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978-0-521-25627-8 — The Scientific Letters and Papers of James Clerk Maxwell
Volume 3: 1874–1879
James Clerk Maxwell , Edited by P. M. Harman
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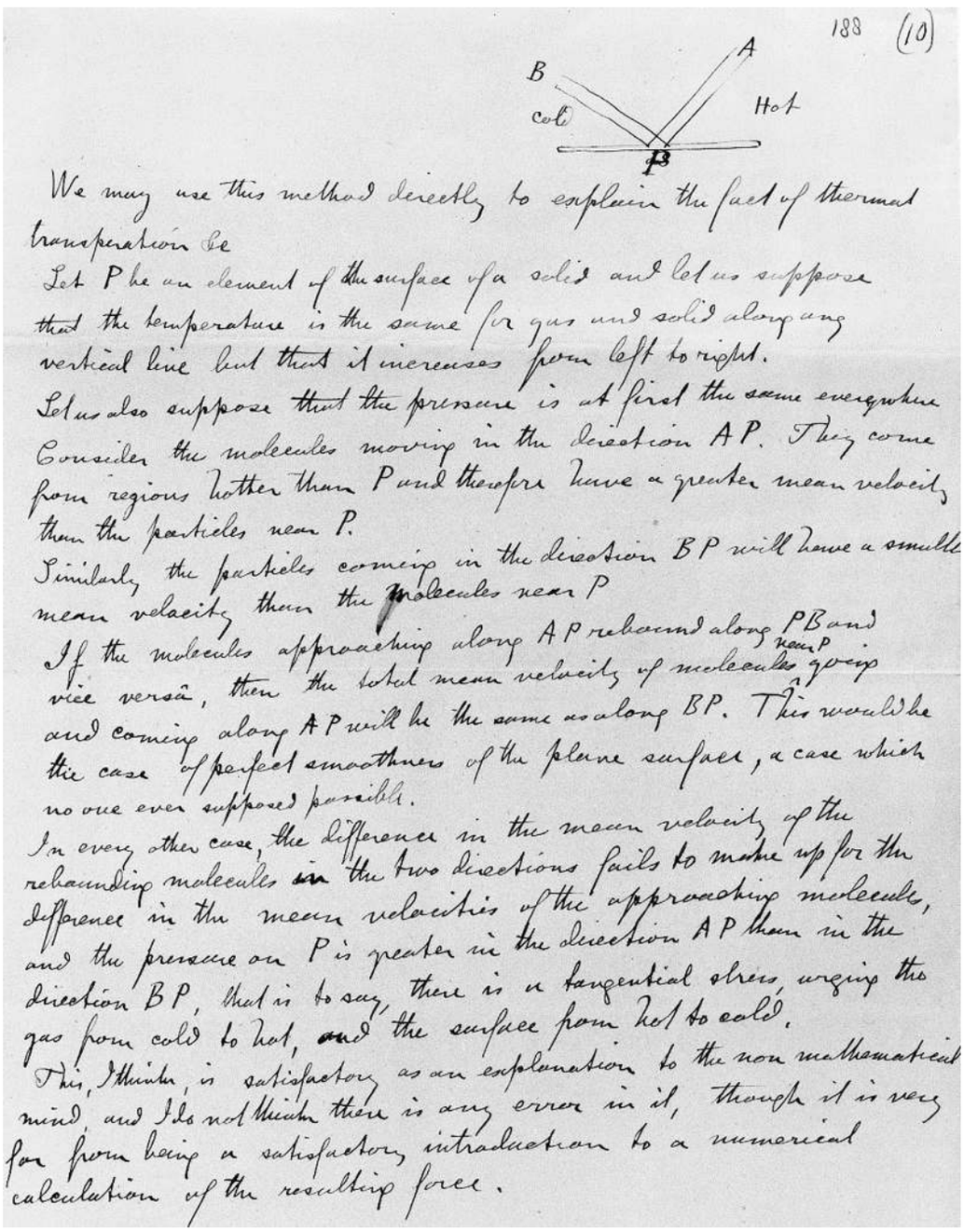
More Information

The final volume of James Clerk Maxwell's correspondence and manuscript papers begins in 1874, with the formal inauguration of the Cavendish Laboratory at Cambridge, and concludes with his death on 5 November 1879 at the age of forty-eight. In this period his main effort was given to the direction of the Cavendish Laboratory; to his duties as a Cambridge professor; to his work as author and reviewer, for the ninth edition of the *Encyclopaedia Britannica*, and in editing *The Electrical Researches of Cavendish*; and to writing reports on papers submitted for publication in the Royal Society's *Philosophical Transactions*. While his time was directed towards public duties, his letters show his continuing commitment as a natural philosopher, apparent in his response to innovations in physical theory (by Boltzmann, Gibbs, Lorentz and van der Waals), and in his expansion of the scope of his work on statistical physics and the kinetic theory of gases. His correspondence shows his influence on the younger generation of physicists whose outlook was shaped by his own style of physical theorising: the emergent Maxwellian physics. This edition is annotated with a full historical commentary.

