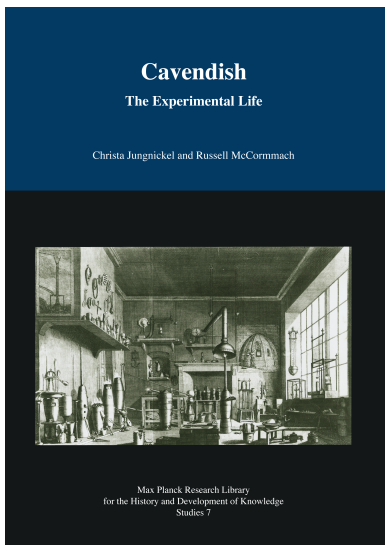


Max Planck Research Library for the History and Development of Knowledge

Studies 7

Christa Jungnickel and Russell McCormach:

Preface and Acknowledgements



In: Christa Jungnickel and Russell McCormach: *Cavendish : The Experimental Life (Second revised edition 2016)*

Online version at <http://edition-open-access.de/studies/7/>

ISBN 978-3-945561-06-5

First published 2016 by Edition Open Access, Max Planck Institute for the History of Science under Creative Commons by-nc-sa 3.0 Germany Licence.

<http://creativecommons.org/licenses/by-nc-sa/3.0/de/>

Printed and distributed by:

PRO BUSINESS digital printing Deutschland GmbH, Berlin

<http://www.book-on-demand.de/shop/14971>

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>

Cavendish
The Experimental Life

Revised Second Edition

Max Planck Research Library for the History and Development of Knowledge

Series Editors

Ian T. Baldwin, Gerd Graßhoff, Jürgen Renn, Dagmar Schäfer,
Robert Schlögl, Bernard F. Schutz

Edition Open Access Development Team

Lindy Divarci, Georg Pflanz, Klaus Thoden, Dirk Wintergrün.

The Edition Open Access (EOA) platform was founded to bring together publication initiatives seeking to disseminate the results of scholarly work in a format that combines traditional publications with the digital medium. It currently hosts the open-access publications of the “Max Planck Research Library for the History and Development of Knowledge” (MPRL) and “Edition Open Sources” (EOS). EOA is open to host other open access initiatives similar in conception and spirit, in accordance with the *Berlin Declaration on Open Access to Knowledge* in the sciences and humanities, which was launched by the Max Planck Society in 2003.

By combining the advantages of traditional publications and the digital medium, the platform offers a new way of publishing research and of studying historical topics or current issues in relation to primary materials that are otherwise not easily available. The volumes are available both as printed books and as online open access publications. They are directed at scholars and students of various disciplines, and at a broader public interested in how science shapes our world.

Cavendish
The Experimental Life

Revised Second Edition

Christa Jungnickel and Russell McCormach

Studies 7

Communicated by Jed Z. Buchwald

Editorial Team: Lindy Divarci, Georg Pflanz, Bendix Düker, Caroline Frank, Beatrice Hermann, Beatrice Hilke

Image Processing: Digitization Group of the Max Planck Institute for the History of Science

Cover Image: Chemical Laboratory. This idealized laboratory with metallurgical furnaces is from William Lewis, *Commercium Philosophico-Technicum* (London, 1756). Courtesy of Smith Image Collection, Van Pelt Dietrich Library, University of Pennsylvania.

ISBN 978-3-945561-06-5

Original edition published in 1999 by Bucknell University Press.

Revised second edition first published in 2016 by Edition Open Access.

Max Planck Institute for the History of Science

<http://www.edition-open-access.de>

Printed and distributed by

PRO BUSINESS digital printing Deutschland GmbH, Berlin

Published under Creative Commons by-nc-sa 3.0 Germany Licence

<http://creativecommons.org/licenses/by-nc-sa/3.0/de/>

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

Max Planck Research Library for the History and Development of Knowledge

The Max Planck Research Library for the History and Development of Knowledge comprises the subseries, Studies, Proceedings and Textbooks. They present original scientific work submitted under the scholarly responsibility of members of the Scientific Board and their academic peers. The initiative is currently supported by research departments of three Max Planck Institutes: the MPI for the History of Science, the Fritz Haber Institute of the MPG and the MPI for Gravitational Physics (Albert Einstein Institute). The publications of the Studies series are dedicated to key subjects in the history and development of knowledge, bringing together perspectives from different fields and combining source-based empirical research with theoretically guided approaches. The Proceedings series presents the results of scientific meetings on current issues and supports, at the same time, further cooperation on these issues by offering an electronic platform with further resources and the possibility for comments and interactions.

