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International History, Philosophy and Science Teaching Group

NEWSLETTER

September 2014

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2. *Science & Education* Journal Report

(a) Rationale and Purpose of the Journal

All involved with *Science & Education* journal are concerned to improve school and university science education by publishing substantial research that utilises historical, philosophical and sociological scholarship.

The journal promotes the engagement of these fields with theoretical, curricular and pedagogical issues in science education. It has a particular interest in bringing these fields of knowledge into teacher-education programmes. The journal welcomes contributions that examine and extend the liberal or humanistic tradition of science teaching. It welcomes serious cross-disciplinary approaches to theoretical, curricular and pedagogical issues. It seeks to promote discussion of the philosophy and purposes of science education, and its contribution to the intellectual and ethical development of individuals and cultures. In this latter endeavour it recognises that many of the major decisions facing science teachers, curriculum writers and administrators have their roots and solutions in fundamental philosophy of education.

(b) Journal on the Web

The journal *Science & Education* is now available on the web at: http://www.springerlink.com then PUBLICATIONS, then S, then 'Science & Education'), or more directly at the journal's home page: www.springer.com/journal/11191. The home page has provision for signing up for 'Table of Contents Alert', which means each time an issue of the journal is published, the Contents are contents are conveyed by email.

The articles can be accessed directly at:
http://springerlink.metapress.com/content/1573-1901

All articles can be downloaded as pdf files for free if the individual's institution subscribes to the relevant Springer journal package; otherwise they can be downloaded for a fee.

The Springer site is now linked to Google, and articles can be searched in Google by typing in author name and first words of title. This goes direct to the Springer site and the pdf file of the article.

The web site provides many services to researchers:

The 'On Line First' section allows access to all accepted, forthcoming articles in the journal. As soon as an article is accepted for publication, a typeset pdf version of it is posted on the web and can be accessed by individual journal subscribers or by individuals whose institutions subscribe to a Springer package that includes *'Science & Education'*.
The Contents of each issue of the journal, back to Volume 1 Number 1 in 1992, are available. These can be downloaded by subscribers and individuals whose institutions subscribe to the journal. They are also available, at a cost, to non-subscribers.

(c) Manuscript Submissions

Scholars can submit manuscripts in file form direct to the journal at: www.editorialmanager.com/sced

Thereafter they can check on its progress through the review process. Most submissions are reviewed by three senior scholars, usually involving a spread of educator, historian, philosopher or cognitive scientist. The submission site also has a guide to the journal's format and style conventions.

(d) Copyediting Assistance Required for Manuscripts from Non-English Authors

The journal publishes many works by scholars whose native language is not English. Copyediting of these papers is very time-consuming and assistance would be greatly appreciated. The papers would all be ones that have passed review and are in reasonable linguistic shape, but they do need refinement. Volunteers would be asked to copyedit no more than one paper per year. Such assistance is one tangible way of promoting good non-English background research to the international community.

If any colleagues are able to assist in this important task, please email the editor.

(e) Article Downloads

Since in its twelfth year being available on the web, the journal's article downloads have progressively increased.

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Downloads	21,373	22,500	23,584	37,593	48,634	65,152	88,220	108,605*	73,664	86,596

* In 2011 Springer advertised one month of 'free downloads' for the journal.

These figures are most gratifying especially for a 'niche' journal in science education. They indicate the amount of worldwide interest in the utilization of historical and philosophical studies in addressing the numerous theoretical, curricular and pedagogical problems in contemporary science and mathematics teaching.

The usage reflects the quality of manuscripts submitted to the journal, and the rigor and competence of the journal's reviewers (normally three per manuscript, often four or five).

One 'lesson' from the download figures is the need to incorporate history and philosophy of science material, if not courses, in science teacher education programmes. The download figures demonstrate a clear interest in HPS-related material by science teachers, educators, and researchers more widely, but unfortunately HPS is rarely included in either undergraduate or graduate teacher education programmes.

Geographic distribution of downloads

North America	30%
Europe	28%
Asia-Pacific	24%
Latin America	9%
Middle East	6%
Africa	3%

(f) Impact Factor

The journal's Thomson-Reuters Impact Factor (IF) for 2013 is 0.718. The journal was first ranked in 2011 (0.702). So there has been a pleasingly steady, though small increase in the IF measure of the journal's impact.

(g) Thematic Issues

Since its inception in 1992 the journal has regularly published thematic issues that bring together historical, philosophical and educational scholarship on particular theoretical or pedagogical themes related to History, Philosophy and Science Teaching.