THE SCIENTIFIC LETTERS AND PAPERS OF JAMES CLERK MAXWELL



We may use this method directly to explain the fact of thermal transperation &c

Let P be an element of the surface of a solid and let us suppose that the temperature is the same for gas and solid along any vertical line but that it increases from left to right.

Let us also suppose that the pressure is at first the same everywhere

Consider the molecules moving in the direction AP. They come from regions hotter than P and therefore have a greater mean velocity than the particles near P.

Similarly the particles coming in the direction BP will have a smaller mean velocity than the molecules near P

If the molecules approaching along AP rebound along PB and vice versâ, then the total mean velocity of molecules going near P and coming along AP will be the same as along BP. This would be the case of perfect smoothness of the plane surface, a case which no one ever supposed possible.

In every other case, the difference in the mean velocity of the rebounding molecules in the two directions fails to make up for the difference in the mean velocities of the approaching molecules, and the pressure on P is greater in the direction AP than in the direction BP, that is to say, there is a tangential stress, urging the gas from cold to hot, and the surface from hot to cold.

This, I think, is satisfactory as an explanation to the non mathematical mind, and I do not think there is any error in it, though it is very far from being a satisfactory introduction to a numerical calculation of the resulting force.

On gas-surface interactions, and the radiometer. From Maxwell's report on a paper by Osborne Reynolds, 28 March 1879 (Number 736).

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VOLUME III
1874–1879

EDITED BY

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For Rosie

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PREFACE

This third and final volume of James Clerk Maxwell's scientific letters and manuscript papers documents the period of his direction of the Cavendish Laboratory in Cambridge, and concludes with his death on 5 November 1879. While much of his effort was given to public duties, the documents reproduced here show that his commitment as a natural philosopher was not thwarted during this final period of his life. This volume prints all Maxwell's extant letters from the period 1874–9. Letters he received from his major correspondents George Gabriel Stokes, Peter Guthrie Tait, William Thomson (later Lord Kelvin) and George Chrystal are reproduced; letters from other correspondents are printed selectively; and third-party correspondence is included.

This final volume of the edition includes a Supplement. The major source for these additional documents is a microfilm copy of holograph Maxwell manuscripts. I am immensely grateful to Edward Daub (Madison, Wisconsin) for his effort and his generosity in giving me his personal copy of the microfilm, which was supplied to him in the 1960s by Edinburgh University Library; but there is no archival record of the manuscripts. The microfilm, missing from the archive, has now been deposited in Special Collections, Edinburgh University Library.

In bringing the edition to a conclusion it is a pleasure to thank friends and colleagues who have fostered this work. Ted McGuire first encouraged my interest in Maxwell; Richard Ziemacki fostered the publication and completion of this edition; Tom Whiteside, Martin Klein and Robert Fox stiffened my resolve; Alan Shapiro, Dan Siegel, David Wilson and the late Tom Fuller gave advice on points of scholarship; Charles Webster and Ivor Grattan-Guinness generously gave books; Sir Brian Pippard, Sir Alan Cook and Malcolm Longair helped sustain my work by their interest; Bernard Cohen, Erwin Hiebert, Bashi Sabra and Sam Schweber gave warm encouragement. For information bearing on this final volume I thank Ken Caneva, the late Donald Cardwell, Olivier Darrigol, Francis Everitt, David Forfar, Kostas Gavroglu, Rosie Harman, Lord Jenkin of Roding, W. T. Johnston, Dong-Won Kim, Anne Kox, Henk de Regt, the late David Sealey, Thomas Simpson, the Hon. Guy Strutt, Andrew Warwick, Malcolm Willcock and L. Pearce Williams.

I have benefited from the ready help of archivists and librarians in many libraries, and wish to acknowledge their assistance and courtesy. Much of the work on this edition has been carried out in the Cambridge University Library,

and I thank especially A. E. B. Owen (who first introduced me to the collection of Maxwell manuscripts held by the Library) and Godfrey Waller and his colleagues in the Manuscripts Room for their kindness and efficiency.