Scientific Board

Markus Antonietti, Antonio Becchi, Fabio Bevilacqua, William G. Boltz, Jens Braarvik, Horst Bredekamp, Jed Z. Buchwald, Olivier Darrigol, Thomas Duve, Mike Edmunds, Fynn Ole Engler, Robert K. Englund, Mordechai Feingold, Rivka Feldhay, Gideon Freudenthal, Paolo Galluzzi, Kostas Gavroglu, Mark Geller, Domenico Giulini, Günther Görz, Gerd Graßhoff, James Hough, Manfred Laubichler, Glenn Most, Klaus Müllen, Pier Daniele Napolitani, Alessandro Nova, Hermann Parzinger, Dan Potts, Sabine Schmidtke, Circe Silva da Silva, Ana Simões, Dieter Stein, Richard Stephenson, Mark Stitt, Noel M. Swerdlow, Liba Taub, Martin Vingron, Scott Walter, Norton Wise, Gerhard Wolf, Rüdiger Wolfrum, Gereon Wolters, Zhang Baichun.

for
Robert Deltete
and
Marvin Sparks

Nothing is more fantastic, ultimately, than precision.
– Robbe-Grillet on Kafka

Contents

| | | |
|----------|---|-----|
| | List of Illustrations | 5 |
| | Preface and Acknowledgements | 9 |
| | Introduction: The Problem of Cavendish | 11 |
| | Part I: Lord Charles Cavendish | 21 |
| 1 | The Dukes | 23 |
| | Kent | 24 |
| | Devonshire | 27 |
| 2 | Politics | 37 |
| | Early Years and Education | 37 |
| | House of Commons | 43 |
| | Gentleman of the Bedchamber | 47 |
| 3 | Science | 49 |
| | De Moivre Circle | 49 |
| | Royal Society | 54 |
| 4 | Family and Friends | 61 |
| | Marriage and Money | 61 |
| | Family of the Greys | 67 |
| | Great Marlborough Street | 68 |
| | Friends and Colleagues | 70 |
| | Relatives | 80 |
| | Holker Hall | 84 |
| 5 | Public Activities | 95 |
| | Public Life | 95 |
| | Scientific Administration | 106 |
| | Science | 110 |
| | Part II: The Honorable Henry Cavendish | 121 |
| 6 | Education of Henry Cavendish | 123 |
| | Hackney Academy | 123 |
| | Peterhouse, Cambridge | 125 |
| | Learning Science | 131 |

| | | |
|-----------|--|-----|
| | Giardini Academy | 144 |
| 7 | Science | 147 |
| | Introduction to Scientific Society | 148 |
| | Science at the Royal Society | 152 |
| 8 | Early Researches | 167 |
| | Cavendish's Correspondent | 167 |
| | Chemistry | 170 |
| | Arsenic | 174 |
| | Factitious Air | 178 |
| | Instruments and Meteorology | 187 |
| 9 | Electricity | 201 |
| | Mathematics and Theory | 201 |
| | Electrical Theory | 206 |
| | Experiments on Capacity | 214 |
| | Conduction | 227 |
| | The Work | 238 |
| 10 | Learned Organizations | 241 |
| | Royal Society | 241 |
| | British Museum | 256 |
| | Society of Antiquaries | 257 |
| 11 | Places | 261 |
| | Leaving Home | 263 |
| | Bedford Square | 267 |
| | Library | 272 |
| | Clapham Common | 276 |
| | Land Developer | 287 |
| | Man of Property | 290 |
| | Places and Precision | 295 |
| 12 | Associates | 301 |
| | Charles Blagden | 301 |
| | Clubs | 309 |
| 13 | Politics | 315 |
| | Royal Society | 315 |
| | Nation | 327 |
| 14 | Air and Water | 329 |
| | Good Air | 329 |
| | Water | 339 |
| | Nitrous Acid | 343 |
| | Atmosphere | 345 |