These thematic issues have included:

1994, 'Science and Culture', **3**(1).
1995, 'Hermeneutics and Science Education', **4**(2).
1996, 'Religion and Science Education', **5**(2).
1997, 'Philosophy and Constructivism in Science Education', **6**(1-2).
1997 'The Nature of Science and Science Education', **6**(4).
1999, 'Values in Science and in Science Education', **8**(1).
1999, 'Galileo and Science Education', **8**(2).
1999, 'What is This Thing Called Science?', **8**(4)
1999, 'Children's Theories and Scientific Theories', **8**(5).
2000, 'Thomas Kuhn and Science Education', **9**(1-2).
2000, 'Constructivism and Science Education', **9**(6).
2003, 'History, Philosophy and the Teaching of Quantum Theory', **12**(2-3)
2004, 'Science Education and Positivism: A Re-evaluation', **13**(1-2)
2004, 'Pendulum Motion: Historical, Methodological and Pedagogical Aspects', **13**(1-2,7-8)
2006, 'Textbooks in the Scientific Periphery', **15**(7-8)
2005, 'Science Education in Early Modern Europe', **14**(3-4)
2007, 'Models in Science and in Science Education', **16**(7-8)
2008, 'Teaching and Assessing the Nature of Science', **17**(2-3)
2008, 'Studies in Historical Replication in Psychology', **17**(5)
2008, 'Social and Ethical Issues in Science Education', **17**(8-9)
2008, 'Women, Science Education, and Feminist Theory', **17**(10)
2009, 'Politics and Philosophy of Science', **18**(2)
2009, 'Constructing Scientific Understanding through Contextual Teaching', **18**(5)
2009, 'Science, Worldviews and Education', **18**(6-7)
2010, 'Darwin and Darwinism: Historical, Philosophical, Cultural and Pedagogical Studies', **19**(4-5, 6-8)
2011, 'Science and Pseudoscience in Society and School', **20**(6-7)
2012, 'The History of Experimental Science Teaching', **21**(2)
2012, 'Popular Science between News and Education: A European Perspective', **21**(3)
2012, '"Popularizing and Policing 'Darwinism' 1859-1900", **21**(7)
2012, 'Mario Bunge: An Evaluation of His Systematic Philosophy, **21** (10)
2013, 'Philosophical Considerations in the Teaching of Biology: Pts.I, II, **22** (1, 2).
2013, 'Cross-National and Comparative History of Science Education', **22**(4)
2013, 'Philosophy and Chemistry Education', **22**(7)
2013, 'Commercialisation and Commodification of Science: Educational Responses', **22**(10)
2014, 'History, Philosophy and Mathematics Education', **23**(1)
2014, 'Genetics and Society', **23**(2)
2014, 'Science and Literature', **23**(3)
2014, 'History in Science Museum', **23**(4)
2014, 'The Energy Concept: History, Philosophy and Pedagogy', **23**(6)
2014, 'Modelling Conceptual Change', **23**(7)

The Contents of all the above issues can be downloaded from the journal's Springer site: http://www.springer.com/education/science+education/journal/11191

(h) Reviewing

Informed and competent reviewing is a time-consuming and arduous task, but it is crucial to the integrity and quality of published work. Editors, authors, readers, and the scholarly enterprise more generally, benefit from this mostly anonymous and un-rewarded labour of dedicated scholars.

The journal policy is to send only strong papers to review, and then to seek multiple (3-6 and sometimes more) reviewers for these papers. About one-third of strong papers sent to review are nevertheless rejected, with the balance being asked to revise in the light of reviewers' comments. Reviewers' time is precious and already over-committed with their own research, writing and teaching responsibilities. Given a limited pool of high-quality reviewers, it is best that their energy is concentrated into improving strong papers, rather than being spread thinly across numerous papers many of which are far from publishable quality. Authors of these latter papers are encouraged to improve them and make a new submission that is developed enough for review.

The journal is noteworthy for having so many competent reviewers from the disciplines of Education, Science, Mathematics, Philosophy of Science, History of Science, Sociology and Psychology. Manuscripts are usually reviewed by three scholars, and often by four, five and sometimes more established scholars from these different disciplines.

A list of the 940+ reviewers who have contributed their time and expertise to making the journal so successful can be found at:

http://ihpst.net/journal/reviewers/list-of-reviewers/

Apologies to any journal reviewer inadvertently left off this list. Please inform the editor so that the posted list can be corrected.

The following are comments from authors about the reviewing process:

> *# We would like to thank the seven reviewers for their inspiring comments and suggestions. By taking them into account we certainly have improved our paper. Below, we explain how we addressed each specific comment.*
>
> *# I have never been provided with such a comprehensive body of criticism to any paper I have submitted to press. Furthermore I agree with most of the criticism and believe it will help me to improve on the paper. There are some issues I do not agree with, but I will argue this in detail in my response.*
>
> *# We are thankful for the decision of sending the manuscript to eight competent reviewers. Despite the bigger amount of work, we are sure that it has greatly improved the quality of the paper. The decision demonstrates your awareness of the complexity and interdisciplinary character of our proposal. This is confirmed by noticing that the reviews address different issues, which are related to different parts of the article. It also attests your commitment to the quality of the papers published in* Science & Education.
>
> *In any case we would like to express our very many thanks to all the referees for what they have done for us. They surely helped us in a way that is quite uncommon in the scientific community. Even better, we have to state that there are no words to express our gratitude to them. We are proud to have such competent and helpful colleagues.*

 # Thank you for sending the manuscript to four senior scholars for review. ...I have never received comments and criticisms from such wide perspective. This will definitely help to improve on the overall quality of the paper.