For permission to reproduce manuscripts I am grateful to Lord Rayleigh; Sir John Clerk, Bart; the late Miss Margaret Tait; the Syndics of the Cambridge University Library; the President and Council of the Royal Society; the Master and Fellows of Trinity College, Cambridge; the Master and Fellows of Peterhouse, Cambridge; the Cavendish Laboratory, Cambridge; the Cambridge Observatory; Oxford University Press; the Archives, Royal Observatory, Edinburgh; Edinburgh University Library; the National Library of Scotland; St Andrews University Library; the Board of Trustees of the Royal Botanic Gardens, Kew; the British Library; the Royal Institution; the Public Record Office; the University of London Library and the Athenaeum; University College London Library; the University of Manchester Institute of Science and Technology; the Royal Dublin Society; The Queen's University of Belfast Library and the Department of Physics; The Johns Hopkins University Library; the Dibner Library, Smithsonian Institution Libraries; Yale University Library; the Manuscript Division of the Library of Congress; the Akademie-Archiv, Berlin; the Staatsbibliothek Preussische Kulturbesitz, Berlin; and the Niedersächsische Staats-und Universitätsbibliothek, Göttingen.

For permission to reproduce photographs of documents and apparatus I am grateful to the Syndics of the Cambridge University Library, the Cavendish Laboratory, the President and Council of the Royal Society, The Queen's University of Belfast Library and the Department of Physics and the Whipple Museum of the History of Science, University of Cambridge.

The edition owes much to the support of the Cambridge University Press. I thank the Syndics of the Press for undertaking the publication of such a large work, and the editors, production staff, draughtsmen and typesetters, whose effort has resulted in the publication of the edition in such an elegant form. I am grateful to Isabel Matthews for assistance in drawing the figures and Keith Papworth for his help with photographs. It is a pleasure to thank the President and Fellows of Clare Hall, Cambridge for offering hospitality during my numerous and lengthy visits to Cambridge. I am especially grateful to the President and Council of the Royal Society for awarding me a succession of research grants, and to the Arts and Humanities Research Board for a research leave award which enabled me to bring this project to a conclusion.

To end on a very personal note, my deepest thanks are to Juliet, Tim and Rosie who have lived with this work for the past twenty years.

LIST OF TEXTS

EDITORIAL NOTE

The terms of reference of this edition of Maxwell's scientific letters and papers are described in the General introduction and Editorial note to the first volume. Maxwell's extant autograph letters and papers are supplemented by documents drawn from the *Life of Maxwell*, and by his shorter publications – letters, reviews, abstracts of published papers and contributions to discussions – which were omitted from the memorial edition of his *Scientific Papers* published by Cambridge University Press in 1890. The texts are reproduced in chronological sequence, so far as can be determined. In the case of postcards, where there is generally no date written by Maxwell, the convention is adopted (in the absence of any other evidence) of dating the cards by their postmarks. In the case of published papers, either the date of receipt or presentation is cited.

The primary intention of this edition is the reproduction of an accurate text of all Maxwell's scientific letters and substantive manuscript papers. Manuscript fragments and jottings have been included on a selective basis. Letters addressed to Maxwell are listed in the Appendix. Many of these letters, notably those from his major correspondents, are printed *in extenso*; other letters are reproduced in extract; and some are merely cited, as judged appropriate. Third-party letters and other documents containing information bearing on Maxwell's career and writings are included, generally in selective extract.

In accordance with the principles of modern scholarship the reproduction of the texts faithfully follows the manuscripts; endpoints to sentences have been silently inserted. Where a text is reproduced from a printed source the style of the original is followed. Trivial cancellations have been omitted without comment, but corrections deemed significant have been recorded. Minor deletions are placed within angle brackets ⟨. . .⟩ preceding the revised text; longer cancelled passages are reproduced by setting a double vertical bar against them in the left-hand margin. Appended passages are reproduced with a single vertical bar in the left-hand margin; appended phrases by corners ⌊. . .⌋ which enclose the added words. Annotations which were subsequently appended by Maxwell or by his correspondents are recorded; the name enclosed by brackets {. . . } denotes the annotator. The very few editorial insertions to the texts, introduced for the sake of clarity, are enclosed within square brackets.

The layout of the manuscripts has been preserved in their transformation to the printed page, but some adjustments have been made for reasons of clarity.

This applies especially to the reproduction of Maxwell's figures, most of which are rough sketches. The aim has been to elucidate Maxwell's intentions as determined by study of both the figures and the corresponding texts. The aim has been clarity rather than the precise reproduction of the originals. Figure numbers have been added; the captions are Maxwell's. In printing documents in the editorial annotations, the convention is adopted of marking paragraph divisions and lines of poetry by a solidus.

The editorial commentary – the historical and textual notes and the Introduction – is intended to aid the reader in following Maxwell's arguments and his allusions to concepts, events, personalities and publications. The Introduction gives a broad account of his scientific and literary work in the period covered by this volume, and provides an outline review of the texts here reproduced. In addition to clarifying obscurities in the texts, the historical notes seek to establish the context within which the documents were written. Some manuscripts reproduced here already form part of the historical record, by publication in Knott's *Life of Tait* and Larmor's *Memoir and Correspondence of Stokes*; this has been noted. Reference to the first two volumes of the edition is made in the form Volume I: 438, meaning Volume I: [page 438].

