

## Article

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*Scientia Canadensis: Canadian Journal of the History of Science, Technology and Medicine / Scientia*

*Canadensis : revue canadienne d'histoire des sciences, des techniques et de la médecine*, vol. 29, n° 2, 2006, p. 17-44.

Pour citer cet article, utiliser l'information suivante :

URI: <http://id.erudit.org/iderudit/800518ar>

DOI: 10.7202/800518ar

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# A Blackboard in Her Kitchen: Women and Physics at the University of Toronto<sup>1</sup>

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**Abstract:** Despite a widespread belief that they were a tiny minority in twentieth-century physics, women have been far more present in the field than we imagine. In this essay I explore three periods in the history of the University of Toronto physics department between 1890 and 1990. In the first expansionist period (1890-1933) women were much in evidence, earning nearly 20 percent of the university's doctoral degrees in physics; during the middle years of the century (1934-1961), some of these women taught in the physics department, but participation in the graduate program declined, with no women completing doctorates; between 1962 and 1990, when physics was again expanding rapidly, women gained some ground but still earned less than five percent of the doctorates. The essay explores the histories of nine of the women who earned PhDs in physics at Toronto during this third period, with a view to discovering the factors that helped or hindered their success in the field.

**Résumé:** Les femmes occupent dans l'univers de la physique du début du 20<sup>e</sup> siècle une place beaucoup plus importante qu'on a pu le croire. Cet article aborde trois périodes de l'histoire du département de physique de l'Université de Toronto entre 1890 et 1990. Dans la première période d'expansion du département (1890-1933), les femmes sont bien visibles et décrochent près de 20 % des diplômes de doctorat décernés en physique. Au milieu du siècle (1934-1961), certaines de ces femmes enseignent au département, mais la participation féminine au programme diminue et aucune femme ne complète de doctorat. De 1962 à 1990, alors que le domaine de la physique connaît une nouvelle croissance, les femmes reprennent du terrain mais ne décrochent malgré tout que moins de 5 % des diplômes de doctorat. L'article explore les histoires de neuf

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1. Much of the research on the earlier women physicists was supported by the Social Sciences and Humanities Council of Canada. I am also grateful for the outstanding research assistance of Cathy James and Alyson King. Finally, I thank the nine physicists who kindly responded to my inquiries in the summer and fall of 2000, especially Dr. Helen Freedhoff and Dr. Olga Mitchell, who provided the photos illustrating the article.

femmes ayant décroché un doctorat pendant cette dernière période, pour dégager les facteurs ayant pu favoriser ou limiter leur succès en physique.

Who were the first women physicists in Canada? When did Canadian women first begin to earn doctorates in the subject and teach in our universities? Concentrating on “firsts” can be problematic for more reasons than one, as will become apparent, but these questions have nevertheless intrigued me ever since I was surprised to discover, in the course of some more general explorations of women’s work in higher education, how many women physicists were to be found at the University of Toronto in the early decades of the twentieth century. The results of my explorations were three essays about Canadian women and physics, which for the most part focused on women connected with that university during those early years.<sup>2</sup> Frustratingly, they all contained one small error. In all three, I identified Vivian Ellsworth Pound as the first woman to receive a doctorate in physics at the University of Toronto. Only after they were published did I discover that Vivian Pound was not the first woman to do anything, because “she” in fact was a “he.” The truth is that Mattie Levi Rotenberg, who earned her Ph.D in physics from the University of Toronto in 1926, was the first woman to achieve this distinction.<sup>3</sup>

Why was I so interested in finding women physicists in Toronto’s past that I not once, but three times, erroneously placed Vivian Pound among the first women Ph.Ds in the field? Therein lies a tale, which serves as a necessary prelude to what follows, since we insist increasingly on acknowledging where we come from as researchers, not only to ourselves but to our readers. My interest in women in physics derives from my situation as the wife of a physicist, whose scholarly home was the University of Toronto; over the years we shared a concern about gender dynamics in his field. There were a number of issues, but the major one at

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2. Alison Prentice, “The Early History of Women in University Physics: A Toronto Case Study,” *Physics in Canada/La Physique au Canada* 52, 2 (1996): 94-100; “Elizabeth Allin: Physicist,” in *Great Dames*, eds. Elspeth Cameron and Janice Dickin (Toronto: University of Toronto Press, 1997), 264-287; and “Three Women in Physics,” in *Challenging Professions: Historical and Contemporary Perspectives on the History of Women’s Professional Work*, eds. Elizabeth Smyth, Sandra Acker, Paula Bourne and Alison Prentice (Toronto: University of Toronto Press, 1999), 119-140.

3. E-mail from Charles Levi, 12 June, 2000. The full story of my error, Charles Levi’s discovery of it, and how this eventually led to much of the research underpinning the present article may be found in Alison Prentice, “Vivian Pound Was a Man? The Unfolding of a Research Project,” *Historical Studies in Education/Revue d’histoire de l’éducation* 13, 2 (2001): 99-102.

Toronto was the lack of women professors in the university's Department of Physics. After the retirement of Professor Elizabeth Allin in 1972, there were no women among the tenured faculty in the department for years and it seemed virtually impossible to change this state of affairs.

As a young faculty wife in the 1960s I had met Elizabeth Allin and assumed that she was a lone woman in her field. It was not until much later that I learned that Allin was by no means the only woman to earn advanced degrees in physics or to teach the subject at Toronto during her era. Women had always been in the minority in the sciences both among Toronto graduate students and faculty but, especially in the 1920s and early 1930s, a surprising number had been welcomed into graduate programs and teaching roles at the university. Indeed, an examination of the records for the period prior to 1940 showed that it was actually in the sciences that women were to be found teaching in the greatest numbers at Toronto and that they were more numerous in physics than in most other fields.<sup>4</sup> I became especially interested in the women who earned Toronto doctorates in physics. Although Pound included I thought there had been seven such women prior to the mid 1930s, we now know that the number was in fact six. As Toronto awarded a total of 31 Ph.Ds in physics between 1900, when the first was granted to J.C. McLennan, and 1933 when the last of the six women, May Annetts, completed hers, women of that era in fact earned nearly twenty percent of the physics doctorates granted by the university in the first third of the twentieth century.<sup>5</sup> This is a significant, even startling, percentage. According to the census, in Canada as a whole women earned less than 10 percent of all doctorates awarded in 1931. A decade later, women earned only 5 percent or one in twenty,<sup>6</sup> a decline that was also reflected in physics.

Who were the women who had such success in physics at the University of Toronto in the early decades of the twentieth century? How did they make their way in their chosen field? And what happened to women who were interested in physics in the generations that followed them? The histories of the women physicists who pursued advanced degrees at Toronto between 1890 and 1990 and the careers they forged have

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4. Alison Prentice, "Bluestockings, Feminists, or Women Workers? A Preliminary Look at Women's Employment at the University of Toronto," *Journal of the Canadian Historical Association*, New Series, 2 (1991): 231-261.

5. These numbers were calculated from the information provided in Elizabeth J. Allin, *Physics at the University of Toronto, 1843-1980* (Toronto: Department of Physics, University of Toronto, 1981), 75, 79-80.

6. Alison Prentice, Paula Bourne, Gail Cuthbert Brandt, Beth Light, Wendy Mitchinson, and Naomi Black, *Canadian Women: A History* (Toronto: Harcourt Brace 1996), 477, Table A9.

something to tell us. While there are many gaps in the overall story and many questions remain unanswered, the general outline is clear. After a burst of activity in the post-World War I years that carried some women into part- or full-time careers that spanned the mid-century, relatively few women were to be found either studying or, later on, teaching physics at the University of Toronto. This pattern reflected a more general North American picture which only began to change at the century's end.