One reviewer has written:

I have reviewed for other journals. I certainly must say that you provide excellent support to the authors. You are providing excellent service to researchers. Reading other reviewers comments is also a great learning experience for me.

The editor of another research journal has pleasingly written:

Your review process is exemplary.

Scholars with research interests in areas of history, philosophy and science/mathematics education are most welcome to apply to join the journal's reviewer group. Please send email with brief Curriculum Vitae and mention of particular areas of competence and interest to the journal editor: Michael R. Matthews (m.matthews@unsw.edu.au)

3. The 2nd Asian Regional IHPST Conference, December 4–7, 2014, Taipei, Taiwan

The second Asian Regional IHPST conference will be held in Taipei, Taiwan, December 4-7, 2014. The Conference Chair is Prof. Dr. Chen-Yung Lin (lcy@ntnu.edu.tw) and the Secretary is Shiang-Yao Liu (liusy@ntnu.edu.tw) both from National Taiwan Normal University.

Conference theme

Re-examining Science: Historical, Philosophical, and Sociological Approach to Public Engagement with Science.

The conference will be held at the Howard Civil Service International House, located alongside the university.

Keynote speakers

John Dupré is Professor of Philosophy of Science and Director of Egenis, the Centre for the Study of Life Sciences, at the University of Exeter.
Mansoor Niaz is a Professor of science education at the Universidad de Oriente, Venezuela.
Kuang-Tai Hsu is a professor of history at National Tsing Hua University, Taiwan.
C. Kenneth Waters is currently the Samuel Russell Chair of he Humanities and Director of the Minnesota Center for Philosophy of Science at the University of Minnesota.
Otávio Bueno is Professor of Philosophy and Chair of the Philosophy Department at the University of Miami.
Alan Love is Associate Professor of Philosophy at the University of Minnesota and a member of the Minnesota Center for Philosophy of Science.
Szu-Ting Chen is a professor in graduate institute of philosophy in National Tsing Hus University, Taiwan.

Important Dates

- Early bird registration deadline: 30 September, 2014
- Registration deadline: 15 October, 2014

Registration fee:

		Before September 30	*After September 30*	*On-site (cash only)*
Regular	member	180 USD	220 USD	245 USD
	Non-member	225 USD	265 USD	290 USD
Student		125 USD	155 USD	175 USD

Further information about the conference can be found at:

http://www.sec.ntnu.edu.tw/ihpst2014/.

4. The 3rd Latin American Regional IHPST Conference, November 17-19, 2014, Santiago, Chile

The *3rd Latin-American Regional Conference of the International History, Philosophy, and Science Teaching Group*, *IHPST-LA 2014*, will be held in Santiago, Chile, from the 17th to the 19th, November 2014. The conference follows earlier successful regional IHPST conferences in Brazil (2010) and Argentina (2012).

The Conference is organised by the "Laboratorio GRECIA", Laboratory of Research and Innovation in Science Education, from the Pontificia Universidad Católica de Chile (PUC), and sponsored by IHPST, the "Bellaterra Society" for research in didactics, history and philosophy of science in Chile, and several public and semi-public Chilean Universities.

Head of the Organising and Scientific Committees is Dr. Mario Quintanilla, Director of the "Laboratorio GRECIA", and Professor at the PUC (mariorqg@gmail.com)

The venue for the Conference will be the Facultad de Educación (School of Education) of the PUC, located in the San Joaquín Campus, District of Macul, conveniently connected to the city centre by metro and bus.

Activities include plenary lectures, oral and poster presentations, and symposia. As it was instituted in the previous Latin-American Conferences (Maresias 2010 and Mendoza 2012), the official languages will be Spanish, Portuguese, and English.

More information on important dates, fees, forms of participation, venue, accommodation, contact is available at the web-site of the Conference:

http://sociedadbellaterra.cl/congreso2014 /

5. The 8th Hellenic HP&ST Conference, November 14 –16, 2014, Patras, Greece

The 8th Hellenic HP&ST Conference will be held in Patras, Greece, November 14-16, 2014. The Conference Chair is Prof. **Dimitris Koliopoulos** (http://dkoliopoulos.gr) from University of Patras. The main conference theme is: *The Contribution of History & Philosophy of Science in Teaching and Public Understanding of Science*.

The 1st Hellenic Conference of History, Philosophy and Teaching of Natural Sciences took place in Thessaloniki in 2001. Since then, it has become a standard multidisciplinary meeting of people working as researchers or teachers on history, philosophy or teaching of science. The latest two Hellenic conferences were held together with In-ternational ones (the ***11th International History, Philosophy and Science Teaching Conference*** in Thessaloniki & the ***5th International Conference of the European Society of History of Science*** in Athens) and elicited a dialogue between scholars and teachers around the world.