LIST OF PLATES

ABBREVIATED REFERENCES

Ann. Chim. Phys.	*Annales de Chimie et de Physique* (Paris).
Ann. Phys.	*Annalen der Physik und Chemie* (Leipzig).
Boase	*Modern English Biography containing Many Thousand Concise Memoirs of Persons who have Died since the Year 1850*. By Frederic Boase, 3 vols. and supplement (3 vols.) (Truro, 1892–1921).
Camb. & Dubl. Math. J.	*Cambridge and Dublin Mathematical Journal* (Cambridge).
Comptes Rendus	*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences* (Paris).
DNB	*Dictionary of National Biography*. Ed. L. Stephen and S. Lee, 63 vols. and 2 supplements (6 vols.) (London, 1885–1912).
The Electrical Researches of Cavendish	*The Electrical Researches of the Honourable Henry Cavendish, F. R. S. Written between 1771 and 1781, Edited from the Original Manuscripts in the Possession of The Duke of Devonshire, K. G., by J. Clerk Maxwell, F. R. S.* Edited for the Syndics of the University Press (Cambridge, 1879).
Electrostatics and Magnetism	William Thomson, *Reprint of Papers on Electrostatics and Magnetism* (London, 1872).
Knott, *Life of Tait*	Cargill Gilston Knott, *Life and Scientific Work of Peter Guthrie Tait. Supplementing the two Volumes of Scientific Papers Published in 1898 and 1900* (Cambridge, 1911).
Larmor, *Correspondence*	*Memoir and Scientific Correspondence of the Late Sir George Gabriel Stokes, Bart.* Ed. J. Larmor, 2 vols. (Cambridge, 1907).
Larmor, 'Origins'	'The origins of Clerk Maxwell's electric ideas, as described in familiar letters to W. Thomson'. Communicated by Sir Joseph Larmor, in *Proc. Camb. Phil. Soc.*, **32** (1936): 695–750. Reprinted separately (Cambridge, 1937).
Life of Maxwell	Lewis Campbell and William Garnett, *The Life of James Clerk Maxwell. With a Selection from his Correspondence and Occasional Writings and a Sketch of his Contributions to Science* (London, 1882).
Life of Maxwell (2nd edn)	Lewis Campbell and William Garnett, *The Life of James Clerk Maxwell with Selections from his Correspondence and Occasional Writings*, new edition, abridged and revised (London, 1884).
Math. & Phys. Papers	William Thomson, *Mathematical and Physical Papers*, 6 vols. (Cambridge, 1882–1911).
OED	*The Oxford English Dictionary*, 12 vols. (Oxford, 1970).
Phil. Mag.	*Philosophical Magazine* (London).
Phil. Trans.	*Philosophical Transactions of the Royal Society of London* (London).

Proc. Camb. Phil. Soc.	*Proceedings of the Cambridge Philosophical Society* (Cambridge).
Proc. Roy. Soc.	*Proceedings of the Royal Society of London* (London).
Proc. Roy. Soc. Edinb.	*Proceedings of the Royal Society of Edinburgh* (Edinburgh).
Scientific Papers	*The Scientific Papers of James Clerk Maxwell*. Ed. W. D. Niven, 2 vols. (Cambridge, 1890).
Trans. Camb. Phil. Soc.	*Transactions of the Cambridge Philosophical Society* (Cambridge).
Trans. Roy. Soc. Edinb.	*Transactions of the Royal Society of Edinburgh* (Edinburgh).
Treatise	James Clerk Maxwell, *A Treatise on Electricity and Magnetism*, 2 vols. (Oxford, 1873).
Treatise (2nd edn)	James Clerk Maxwell, *A Treatise on Electricity and Magnetism*. Second edition, ed. W. D. Niven, 2 vols. (Oxford, 1881).
ULC	Manuscripts in the University Library, Cambridge.
Venn	*Alumni Cantabrigienses. A Biographical List of all Known Students, Graduates and Holders of Office at the University of Cambridge, from the Earliest Times to 1900*. Compiled by J. A. Venn. Part II. From 1752 to 1900, 6 vols. (Cambridge, 1940–54).
Wiener Berichte	*Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften* (Vienna).
Wilson, *Stokes–Kelvin Correspondence*	*The Correspondence between Sir George Gabriel Stokes and Sir William Thomson, Baron Kelvin of Largs*. Edited with an introduction by David B. Wilson, 2 vols. (Cambridge, 1990).