Oxford Dictionary of National Biography

Heaviside, Oliver

(1850–1925)

- Bruce J. Hunt

- https://doi.org/10.1093/ref:odnb/33796
- **Published in print:** 23 September 2004
- **Published online:** 23 September 2004
- **This version:** 06 January 2011
- Previous version

Oliver Heaviside (1850–1925)

by Charles T. Heaviside, *c.* 1893

Institution of Electrical Engineers Archives Department

Heaviside, Oliver (1850–1925), physicist and electrical engineer, was born on 18 May 1850 at 55 King Street, Camden Town, London, the youngest of four sons of Thomas Heaviside (1813–1896), a wood-engraver from Stockton-on-Tees, and his wife, Rachel Elizabeth (1818–1894), the daughter of John Hook West of Taunton. In 1847 his mother's sister Emma had married Charles Wheatstone (1802–1875), one of the inventors of the telegraph, and through him both Oliver and his brother Arthur West Heaviside (1844–1923) were drawn into work on telegraphy. Although entirely self-taught, Heaviside became a leading authority on electromagnetic theory and

its applications to telegraph and telephone transmission. He also acquired a reputation as an eccentric, particularly in his later years. One of his closest friends, the Cambridge physicist G. F. C. Searle (1864–1954), described Heaviside as 'a first rate oddity' though, he felt compelled to add, 'never, at any time, a mental invalid' (Searle, Sketch, 96).

Early years

Heaviside's early years were pinched and difficult. His father, he later said, was 'a naturally passionate man, soured by disappointment, always whacking us, so it seemed'; his mother, formerly a governess, was 'similarly soured, by the worry of keeping a school' (Hunt, *Maxwellians*, 49–51). An early bout of scarlet fever left him nearly deaf and, though his hearing later improved, he developed a lifelong tendency to isolation and self-sufficiency. After starting at his mother's ‘dame-school’, he went to school in the High Street, St Pancras, and then to Camden House grammar school, where he came first in natural sciences in 1865. Further schooling was financially out of reach, however, and in 1867 he was sent north to Newcastle to join his brother Arthur in the telegraph business.

In 1868 Heaviside took a job as an operator on the Anglo-Danish cable, first at Fredericia in Denmark and later back in Newcastle. The newly laid cable was part of the burgeoning global telegraph network, and Heaviside's work on it exposed him to the most advanced electrical technology of the day. In 1873 he sent the *Philosophical Magazine* an exhaustive mathematical analysis of the sensitivity of the Wheatstone bridge, or electrical balance, that drew praise from both William Thomson (later Lord Kelvin; 1824–1907) and James Clerk Maxwell (1831–1879), the leading electrical physicists of the day. Wishing to devote himself wholly to scientific work, Heaviside ‘retired’ from the cable company in 1874. He never again held a regular job, but spent the next fifteen years living with his parents in London, working full time and in almost total isolation on electrical theory. These were lean years but happy ones, for, as Heaviside later recalled in a 1908 letter to Joseph Larmor, 'I was making discoveries. It matters not what others may think of their importance. They were meat and drink and company to me' (Hunt, *Maxwellians*, 61).

Independent research

Heaviside's main discoveries centred on telegraphic propagation and Maxwell's field theory. In 1854 Thomson had worked out a theory of signal transmission that treated the passage of a pulse of current as a case of simple diffusion. Although it gave a good account of how an initially sharp and clear signal was distorted *en route* by the joint action of resistance and capacitance, Thomson's theory was admittedly incomplete. In a series of

highly mathematical papers published between 1874 and 1881, Heaviside revised and extended it, showing in particular that the action of self-induction or 'electromagnetic inertia' could cause a pulse of current not simply to diffuse along a wire but to surge back and forth in a series of waves.

In the mid-1870s Heaviside began to study Maxwell's *Treatise on Electricity and Magnetism* (1873). He spent the rest of his career teasing out the implications of Maxwell's theory, which focused not on charges and currents themselves but on stresses and strains in the electromagnetic field around them. Heaviside's greatest advance came in 1884 when he found that, on Maxwell's theory, energy flows through the field along paths perpendicular to the lines of both electric and magnetic force. Although he later learned that J. H. Poynting (1852–1914) had hit on this result a few months earlier—along with its surprising consequence that energy does not flow along within an electrical wire, as everyone had always thought, but enters it sideways from the surrounding field—it was Heaviside who made it the key to revolutionizing the way Maxwell's theory was understood and expressed. Once he had found the energy flow theorem, Heaviside later declared, 'I did more in a week than in all the previous years' (O'Hara and Pricha, 67). Working back from the flow formula, he recast Maxwell's long list of fundamental electromagnetic relations into a compact and symmetrical set of four vector equations, now universally known as ‘Maxwell's equations’. He then used these equations to explicate the behaviour of electromagnetic waves, which had come to be recognized as the most distinctive feature of Maxwell's theory. Heaviside was by then publishing regularly in *The Electrician*, a weekly trade journal whose editor, C. H. W. Biggs, was his chief supporter. His new results appeared there in 1885 but initially drew little notice from other electrical theorists.