This year's conference aims at reclaiming its fundamental questions on whether and how history and philosophy of natural sciences could help their ***teaching***, their ***teachers' training*** and their ***public understanding*** in both formal and non-formal learning settings (science & technology museums, press, mass media and the web, scientific publications, etc.). The debate is ongoing today. Many still argue, following Kuhn, that including history & philosophy of science in the curricula can lead to serious misconceptions, while others underline its didactical importance.

In this conference, we will explore what current research shows with respect to these questions. Part of the conference will concentrate on the Greek efforts to develop innovative research-based teaching methods. We also hope to host research studies on the cultural dimension of scientific knowledge, in both formal and non-formal forms of education. Thus, we expect that the relations between school-science or popular-science and everyday issues concerning technology, environment and arts will be highlighted. In an era when the cultural capital seems to be entirely unrelated with the scientific one, it would be useful to find ways to connect the two.

Invited speakers include:

	**Igal Galili** is professor of Science Education at the Hebrew University of Jerusalem and Director of the Science Teaching Center. His research interests are the conceptual knowledge of physics, physics curriculum and theory of science teaching, representation of knowledge in science education and, the interaction between physics with the history and philosophy of science in physics education’.
	**Costas Gavroglou** is professor of History of Science at the Department of History and Philosophy of Science at the University of Athens. His research fields are the history of physical chemistry, the history of quantum chemistry, the history of artificial cold as well as issues related with the appropriation of the scientific ideas and practices by the European periphery from the 18th century.
	**Kostas Kampourakis** is a researcher at the University of Geneva (Section of Biology and University Teacher Training Institute). He is the incoming Editor-in-Chief of the journal Science & Education and the founding Editor of the book series Science: Philosophy, History and Education (both published by Springer). Kostas Kampourakis’ research interests include the teaching and public understanding of evolution, genetics and nature of science.
	**Laurence Maurines** is professor of Science Education in Orsay Faculty of Science at the University of Paris Sud. Research interests among others are the study of relationships between elements of history of science and students' conceptions about different topics in physics and the use of history of science by teachers in secondary and higher education and its impact among students.

	**Athanassios Raftopoulos** is professor of Epistemology and Cognitive Science in the Department of Psychology at the University of Cyprus. His research fields are epistemology, cognitive science, philosophy and history of Science, philosophy of perception, philosophy of mind, cognitive psychology, and developmental psychology.
	**Evangelos Vitoratos** is professor of Physics at the University of Patras. He is also Director of the Science and Technology Museum of the University of Patras. His research fields are nanosciences, nanotechnologies, materials & new production technologies, energy and environment and science education.

Web Page: http://www.hipst.gr/

6. European *Society for History of Science, Conference, Lisbon, Sept.4-6* , Science Faculty, University of Lisbon (http://eshs2014.ciuhct.com/) Symposium: History of Science for Science Education

Date: Thursday September 4, 2-6.30pm, UCL, Building 6, Floor 2, Room 50
Sponsored: Interdivisional Teaching Commission of the International Union of History and Philosophy of Science

Organizer & Chairperson: Peter Heering, *University of Flensburg*

Fabio Bevilacqua, *Pavia University; ESHS*
Historical Roots of Energy Educational Debates

Constantine D. Skordoulis, *National and Kapodistrian University of Athens*
Investigating the historical development of the concept of matter from ancient atomism to quantum mechanics

Michael R. Matthews, *School of Education, University of New South Wales, Sydney*
The Springer International Handbook of Research in History, Philosophy and Science Teaching

Pere Grapí, *CEHIC_ Universitat Autònoma de Barcelona;* **Mercè Izquierdo-Aymerich,** *CEHIC_ Universitat Autònoma de Barcelona*
A Contribution from the History of Chemistry to the Understanding of the Nature of Science in Science Teacher Education

Maria-Rosa Massa-Esteve, *Universitat Politècnica de Catalunya, Barcelona*
Algebra and geometry through the history of quadratic equation

Peter Heering, *University of Flensburg*
Developing Stories from the History of Science for the Science Classroom

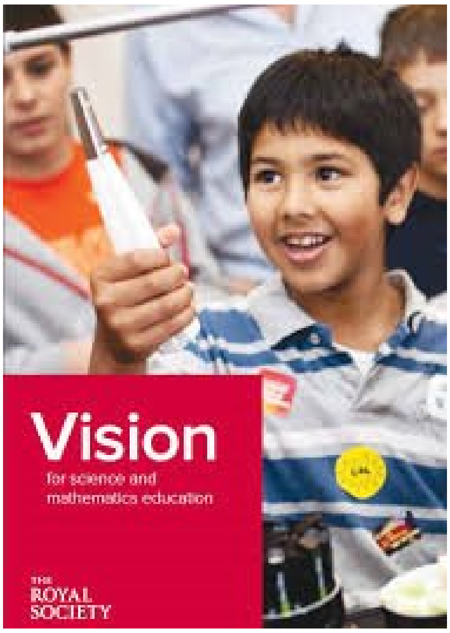
Antoni Roca-Rosell, *Centre de Recerca per a la Història de la Tècnica, Universitat Politècnica de Catalunya, Barcelona*
Engineering Education In The Nineteenth Century: The Collections At The Barcelona School Of Industrial Engineering