### The Women Pioneers

The desire of women to pursue undergraduate and advanced degrees in physics can be traced to the first generation of women at the University of Toronto and is best illustrated by the career of Elizabeth Laird, who earned her Bachelor's degree at Toronto in 1896, only twelve years after women were admitted to the university. Laird graduated at the top of her class in mathematics and physics, but later admitted to the discomfort she felt as one of the few women in her course. She was also denied the scholarship to do graduate work in Europe that normally went to the leading student, losing out—as a newspaper article later reported it—because she was a “she” not a “he.” As I have recounted elsewhere, Laird nevertheless made a career in her chosen field, eventually heading the physics department of Massachusetts' renowned Mount Holyoke College.<sup>7</sup>

Another early student was Annie Theresa Reed, whose Toronto BA was conferred in 1897. Reed was one of the first women to obtain work teaching physics at Toronto, remaining, as Elizabeth Allin later put it in her history of the physics department, “for a lifetime.” University records show Annie Reed earning money as a typist for the department beginning in 1906; by 1910-11, she was also listed as a “Class Assistant in Physics,” a job she continued to perform until some time in the 1930s. Well before this work came to an end, Annie Reed was also made “Secretary of the Physics Department,” a position she held from 1924 until her retirement in 1946. Reed was only one of many female graduates at Toronto who turned their success as students into careers as secretaries and part-time teachers in the departments from which they had graduated.<sup>8</sup>

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7. See Prentice, “Three Women in Physics.”

8. I explore the expansion of secretarial work at the university in Prentice, “Bluestockings, Feminists, or Women Workers?” Comments about Reed are to be found in Allin, *Physics at the University of Toronto*, 10, and in interviews of Allin, by myself (May, 1991) and by Karen Fejer (April-June, 1993), University of Toronto Archives (UTA). Reed's titles and the years she was employed in various capacities are to be found in UTA, *University of Toronto Calendars*, P78-0021, and *University of Toronto Directories of Staff*

Around the time that Annie Reed was beginning her work as a class assistant in physics, another young woman was nearing the completion of her BA in mathematics and physics at Toronto. The fourth year representative to the Mathematical and Physical Society at Toronto during her final year and also a gold and silver medalist, Clara Clinkscale embarked on an MA when she completed her degree in 1912 and, in 1913 and 1914, she is to be found in the university calendars under the same title as that initially bestowed on Annie Reed: Class Assistant in Physics. But the master's degree was never finished. It was not until she was in her 90s that Clara Clinkscale Morrison finally revealed to her family the incident that drove her out of graduate school. Shocked by the sexual advances of a professor who was married and the father of several children, she felt she could not continue her MA and fled Toronto.<sup>9</sup>

The stories of Laird, Reed and Clinkscale make it clear that, for women of this first generation, seeking a career in physics might involve leaving Canada; it probably also meant remaining unmarried; and that relations with male physicists could be a serious obstacle. Laird and Reed did find permanent niches in the field, while Clara Clinkscale, who clearly wanted to go on in physics, was forced (temporarily, as we shall see) to leave the university. With Clinkscale, we nevertheless begin to see glimmerings of new possibilities for women physicists in Canada. It was not long after her attempt to complete a master's degree that a more successful generation of women aspiring to be physicists moved not only into MA programs, but also into Ph.D programs at the University Toronto. Although Elizabeth Allin is perhaps the best known of these women because she eventually became a full professor at the university, in fact she was only one of a relatively large group of University of Toronto women who pursued advanced study, taught for a few years and, as we have seen, in six cases went on to do doctorates in physics in the interwar years.

The university both taught and employed a remarkable number of graduate women scientists, almost from the beginning of women's presence at Toronto as students. In fact, of the total of 146 women to be found in various research or teaching capacities at the university between 1900 and 1920, the majority were in science departments and twenty-five of these women were in physics. The trend continued in the 1920s. Between 1920-21 and 1930-31, women began to catch up in other fields,

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*and Students*, P78-0171, the sources for most details about university appointments that follow.

9. Telephone conversation with Jean Clement, Clara Clinkscale Morrison's daughter, 21 October, 2000, and e-mail from Morrison's second cousin, Dr. Suzanne Majhanovich, 2 November, 2000. My thanks to Suzanne for calling my attention to her cousin's story.

but the majority of jobs for women were still to be found in science; eighteen physicists could be counted among the 165 women the university employed for one or more years in the sciences during that decade. Only botany, with a total of twenty-one women, employed more. Although one might have expected a tapering off or substantial decline during the years of the Great Depression, this was in fact not the case. Overall numbers of women scientists working at Toronto continued to be high even during the 1930s.<sup>10</sup> Although most of these women were employed only temporarily and eventually moved on, some women made a more permanent mark. This was certainly true in the case of the six women physicists who obtained doctorates at Toronto and of several other women from this period who found temporary or permanent jobs in the university's department of physics prior to the middle of the century.

One of the most interesting of these instructors was Kathleen Crossley (BA, 1918) who, like Annie Reed, had a career that unfolded without benefit of a graduate degree. Beginning as an assistant demonstrator for the physics department in 1920, Crossley was promoted to demonstrator the following year; by the mid-1930s the records show that she was occasionally accorded the title of lecturer. It was undoubtedly the shortages and challenges of the Second World War that brought about her final promotion to assistant professor, a title granted to her and two other women who were teaching physics at Toronto in 1941.

Kathleen Crossley kept detailed appointment diaries, which were preserved in the papers of Professor Elizabeth Allin and are now in the University of Toronto Archives. These tiny books reveal much of interest about the network of women and men who made up the physics department in the interwar years. Crossley's social life revolved around her physicist friends. We learn, for example, of a tea held in the university library in January, 1927 and the presentation there of a prize to her friend Elizabeth Allin, the latter just beginning her graduate studies at Toronto. Bridge, theatre, and luncheon parties often included Allin, along with other women from the physics department and, occasionally, some of the men. Perhaps the most notable social events recorded in her diaries were the annual picnics held every June at Crossley's family home in Oakville. Such social occasions created lifetime friendships among Toronto's interwar physicists, but Kathleen Crossley's contribution did not stop at hosting picnics. Highly successful with first year students, she earned a solid reputation as a teacher and it was in this role that Crossley continued at Toronto, well beyond the age of normal retirement—sadly, because her salary and pension never reflected her contribution to the university.

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10. Prentice, "Bluestockings, Feminists, or Women Workers?" 239-42, 244-53.

Elizabeth Allin loyally remembered her friend's gifts, however. According to Allin, Kathleen Crossley "knew elementary physics better than anyone" and generations of Toronto students were indebted to her for this reason.<sup>11</sup> Allin herself may have benefited from Crossley's teaching; certainly, she benefited from the strong sense of social cohesion that apparently prevailed when she was a student. Despite her later recognition of some segregation and stereotyping of women in physics, Elizabeth Allin remembered her student days with great delight. She was in a small and friendly department, where she and her friends felt so at home it was as if they "owned the place."<sup>12</sup>

These must have seemed heady times for women. In 1926, the year that Allin completed her undergraduate degree, Mattie Levi Rotenberg was awarded her doctorate in physics. In 1929, of the three Ph.Ds awarded in physics at Toronto, two were earned by women: Elizabeth Cohen and Beatrice Reid Deacon. Elizabeth Allin's own Ph.D. came two years later in 1931 and she was followed in quick succession by two more women, when Florence Quinlan and May Annetts completed their doctorates in 1932 and 1933.<sup>13</sup> These women must have caused a stir for, as we have seen, the number of men earning Ph.Ds in physics was not very large.

