George Green | Encyclopedia.com

(*b*. Nottingham, England, July 1793 [baptized 14 July]; *d*. Sneinton, near Nottingham, 31 May 1841),

mathematics, natural philosophy.

Although Green left school at an early age to work in his father's bakery, he had probably already developed an interest in mathematics that was fostered by Robert Goodacre, the leading private schoolmaster of Nottingham and author of a popular arithmetic textbook. Virtually self-taught, Green acquired his knowledge of mathematics through extensive reading. Many of the works he studied were available in Nottingham at the Bromley House Subscription Library, which he joined in 1823. By that time the family had moved to Sneinton, a suburb, where his father had established a successful milling business; Green used the top story of the mill as a study.

Green's most important work. *An Essay on the Application of Mathematical Analysis to the Theories of Electricity and Magnetism*, was published by subscription in March 1828. Apparently, almost all of the fifty-two subscribers were patrons and friends of Green's; a local baronet, Edward ffrench Bromhead of Thurlby, assisted Green later but was not an early promoter. Until other evidence is available, one can only conjecture that Green's supporters included some of the leading members of the Bromley House Library; the list of subscribers suggests only limited circulation outside Nottingham.

In the preface Green indicated that his "limited sources of information" preventing his giving a proper histórical sketch of the mathematical theory of electricity, and indeed, he cites few sources. Among them are Cavendish's single-fluid theoretical study of electricity of 1771, two memoirs by Poisson of 1812 on surface electricity and three on magnetism (1821-1823), and contributions by Arago, Laplace, Fourier, Cauchy, and T. Young. The preface concludes with a request that the work be read with indulgence, in view of the limitations of the author's education.

The *Essay* begins with introductory observations emphasizing the central role of the potential function. Green coined the term "potential" to denote the results obtained by adding the masses of all the particles of a system, each divided by its distance from a given point. The general properties of the potential function are subsequently developed and applied to electricity and magnetism. The formula connecting surface and volume integrals, now known as Green's theorem, was introduced in the work, as was "Green's function," the concept now extensively used in the solution of partial differential equations.

Bromhead correctly surmised that Green's ''publication must be a complete failure and dead born, "but he was unaware that its significance would be appreciated later. Bromhead persuaded Green to matriculate at Caius College, Cambridge—a decision undoubtedly influenced by the death of Green's father in January 1829, for the subsequent sale of the family business afforded him the necessary financial backing. Before he could be admitted, however, he had to close the gaps in his classical education; but it is not known whether this was done at Nottingham, Cambridge, or both.

Green's second work, "The Laws of the Equilibrium of Fluids Analogous to the Electric Fluid," was read at the Cambridge Philosophical Society on 12 November 1832, so it is possible that he had already moved there. The paper was reportedly communicated by Bromhead, as was Green's next memoir. "Exterior and Interior Attractions of Ellipsoids of Variable Densities," read to the society the following May. Although not as significant as the Essay, both papers contain generalizations of his methods to cover an inverse *nth* power law of force and s dimensions.

Admitted to Caius College in October 1833, Green became scholar on 25 March 1834, after having submitted, again through Bromhead, a paper to the Royal Society of Edinburgh. In "Researches on the Vibration of Pendulums in Fluid Media," read in December 1833, Green obtained formulas, valid for small oscillations, for the effective increase of the mass of the pendulum due to the density of the surrounding fluid. In January 1837 Green received the B.A. as fourth wrangler—"to the disappointment of his friends. "His attention may perhaps have been distracted by the demands of his own mathematical research.

"On the Motion of Waves in a Variable Canal of Small Depth and Width,"read to the Cambridge Philosophical Society in May 1837, included the formula for determining the height of a wave,

where β and γ represent the variable breadth and depth of the canal. A note to the paper, read in February 1839, commented on J. S. Russell's report (1837) to the British Association for the Advancement of Science.

Two papers followed in December 1837: “On the Reflexion and Refraction of Sound” and “On the Reflexion and Refraction of Light at the Common Surface of Two Non-Crystallized Media“; a supplement to the latter work, in which both papers were related, followed in May 1839. The first memoir simplified —and in one respect corrected —Poisson’s memoir (1831); the second followed the work of Cauchy and Airy. In May 1839 Green read his second most important paper,” On the Propagation of Light in Crystallized Media,” in which he used the vis viva theorem (conservation of mechanical energy) to simplify Cauchy’s treatment.

