

## Femininity, Mathematics and Science, 1880-1914

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In the two decades since Margaret Rossiter's first volume on *Women Scientists in America* (1), there has been a steady series of books which have investigated the place of women in science, seeking to discover if and where they existed, the nature of their contribution and the reasons why for so often and so long there has been a perceived disjuncture between women and scientific creativity. For many, it is even stranger to contemplate women being good mathematicians: in England and Wales the increasing equality of girls with boys in mathematics examination results in the 1990s led to fears both of the examinations being dumbed down and about what was happening to the boys. Yet at the same time, scholars such as Leone Burton (2) urged that there was a 'pervasive culture' in the subject of masculine exclusivity, competition and depersonalized objectivity which, coupled with unattractive teaching methods, discouraged many girls and some boys. Claire Jones, in this excellent scholarly, yet very readable, book, turns to the past to explore this issue, one somewhat neglected in the history of science, gender and education alike.

Jones examines the 'fin de siècle' in England, a time of tension when many things were questioned, including notions of gender and women and of the status of both science and mathematics. Her original and imaginative approach is to use as a continuing thread the lives of two women, Hertha Ayrton and Grace Chisholm Young, both of whom studied maths at Girton College, Cambridge, became practitioners of their discipline rather than teachers and married men within the same discipline. Her wise decision to use the women's first names to distinguish them from their husbands is, in itself, illustrative of the tangled problems which surrounded women achievers in many fields. Hertha (then Sarah Phoebe Marks), dark-haired daughter of an impoverished Jewish immigrant watch-maker and jeweller had problems over and above those of middle-class Grace Chisholm who attended Girton a decade later than her when teaching and resources had improved. Deeper differences lay in their political and philosophical stance which vitally affected the aspects

of maths they chose to practice and their gender outlook. By teasing out their intellectual and affective relationships and their lives in mathematics, Claire Jones is able to explore deeply the changing nuances of both gendered attitudes and practices and of the world of mathematics, science and engineering.

At a time when professional science was changing beyond all recognition, the boundaries between science, engineering and mathematics and those within each of these fields were hotly disputed, with important effects on status and privilege. Jones opts for the purposes of this study to distinguish between the mathematics of 'practical science' which was predominantly laboratory-based and that which was predominantly desk-based, Hertha choosing the first and Grace the second. Contemporary definitions were fluid and overlapping so in charting the careers of two women who went in different directions within mathematics, Jones is able to analyse changing aspects of these areas and, significantly, to bring to the surface the all-important interrelationship between mathematics and its social and cultural context.

In the emergent tradition of feminist scholarship, Jones uses a wide range of sources beyond institutional records, letters and memoirs. Thus photographic/pictorial sources are used alongside literary and journalistic. For instance, Jones argues that the way the image of a classical female 'goddess' of light was used to symbolise the amazing new power of electricity was reminiscent of female personifications of science in earlier periods where men were portrayed as those who discovered, unleashed and controlled the powers of nature. Images are chosen well, indeed, to highlight assumptions about laboratory spaces as places for men and the unattractiveness of scientific women. The cover picture of a highly romanticised late Victorian painting of a nude, besieged Hypatia, is not discussed in the book, however.

Jones begins by examining how women gained access to the elite Cambridge mathematical tripos, symbol of the highest 'male' intellect in the recognised heart of mathematics in England. She explores the pressure on women to do mathematics to demonstrate their intellectual equality with the brightest of men, their lack of such long preparation and good coaching compared with men and how differently their success was perceived. Some spectacular achievements which made international headlines, however, rather than proving women's prowess in mathematics, led to their success becoming characterized as the result of hard work rather than natural brilliance – an interpretation not unknown in women's intellectual history. Jones argues that the mathematical tripos became devalued because women competed well in it while men who failed might be assumed to have more original minds.

Grace's history after her success at Cambridge is aptly used by Jones to unravel the tangled web of opportunities and limitations met by highly-achieving women at this time. One of those elite international women who took a doctorate at the prestigious University of Göttingen, despite the controversy over women in higher education in Germany, she was frustrated by the lack of academic openings for women. With few prospects at Cambridge or even in American universities and the Sorbonne, despite the increasing numbers of women taking mathematical options, Grace, now married to William Henry Young, a fellow mathematician at Cambridge, moved back with her young family to Göttingen. Although she was welcomed because of her great talents, it was now however as a wife who researched and, indeed, her ambitions and career were increasingly put to the service of her husband's. Jones very skilfully explores in depth the true nature of their working relationship. Despite Grace's belief in Francis Galton's eugenics, the superiority of men and the duty of women to be wife and mother first (although she had an army of relatives and servants looking after her six children), Jones disputes the usual stereotypical interpretations which easily assume Grace to have been the pupil of, then assistant to, William. Instead, she shows her to have been mentor to her husband and then his equal, if not his superior at times, in a partnership where they deliberately highlighted William's role so that he would gain remunerative appointments closed to Grace. This strategy, not unknown among women scientists and their husbands, challenges easy distinctions between 'career' women and submissive intellectual wives. While her husband pushed his career in Britain, from her base in Göttingen, Grace ensured the couple's expertise was up-to-date and their publications were accurate, built up important networks, wrote their papers, provided material and support for William's lectures and researched and developed significant ideas of her own. Jones argues that similar male partnerships in science have been recognised as being of equal, complementary talents, but gendered notions prevent this happening when partners are a male and female. This difficulty was enhanced in the complex case of the Youngs because of

their own eugenic views and William's ambitious, prickly personality.

