BROOKS - HER LIFE AND WORK

Brooks was born in Exeter, Ontario, in 1876. Her family moved to Montreal and she enrolled at the Victoria (women's) College of McGill University. In 1899, she received an M.A. degree for work with Rutherford on the "Damping of Electrical Oscillations" [9]. Why did he not assign her initially to a project on radioactivity? The answer came from a comment by Peter Kapitza [10]:

> He [Rutherford] was also very particular not to give a beginner technically difficult research work. He reckoned that, even if a man [or woman] was able, he needed some success to begin with. Otherwise he might be disappointed in his abilities which could be disastrous for his future. Any success of a young research worker must be duly appreciated and must be acknowledged.

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Fig. 1 The Physics Department at McGill University, ca. 1904. Brooks is at the back, Rutherford, far right.

She spent the next two years doing research with Rutherford on radioactivity. Brooks had been assigned one particular puzzle: the nature of thorium 'emanation.' There were three theories: that it was a radioactive gas, a vapour, or a finely divided powder. Brooks' concluded that it was a gas of lower atomic weight than thorium itself. This was among the first evidence for the transmutation of elements (an anathema to the chemists of the time!). The published paper "The New Gas from Radium" [11] showed the diagram of the diffusion apparatus she used and we were excited to be able to match the figure with an actual apparatus held in the Rutherford Museum at McGill University.

We now know this gas to be radon. History is often simplified and, in this context, a recent paper assigns the discover of radon to Rutherford [12]. Unfortunately, the authors seem to have missed the original report in the Transactions of the Royal Society of Canada, co-authored by Rutherford and Brooks. Instead, they used as their source a later paper in Nature authored solely by Rutherford [13] in which Brooks is relegated to an acknowledgement as "In these experiments I have been assisted by Miss H.T. Brooks …."

Brooks then moved to Bryn Mawr College (1901-02) where she commenced working on a Ph.D. Bryn Mawr was (and continues to be) a very crucial institution for young women scientists. At the time of Brooks' arrival, it was run by the redoubtable M. Carey Thomas [14]. Thomas contended that: "Bryn Mawr women would not be prepared for marriage but for careers in which they would excel." At Thomas's behest, Bryn Mawr offered a President's European Fellowship. This award enabled the best and brightest of Bryn Mawr's students to spend a year with a famous European academic. Brooks received the Fellowship in 1902 and elected to spend the 1902-03 year with J.J. Thomson at Cambridge.

While at Cambridge, Brooks missed the moral support she had received from Rutherford. She wrote to him [15]:

> I am afraid I am a terrible bungler in research work, this is so extremely interesting and I am getting along so slowly and so blunderingly with it. I think I shall have to give it up after this year, there are so many other people who can do so much better and in so much less time than I that I do not think my small efforts will ever be missed.

