

Ayrton [*née* Marks], (Phoebe) Sarah [Hertha]

(1854–1923)

- Joan Mason
- <https://doi.org/10.1093/ref:odnb/37136>
- Published in print: 23 September 2004
- Published online: 23 September 2004
- This version: 23 September 2010

Ayrton [*née* Marks], (Phoebe) Sarah [Hertha] (1854–1923), electrical engineer and suffragist, was born Phoebe Sarah Marks on 28 April 1854 at 6 Queen Street, Portsea, Portsmouth, third child of Alice Theresa (*d.* 1898), seamstress, daughter of Joseph Moss, glass merchant of Portsea, and Levi Marks (*d.* 1861), watchmaker and jeweller of Petworth, Sussex. Levi Marks, whose father was a Polish innkeeper, came to England to escape pogroms; he died as his impoverished family, with six boys, was expecting another child. When Sarah was nine her aunts Marion Hartog and Belle Leo, who ran a school in north-west London with Alphonse Hartog, invited her to live with them to be educated with her cousins. Her mother generously agreed. Sarah learned languages and music in this talented family; her cousin Marcus introduced her to science, and Numa (the first Jewish senior wrangler) to mathematics. Sarah and her family mostly became agnostic, though proud of their Jewish heritage. At sixteen she began teaching in London to support her mother. With Otilie Blind, who called her Hertha after Swinburne (and the earth goddess Erda), she took the Cambridge University (local) examination for women. She was encouraged by her friends and patrons Barbara Bodichon, artist, women's activist, and co-founder of the new Girton College for women, and George Eliot. Marquis (Marky), as they called Sarah, with her curly black hair and grey-green eyes, was an exemplar for Mirah, heroine of *Daniel Deronda*, as Barbara Bodichon was for *Romola*.

Hertha read mathematics at Cambridge from 1877 to 1881, coached by Richard Glazebrook. While at Girton she constructed a sphygmomanometer (pulse recorder), led the choral society, founded the fire brigade, and with Charlotte Scott, Girton's first wrangler, formed a mathematical club. She published problems and solutions in *Mathematical Questions from the Educational Times* for almost two decades. After her return to London she earned money by teaching and embroidery. She ran a club for working girls and cared for her invalid sister. She invented a line divider, which was sold under her patent. In 1884 she went to Will Ayrton's evening classes in electricity at Finsbury Technical College.

Hertha and [William Edward Ayrton \(1847–1908\)](#) were married in 1885 and their daughter, Barbara, was born in 1886. Will Ayrton was an electrical engineer and co-founder of the City and Guilds Institute. His first wife, his cousin Matilda Chaplin (1846–1883), was a pioneer woman doctor, with his encouragement; their daughter Edith, who married Israel Zangwill, wrote novels as Edith Ayrton Zangwill; the Zangwills' son, Oliver, was professor of experimental psychology at Cambridge.

Hertha Ayrton lectured to women on electricity and its domestic potentialities. She took over Ayrton's experiments on the electric arc at South Kensington while he was at the Chicago Electrical Congress in 1893. She traced the hissing, sputtering, and instability to oxidation of the positive carbon. Excluding air, she obtained a steady arc, and demonstrated a linear relationship between arc length, pressure, and potential difference, the Ayrton equation. Observing the image on a screen, she showed that cratering, as the carbon evaporates, determines the potential for a given current and arc length, and improved efficiency by reshaping the electrodes.

Her analysis and technical advances, described in twelve papers in *The Electrician* (1895–6), established her reputation, unique for a woman. She demonstrated her experiments at the Royal Society's *Conversazione* in 1899, and spoke on 'The hissing of the electric arc' at the Institution of Electrical Engineers. The institution elected her a member, the only woman member until 1958. Her lecture 'L'intensité lumineuse de l'arc à courants continus' at the International Electrical Congress in Paris in 1900 helped Marcus Hartog persuade the British Association to allow women on to their committees. John Perry gave her paper on 'The mechanism of the electric arc' at the Royal Society in 1901. Her book *The Electric Arc* (1902), which became a standard work, included the history from Davy's discovery in 1800 (and a dedication to Barbara Bodichon). She later patented anti-aircraft searchlights, developed for the Admiralty, and arc lamp technology.