Heaviside's career reached a watershed in 1887, when he helped his brother Arthur, by then a prominent engineer in the Post Office telegraph system, write a paper on the new ‘bridge system’ of telephony. Applying his propagation theory to a circuit along which telephones were arranged in parallel, Heaviside found that the extra self-induction they introduced actually reduced the distortion signals suffered in passing along the line. Indeed, he showed that by loading a circuit with enough inductance and adjusting its other parameters, one could eliminate distortion altogether. Unfortunately, W. H. Preece (1834–1913), head of the Post Office telegraph engineers, had recently declared self-induction to be the great enemy of clear transmission. As Arthur's superior, Preece was able to block publication of the Heavisides' paper, and Oliver was convinced that Preece was also behind the abrupt removal of Biggs as editor of *The Electrician* in October 1887 and the subsequent cancellation of Heaviside's long-running series of articles. Heaviside developed an abiding bitterness towards Preece and peppered his later writings with sarcastic jibes at 'the eminent scienticulist'. Rebuffed by the engineers (or at least by Preece), Heaviside turned to the physicists, whom he soon found to be remarkably receptive. Late in 1887 he sent the *Philosophical Magazine* the first of a series of articles on electromagnetic waves. Its publication in February 1888 gained the attention of the Liverpool physicist Oliver Lodge (1851–1940), whose experiments on

lightning conductors would soon culminate in his detection of electromagnetic waves along wires. Struck by how thoroughly Heaviside had treated the theory of such waves, Lodge went out of his way in a London lecture to praise the 'singular insight' and 'masterly grasp of a most difficult theory' he had found in 'the eccentric, and in some respects repellent, writings of Mr Oliver Heaviside' (Hunt, *Maxwellians*, 149). The reservations about his style aside, Heaviside was delighted by the favourable notice Lodge's remarks stirred up. When the German physicist Heinrich Hertz's even more striking experiments on electromagnetic waves in air were announced to the British scientific public by G. F. FitzGerald (1851–1901) in September 1888, interest in Maxwell's theory, and particularly in Heaviside's writings, was raised to an even higher pitch. A final stamp of approval came in January 1889 when Thomson used his presidential address to the Institution of Electrical Engineers to praise Heaviside's transmission theory. After years on the fringes, Heaviside had suddenly been welcomed into the inner circle of electrical theorists. He soon struck up an active correspondence with Lodge and FitzGerald (both of whom visited him in London early in 1889), as well as with Hertz, and with them formed the core of the group known by contemporaries as the Maxwellians, who were to lead electrical theory over the next decade.

Mathematics and the 'Heaviside layer'

Heaviside was a slim, short man with fair hair and an impish sense of humour. He never married, and in 1889 moved with his parents to Devon, where they lived above his brother Charles's music shop in the seaside town of Paignton. He remained there until after his mother's death in 1894 and his father's in 1896. By then his scientific reputation and influence had risen greatly: he was elected a fellow of the Royal Society of London in 1891, his collected *Electrical Papers* were published in two volumes in 1892, and the first of the three volumes of his *Electromagnetic Theory* (1893–1912) appeared in the following year. His system of vector algebra was becoming standard (though only after a nasty fight with advocates of the rival quaternion system), and his set of Maxwell's equations was finding its way into textbooks. His 'operational calculus' for solving differential equations attracted a following among physicists and engineers, but pure mathematicians criticized the method as unrigorous and blocked the Royal Society from publishing one of his papers on the subject in 1894. Incensed, Heaviside launched caustic attacks on 'mathematicians of the Cambridge or conservatory kind, who look the gift-horse in the mouth and shake their heads with solemn smile' (*Electromagnetic Theory*, 1894, 2.12). *The Electrician* began publishing Heaviside's articles again in 1891 and, with a few gaps, carried one every few weeks until 1902. In an 1893 article he suggested that his idea of improving telephone transmission by loading lines with inductance might best be carried out by inserting coils at suitable intervals along the line. Such lumped loading eventually proved of enormous commercial value, but Heaviside never patented the idea and the profits went instead to Michael Pupin, who secured a United States patent in 1900, and to AT&T, which built an extensive network of loaded lines.

Heaviside's name became most widely known for an idea he mentioned as an aside in a 1902 *Encyclopaedia Britannica* article on telegraphy. The puzzling ability of radio waves to bend around the earth might be explained, he said, if there were a conducting layer in the upper atmosphere to act as a guide. After its existence was demonstrated experimentally in the 1920s, the ‘Heaviside layer’ became familiar to radio listeners around the world.