Fàtima Romero Vallhonesta, *Centre de Recerca per a la Història de la Tècnica, Universitat Politècnica de Catalunya, Barcelona*
The Dialogue on Arithmetics in the Arithmética Práctica y Speculativa by Juan Pérez de Moya

7. The Royal Society (2014). *Vision for Science and Mathematics Education.* London: Royal Society

Jonathan Osborne, School of Education, Stanford University, USA (osbornej@stanford.edu)

The introduction to this report claims to set out the UK Royal Society's vision for Science and Math Education for the next 20 years claiming that "It is about how such education can enable people to make informed choices, empower them to shape scientific and technological developments, and equip them to work in an advanced economy." Such sentiments are in one sense worthy but what are the specific skills and knowledge that a knowledge of science offers to meet these challenges? Surely, such an august body as the Royal Society should have a good answer to such a question. Sadly, the answer is no.



This report is full of well-meaning platitudes about the value of science education for maximizing "young people's chances of success"; that improving the educational outcomes in STEM subjects "can bring economic benefit" and that "growth and competitive advantage can only be sustained through a highly educated and skilled population". The authors claim that there is a lack of high quality educational research on which to base decision making. It is a pity that they did not ask themselves then, whether there was a lack of high quality understanding of the nature of the discipline they purport to represent.

The 'vision' they present of the discipline is of the need to nurture scientific and mathematical thinking but beyond a commitment to evidence as the basis of belief (a value which is not unique to science), the resolution of difference by argument (another practice which is not unique to science), or that science is dynamic (also not unique to science), the only distinctive feature that they manage to pick out about science is that science is committed to falsification. Even that, as readers of the journal and this newsletter will know is contestable.

Where, for instance, is the vision that actually what makes science distinctive is that over the past 2000 years, individuals have managed to develop a set of ideas about the material and natural world that have changed the way we think. They have done this in response to three questions – what exists (the ontic question); why does it happen (the casual question); and how do we know (the epistemic question). In attempting to answer these question they have developed 6 distinctive styles of reasoning (Crombie, 1994; Netz, 1999). Each of these styles of reasoning has had to invent its own ontic entities, procedures for supporting its thinking, and epistemic commitments and values – each of which is distinct. First there was the Greeks with mathematical deduction – a style of reasoning which was taken further by Newton, Leibniz, Riemann and others. Then there was the development of experimental exploration which begins in the 14th Century but given a big boost by Galileo. Then the notion that it was possible to model the world with representations which were simplifications but nevertheless, enable science to make testable predictions.

None of this would have been possible if all the sciences had not engaged in the substantial work of answering the ontological question of what exists. While taxonomy is essential to biology, chemistry without the work of early chemists in identifying the elements that exist was essential to Mendelev's development of the periodic table. Likewise, physics required the differentiation of concepts such as heat and temperature, speed and velocity. Astronomy depends upon the work of astronomers to identify the patterns in motion of the planets etc. Having established what exists the fifth style of reasoning – probabilistic and statistical thinking is essential to identifying patterns that need to be explained. Looking at such patterns is also the basis of the 6th style of reasoning – evolutionary accounts of the origins. The difference in the species of finch on the Galapagos islands was one of the patterns which led Darwin to the theory but similar kind of thinking was necessary to develop our ideas about the origin of the solar system, the Universe and the continents.

In short, science has developed 6 major styles of reasoning which frame the way we think about the material world in our culture. This achievement is the result of years of intellectual work – a history of vision and argument. This is the argument for why it represents some of the "best that is worth knowing" (Spencer, 1884) and deserves an essential place on the curriculum. Anybody can tell you that the economic rationale for science education is questionable when we are overproducing scientists in some disciplines.

So it is a real pity that the Royal Society is such a poor spokesman for the discipline that it purports to represent. Somehow, you have the feeling when reading it that Lakatos was right – "scientists know as much about their own subject as fish do about hydrodynamics". This is why the IHPST group – its journal, newsletter and work - matters.

Crombie, Alistair Cameron. (1994). *Styles of scientific thinking in the European tradition: The history of argument and explanation especially in the mathematical and biomedical sciences and arts* (Vol. 1): Duckworth London.

Netz, Reviel. (1999). *The shaping of deduction in Greek mathematics: A study in cognitive history*: Cambridge University Press Cambridge.

Spencer, H. (1884). *What knowledge is of most worth*: JB Alden.