Of the six women who obtained doctorates between 1926 and 1933, only Elizabeth Allin and Florence Quinlan appear to have been successful in securing permanent work in physics, both at the University of Toronto. For three of the four other women, the fact that they were married may account for the brief or sporadic nature of their employment. Mattie Rotenberg probably had the most varied and colourful career. Although she was already married when she earned her doctoral degree in 1926, neither marriage nor the arrival of five children prevented the flowering of other interests or, ultimately, work outside the home. Rotenberg eventually managed not only to keep up with her physics, but also to be involved in other part-time work, most famously as a radio commentator for the CBC, but also as the operator of a progressive school, and an active volunteer with the Jewish charity, Hadassah-Wizo.<sup>14</sup> She did not teach physics in either the 1920s or the 1930s, but was brought back to the field by the Second World War, beginning as a part-time assistant demonstrator in 1941. Quickly promoted to demonstrator and, finally, in 1964, to instructor, Rotenberg continued in that role until her retirement in

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11. Allin, *Physics*, 11, and Allin interview by the author, May 1991.

12. For a more extensive discussion of Elizabeth Allin and Kathleen Crossley, see Prentice, "Elizabeth Allin."

13. Allin, *Physics*, 16 and 75.

14. Conversations with Charles Levi, October 2000, and Rachel Schlesinger, "Volunteers for a Dream," *Canadian Jewish Historical Society Journal* 1, 1 (1988), 31.



1967. Remembered by one physics student of the 1950s and 60s as “a great lady,” Mattie Rotenberg had certainly managed to make good use of her doctorate in physics once there was a demand for her services compatible with her family and other commitments.<sup>15</sup>

Beatrice Reid Deacon did not leave such vivid tracks. Like Rotenberg, she was married by the time her doctorate was granted in 1929 but, unlike Rotenberg, she had worked for the physics department during some of her student years. It was also the Second World War that gave her the chance to get back into physics. “Mrs. B.R. Deacon” began as a research assistant in 1943, became a lecturer in 1946, returned to a part-time research assistantship in 1947, and then must have retired, because at this point she disappears from the university directories. Her interest in the field continued, however, as Deacon’s name may be found in the membership lists of the Canadian Association of Physicists, for at least one year in the 1950s.<sup>16</sup>

Perhaps, of the three married women, May Annetts was the one most likely to have continued a career in physics had circumstances favoured it. Annetts taught for the physics department at Toronto both before and after receiving her doctorate and, as late as 1935, was still very serious about a research or university teaching career in her field. In January of that year, Eli Burton wrote to the Canadian Federation of University Women to support Annetts’ application for a scholarship to pursue her studies abroad. Burton obviously thought very highly of his former student’s abilities; he had “often called upon her to give...lectures” when for any reason he had not been able to give them himself. Annetts must have won the scholarship, as she was soon to be found working with the “leading world authority” on her field of research at the University of Uppsala in Sweden.<sup>17</sup> By October of the following year, however, the “brilliant young physicist” was planning to marry and move to England. She had taught during the fall term at Toronto, and newspaper accounts also indicate that she intended by January to be engaged in research at the University of London, where her future husband would be lecturing. As one account put it, the couple planned “to work together.”<sup>18</sup> From her student card, however, we learn that May Annetts Smith gave birth to a son the following year. She also eventually came back to Canada, recording moves to Winnipeg, then Saskatoon, then to Vancouver, and

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15. Telephone interview of Dr. Helen Freedhoff, 21 September 2000.

16. CAP membership list, *Physics in Canada/La Physique au Canada* 8, 2 (1952).

17. Annetts’ field was the study of colloids, UTA Cody Papers, A68-006/14, E.F.Burton to Margaret Cameron, 10 January 1935.

18. UTA, Clippings Files, A 73-0026/9(68), *Telegram*, October 6 and December 16, 1936.

finally Montreal, the last address given.<sup>19</sup> She has been located in three other records, however, as a demonstrator in physics at Toronto in 1940-41, an assistant or lecturer in physics or math at the University of Manitoba from 1943 to 1951, and a sessional lecturer in agricultural physics at McGill's Macdonald College in 1955-56.<sup>20</sup> But no further record of employment has been found.

As we have seen, Clara Clinkscale was unable to complete the MA in physics that she began just before the First World War. But, in the 1940s, as Clara Morrison, she became another member of the interesting group of married women teaching physics at Toronto. She began in 1942 as an assistant demonstrator, was promoted eventually to demonstrator, and taught regularly until she retired in 1952. In 1944, Clara Morrison's part-time salary was exactly what it had been in 1913: \$600.00. But perhaps the money was not the issue for, as her daughter remembers it, "she loved the work and she loved the students."<sup>21</sup>

It was Morrison's second cousin who first told me about her second relative's physics career and the centrality to it of the blackboard in her kitchen. Remembering "cousin Clara" as a "formidable, reserved woman," she found it hard to imagine how she had been deflected from her love of physics by her professor's improper behaviour; by the time her young relative began to know her in the 1950s, Clara Morrison was a successful and committed university demonstrator. The blackboard in her kitchen served as a place to work out problem sets—problem sets that Morrison must have treasured as she kept them for many years, along with other teaching notes and her physics textbooks. Taken all together, these materials filled five boxes when her family donated them to the university archives. What might Clara Clinkscale have achieved in physics, had an unnamed professor not thrown her off track, more than thirty years earlier?

We cannot know. But we do know that it was the unmarried women, Elizabeth Cohen, Florence Quinlan and Elizabeth Allin, who had the best chance for full-time and continuing careers in physics. Of these three, Cohen's beginnings may have been the most auspicious. The winner of the gold medal in physics at Toronto in 1925, she was graduate representative to the Mathematical and Physical Society during the year she completed her master's degree and quickly went on to finish her doctorate

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19. UTA, A73-0026, May Annetts Smith's student card.

20. My thanks to Marianne Gosztonyi Ainley, who found Smith in the calendars of the Universities of Toronto and Manitoba. For Macdonald College, see McGill University Archives, *McGill Calendar*, 1955-56.

21. UTA, University of Toronto President's Report, 1942-1952. For the other sources on Sara Clinkscale Morrison, see footnote 9.

in 1929, helped along the way by bursaries and National Research Council scholarships.<sup>22</sup> On the completion of her Ph.D, Cohen spent a post-doctoral year in England, where she worked at the Universities of London and Bristol. Returning to Canada, she enrolled at the Ontario College of Education, which suggests that she may have seen little chance of a university job at first.<sup>23</sup> However, by the next year Cohen had landed a position at Mount Holyoke College, working initially as an instructor and then as an assistant professor in the physics department led by Elizabeth Laird. Elizabeth Cohen might have gone on to a lifetime career there but, by 1935, financial problems forced Mount Holyoke to cut Cohen's job and, for some years thereafter, permanent employment seems to have eluded her. In 1937, she was apparently teaching at Toronto's Moulton College; we also find her at Humber College for one year (1941-42), and at Havergal College in 1948.<sup>24</sup> And yet, in 1936-37, she is listed as working for Toronto's physics department, where she was involved in research as well as teaching; and, by 1946, she was back in the department as an assistant demonstrator. Although full-time employment at the university seems inconsistent with even a one year job at Havergal, the University of Toronto directories indicate that Elizabeth Cohen was an instructor in physics at Toronto from 1947 to 1951, and an instructor and reader from then until her retirement in 1968. Cohen, who ran the second year optics lab in the 1960s, was remembered by one woman graduate student of the time as enjoying photography and putting it to good use by kindly photographing this student's young children. But another recalled Elizabeth Cohen as somewhat bad tempered. Given her career path, she was perhaps a justifiably disappointed woman.<sup>25</sup>

Unlike Elizabeth Cohen, Florence Quinlan was able to move into what amounted to a permanent job at Toronto quite early in her career and also, eventually, to an assistant professorship. A graduate of St. Joseph's

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22. UTA, Newspaper Clippings Collection, A73-0026/64(17). Also see *Torontonensis*, 1926.