From 1901, when Will Ayrton was convalescing at the seaside in Margate, Kent, she studied the formation of sand ripples and sand bars by wave motions of the water, conducting experiments in the landlady's zinc bath, with soap dishes and baking tins. Back home, in her attic, she produced stationary waves of different wavelengths by rocking glass vessels 4 to 44 inches wide, using permanganate, paint, or metal powder to show eddies and vortices. She reported her work to the Royal Society in 1904 (in person), in 1908, and 1911, and to the British Association and the Physical Society. The mathematical description gave difficulty: it is now known to involve complicated viscous effects and (chaotic) turbulence. After Will Ayrton died in 1908 she moved her laboratory down to the drawing room, as shown in the photograph 'Mrs Ayrton in her Laboratory' (Appleyard, 167–8). Her interest in vortices in water and air inspired the Ayrton fan, or flapper, used in the trenches in the First World War to dispel poison gas. She fought for its acceptance and organized its production, over 100,000 being used on the western front.

In 1902 John Perry, with distinguished co-signatories, proposed her candidature for the Royal Society, but lawyers pronounced that a married woman, having no standing in law, was ineligible. Such arguments were quashed by the Sex Disqualification Removal Act (1919), but no woman was proposed again until 1944. In 1906, however, she was awarded the society's Hughes medal for her work on the electric arc and on sand ripples. In 1998 she remained the only female recipient of this medal, awarded annually for original discovery in the physical sciences. Armstrong's obituary in *Nature* exemplifies the opposition to such work by a woman, and elicited a rebuttal.

Hertha Ayrton, despite recurrent ill health, supported by her extended family, was a stalwart of the women's movement. She chaired the physical science section of the International Congress of Women in London in 1899, and encouraged women in applied science. She supported the militant suffragists, as did her friend Marie Curie, who brought her daughters for summer holidays with her in 1912 and 1913. Hertha marched in all the suffrage processions: in 1911, with 800 women graduates in academic dress (which Cambridge women could not wear until 1948), she was in the science section. In 1912–13 Mrs Pankhurst and others recovering from hunger strike were nursed in Hertha's home, returning to prison when they recovered, under the 'Cat and Mouse Act'—the Prisoners (Temporary Discharge for Ill-Health) Act of 1913. Hertha was 'very proud' when her daughter [Barbara Bodichon Ayrton Gould \(1886–1950\)](#) went to prison in 1912. Barbara became Labour member of parliament for Hendon North in 1945; her husband, Gerald Gould (*d.* 1936), was a poet and journalist; their son was the artist [Michael Ayrton \(1921–1975\)](#).

Hertha Ayrton helped found the International Federation of University Women in 1919 and the National Union of Scientific Workers in 1920. She died of blood poisoning (resulting from an insect bite) on 26 August 1923 at New Cottage, North Lancing, Sussex.

Sources

- DNB*
- E. Sharp, *Hertha Ayrton, 1854–1923: a memoir* (1926)
- K. T. Butler and H. I. McMorran, eds., *Girton College register, 1869–1946* (1948), 8–9
- J. Mason, 'Hertha Ayrton and the admission of women to the Royal Society of London', *Notes and Records of the Royal Society*, 45 (1991), 201–20
- Early days of the electrical industry, and other reminiscences of Alexander P. Trotter* (1948), 125–9
- R. Appleyard, *The history of the Institution of Electrical Engineers, 1871–1931* (1939), 167–8
- A. P. Trotter, 'Mrs. Ayrton's work on the electric arc', *Nature*, 113 (1924), 48–9
- H. Armstrong, *Nature*, 112 (1923), 800–01
- T. Mather, *Nature*, 112 (1923), 939 [rebuttal of Armstrong's obit.]
- private information (2004)
- b. cert.
- d. cert.

Archives

- Museum of Jewish Life, Golders Green, London, Steinberg Centre, Edith Chaplin Ayrton diaries

Likenesses

- H. Darmesteter, portrait, Girton Cam.
- photograph, repro. in Sharp, *Hertha Ayrton*, frontispiece
- photograph, repro. in Appleyard, *History of the Institution of Electrical Engineers*
- photographs, Girton Cam.

Wealth at Death