8. *International Handbook of Research in History, Philosophy and Science Teaching*, Springer 2014

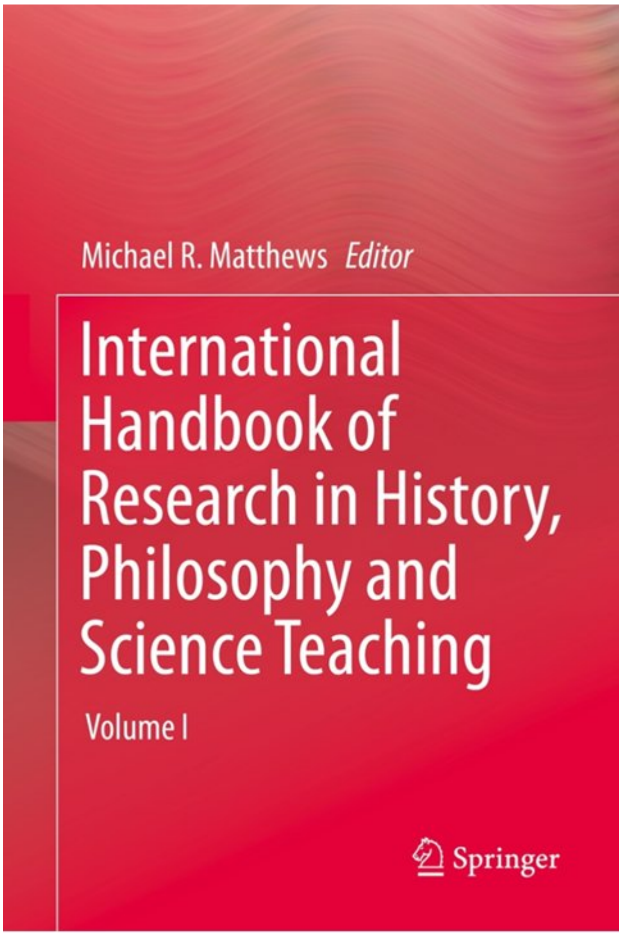
The first handbook devoted to the appraisal and synthesis of past and present Research in History, Philosophy and Science and Mathematics Teaching has been published by Springer. It consists of 2,544 pages in 3-volumes, with76 chapters, written by 125 authors from 30 countries.

The extensive scope of the work is reflected in the Subject Index which has 2,000 entries, the Name Index which has 3,600 entries, and in the 10,200 references cited.

Recognising the intimate historical connection between science and mathematics, and between students' learning of science and learning mathematics, seven chapters are devoted to historically and philosophically-informed research in mathematics education.

The handbook is structured in four sections: pedagogical, theoretical, national, and biographical research.

Each chapter sets the relevant literature in its historical context, and engages in an assessment of the strengths and weakness of the research addressed, and suggests potentially fruitful avenues of future research.



The Handbook lays out the rich tradition of historical and philosophical engagements with science and mathematics teaching, and the lessons can be learnt from these engagements for the resolution of current theoretical, curricular and pedagogical questions that face teachers and administrators.

Where institutions have purchased the Handbook, their staff and students can download individual chapters gratis. Further, such staff and students utilising the Springer *MyBook* scheme can purchase the whole 3-volume printed work for EUR25 or USD25. An e-Book version will be available for general purchase.

Gerald Holton, Physics Department, Harvard University

> Science educators will be grateful for this unique, encyclopaedic handbook, which provides a balanced guide to the whole spectrum of research on the inclusion of history and philosophy in science teaching.

Fabio Bevilacqua, Physics Department, University of Pavia

> This handbook is the most comprehensive attempt at bridging the worldwide "two cultures" gap in education. It gathers the fruits of over thirty years' research by a growing international and cosmopolitan community

ISBN: 978-94-007-7653-1 (hardcover); 978-94-007-7654-8 (e-book)

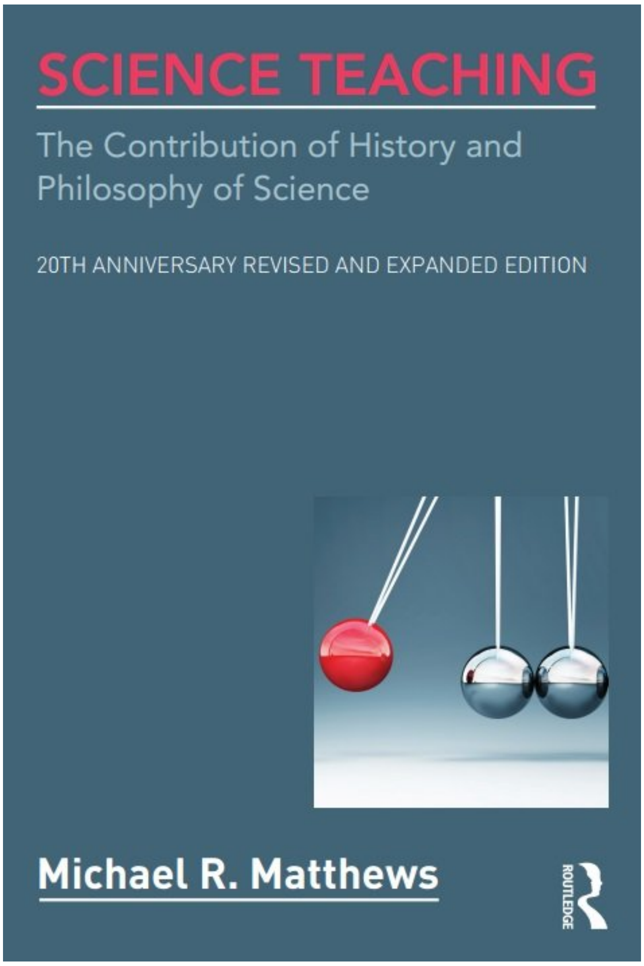
Complete contents and purchase information can be seen at:

http://www.springer.com/education+%26+language/book/978-94-007-7653-1

9. 20th anniversary, revised and enlarged edition, *Science Teaching: The Contribution of History and Philosophy of Science,* Routledge 2015

The 20th anniversary edition of this 1994 book has been published by Routledge. It has twelve chapters, 1,300 references, 500 pages, and 185,000 words; it provides a foundation for HPS-informed research and teaching in science education; it has been well received by philosophers, psychologists and educators.