23. For the pressure on women graduate students to seek careers in secondary teaching, see Alison Prentice, "Scholarly Passion: Two Women Who Caught It," in *Women Who Taught: Perspectives on the History of Women and Teaching*, eds. Alison Prentice and Marjorie Theobald (Toronto: University of Toronto Press, 1991), 272.

24. Prentice, "The Early History of Women in University Physics"; UTA, Elizabeth Cohen's student card, A73-0026; Government of Ontario, *Staffs of Collegiate Institutes, High Schools, Continuation Schools, Vocational Schools and Normal Schools* (Toronto, 1941).

25. Telephone interviews of Dr. Olga Mitchell, 27 September, 2000, and Dr. Helen Freedhoff, 21 September, 2000. The only other information I have been able to glean about Elizabeth Cohen is that she was a serious smoker. Undated conversation with Dr. Malcolm Graham.

Academy, Quinlan earned her first degree at Toronto in 1917 and began to teach physics at the university shortly after the First World War, evidently either starting her doctorate somewhat later or taking a long time to complete it in 1929. Gradually moving into a specialized role as instructor of physics to household science and music students, Florence Quinlan, like Kathleen Crossley, stayed put at the assistant professor level until she retired in 1958.

Only Elizabeth Allin managed to follow something resembling a typical male career in science. Completing her Ph.D in 1931, she carried on as a demonstrator until 1933-34, when she had a wonderful post-doctoral year in Cambridge, journeying there, as she put later it, "to learn some modern physics." Shortly after her return she was lecturing as well as demonstrating, although her own later view of the matter was that she mainly demonstrated in the lab, "from time to time" giving lectures that were requested by the department's professors.<sup>26</sup> Allin continued to work for the Toronto physics department throughout the 1930s, in one or other of the various assistantship positions available to "junior staff" during that period. According to her history of the department, these positions - variously designated as "lecturer, research assistant or associate, demonstrator" - were actually "yearly appointments, although in quite a few cases they were renewed year after year. Some were for twelve months but many for nine months only, in which case the person was ineligible for pension rights."<sup>27</sup>

The university directories indicate that from 1937 on, Allin's title was "lecturer in physics," and she may or may not have been considered permanent staff. At the time, there were still only five professors in the department. Expansion presumably did not seem possible during the Great Depression, when "all university staff were asked to accept a reduction in salary, and married women in all departments were under pressure to resign."<sup>28</sup> The 1930s were clearly a difficult period for many academic women and it is not surprising that Elizabeth Allin's career at first progressed slowly. Finally, in 1941, she was among the three women appointed to the rank of assistant professor. Allin would wait nearly twenty years to become an associate professor and a few years more for her full professorship, which was not bestowed until 1964. Promotions certainly came faster for her male colleagues. Although they began with comparable pay scales, male physicists eventually earned more money than Allin did as well. The men were more mobile, she believed, and were

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26. Interview of Elizabeth Allin, by Karen Fejer, 1993.

27. Allin, *Physics*, 24.

28. *Ibid.*, 25.

able to parley job offers from elsewhere into demands for higher salaries.<sup>29</sup> Not commented upon by Elizabeth Allin, but noticed by a later generation of students, was a third measure of women's unequal status in the physics department. Male faculty were normally addressed as Doctor or Professor, but this was not true of female faculty, who were more typically referred to as Mrs. Rotenberg, Miss Cohen, Miss Quinlan, or Miss Allin.<sup>30</sup>

Still, Allin's recollections of her work during the 1940s and 1950s were happy ones. Teaching during the war had been demanding, as student numbers almost tripled; Allin had vivid memories of instructing huge classes of servicemen who needed to learn about the physics of radar, radiation, and radio. Time and funding for research unrelated to the war were non-existent; department members saved from their own salaries in order to re-establish research programs after the war. At that point, undergraduate numbers tapered off, but the number of graduate students doubled and new faculty began to be hired. Within a decade of the war's end Allin was a member of a much larger department with a strong focus on research, in which she was an active participant. Deeply involved in the founding and early development of the Canadian Association of Physicists (CAP), Elizabeth Allin was justifiably proud of what must have seemed a very exciting career by the late 1950s.<sup>31</sup>

### **The 1940s and 1950s: Where Were the New Women?**

These were indeed fascinating times for Elizabeth Allin and, for Mattie Rotenberg, Clara Morrison, Beatrice Reid Deacon, Florence Quinlan, Kathleen Crossley, and Elizabeth Cohen, physics was at least providing employment either part- or full-time. But gradually even Allin must have become aware that trouble was brewing. The trouble was not confined to Toronto; nor were the difficulties experienced exclusively by women physicists. Margaret Rossiter's explorations of American scientific careers have revealed women scientists in all disciplines subsiding into tiny, uncomfortable minorities during the two decades between 1940 and 1960. In a transition that she characterizes as frequently "brutal and traumatic,"<sup>32</sup> older women scientists came under attack, as young men entered scientific fields in ever growing numbers. Some senior women

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29. Prentice, "Elizabeth Allin," 275-77.

30. E-mail from Dr. Olga Mitchell, 26 September 2000; Interview of Dr. Mitchell, 27 September 2000.

31. Prentice, "Elizabeth Allin," 276-77.

32. Margaret W. Rossiter, *Women Scientists in America: Before Affirmative Action, 1940-1972* (Baltimore: Johns Hopkins University Press, 1995), 191.

were pushed out of their jobs; others took early retirement because their working conditions became so difficult.

Nor were these older women the only victims, for young women with new doctorates were often not getting academic work in the first place, despite the huge expansions in higher education after the Second World War. In the physical sciences alone, seventy-four women earned doctorates in the United States in 1958; but in 1957-58, only twenty-two women with such degrees found academic jobs; the following year the number was twenty-six.<sup>33</sup> In the physical sciences, physics was only exceeded by geology as a field that seemed to discourage women. Of the 1,657 physicists working at 673 American degree-granting institutions in 1954-55, only fifty or 3.02 percent were women.<sup>34</sup> Everywhere, science was expanding, but women's share of the work was shrinking.

There is little evidence of trauma in the physics department at Toronto, although Elizabeth Cohen's bad temper may have been symptomatic of the times. There are small signs of concern, however. In the spring of 1949, the Toronto *Telegram* interviewed Florence Quinlan and reported that, although there had been two women graduating with her when Quinlan got her first degree in physics in 1917, there were no woman physics graduates in the class of 1949. Ten months later, Elizabeth Allin was also the subject of a *Telegram* interview and, once again, comparisons were made between Allin's graduating year, when four women had earned degrees in physics, and 1950, when few or none were on the horizon. We cannot know who initiated these interviews, but it is clear that at least one Toronto journalist and two women physicists had observed a major shift in the educational climate.<sup>35</sup> Numbers also suggest a changing picture for women on faculty. Nine new appointments were made to the Toronto physics department between 1940 and 1949 and, between 1950 and 1959, another fourteen physicists joined the staff. None of these new appointments went to a woman.<sup>36</sup>

For Allin, the moment to say something about how things had changed came in 1984, when she replied to a letter from the chair of the CAP Committee to Encourage Women in Physics, Ann McMillan, about the status of women in the field. Allin listed the things that she thought discouraged women in physics. One was the prevailing view that the B.Sc. in physics lacked professional status and was therefore not practical.

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33. *Ibid.*, 196.