| | | |
|-----------|---|-----|
| | New Chemistry | 347 |
| | Water Controversy | 356 |
| | Keeping up with Chemistry | 359 |
| | Theory | 361 |
| | Exactitude | 373 |
| 15 | Mercury | 381 |
| | Specific and Latent Heats | 381 |
| | Cold | 390 |
| | Heat | 396 |
| | The Natural Philosopher | 411 |
| | Workplace | 415 |
| 16 | Earth | 421 |
| | Philosophical Tours in Britain | 421 |
| | Weighing the World | 435 |
| | The Cavendish Experiment | 443 |
| 17 | Last Years | 445 |
| | Clapham Common | 445 |
| | Banks, Blagden, and Cavendish | 447 |
| | The Duchess and the Philosopher | 451 |
| | Unpublished Work | 453 |
| | Published Work | 463 |
| | Reasons for Not Publishing | 469 |
| | Coinage of the Realm | 471 |
| | Royal Institution | 477 |
| | Institute of France | 481 |
| | Wealth | 481 |
| | Religion | 488 |
| | The End | 489 |
| 18 | Cavendish | 501 |
| | Early Interpretation | 502 |
| | Normality and Eccentricity | 506 |
| | Autism | 513 |
| | Eccentricity, Autism, and Other Explanations | 517 |
| | How Do We Decide? | 521 |
| | Appendix I: Family Trees | 525 |
| | Cavendish and Grey Family Trees | 525 |
| | Appendix II: Chronology and Publications | 531 |
| | Henry Cavendish's Chronology and Publications | 531 |
| | List of Abbreviations | 533 |

| | |
|----------------------------|-----|
| Archives | 535 |
| Bibliography | 537 |
| Subject Index | 562 |
| Name Index | 567 |

List of Illustrations

- 1.1 Henry de Grey, Duke of Kent
- 1.2 Jemima (Crewe), Duchess of Kent
- 1.3 Kents
- 1.4 Wrest House and Park
- 1.5 Wrest Park
- 1.6 Chatsworth House and Gardens
- 1.7 Chatsworth House
- 1.8 William Cavendish, Second Duke of Devonshire
- 1.9 Rachel (Russell), Duchess of Devonshire
- 2.1 House of Commons
- 3.1 Abraham de Moivre
- 4.1 Lord Charles Cavendish
- 4.2 Lady Anne de Grey
- 4.3 The Honorable Henry Cavendish
- 4.4 No. 13 Great Marlborough Street House
- 4.5 Map of Great Marlborough Street
- 4.6 Thomas Birch
- 4.7 William Watson
- 4.8 William Heberden
- 5.1 Royal Society
- 5.2 Foundling Hospital
- 5.3 British Museum. Entrance
- 5.4 British Museum. Staircase
- 5.5 The Building of Westminster Bridge
- 5.6 Westminster Bridge
- 5.7 James Bradley
- 5.8 Charles Cavendish's Thermometers
- 6.1 Hackney
- 6.2 Peterhouse, Cambridge
- 6.3 Sir Isaac Newton
- 8.1 Chemical Laboratory
- 8.2 Chemical Laboratory
- 8.3 Factitious Air Apparatus
- 8.4 Register Thermometer
- 8.5 Apparatus for Adjusting the Boiling Point
- 8.6 Variation Needle
- 8.7 Dipping Needle
- 9.1 Mathematical Instruments 1
- 9.2 Mathematical Instruments 2

- 9.3 Mathematical Drawings
- 9.4 Electrical Machine
- 9.5 Battery of Leiden Jars
- 9.6 Cork-Ball Electrometer
- 9.7 Apparatus for Determining the Electric Force
- 9.8 Apparatus for Determining the Electric Force
- 9.9 Trial Plate
- 9.10 Apparatus for Determining Charges of Bodies
- 9.11 Apparatus for Determining Charges of Coated Plates
- 9.12 Leiden Jar
- 9.13 Electric Structure of Glass
- 9.14 Artificial Electric Fish
- 10.1 Transit of Venus
- 10.2 Cavendish's Drawings of Mountains
- 10.3 Schehallien
- 10.4 Royal Society
- 11.1 No. 34 Church Row
- 11.2 Hampstead Bearings
- 11.3 Hampstead Environs
- 11.4 Mileage Counter
- 11.5 No. 11 Bedford Square
- 11.6 No. 11 Bedford Square
- 11.7 Map of Cavendish's Land on Clapham Common
- 11.8 Cavendish's House on Clapham Common
- 11.9 View of Clapham Village from the Common
- 11.10 Plan of Drains at Cavendish's House
- 11.11 Mast for Aerial Telescope
- 11.12 Map of Clapham Common
- 11.13 Triangulations around London
- 11.14 Places where Henry Cavendish Lived
- 11.15 Map of Cavendish's London (West End)
- 11.16 Map of Cavendish's London (East End)
- 12.1 Sir Charles Blagden
- 12.2 Alexander Dalrymple
- 12.3 Alexander Aubert
- 12.4 John Hunter
- 12.5 Nevil Maskelyne
- 12.6 Sir William Herschel
- 12.7 Map of Cornhill
- 13.1 Sir Joseph Banks
- 14.1 Eudiometer 1
- 14.2 Eudiometer 2
- 14.3 Standard Volume Measures for Air
- 14.4 Apparatus for Experiments on Air
- 14.5 Joseph Black
- 14.6 Antoine Laurent Lavoisier