ISBN: HB: 978-0-415-51933-5
PB: 978-0-415-51934-2



The book has four new chapters: The Enlightenment Tradition in Science Education; Joseph Priestley and Photosynthesis; Science, Worldviews and Education; and Nature of Science Research. All previous chapters have been fully updated and expanded.

The work explains how history and philosophy of science contributes to the resolution of persistent theoretical, curricular and pedagogical issues in science education.

The argument shows why it is essential for science teachers to know and appreciate the history and philosophy of the subject they teach and how this knowledge can enrich science instruction and enthuse students in the subject.

Through its historical perspective that takes in Ancient Greek society, through medieval times, the Scientific Revolution and its associated European Enlightenment, to modern times, the book reveals to students, teachers and researchers the foundations of scientific knowledge and its connection to philosophy, metaphysics, mathematics and broader social influences.

Detailed arguments are developed about constructivism, worldviews and science, multicultural science education, inquiry teaching, values and teacher education and nature of science (NOS) research. Relevant aspects of contemporary US and UK national science curricular documents are discussed and evaluated.

The book strives to demonstrate to educators that HPS is an engaging subject that should be at the core of their own professional development; and conversely to show historians and philosophers that their own expertise and scholarship can be utilised in science education debates, curriculum development and classroom teaching.

The book reinforces the understanding of science teachers as belonging and contributing to the important scientific and philosophical tradition that has had such enormous social and cultural influence among all nations; it contributes positively to teachers' sense of professional identity and to their understanding of being an educator.

Some Appraisals

Alberto Cordero, Philosophy Progam, The CUNY Graduate Center and Queens College CUNY, USA.

> *This is a transformative book. It provides an enlightening cartography of the uses of history and philosophy in the science classroom. No one interested in science teaching or science culture should be without a copy of this updated classic.*

John Sweller, School of Education, University of New South Wales, Australia

> *This book's importance transcends science education. Its coverage of topics such as the impact of constructivism on education provides the book with a universal importance. I strongly recommend it to everyone interested in teaching and learning.*

Ricardo Karam, Physikdidaktik, Universität Hamburg, Germany

> *The Pendulum chapter is a masterpiece! It should be considered obligatory reading for everyone who aims at becoming a science (especially physics) teacher.*

Sibel Erduran, School of Education, University of Limerick, Ireland

> *This is a rigorous and necessary resource for science education researchers, policy makers and practitioners*

Ordering

Standard price is USD65. Till December 31, IHPST newsletter readers can receive a 20% discount (USD52) by using discount code **IRK69** at the book's Routledge site:

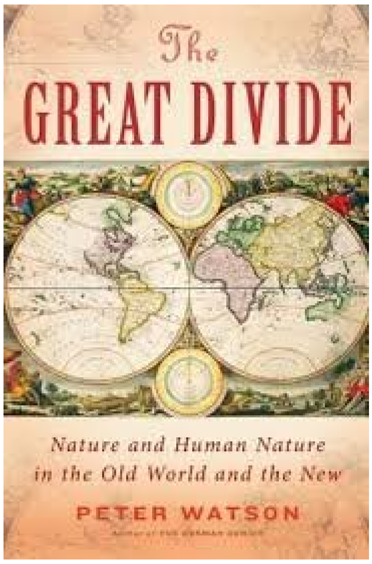
www.routledge.com/9780415519342

10. Book Reviews

(i) Peter Watson (2012) *The Great Divide: History and Human Nature in the Old World and the New*. Weidenfeld & Nicolson, London. ISBN 978-0-29785857-7.

Reviewed by: Jon Agar, Department of Science and Technology Studies, University College London, London, UK. Email: jonathan.agar@ucl.ac.uk

Peter Watson is an intellectual historian, who writes big, ambitious books. His previous work, *The German Genius* (2010) did an admirable job surveying the extraordinary florescence of German intellectual thought from the seventeenth to the twentieth centuries. It was an accessible, although lengthy, guide to not only the great names – Goethe, Gauss, Kant, Einstein – but also managed to include a host of relatively minor figures, while making sense of the whole.