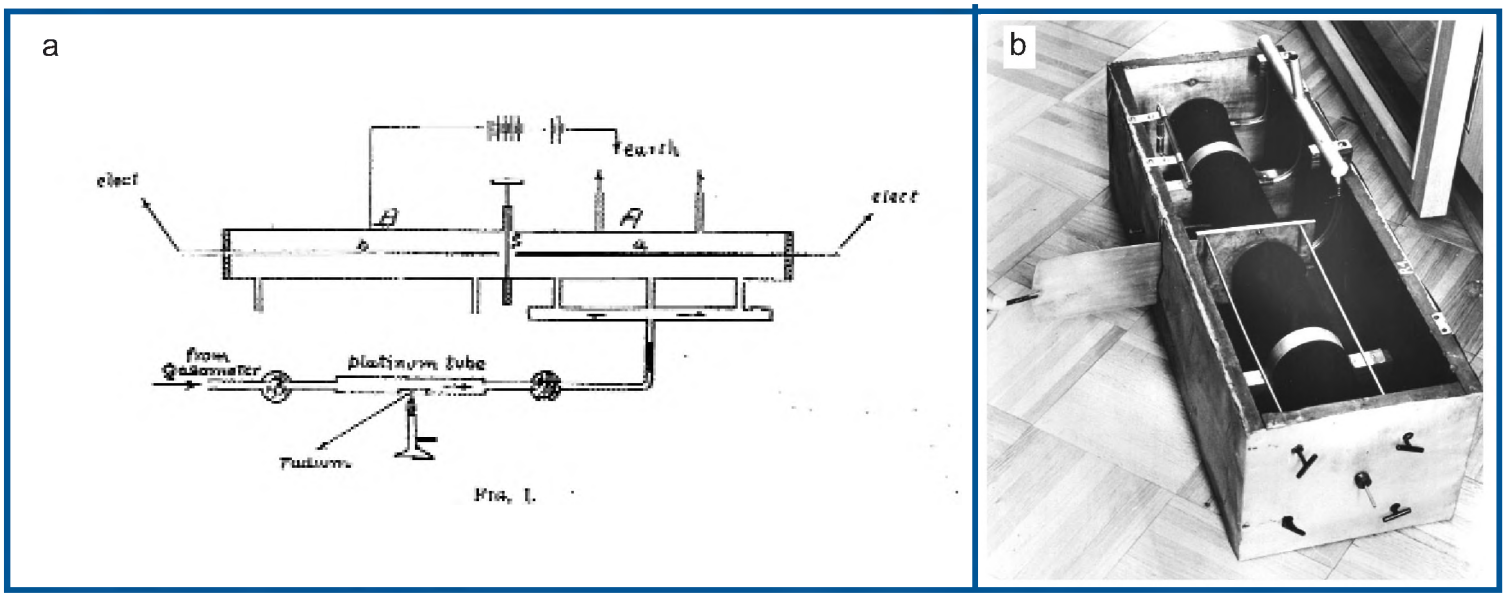

Fig. 2 (a) The hand-drawn figure of the diffusion apparatus used to identify 'emanation' as a gas; (b) The matching apparatus held in the Rutherford Museum, McGill University.

This lack of self-confidence typifies those - usually women - who suffer from the imposter syndrome, a problem in the sciences among women even today. As Susan Watson has stated [16]:

> There can be very talented women at the tops of their classes who still feel that their male colleagues are much smarter and that any moment someone's going to reveal how stupid and incompetent they really are.

Despite her self-doubt, during her sojourn at Cambridge, she did make the first measurement of the half-life of radon [17]. The value she recorded was one minute compared with the currently accepted value of 55 seconds. Nevertheless, her research at Cambridge had been hindered by Thomson's insistence at the time that radioactivity was a chemical process.

Perhaps as a result of diminished faith in her own abilities, instead of returning to Bryn Mawr to complete her Ph.D., she travelled back to McGill. There she spent another year working with Rutherford. It was during this period she observed what she referred to as the 'volatility' of radioactive substances: that a non-radioactive plate placed into a radioactive container would, itself, become radioactive [18]. We now realize this crucial observation to be the recoil of the radioactive atom: that the expulsion of an α-particle causes the daughter nucleus to be repelled in the opposite direction - often with enough energy to escape from the surface of the material and embed itself on the inserted plate. This technique was later used by Hahn & Meitner and Russ & Markower to separate daughter products and identify new elements.

Later, Hahn claimed to have discovered the recoil phenomenon, but Rutherford wrote to him [19]:

> By the way, I thought I had the idea of the removal of atoms by recoil in my Radioactivity somewhere-see page 392 2nd edition. It is given in explanation of the volatility of Radium B observed by Miss Brooks.

Brooks also reported that there could be successive radioactive decays [20], a finding that formed a significant part of Rutherford's Bakerian Lecture [21], in which he acknowledges the contributions of Miss Brooks.

In 1904, Brooks accepted a position of tutor in physics at Barnard College, New York, the women's college associated with Columbia University. All went well until 1906 when she announced her engagement to Bergen Davis, a professor of Physics at Columbia University. Laura Gill, Dean at Barnard College, demanded Brooks' resignation, effective the date of marriage, as she would not countenance a woman who would consider that she could perform both her wifely and her academic duties. Brooks made a powerful rebuttal in a letter to Gill [22]:

> I think also it is a duty I owe to my profession and to my sex to show that a woman has a right to the practice of her profession and cannot be condemned to abandon it merely because she marries.

The then-Head of Physics, Margaret Maltby, weighed in on Brooks' side [23]:

> Neither you nor I would like to give up our active professional lives suddenly for domestic life ... . I know of no woman to take her place -- no one available who has the preparation and the personality and ability to teach, and the skill in physical manipulation that she has.

