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The Allure of Mathematics or Book Review: Seduced by Logic: Émilie Du Châtelet, Mary Somerville, and the Newtonian Revolution, by Robyn Arianrhod

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The Allure of Mathematics
OR
Book Review: *Seduced by Logic: Émilie Du Châtelet, Mary Somerville, and the Newtonian Revolution*, by Robyn Arianrhod

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Synopsis

Today, there is a tendency to overlook the contributions of women such as Émilie du Châtelet and Mary Somerville; yet, despite numerous obstacles, they were able to make meaningful contributions to science. This review of Robyn Arianrhod's book provides brief biographical summaries of the lives of these extraordinary women. It also considers some of the ramifications of Isaac Newton's theory.

Throughout history, various factors have impeded women from full participation in scientific research; nevertheless, Émilie du Châtelet and Mary Somerville found and took advantage of opportunities to engage in scientific activities. This raises the question: had these women been born during contemporary times, what original scientific discoveries might they have made?

> **Seduced by Logic: Émilie Du Châtelet, Mary Somerville, and the Newtonian Revolution.** By Robyn Arianrhod, Oxford University Press, New York, 2012. (Hardcover US$38.95, ISBN: 978-0-19-993161-3. 285 pages.)

In early fall of 2012, I had been considering the possibility of submitting a sabbatical proposal. After all, I had been teaching full-time at the college level for nearly twenty years and had never taken one. I was certainly overdue. But what would my study entail? Over time, my focus had

shifted from research mathematics to education at the undergraduate level. In recent years, I had also developed a strong interest in the historical development of my discipline. In fact, in the fall of 2010, I had taught, for the first time, a writing-intensive course entitled *History of Mathematics*. So, in September of 2012, while attending a faculty workshop on interdisciplinarity, an idea occurred to me: what better way to approach my sabbatical than to take an interdisciplinary approach? I would study the significant, yet often-overlooked, contributions of women to mathematics. Such a study would incorporate aspects of history, philosophy, mathematics, and science. It could even lead to a new course.

After careful thought and discussion with colleagues, I decided to broaden my focus, and in fall of 2013, I began my study of women in science. This survey would include the discipline of mathematics. Left with the task of deciding how to begin, I started to surf the Internet and came across a book with a rather interesting title: *Seduced by Logic: Émilie Du Châtelet, Mary Somerville, and the Newtonian Revolution* [1]. I had long been intrigued by the life and work of Isaac Newton and had emphasized his significance in many of my classes. What role could these women have played in disseminating and/or developing his ideas? I was a woman in mathematics with three degrees in the discipline, yet I had never studied their contributions. Had I even heard of them? I decided to read the book. What I found was a vibrant account of the lives of two women who played an important role in the mathematical and scientific discussions of their day.

Today, Isaac Newton's *Principia Mathematica* is regarded as perhaps the most influential scientific work of all time. However, his theory of gravity was initially considered quite controversial and was firmly rejected by the French Cartesians. Remarkably, Émilie du Châtelet, a "self-taught marquise," had the foresight to recognize the significance of Newton's work; she became one of the first Continental scholars to actively promote his theory. Almost a century later, Scottish-born Mary Somerville became a leading authority on nineteenth-century Newtonian physics. [1, page 3]

In *Seduced by Logic*, author Robyn Arianrhod explains how these extraordinary women would clarify and expand on Newton's work through their scientific writing. Furthermore, she states, "When I started out studying higher mathematics, the very existence of these women was enough to encourage me to believe that I, too, could succeed" [1, page 1]. Indeed, Arianrhod makes

an important point: Émilie du Châtelet and Mary Somerville lived during a time when women had limited access to formal education. Moreover, opportunities for women to engage in scientific research were almost nonexistent. The fact that these women were able to accomplish so much should serve as a source of inspiration. The translation and popularization of scientific works were, for the most part, the only opportunities that women had to make meaningful contributions to science.

Arianrhod's decision to refer to her "heroines" on a first-name basis is one of several remarkable features of this book; and while the author's approach may be too informal for many, I can understand her reasons for doing so. It certainly left me, the reader, better able to connect with these women on a personal level; it also makes their struggle come across as more genuine. However, *Seduced by Logic* is not mere feminist fodder. It is an historical work, one that cultivates an awareness of the cultural and intellectual climate in which Émilie and Mary lived.