Yet Grace's aim to prove the greatness of her husband fitted Göttingen, the 'shrine of pure thought' whose abstract mathematics was to revolutionise the discipline and whose mathematical men were seen as intellectual heroes epitomising a very special 'masculinity'. Grace and William helped channel such ideas to Cambridge reformers who excitedly hoped such a model would revitalise their mathematical examination and promoted pure mathematics as the new 'Queen of Science', creating tools for more practical and 'inferior' sciences. Jones depicts this as a reiteration of the romantic view of 'divine' genius combining 'masculine' rationality and 'feminine' intuition, but in a male body. Nevertheless, she argues that women were accepted into the mathematical community, including networks and societies, more easily than into science because of key differences in practice and culture between the two disciplines. Pure mathematics retained a strong tradition of amateur involvement and, despite its long characterization as being too abstract and rational for 'emotional' women, had a growing affinity with femininity in the late 19th century, especially when its elegance and beauty were stressed in opposition to 'robust, masculine science' (p. 171). Those who took the latter were increasingly contrasted with 'intellectual' women, involved in art, classics and other scholarly pursuits. It was experimental science which increasingly used metaphors of 'rugged, athletic manliness' which excluded women. Pure mathematics was promoted for its own sake and to develop mental cultivation, arguments which suited the women's cause in higher education, but, while elite women were welcome to swell the higher ranks of mathematicians, the very top, with its ideal of individual creativity and genius, was considered beyond their reach.

Hertha, in contrast, chose electrical engineering, one of the new disciplines aiming to erect a practical, utilitarian, 'manly' science. She studied at the recently-instituted Finsbury Technical College where she met and married Professor William Ayrton who thence became Professor at the new Central Institution at South Kensington (later a constituent part of Imperial College). Both institutions were vigorously masculine enterprises, challenging the elite 'masculinity' of pure mathematicians with their 'hands-on' mathematics and engineering. William and some of his engineering colleagues were supporters of the suffrage and of women participating in science, yet the ethos of the Central was masculine in its aim of producing practical men who could service both industry and empire in active, virile enterprises. The Ayrtons supported each other's independent work and strove for a true collaborative partnership, but Hertha, despite recognised ground-breaking research and inventions, could gain no independent professional position or even be termed an engineer. Her marginal status limited her potential to exploit her discoveries.

Hertha needed space for experiment. In the new professional world of experimental science, there was an enormous expanse of institutional laboratories but Jones's superb analysis shows how, in this period, these became defined as 'masculine' spaces and were portrayed as such in official images, scientists' descriptions, novels and biographies alike. Even those built at the women's colleges hardly broke down the notion that *research* laboratories were male spaces. Few women actually entered even the scarce shared facilities available. Jones argues cogently that this was because of the virulent representation of the laboratory as a dangerous place (as, indeed, it often was) suitable for the heroic endeavours of men, biologically and emotionally deemed more suitable for dispassionate intellectual labour. Unlike men in similar circumstances, both the dangers of Hertha's investigations and her inventiveness with primitive apparatus were either ignored or derided. Despite the warm support she received when she was researching at the Central, her achievements were not publicised as they did not promote the ideal of 'manly scientific citizenship' (p. 126), increasingly the image opposing elite mathematics even at Cambridge. Hertha's support of the militant Women's Social and Political Union (WSPU), her researches in a domestic space after the death of her husband lost her access to the Central's laboratories, together with her lack of ties to institutional laboratories and the Royal Society – scientific spaces from which she was excluded – all served to downplay her very real achievements and thus her results were suspected. Jones suggests that, possibly, so did her Jewish looks, a factor in Hertha's life of which Jones is always aware but careful not to over-play. She adds that especially after 1914 women increasingly did enter laboratories, wryly noting that their perceived suitability for patient, persevering work, including precise measurement, was now characterized as lowly science, although previously heralded as crucial to scientific practice when done by men.

The growth of higher education for women in Britain did mean that many more women entered higher-level mathematics. Indeed, although the figures were not large, just as in medicine they were at their highest proportionally at the turn of the century until again in the 1970s. Mathematics was most popular for women in Cambridge, but their highly-publicised successes did not give them much access to the fellowships and opportunities male wranglers automatically received. Their chief impact, indeed, was to cause changes in the examination process, including the abolition of the order of merit in 1909, leading to a more specialised part II of the Mathematical Tripos which, in fact, fewer men took since more now moved into the Natural Science Tripos. This had a higher mathematical component and became predominantly male, especially as women had so little preparation in applied mathematics or physics at school. Women were more numerous and more successful in natural history at the University of London, especially UCL and Royal Holloway.