Declining years

Although he long lived in near poverty, Heaviside was too proud to accept repeated offers of charity from the Royal Society and others. In 1896 FitzGerald and the London engineer John Perry secured a civil-list pension for him of £120 per year—and, what was harder, persuaded him to accept it. (It was increased to £220 in 1914.) In 1897 he left Paignton and rented a house in nearby Newton Abbot. 'Behold a transformation!', he wrote to FitzGerald. 'The man “Ollie” of Paignton, who lives in the garrets at the music shop, is transformed into Mr Heaviside, the gentleman who has taken Bradley View' (Hunt, *Maxwellians*, 234). However, the situation soon soured; local boys harassed him, calling him names and throwing stones at his windows. He had long suffered from dyspepsia and what he called 'hot and cold disease', and being now left to cook and keep house for himself, his health declined further. After Heaviside suffered an especially serious illness in 1908, his brother Charles arranged for him to board with Mary Way, Charles's sister-in-law, at her Torquay home. Miss Way eventually sold the house to Heaviside and moved out, and from about 1916 until just before his death in 1925 he lived there alone. A local policeman, Henry Brock, helped tend to his affairs and Searle and other scientific friends paid occasional visits, but Heaviside grew increasingly isolated and eccentric. He published little after 1905 and almost nothing after the third volume of *Electromagnetic Theory* finally appeared in 1912. Later reports that he continued to produce important new work in his last years appear to be unfounded.

In 1922 Heaviside agreed to accept the Institution of Electrical Engineers' newly instituted Faraday medal. When the president of the institution, J. S. Highfield, went to Torquay to present the award, he found Heaviside to be 'fully competent' and still wittily acerbic, though filled with 'homely grumbles at the many defects of his neighbours' (Nahin, 293). After collapsing in his home early in January 1925 Heaviside agreed to enter the Mount Stuart Nursing Home, Torquay. His chronic health problems proved untreatable, and he died there on 3 February 1925. He was buried beside his parents in Paignton cemetery on 6 February 1925.

Sources

- P. J. Nahin, *Oliver Heaviside: sage in solitude* (1988)
  - Google Preview
  - WorldCat
- B. J. Hunt, *The Maxwellians* (1991)
  - Google Preview
  - WorldCat
- G. Lee, 'Oliver Heaviside—the man', *The Heaviside centenary volume* (1950), 10–17
  - Google Preview
  - WorldCat
- G. F. C. Searle, 'Oliver Heaviside: a personal sketch', *The Heaviside centenary volume* (1950), 93–6
  - Google Preview
  - WorldCat
- R. Appleyard, *Pioneers of electrical communication* (1930)
  - Google Preview
  - WorldCat
- J. G. O'Hara and W. Pricha, *Hertz and the Maxwellians* (1987)
  - Google Preview
  - WorldCat
- G. F. C. Searle, *Oliver Heaviside, the man*, ed. I. Catt (1987)
  - Google Preview
  - WorldCat
- I. Yavetz, *From obscurity to enigma: the work of Oliver Heaviside, 1872–1889* (1995)
  - Google Preview
  - WorldCat
- W. E. Sumpner, 'The work of Oliver Heaviside', *Journal of the Institution of Electrical Engineers*, 71 (1932), 837–51
  - Google Preview
  - WorldCat
- E. T. Whittaker, 'Oliver Heaviside', *Bulletin of the Calcutta Mathematical Society*, 20 (1928–9), 199–220
  - Google Preview
  - WorldCat
- D. W. Jordan, 'The adoption of self-induction by telephony, 1886–1889', *Annals of Science*, 39 (1982), 433–61
  - Google Preview
  - WorldCat

- B. J. Hunt, ‘Rigorous discipline: Oliver Heaviside versus the mathematicians’, *The literary structure of scientific argument: historical studies*, ed. P. Dear (1991), 72–95
  - Google Preview
  - WorldCat
- R. Appleyard, *The history of the Institution of Electrical Engineers, 1871–1931* (1939)
  - Google Preview
  - WorldCat
- A. Heather, *Oliver Heaviside: it's my genius that keeps me warm* (2008)
  - Google Preview
  - WorldCat
- B. Mahon, *Oliver Heaviside: maverick mastermind of electricity* (2009)
  - Google Preview
  - WorldCat

Archives

- Inst. ET, archives, corresp., and papers incl. notebooks
- RS, MSS

- CUL, corresp. with Lord Kelvin
- Deutsches Museum, Munich, letters to Heinrich Hertz

- ICL, corresp. with S. P. Thomson
- Inst. ET, archives, corresp. with John Somerville Highfield
- Royal Dublin Society, letters to G. F. Fitzgerald

- RS, corresp. with Joseph Larmor
- UCL, corresp. with Sir Oliver Lodge

Likenesses

- C. T. Heaviside, photographs, 1893, Inst. ET [see illus.]
- group portrait, photograph, 1893 (with his family), Inst. ET; repro. in Appleyard, *Pioneers*, 225
- F. Hodge, oils, 1945 (after photograph by C. T. Heaviside), Inst. ET; repro. in Lee, ‘Oliver Heaviside’, frontispiece
- photograph, Inst. ET

Wealth at Death

£1384 18*s*. 4*d*.: administration, 20 July 1925, *CGPLA Eng. & Wales*

View the article for this person in the Dictionary of National Biography archive edition.

More on this topic

- Heaviside, Oliver, (18 May 1850–4 Feb. 1925), mathematical physicist and electrician in Who Was Who

External resources

- Bibliography of British and Irish history
- National Archives