Gabrielle-Émilie Le Tonnelier de Breteuil was born on December 17th, 1706, nineteen years after the publication of Isaac Newton's *Principia*. Anecdotes suggest that young Émilie was allowed a great deal of "intellectual freedom," although most of her knowledge was acquired through self-study [1, page 7]. Émilie's father was chief of protocol at Louis XIV's palace at Versailles, and at the age of eighteen, she entered an arranged marriage with Florent-Claude, marquis du Châtelet and count of Lomont. For the next seven years, Émilie assumed "the role of society wife" and dutifully gave birth to three children; however, sometime in 1732, she experienced an intellectual awakening, being drawn to "people who think." [1, page 8]. Evidence suggests that she began a study of the works of René Descartes, Isaac Newton, and the English philosopher John Locke [1, page 9].

The following year, Émilie began her courtship with Voltaire, the French writer and activist who played a key role in the eighteenth-century Enlightenment. While in exile in England, Voltaire had begun a study of Newtonian science. Building on the work of Galileo, Kepler, and Descartes, Newton had shown that for any object to move in an elliptical path, its motion must be governed by an inverse-square force. His calculations also "suggested that gravity was the source of the ... force required to keep the moon in its ... orbit" [1, page 13]. "He concluded that the sun has gravity," thus providing an explanation for the elliptical paths of the planets [1, page 14]. Using his theory, Newton was able to explain the precession of the equinoxes and the

motion of the tides, two phenomena that had long puzzled scientists. Arianrhod observes that Émilie and Voltaire recognized the great philosophical significance of Newton's theory. He had been able "to unite two apparently different ... phenomena," planetary motion and the motion of falling bodies. The fact that a single principle could be used to explain so many physical phenomena made the world seem comprehensible. [1, page 15]

Although Newton's *Principia* was first published in 1687, it would be many years before this monumental work was fully accepted. In particular, the ideas of the early seventeenth-century philosopher René Descartes still dominated scientific thought. Upon reading *Seduced by Logic*, I was surprised to find that Émilie played such a noteworthy role in promoting Continental Newtonianism. In fact, Arianrhod observes that Émilie assumed the functions of advisor and co-researcher in the preparation of Voltaire's *Elements of Newton's Philosophy*, the first French popularization of gravitational theory. Furthermore, she writes that Émilie "is entitled to be seen as co-author of the book" [1, page 47]. Without question, Émilie had achieved a high level of mathematical expertise. In 1744, she began her translation of Newton's *Principia* from Latin into French; this translation included detailed commentary. Sadly, this work, often considered her most outstanding achievement, was not completed until 1749, the year of her death.

Newton's approach helped define modern physics, and Émilie du Châtelet played an important part in this Newtonian revolution. Scientific theories were no longer deduced from assumed causes. Science was now an empirical discipline, with mathematics being used to describe observed phenomena. It is this power of mathematics, its innate ability to help us understand our natural world, which Mary Somerville found so appealing.

Mary Fairfax was born on December 26th, 1780, in Jedburgh, Scotland and spent much of her childhood in the seaside town of Burntisland, opposite Edinburgh across the Firth of Forth. Regrettably, little had changed for women in the years since Émilie's death; they were excluded from participating in political life and had limited access to formal education. Mary attended school for only one year where she learned the rudiments of French and English grammar. As fate would have it, she gained her first exposure to algebra at the age of fifteen. However, none of her relations had any knowledge of mathematics, and she dared not ask about it for fear of being ridiculed.

In 1804, she married Samuel Grieg, "a commissioner in the Russian navy and a London-based Russian consul" [1, page 171]. Her husband, having a low opinion of women, was not supportive of her intellectual pursuits; nevertheless, Mary began her study of higher-level mathematics. When widowed after three years of marriage, she returned to her parents' home, taking along her two young sons. With a new-found "sense of independence," Mary began her study of Newton's *Principia* [1, page 172]. She also met John Playfair, Professor of Mathematics and Natural Philosophy at Edinburgh University, who encouraged her study of mathematics. Within time she would begin a correspondence with William Wallace, a protégé of Playfair's. With growing confidence, Mary began her study of Laplace's *Mécanique Céleste* (Celestial Mechanics). In this five-volume work, Pierre-Simon de Laplace, one of France's leading Newtonians, had summarized Newton's theory in modern language. He had also addressed the mathematical results that followed the publication of Newton's *Principia*. [1, page 173]

Mary's marriage to William Somerville in 1812 marked a turning point in her life. For the first time, she had both encouragement and the financial resources to pursue her mathematical studies. William had worked as head of the army medical department, and in 1816, the Somervilles moved to London. It was here that they became part of a large social circle, a group which included leading scientists of the day. Mary returned to her study of the *Principia*, and in 1826, she published her first scientific paper in the *Philosophical Transactions of the Royal Society at London* [3, page 25]. Since women were not allowed to attend meetings of the Royal Society, her paper was presented by her husband, William Somerville.