Post-university opportunities for women to follow creative mathematical careers were very limited. Many became teachers for the new girls' schools, but although there was a growth of 'computing' jobs in research laboratories, observatories and businesses such as insurance, these were usually limited in number, badly paid and with little opportunity for promotion. Some scientific women published in *The Educational Times*, but most publications gave limited voice to women. Jones shows the situation to have been better in the USA, although some British women did attend the international congresses held from 1893.

At the same time, elite scientific and mathematical societies were very resistant to female membership. Many of the new scientific societies, wanting to attract a wide membership, were open to women and Hertha was active in some of these and even elected – on special terms – to the Institution of Electrical Engineers. Some older societies gave way in the 1900s, but the Royal Society and others defined themselves as superior *because* they did not admit women. Even at the London Mathematical Society where they were admitted, numbers were small and women were not given the same recognition, although some of them presented papers. Grace Young's work, for example, was often subsumed into that of her husband. Jones cleverly uncovers the multiple layers of conflict by giving a close and deep analysis of Hertha's highly publicised relationship with the Royal Society and its refusal to grant her membership, an important block on Hertha's research as well as standing. Counteracting former narratives which over-gild Hertha's achievements in this regard, she reveals that Hertha was one of a small, but important number of women appearing in Royal Society publications between 1880–1914; that, although she appears to have been the first woman both to speak in person at the Royal Society and to exhibit her apparatus, the former was only for ten minutes and the latter was at the annual 'Ladies Soiree', attended (as Dr Marie Stopes fulminated in 1914 in *The Times*)

by wives of scientists, not women who were scientists. Hertha won the Royal Society's Hughes Medal for originality in the physical sciences in 1906 but when the President, William Huggins, a bitter opponent of women's membership despite his collaboration with his wife Margaret, was away ill. Huggins fought to safeguard the Society against both amateurism (with which women were always associated) and 'commercialism', that is applied science tied up to commercial interests, but Hertha's nominators were all physical scientists, some connected to commercial interests. They were also modernisers, but the Royal Society, after bitter disputes, clung to its exclusively male history, language and rituals, using all-male meeting places to further male sociability and scientific patronage.

Jones's achievement is to prove how significant gender was in such infighting in science and how it related to changes within society. Hertha was a member of the WSPU, perceived by prominent scientists such as Huggins and Francis Galton, as displaying those emotional hysterics typical of women, thus proving that their reasoning was untrustworthy. The latter charge was increasingly made against Hertha in the 1900s, especially when her work on sand ripples solved problems which had baffled top male scientists with position, titles and standing. Resistance to her conclusions was not overcome until one of these endorsed her findings in 1915. Confidence in the trustworthiness of her work was exacerbated by the facts that she worked outside prestigious institutions and their apparatus, was not FRS and was ageing – this in a period when medical publications increasingly represented menopausal women as degenerating to the point of imbecility. Hertha's lack of success in getting her anti-gas fan accepted shows her marginalisation, especially after her supportive husband's death in 1908.

Hertha, herself, believed sex should not be brought into science: other women argued women did approach things differently but this was the reason why women should be included. The Royal Society did give limited recognition to women's work, but this left it in control as 'arbiter of excellence and gatekeeper of science' (p. 203). In 2009 5 per cent of its fellows were women.

Thus Jones reveals the pivotal role of gender in identity and status battles in both pure and practical mathematics. As she says, '[G]ender – femininity and masculinity – is not peripheral to the social history of science and mathematics, it is fundamental' (p. 7). Her book ostensibly is about 'femininity' rather than gender, although, as is necessary when analysing women in science, 'masculinity' is much debated too, a notion which Jones recognises needs to be understood in all disciplines. The period researched was one of intense scrutiny on suffrage, eugenic thinking and women's higher education. This depiction of the clash of older tradition of inherited genius in mathematics and of modern meritocratic, professional ideals of mathematics – arguments that were partly both class and 'hand and brain' based – shows that each had barriers for women.

There is a very good bibliography and further references in the excellent notes which include a wealth of interesting details on people mentioned in the text and on attitudes to women in science. Well structured and with useful tables, the way the book goes back and forth between Grace and Hertha keeps the contrast yet similarities of their lives consistently in view. This excellent, thought-provoking study will deepen the understanding of all interested in gender issues and in the conflicts in science and mathematics in this period.

## Notes

1. Margaret Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore, MD, 1984). [Back to \(1\)](#)
2. *Gender and Mathematics: an International Perspective*, ed. Leone Burton (London, 1990). [Back to \(2\)](#)

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