This succession of works secured Green’s election in October 1839 as Perse Fellow of Caius College, although he apparently made no significant contribution to academic life. It is reported that he set the problem papers for two college examinations but never lectured. In May 1840 he was in Nottingham; and it is doubtful that Green ever returned to Cambridge. His will, dated 28 July 1840, was probably written at Nottingham and confirms that he was in poor health, but no details of his illness are given. A codicil, added four months before his death, is his last known action. A locally published obituary, referring to Bromhead’s support, concluded that” had his life been prolonged, he might have stood eminently high as a mathematician.”

Only a few weeks before Green’s death, William Thomson had been admitted to St. Peter’s College, Cambridge. In a paper by Robert Murphy published in the *Transactions of the Cambridge Philosophical Society*, Thomson noticed a reference to Green’s Essay, although Murphy did not mention any of his other works published in that journal. Thomson was unable to find a copy of the *Essay* until, just after receiving his degree in January 1845, his coach, William Hopkins, gave him three copies. Sixty years later Thomson recalled his excitement and that of Liouville and Sturm, to whom he showed the work in Paris in the summer of 1845. After returning to Cambridge, Thomson was responsible for republishing the work, with an introduction (1850- 1854). Through Thomson, Maxwell, and others, the general mathematical theory of potential developed by an obscure, selftaught miller’s son would lead to the mathematical théories of electricity underlying twentieth-century industry.

BIBLIOGRAPHY

I. Original Works*An Essay on the Application of Mathematical Analysis to the Theories of Electricity and Magnetism* (Nottingham, 1828) is extremely rare; the total number of copies is estimated to have been less than 100. There are two facsimile reprints (Berlin, 1889); Göteborg, 1958 and a German trans. In *Ostwalds Klassiker der exakten Wissenschaften*, no. 61 (Leipzig, 1895). Thomson republished the *Essay,* with a brief biography of Green, a list of his writings, and a bibliography of eight “independent investigations on the subject of Green’s *Essay*,” in *Journal für die renie und sngewandte Mathematik*,**39** (1850), 73-89; **44** (1852), 356-374; and **47** (1854), 161-221.

All but one of Green’s subsequent writings were published in *Transactions of the Cambridge Philosophical Society*,**5-7** (1835-1842). Together with the *Essay,* they were edited for Caius College by N. M. Ferrers (London-Cambridge, 1871; facs. repr., Paris, 1903). The preface includes a brief biography that is chiefly a sketch of the contents of the papers; a few notes on particular points in them are collected in an appendix.

II. Secondary LiteratureThe above account is based largely on H. G. Green, “A Biography of George Green,” in *Studies and Essays… Offered in Homage to George Sarton* (New York, 1946), 545-594, which includes a complete bibliography. Adam W. Thomas, *A History of Nottingham High School 1513-1953* (Nottingham, 1958), is useful for Green’s educational background; and A. R. Hall, *The Cambridge Philosophical Society: A History, 1819-1969* (Cambridge, 1969), provides details of the Society in whose *Transactions* most of Green’s work was published. H. G. Green (see above) reveals the importance of the Bromley House Library in providing facilities for the young mathematician; and John Russell, *A History of the Nottingham Subscription Library* (Nottingham, 1916), ch. **5,** indicates its keen interest in science in the 1830’s. See also J. E. G. Farina, “The Work and Significance of George Green, the Miller-Mathematician, 1793-1841,” in *Bulletin of the Institute of Mathematics and Applications*,**12,** no. 4 (1976), 98-105.

J. S. Russell’s report was published as “Report of the Committee on Waves,” in *Report of the British Association for the Advancement of Science*,**7** (1837), 417-496-see esp. 425 and 494; Poisson’s memoir was” Sur le mouvement de deux fluides èlastiques superposes,” in *Mémories de l’Académie des sciences*,2nd ser., **10** (1831), 317-404.

P. J. Wallis