The following year, Mary received a request from Lord Henry Brougham, co-founder of the *Edinburgh Review*, to write a popular account of Laplace's *Celestial Mechanics*. Her "account," *Mechanism of the Heavens*, was eventually published in 1831. This exposition, an expanded version of Laplace's first two volumes, was written to help readers gain a better understanding of gravitational theory; special emphasis was placed on astronomy. Mary's *Mechanism of the Heavens* was very well-received. In fact, it was adopted for use at Cambridge University and would become the standard text on celestial mechanics for the following century [1, page 195]. Mary continued her study of science and mathematics and would go on to write three additional books.

In her introduction to *Seduced by Logic*, Robyn Arianrhod asserts that "Newton is probably the most important scientist of all time" [1, page 3]. Of course, it's natural to take this point of view, considering the scientific advances of the past two centuries. Arianrhod successfully conveys the scope of Newton's influence; for example, she explains how Newton's *Opticks* inspired Young's wave theory of light [1, page 230]. She also notes that Joseph Priestley, using a "superb" theorem, was able to predict an inverse-square law for stationary electric charges. Incredibly, the same mathematical pattern can be used to describe gravitational, electric, and magnetic forces [1, page 236]. Using eloquent prose, Arianrhod outlines the discoveries that led to the theory of electromagnetism.

Seduced by Logic is far more than an account of the lives of Émilie du Châtelet and Mary Somerville. This book exposes the nature of scientific revolutions, and in the process, outlines the progression of fundamental scientific debates. As one might expect, I was surprised to learn that Jean-Jacques Dortous Mairan, permanent Secretary of the Parisian Academy of Sciences, openly challenged Émilie's support of Leibniz in the *vis viva* debate [1, page 127]. I found this amazing since, as a woman, she could not become a member of the Academy. The title of the book is certainly appropriate as it reveals the author's desire to underscore the seductive power of logic; for Émilie, reason alone, without experiment or rigorous proof, was insufficient [1, page 106]. In promoting Newton's ideas, she and Voltaire were challenging an established tradition of thought, one based on religious doctrine and nationalism.

At times, Arianrhod tends to digress, drifting too far off topic; but then she skillfully draws us back in again, shedding light on the lives of two remarkable women. Occasionally her approach seems too naive. Nonetheless, I found her exposition engaging. Arianrhod's portrayal highlights the *humanness* of her heroines; she brings their stories to life. As an educator, I can certainly appreciate Mary's desire to expound on complex scientific theory.

I am also left to wonder: had these women been born during contemporary times, what original scientific discoveries might they have made? Émilie pursued her studies "from a socially secure position as the marquise du Châtelet" [1, page 124]. How much more difficult it must have been for women of lesser means and ability! In the case of Mary Somerville, how did she coordinate the demands of motherhood and scholarship? As I wrote

elsewhere [2], William Somerville's role in Mary's success should not be overlooked. He provided his wife with access to scientists while still conforming to very traditional social norms.

In my opinion, the book's most impressive feature is its attention to rich historical detail. Arianrhod does an excellent job of explaining the relevant science and identifies individuals who figured prominently in the development of scientific theory. In addition, she familiarizes her readers with other accomplished women. Indeed, *Seduced by Logic* could serve as the foundation of a course, although one of limited scope. Undoubtedly, there is much to be learned from a focused biographical study. There is also an increasing body of literature that highlights the lives of women who contributed to the growth of mathematical and/or scientific knowledge; for example, the book *I Died for Beauty: Dorothy Wrinch and the Cultures of Science* by Marjorie Senechal [5] provides another very humane account of a pioneer mathematician and scientist. Both Émilie du Châtelet and Mary Somerville are featured in the comprehensive work *Women in Science: Antiquity through the Nineteenth Century*, by Marilyn Bailey Ogilvie [4].

Well-researched and informative, *Seduced by Logic* includes thirty-two pages of notes and sources, in addition to the bibliography. These notes should serve as an invaluable resource for those interested in pursuing further study. A twenty-eight page supplementary appendix is provided to help clarify relevant scientific theory.

In summary, *Seduced by Logic* is both captivating and comprehensive, an interdisciplinary work with wide appeal. In telling her story, the author transcends traditional academic disciplines — history, philosophy, and physical science — and creates something richer in the process.

References

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