34. *Ibid.*, 188-89.

35. *Telegram* 23 April, 1949, and 4 February, 1950. UTA, Newspaper Clippings Files, A73-0026/371 (08) and 005 (55).

36. Allin, *Physics*, 70-74.

Secondly, women who wanted to teach secondary school had to have both physics and chemistry, while teaching at the university level required the lengthy doctorate, for which few women had the time. Allin also pointed her finger at the pressures exerted on women, pressures that gradually persuaded them they could not do mathematics and pushed or pulled them towards other subjects at university. According to Allin, a climate had developed in which people felt that to study mathematics or science was “scarcely human,” let alone suitable for a woman. It’s clear that she believed these to be entirely new pressures that had not plagued the women of her generation.<sup>37</sup>

Was Allin trying to get at something about the culture of big science and how women might feel as they found themselves almost alone in a field that for several decades had involved smaller and smaller percentages of women? It was certainly true that, from some point in the mid-1930s, women had not been attracted to graduate study in physics at Toronto in the proportions that they had been in the 1920s, when Elizabeth Allin and her women colleagues began their advanced degrees. Yet, in the 1950s they were not entirely absent. And, by the early 1960s - after a gap of nearly 30 years - women were once again earning physics doctorates at Toronto.

### **Toronto’s Women Doctoral Students, 1960-1990**

The circumstances that made it possible to do detailed explorations of the University of Toronto records documenting women’s graduate study and employment during the first half of the twentieth century could not be duplicated for the second half of the century. The magnitude of records is overwhelming, for one thing; the calendars and directories that were so useful for the earlier decades would not be very revealing, in any case, since after Elizabeth Allin and her contemporaries retired there were, for some time, few if any women on the physics faculty to document. Yet, for the period after 1950, other interesting investigative possibilities open up. From a list of women who were awarded Ph.Ds in physics at the university up to the mid-1970s, I learned that no woman apparently earned a physics doctorate between 1933 and 1961, but that at least seven women were granted the degree between 1962 and 1975.<sup>38</sup> For the period

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37. UTA, Elizabeth Josephine Allin Papers, E.J. Allin to Ann McMillan, 26 January 1984.

38. The list was compiled from two sources: Judy Mills and Irene Dombra, comp., *University of Toronto Doctoral Theses, 1897-1967: A Bibliography* (Toronto: University of Toronto Press, 1968) and *University of Toronto Doctoral Theses, 1968-1975* (Toronto: University of Toronto Press, 1977). Both sources, I have learned, are somewhat flawed.

between 1975 and 1990, the physics department supplied the names of fifteen women who earned physics doctorates between 1979 to 1989.<sup>39</sup> I wrote to the women in these two groups, enclosing first a list of the 22 women I was contacting and, secondly, a questionnaire about their student years and subsequent employment.<sup>40</sup>

The first thing I discovered is that some women Ph.Ds were missing from my list of 22. Those who responded to the initial inquiry were able to refer me to four additional women: one whose doctorate dated from the early 1960s, one whose date of graduation was not specified, and two who got their Ph.Ds in the 1980s, bringing my total to 26. An important point emerges from the records regarding the number of women who were awarded their degrees before 1975. Altogether, 227 physics doctorates were granted by the University of Toronto between 1960 and 1975; the women with Ph.Ds from that era thus represented well under five percent of the successful doctoral candidates in the field. While making a comeback, then, women with Toronto doctorates in physics were at first far from matching the nearly twenty percent they had achieved between 1900 and 1933.<sup>41</sup>

Two women who completed their doctorates in the 1960s certainly noticed how few other women there were in their classes. Olga Mracek Mitchell wrote vividly of her shock at finding herself in a first year physics class of about 200 students with only seven other women; moreover four soon switched to other courses. There must have been many departures of both sexes for, when she graduated, Mitchell was one of only six physics majors—four men and two women.<sup>42</sup> Helen Freedhoff had a similar experience. She remembered about 120 students in first year Mathematics, Physics and Chemistry, ten to fifteen of whom were women; she was the only woman to go on in physics.<sup>43</sup> Yet, eventually these two women found that they had no particular reason to be concerned about working in a field that seemed to belong largely to men. Indeed,

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For details regarding the list and my use of it, see Prentice, "Vivian Pound Was a Man?" 99-100.

39. Thanks to Marianne Khurana, Department of Physics, who provided the original list for the period after 1975, and to Allison Lee, Office of Advancement, who provided recent addresses from the university's records.

40. For more detail on the origins of this part of the study, as well as on its methodology and attendant problems, see Prentice, "Vivian Pound Was a Man?", especially 102-09.

41. See Allin, *Physics*, 79-81, for the total numbers. As her study ends in 1980, the percentage could not be calculated for the next decade.

42. E-mail from Olga Mitchell, 26 September 2000.

43. Helen Freedhoff telephone interview, 21 September, 2000.



Helen Freedhoff felt that to be part of a tiny minority was an advantage. As the only woman in her group she was noticed.

*Helen Freedhoff with the Toronto theoretical group in atomic and molecular physics, 1961.*



*Photo courtesy of Dr. Freedhoff.*

In addition to Olga Mitchell and Helen Freedhoff, I have corresponded with and subsequently interviewed two women whose doctorates date from the 1970s, as well as four more women whose Ph.Ds were awarded in the 1980s, and have received a written response to my questionnaire from one other woman who earned her doctorate in that decade.<sup>44</sup> Four of these women also commented on numbers. For Maria Wiszniewska

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44. Undated response to questionnaire by Dr. Maria Wiszniewska Szyjkowski, received in September 2000; E-mail response by Dr. Vida Ghaem-Maghani, 15 August 2000. In both cases, there were follow-up meetings in Toronto during the week of October 16, 2000. The women whose doctorates dated from the 1980s were represented by telephone interviews of Dr. Juliana Carvalho, 25 September, 2000 (whom I was also able to meet in Toronto during the week of October 16); Dr. Mariana Frank, 10 October 2000; Dr. Janis McKenna, 8 November, 2000; anonymous interviewee, 14 November, 2000; and by an E-mail response from another anonymous respondent, 13 October, 2000. From this point on, information about or quotations from the nine women come from these interviews or questionnaire responses, or from the responses of Olga Mitchell and Helen Freedhoff cited above, in their cases supplemented by a telephone interview of Dr. Mitchell in late September, 2000, and a meeting in Toronto with Dr. Freedhoff, 19 October, 2000.

Szykowski, whose early university education took place in Poland, it was a real surprise to learn how few women there were in Canadian physics classes. In Poland 20 to 30 percent of physics students at her university were women and there was also a woman professor in the field. But when she came to Toronto Maria found that women were an “almost invisible minority” and were treated as “an exception and curiosity.” Another woman who, before enrolling in graduate work at Toronto, had studied at both an American women’s college and an elite university nearby, found that she was only one of three women in a class of over 100 physics students at the latter; eventually the other two female students dropped out and she was the only one. Yet another respondent, Juliana Carvalho, encountered a shift when she moved from Portugal to Canada similar to that experienced by Maria Szykowski. In Portugal, as in Poland, it was considered normal for a woman to study physics; in Canada, people reacted to her choice of career with surprise and found it “amazing.”