Gill was unbending, Brooks had to choose. In the end, Brooks broke off the engagement, but the stress had been such that she resigned her position anyway.

It was then that Brooks life took its most curious turn. She spent the summer of 1906 at Summerbrook, a haven for Fabian socialists in the Adirondack mountains run by John and Prestonia Martin. We think that her connection with the camp came through a lecture given by Maria Andreyeva, Maxim Gorky's second wife, in the Spring of that year at Barnard College. During their stay in the United States, Andreyeva and Gorky were spending much of their time at Summerbrook. Up in the mountains, Brooks became very friendly with the Gorky entourage and in the Fall travelled with them by ship from New York to Naples and thence to the Isle of Capri.

Presumably bored with the indolent life on the island, Brooks left for Paris where she undertook research with Marie Curie. Though her work did not result in any papers under her own name, discoveries of other Curie-group researchers referred to Brooks' unpublished data. In 1907, Curie offered to let her stay for another year, but at this time, Rutherford was moving to Manchester and he offered Brooks a Fellowship so she could return to work with him (an indication of Rutherford's recognition of her abilities). As a result, Brooks declined the invitation from Curie and accepted that from Rutherford. Then, however, Brooks abruptly asked for her name to be withdrawn - a "bolt from the blue" as Rutherford noted in a letter to Arthur Schuster [24].

Brooks withdrew because she had become engaged to Frank Pitcher, her former lab demonstrator at McGill. The two had become reacquainted during a visit by Brooks to Montreal in the summer of 1906 before she left for Capri. The love letters forwarded to us by Paul Brooks Pitcher dated from this period of September 1906 to June 1907. These letters often emphasized the practical rather than the romantic: that there were limited academic opportunities for Brooks and that marriage would provide her with a more stable future. Both Mary Rutherford and Prestonia Martin urged Brooks to accept his written offer of marriage, Martin using the eugenics argument that it was vital for learned women to produce children in order to improve the average intelligence of the human race. Brooks acquiesced. Pitcher then undertook a tour of Europe on his own while Brooks made the marriage arrangements.

Following their return to Montreal, Brooks had three children, the first dying of spinal meningitis and the second committing suicide while a student at McGill. The youngest child, Paul Brooks Pitcher died recently, survived by his son, Robin Pitcher, who currently lives in Toronto. Brooks never

Fig. 3 Brooks in later life, with Frank Pitcher and children, Barbara Anne, Charles Roger, and Paul Brooks.

did return to research. Marriage was her new vocation and, in any event, the days of radioactivity at McGill had come to an end with the departure of Rutherford and of Frederick Soddy. After the two tragedies, the Pitchers led an uneventful life in the upper middle-class milieu of Montreal. Unfortunately, Brooks herself was to die in middle age, most likely a result of her exposure to radon.

RECOGNITION AT LAST

This historical research has proved very satisfying. As we mentioned above, her full biography is now available, in English [8] and subsequently in Japanese. For some reason, Brooks is seen in Japan as an icon, as a sort of scientific "Anne of Green Gables." By an amazing coincidence, the copy of Rutherford's text Radioactivity purchased by the Canadian Museum of Science and Technology happens to have "H. Brooks" written inside the cover - presumably a copy given her by Rutherford himself. Last year, Brooks was inducted into the Canadian Science and Technology Hall of Fame for her contributions to the study of radioactivity [25].

Why has Brooks' contributions been overlooked? Robert Merton, a historian of science, proposed the Matthew Effect: that advances in science are attributed to the more famous person [26]. Margaret Rossiter, another science historian, has commented that such erasure from the historical memory is even more acute for women scientists. Thus she proposed the term the Matilda Effect [27] to describe women, such as Brooks, who have been lost from the record.

This was not quite the end of the story. During our research on Brooks, we discovered a total of thirty four women were working in the field of radioactivity in those early years [28]. The majority of these women, like Brooks, had been overlooked. Thus with the help of some contributing authors, we put together our second book, a comprehensive study of all the 'radioactivity' women, A Devotion to Their Science: Pioneer Women of Radioactivity [29]. And all this fruitful historical research originated from the chance observation of a photograph!

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