- 14.7 Joseph Priestley
- 14.8 Priestley's Chemical Apparatus
- 14.9 Carl Wilhelm Scheele
- 14.10 Scheele's Laboratory
- 14.11 James Watt
- 14.12 Affinities 1
- 14.13 Affinities 2
- 14.14 John Smeaton's Air-Pump
- 14.15 Chemical Balance
- 15.1 Thermometers for Extreme Cold
- 15.2 Forces
- 15.3 Laboratory Apparatus 1
- 15.4 Laboratory Apparatus 2
- 15.5 Laboratory Apparatus 3
- 15.6 Laboratory Apparatus 4
- 16.1 Garth Mountain
- 16.2 Portable Barometer
- 16.3 Working Iron at Merthyr Tydfil
- 16.4 Cavendish's Drawing of a Steam Engine
- 16.5 Parallel Motion
- 16.6 Cavendish's Drawing of Watt's Furnace for Burning Smoke
- 16.7 Albion Mills
- 16.8 Weighing the World
- 17.1 Georgiana Spencer, Duchess of Devonshire
- 17.2 Comet's Orbit
- 17.3 Compound Prism
- 17.4 Dividing Instrument
- 17.5 Charles Hatchett
- 17.6 Thomas Young
- 17.7 Sir Humphry Davy
- 17.8 James Lewis Macie
- 17.9 Coinage Apparatus
- 17.10 Royal Institution
- 17.11 Great Hall of the Bank of England
- 18.1 Cavendish Family Tree
- 18.2 Cavendish Family Tree
- 18.2 Grey Family Tree
- 18.2 Grey Family Tree

Preface and Acknowledgements

Fifteen years have passed since my wife Christa Jungnickel and I published *Cavendish, the Experimental Life*.¹ In the meantime, I have published two books about Cavendish. The first, *Speculative Truth*, is about Cavendish's work in theoretical physics.² He is known primarily as an experimentalist but he was no less accomplished as a theorist, and this book helps correct a partial view of his work. Cavendish exhibited some of the most baffling behaviors in the history of science, which are taken up in the second book, *The Personality of Henry Cavendish*.³ We only touched on this subject in our biography, and to that extent it was incomplete.

Cavendish was a “great man with extraordinary singularities,” his colleague Humphry Davy observed. The new edition of the biography brings a fuller understanding to what was “great” about Cavendish, and as well to what was “extraordinary” about his personality, and by clarifying the connections between the two, it more fully integrates his personality and his work. The new materials and perspectives complete the biography of Cavendish. As with any revision, this one also makes improvements of the usual kind: it corrects flaws in the original, sharpens discussions, introduces new materials, and improves the writing throughout.

We express our gratitude to persons who read part or all of the original book in manuscript and to others who in one form or another have given encouragement, advice, and help: Mark Bonthron, William H. Brock, I. Bernard Cohen, Arthur L. Donovan, Mordechai Feingold, John Gascoigne, Charles C. Gillispie, Jan Golinski, Sean Goodlett, Peter Harman, Patrick Henry, Ingrid Hofmaster, Sean Kissane, Carmen Mayer-Robin, David Philip Miller, Betty Mohr, Joseph F. Mulligan, Rosemarie Ostler, Jean Luc Robin, Richard Sorrenson, and Mary Lou Sumberg. We have been aided in our study of Cavendish by many archivists. Here we give special thanks to the archivists in charge of the Devonshire Collection at Chatsworth, which contains Henry Cavendish's scientific manuscripts: Peter Day, Charles Nobel, Michael Pearman, Andrew Peppitt James Towe, and Thomas Wragg.

Russell McCormmach
March 25, 2015

¹Jungnickel und McCormmach (1999).

²McCormmach (2004).

³McCormmach (2014).