What led these women to graduate work in physics? The first telling point is that five of the nine women received their pre-university education and, in several cases, some or all of their undergraduate work, outside of Canada: in eastern and southern Europe, Iran, and in one other non-Canadian setting. In addition, two of the four Canadian-born women physicists grew up in families whose origins were European. Several of the women talked about how their European backgrounds may have affected their choice of careers in science. Juliana Carvalho, for example, commented that girls and boys were typically educated separately in Portugal and noted that in her girls’ school she had encountered an “extraordinary” woman teacher who inspired her interest in physics. For Mariana Frank, the expectation she grew up with in Romania was that a woman needed to be able to earn her living. Her mother was a single parent and a professional; indeed, as a child, she knew no-one whose mother was a full-time housewife. Education was strongly encouraged for both men and women and she had always known that she would stand on her own feet.<sup>45</sup> Similar views were expressed by Maria Szykowski and Olga Mitchell. The latter noted that, as the daughter of Czech immigrants, she did not buy into what she perceived as traditional expectations for

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45. These findings are corroborated in a survey conducted by W.J. Megaw in 1990-91. The responses from 403 universities in 54 countries, showed that Catholic (and I would suggest some eastern European) countries tended to have more women graduating and working in physics than other countries. Megaw infers that segregated education might be one of the determining factors. Numbers were often small, but women were over 30 percent of physics faculty reported in Czechoslovakia, Hungary, Philippines, and Portugal. “Gender Distribution in the World’s Physics Departments,” paper prepared for the meeting, Gender and Science and Technology 6, Melbourne, Australia, July 14-18, 1991.

Canadian women, that is “to finish school, work for a while, get married, have children, quit work and become a homemaker.” The last thing she wanted to be, in fact, was a full-time housewife.

Nearly all of the women commented on their early interest in science, often in both mathematics and physics, and several reported inspiring female teachers from their pre-university or pre-graduate student years. A woman educated in Canada recalled several women teaching mathematics at her suburban high school; another mentioned not only outstanding women math teachers in secondary school, but a particularly brilliant woman teacher of mathematics at the Quebec community college she attended. Others did not comment on particular teachers, but emphasized their love of physics from an early age. Vida Ghaem-Maghani reported that as soon as she was introduced to physics in grade 8, she had “decided to become a physicist” and imagined herself doing research for the rest of her life. Another of the women whose early education took place outside of Canada found that, from the beginning, physics captured her imagination “in a way no other subject did.” She was intrigued by famous physicists of the past such as Isaac Newton and Niels Bohr but, above all, she was fascinated by the subject itself.

Several women talked about having to make a choice between physics and mathematics at some point in their careers. Maria Szykowski echoed a view similar to that expressed by Elizabeth Allin, who chose physics over math because she thought it the more practical of the two subjects; to Maria, physics seemed best because it was “more related to everyday life.”

Helen Freedhoff originally thought that she would go into mathematics, but found physics more interesting when she got to university. Janis McKenna loved math, but wondered what one would do for a job in the field and thought physics the more likely of the two to lead to satisfactory employment. Mariana Frank loved both subjects and, like Helen Freedhoff, probably chose to enter theoretical rather than experimental physics because of her strength in mathematics.

Once at the University of Toronto, most of the women said that they had experienced little in the way of overt bias against women in physics, despite their minority status or, in some cases, their feeling that people found it unusual or even amazing for women to be in the field. Indeed, several singled out their doctoral supervisors as men who were particularly supportive of women. Yet there were subtle pressures that the women encountered and some that were not so subtle. One of the European-born respondents noted how competitive the atmosphere was in Toronto’s physics department; as an example, she recalled a male student who pretended that he had not done a problem set the day before it was

due, when she suggested that they work through the problems together. This would not have happened, she thought, at her European university where students always discussed the problems with their friends - where, indeed, "the students taught each other." The same respondent also recalled a professor whose mode of questioning was so aggressive that it bordered on the offensive. She was surprised, then, that he did not ask a single question at the research seminar she gave just before the examination of her thesis and wondered if he were, perhaps, "intimidated by women students." Another of the European-educated physicists felt that she was treated oddly by a professor who questioned her rather closely about her personal history, when she went to him for help in understanding a mid-term test problem. She wondered if he did not take her seriously as a student, but finally concluded that this was an isolated incident.

A few of the women did encounter put-downs and negative remarks that might not have been directed to them had they been men. One respondent recalled difficulties dealing with a particularly aggressive professor from another university who was involved in her collaborative experiment and made her life difficult on occasion. Another mentioned a professor who questioned her choice of physics as a career. A third remembered considerable hostility from her Toronto advisors and, in her case, the negativity was certainly gender-based. She recalled being told on one occasion that she was too aggressive for a woman; on another occasion she was informed that a woman could not be successful in the sub-field she had chosen.

Despite these experiences, there seemed to be little sense among the women that they had been the victims of prejudice on the part of either male faculty or students at Toronto. What one respondent did note was a kind of built-in or systemic bias, that had to do with the culture of physics and the way things worked in a busy department, with many students requiring time on computers and keen to complete their doctorates as fast as they could. When Mariana Frank was doing her Ph.D, all the students in her group at Toronto worked on the main frame and by far the most effective time to work on it was at night. This put the women students at a serious disadvantage. To work at night meant to go home at 3 or 4 in the morning, when the streets were deserted. Mariana was followed on one occasion and knew that at least one other women physicist had experienced a similar problem. Another of the respondents noted that the university tried to remedy this situation by increasing the number of security guards at night. But there was nothing the university could do to increase the women's safety once they were off campus.

Some women faced obstacles when it came to the choice of a sub-field or a supervisor. One switched fields, choosing both a new field and a new advisor, finding herself unhappy in her first choice. A second felt that her supervisor and the members of her committee had unfairly kept her in the doctoral program far longer than was necessary, given the number of publications she had produced. A third summarized the situation by saying that the position of women graduate students in physics at Toronto was very “discipline dependent” and “person dependent.” In other words, if women were in certain sub-fields of physics and had helpful supervisors as a result, all was well. Presumably, the reverse was also true.

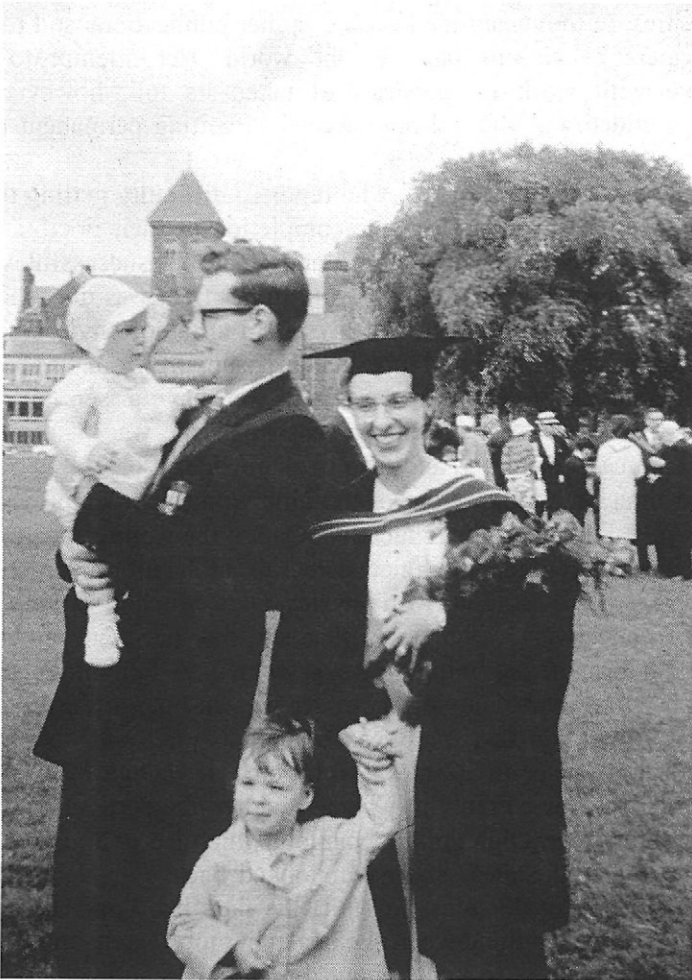
Although a difficult subject to discuss, two women did offer opinions about potentially problematic sexual dynamics that could be embedded in graduate student-professor relationships. One noted that she admired her thesis supervisor’s wife who apparently felt no ill will, despite the fact that her husband’s scholarly discussions with his students, male and female, often went on long past ordinary working hours. She volunteered the opinion that sharing intense scholarly interests had the potential to spill over to sharing feelings that were “beyond what they should be,” a fact that may well have made some male faculty nervous about having women graduate students. Another woman indicated that “romantic encounters” could certainly be a problem when research involved a lot of travel. There were many men at the labs, “some single and some married and away from their families - and there were very few women.” We discussed how difficult these dynamics could be for the women concerned, including the professors’ wives left at home. No-one revealed any particular incident or long-term damage on this score however. Seven of the nine women either married or entered long-term relationships with male partners before or during graduate school. If the subject came up, they all agreed that this probably made for more comfortable relations with their professors than would have been the case had they remained single.

### **From Student to Working Physicist**

Having a partner could also be advantageous when it came to the job market. Olga Mitchell was not only married but the mother of two children when she completed her doctorate and started to seek work in her field. No potential employer, she pointed out, could refuse to hire her because she would inevitably quit to marry or have children; she had already done both. Marriage, partnerships, or the presence of children could cause problems, however. At least six respondents noted that some of their choices had been determined by their husbands’ decisions about

where to locate. For example, several chose the University of Toronto for graduate work in physics because their partners already had work or were graduate students in Toronto; these and others also encountered restrictions arising from partners' locations or concerns after the completion of their Ph.Ds. One woman's husband was not keen to go to the United States, where his wife wanted to take up her post-doctoral fellowship, and so another choice had to be made. Another respondent felt that she could only work in the city in which her husband was employed, and that the resulting immobility may have had a negative effect on her research career.

*Olga Mracek Mitchell and her family on the day her Ph. D. was granted (1962)*



*Photo courtesy of Dr. Mitchell.*

Partners' choices could have an even more profound impact. One of the younger women physicists felt that her job search was compromised from the beginning by the circumstances of her marriage. First, she was not welcomed by the university physics department in which her husband found employment, and in which she had hoped to do her post-doc; as she described it, the atmosphere was "cold" as far as she was concerned, although she was not sure why. Her teaching experience at another university in the same city did not work out, she felt, because of cultural or racial prejudice. She encountered similar prejudice against her in a third university and was finally forced to take university work outside of Canada. As her marriage began to collapse, this young physicist again made adjustments, returning to Canada and sessional work in two other universities, in the meantime keeping up her publications and traveling to give papers in various parts of the world. Her attempt to combine marriage with work in physics had taken its toll, however, for the marriage ended and she did not succeed in getting permanent university work.

This physicist was one of two who reported difficulty getting the kind of employment they wanted after the completion of their doctorates. In the second case, the respondent's long and finally unsuccessful search for permanent industrial or university work in her field was due, she thought, to her lack of networks. "I found myself in an aloof environment...I did not know anybody and did not get any support from anybody." Her difficulties, as in the previous case, may well have arisen not only from the fact that she was a woman, but also that she was of non-Canadian origin, ethnically different, and seen as an outsider.

At the time of writing, eight of the nine women are employed, four in physics research and higher education. One of the women has retired from her industrial job to take up a new career as an aviation instructor. Flying small planes has a lot to do with physics, Olga Mitchell explains, and she loves her new work. Olga feels that she has been enormously lucky throughout her life, as things always seemed to fall into place - from getting her first job to moving on to her present one. Interestingly, it was female networking that produced the first job, and the significant encounter took place in a ladies' washroom. Here Olga Mitchell met Dr. Ursula Martius (later Franklin) who alerted her to a particular job opening that would suit her. Olga got the position, which led to a more permanent one in the United States. She never looked back. For Helen Freedhoff, who completed her doctorate in 1965, the fact that York University was just getting off the ground when she began her job search, and the fact that she had the networks to know about this, proved extremely helpful. She

wrote to the physics department at York when on her London post-doc, was offered a position, continuing there for the rest of her career.

The two women who finished their doctorates in the 1970s ultimately found permanent positions as teachers in Toronto area secondary schools. The university job market was tight in the 1970s, but it was not necessarily easier to get secondary teaching work, either then or subsequently. One of these two physicists had a post-doc in Winnipeg, followed by interesting jobs in Toronto, first in industry and then as a research and teaching assistant, during the period when she was having her children. But, despite all this experience, she was rejected the first time she applied to Toronto's Faculty of Education. She successfully appealed the decision, however, and soon had her B.Ed. The idea to move in this direction was given to her by a male physicist friend and she, in turn, passed it on to her woman colleague from the 1970s, who then also acquired certification for secondary teaching. Teacher training did not instantly lead to getting good secondary school jobs, but both women now have excellent positions and hope that their presence in their respective high schools will encourage young women to go into physics, a hope that the impact early women teachers had on many of the women suggests is fully justified

It was the women who earned Ph.Ds during the 1980s who were most likely to have benefited from affirmative action programs or other special efforts to provide work for young physicists. For Mariana Frank, the advent of the Canadian University Research Fellowships (for both women and men) provided the opportunity she needed to get a university job. Similarly, an affirmative action program eventually helped Janis McKenna to get her job at UBC, where she was hired under the Canadian Women Faculty Award program that came into being in the early 1990s. Juliana Carvalho also reports having benefited from a climate favouring the hiring of women. During the tenure of her post-doctoral fellowship, Juliana landed a job at St. Michael's Choir School, where the director was interested in having a female role model in physics for the boys. Soon she was also teaching courses at Ryerson and York; at York, the department chair was making a particular effort to increase the percentage of women on faculty.<sup>46</sup> When tenure-stream positions came up at York and Ryerson she applied and was offered both, in the end choosing Ryerson. Another woman is not certain, but believes that affirmative action may have influenced her hiring. The university that engaged her advertised one job but, in the end, hired two people; she thinks that this may have resulted from special funds for women.

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46. This was Professor W.J. Megaw, author of the report cited in note 45.



Several women reported heavy workloads, but with a few exceptions their employment experience has been mainly positive. One, who was not initially aware of women's issues, gradually became quite interested in them. But, for another, the growing emphasis on women's issues proved problematic, resulting as it did in constant requests for her to act as the token woman on countless committees or to apply for positions for which she had no experience or talent. Although such pressure was irritating, she learned to say "no." The younger women perhaps took women's issues more for granted, accepting the need for both special programs and for studies on the status of women in physics.

Four of the women focused on the strains of combining motherhood with their careers in physics. Helen Freedhoff has never seen professional prejudice against women physicists, but she does acknowledge "social prejudice." For her generation, far more was expected of women than of men when it came to the tasks of child-rearing and domestic management. This has certainly been, and continues to be in her view, a disadvantage for women. Several of the younger physicists corroborated this. One feels that the men in her department never understood her desire to be at home with her children in the evenings. Another's colleagues criticized her temporary need to keep her baby in her office when she was still trying to get the child into day care. "Why don't you just get day care?" people kept asking, as if good day care were instantly available.

Two of the younger physicists dealt not only with the problem of combining employment and child rearing, but also with commuter marriages. One managed to juggle her career and family life long enough to get tenure, but soon after resigned and moved to the city in which her husband worked, taking up related employment. She loved teaching, but always had other interests, and her marriage and her children's welfare were more important to her than her university job. The other woman in this situation also came to the conclusion that "commuting with children is impossible" and believed that she, too, might have to move to her husband's location; fortunately, her university solved the problem by hiring him. The strain of combining university and parental work remains, however. This physicist meets regularly with a group of women scientists who like to joke with each other that their problems would all be solved, if only they had wives.

Will things change? Most of the women who discussed the problem of combining physics with family life had no doubt that marriage and children alter the dynamics for women physicists. The intense group experience that some had as graduate students, when according to one woman she and her fellow students "worked all day and all night, read journals together and had a really good time," is not likely to be

experienced by a woman with childcare responsibilities. This physicist, who is now a mother as well as a university professor herself, noted that the research group she directs as a faculty member is not as intensely bonded as the one she was part of as a graduate student; the arrival of her own child and women students who have children have meant lifestyles that are more family-oriented. This, of course, could be interpreted as the beginning of a new, healthier regime. There are other signs that could also be seen as hopeful. The physicist who briefly cared for her child in her office commented that the light bulb went on for an older male colleague when his own daughter had problems finding good daycare for a child; she felt that other male scientists might eventually be enlightened by the experience of their daughters. One of the women noted that the younger men in physics will also be more family-oriented, as so many of them are now sharing child care responsibilities with professional wives.

Surveys conducted under the auspices of the CAP, first in the 1980s and again in 1995, also suggest a changing climate for Canadian women in the field.<sup>47</sup> They reveal that, from the mid-1980s to the mid-1990s, Canadian doctoral students in physics who were women increased from approximately five to thirteen percent and that percentages of women faculty in Canadian physics may also be slowly increasing. Although women constituted only five percent of faculty and two percent of tenured faculty in the 40 Canadian physics departments that responded to the survey in 1995, 28 percent of the untenured faculty was women. The authors of the articles reporting these surveys note that there are many complexities hidden in these percentages, however. Male graduate student numbers may have been declining relative to women's numbers overall, but increasing at the Ph.D level as men faced a difficult job market and were deciding to stay in university longer. Thus, a six-fold increase in the number of women doctoral students translated into a much smaller percentage increase. It may also take a very long time for the 28 percent of untenured faculty who were women in 1995 to become anything like 28 percent of *all* faculty, let alone 50 percent. Untenured faculty constituted only 11 percent of physics faculty altogether in the universities responding to the CAP survey and, in 1995, there were still many universities that had only one or no female physicist on staff. Although the numbers do suggest some hope for the future, progress is very slow.

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47. Ann McMillan and Eric Svenson, "Women Students in Physics in Canada: A Decade of Progress," and Jolanta B. Lagowski and Janis McKenna, "Women Physics Faculty in Canada," *Physics in Canada/La physique au Canada* 52, 2 (1996). As noted above, McKenna was one of the women interviewed for this study.

## Conclusion

On her retirement in 1997, the Quebec physicist, Luce Gauthier, published a small book on women scientists that drew on her own experience.<sup>48</sup> Recalling her early success as a student and her feeling that science was as necessary to her as the air she breathed, Gauthier also remembers the women who taught her in the 1960s, in particular an extraordinary mathematics teacher who knew how to convey to her students the spirit of mathematics, although she was pessimistic about women's chances in the field. As it turned out, to become a physicist in this era was to confront deeply held doubts about women's ability to do either physics or mathematics. Gauthier also recalls her sense of isolation as a woman specializing in physics and some of the hostility she eventually experienced. Isolation was reduced for women scientists, she argues, if they were married to scientific men; indeed most of the women physicists Gauthier has known are (or were) married to other scientists. She explores the difficulty some women physicists, herself included, had finding work in their field and what can happen to a woman scientist when her relationship with her scientist partner dissolves. Her own marriage of ten years collapsed under the strain of her search for work and an attempt to commute between two provinces. She also writes of three women she knows who gave up their careers as research physicists to save their marriages: one moving to journalism, another to part-time research, and the third to secondary teaching. Her conclusion: for a woman of her generation, it was necessary to choose between love and science.<sup>49</sup>

With two important exceptions, the stories told here of twentieth century women who pursued scientific careers via advanced physics degrees from the University of Toronto reveal less overt prejudice than Gauthier appears to have experienced. It is true that the nine contemporary women in this study may represent the more successful of the twenty-six women who earned doctorates at Toronto in the period between 1960 and 1990 and, perhaps for that reason, their paths were - at least at first - mainly smooth. Like the women who embarked on graduate study in physics during the first half of the twentieth century, they were spared negative socialization against women in physics in their early years and, once in university, drop-out rates in large science courses did not discourage

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48. Luce Gauthier, *Propos d'une physicienne sur la situation de la femme de science* (Outremont: Carte blanche, 1999). Thanks to Jocelyne Murray for alerting me to the existence of this book.

49. See Alison Mackinnon, *Love and Freedom: Professional Women and the Reshaping of Personal Life* (Cambridge: Cambridge University Press, 1997) for historical treatment of this theme.

them. Unlike Clara Clinkscale, they did not experience serious difficulties with male faculty or fellow students that prevented them from going on to complete their degrees, and the fact of having to study or work almost exclusively with men was generally not an issue for them. For the most part, they got along well with their male professors and fellow students. Although, in retrospect, some greatly appreciated the influence of outstanding women teachers in their early years and several also eventually felt the need for more female friends, at the time of their studies male friends and male teachers generally seemed sufficient. As one of the younger respondents reported, she was happy to be “treated as one of the guys.”

The first really difficult issue for most of the women in this study emerged with the quest for permanent university or research-related employment in the years following the granting of their doctorates. In this quest, two of the contemporary women were seriously disappointed. Yet, if these women experienced gender prejudice, it has to be acknowledged that, in both cases, their problems were compounded by ethnic and/or racial difference. Looking back at the working lives of the six women whose Toronto doctorates date from the interwar years, one has to wonder how much the careers of Mattie Rotenberg and Elizabeth Cohen were similarly affected. They were both Jewish women in a very Anglo-Celtic university environment. The unmarried Cohen, in particular, may well have fallen victim to the antisemitism that was so virulent in the Toronto of her era.<sup>50</sup>

The gender/ethnic problem may have had its origin in difficulties experienced by the men who could or should have been promoting these students' careers or hiring women to fill openings in physics that came up during the years following the Second World War. In a very astute comment, one woman physicist of that period called attention to what she now understands to have been “a great deal of insecurity” among male physicists. While they found it possible to accept women as students, this insecurity prevented many men from accepting women as colleagues on a genuinely equal or permanent basis.

All the evidence suggests that the biggest problems for the women physicists, both those who got the jobs they wanted and those who did not, came with growing family commitments. Coordinating one's professional interests with the needs of one's spouse and, later on, with the needs of children could and did cause difficulties for most of the

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50. See Stephen Speisman, “Antisemitism in Ontario: The Twentieth Century,” in *Antisemitism in Canada: History and Interpretation*, ed. Alan Davies (Waterloo: Wilfrid Laurier University Press, 1992) 125-129.

married women whose stories are told in this study, and this is true for the entire century. Of the three early twentieth-century women who married, none was able to sustain a full-time career in physics as far as we know. Most of the nine women from the second half of the century have had to make adjustments to suit their family circumstances; in three cases, these adjustments when combined with other circumstances meant either not finding, or having to give up, the university and research-oriented careers they initially sought so keenly.

Yet most of the contemporary women in this study would, I think, encourage other women to pursue careers in physics. Certainly all of them, like the earlier Toronto women before them, have proven conclusively that women can do physics as well as men. What their stories tell us is that what women physicists need (as men do) is education, family circumstances and working conditions that encourage and support their ongoing employment in the field. If we read between the lines, their stories also tell us that physics itself may need to change and, perhaps, is already changing to accommodate the needs of women.