In *The Great Divide*, Watson sets himself an even more daunting task: he tries, by tracing human history from origins to the early modern period, to account for why the New World (North, Central and South America) has diverged from the Old. This divergence, in terms of civilisation and power, is what forms the 'great divide'. Like the *German Genius*, then, *The Great Divide* is necessarily a work of synthesis, pulling together scholarship from a host of disciplines: anthropology, comparative theology, archaeology, climatology, biology, geology and history. The diversity of this list is a clue to the sources of Watson's overall argument. The causes of the Great Divide are as much natural as social. To this extent the book is an argument about global environmental history as it relates to grand, large-scale trends in human history.

Comparing the Old and New Worlds

Of course there are many surface similarities between the Old and New worlds, both in terms of civilisations and the environments they formed and grew in. A superficial civilizational similarity, for example, is the appearance of monumental pyramid-type structures. More significantly, humans have always been faced with the needs for food and shelter, have been able to move across some landscapes more easily than others, and have watched a shared sky of sun, moon, stars and planets. Everywhere there has been adaptation, cultural and physical, whether home was a jungle, coastal bay or tundra.

But then there are differences. Like Jared Diamond, in *Guns, Germs and Steel*, Watson notes the significance of two natural contingencies: the north-south orientation of the New World, which contrasts with the east-west sprawl of the Old World, and the accidents of location of animals and plants affording domestication. In addition, Watson highlights two further enormously significant geoclimatical phenomena: the monsoon, which brought rain to Asia (and elsewhere) but has weakened over the millennia, and El Niño, which, in the years of operation, dramatically shifts weather patterns, not least over South America. El Niño has strengthened over time. Finally, to this list of significant environmental factors, Watson picks out two further ones, which, I think it is fair to say, he gives more prominence to compared to other commentators. The first is events of spectacular geological violence, especially great volcano eruptions. The second is the geo-location of strong hallucinogenic plants – there are simply more in the Americas than in Eurasia, 80-100 compared to 8-10, and they are probably stronger.

To summarise Watson's argument in a nutshell: humans in the New World were faced with a natural environment that was qualitatively more hostile than in the Old World. This fostered an ideology, religiously expressed, of angry gods that had to be appeased. Inhabitants sacrificed so that gods would not do things. And this appeasement fundamentally did not work. This failure was a fundamental source of instability in New World civilisations. Endemic war (often for the seizure of captives destined for sacrifice) was a threat that, unlike natural catastrophes, could be manipulated by elites. In the Old World, where the problem was fertility rather than violent nature, of assuring the renewal of crops and animals, the ideology encouraged an appeal to fertility gods to let renewal happen. And it did seem to work (in the sense that, normally, new plants grew in spring, and domesticated animals reproduced). Watson writes:

> Fertility was an issue in the New World but, in the tropical rainforests, teeming with life and with plants growing in profusion all through the year (as manioc did, for example), and where the seasons varied, it was never the overwhelming issue it was in the temperate Old World.
> Much more important in the New World mindset were the feared and admired jaguar, and the weather gods – gods of lightning, rain and hail or violent winds, of thunderstorms, erupting volcanoes, earthquakes and tsunamis… (p. 512)

Of course the Old World had its endemic instabilities too. The most important of these was the expansion of nomadic tribes and their conflicts with sedentary peoples. But this instability had the effect of driving technological change. Furthermore there was just more space, moving east-west, for Old World history to play out these tensions.

How the Old and New World Diverged

That's the static picture of Watson's overall argument. The outcome was a New World that would fold under Spanish conquest, aided of course by the unequal Columbian exchange of disease-bearing organisms, and therefore a divided modern world. Most of the book, however, is an engaging, and at times enjoyably speculative, dynamic, chronological tracing of human history.

Modern humans evolved around 150,000 years ago, and perhaps as early as 25,000 years later had left Africa, probably across the southern end of the Red Sea, which, because of the recent Ice Age, was 230 feet lower than present. Moving around the extended coast (much of it now almost, but perhaps not irretrievably, lost to archaeology) humans reached Australia, Europe, and throughout Asia. By 25,000-20,000 years ago humans found Beringia, the land bridge straddling Old and New worlds which formed a bottleneck in expansion. Watson uses both archaeological and genetic science secondary sources to tell his story, treating the latter with sensible care and balance. It is interesting the extent that these two specialties, one old, one new, have displaced comparative linguistics, the evidence from which Watson also addresses, as guides to ancient pasts.

Watson also draws upon myth structures, such those of the watery creation of the world, the separation of earth from sky, and floods. He agrees that myths encode memories of 'distant occurrences that were so catastrophic, traumatic and bewildering to ancient peoples' (p. 23). The most important area for new myths, he argues, was south-east Asia, which would have formed a more extensive landmass before the waters rose. Creation, as in 'let there be light', for example, might refer to the skies gradually clearing of black dust after the Toba eruption of 74-71,000 years ago. Toba was the 'biggest eruption on earth during the last two million years, a massive conflagration that would have released a vast plume of ash thirty kilometres high … spreading north and west' (p. 24). A site in central India, for example, has an ash layer twenty feet thick. The spread of peoples, fleeing environmental disasters such as catastrophic volcanoes and rising sea levels, took these myths, and possibly 'the early skills of civilisation, such as agriculture' (p. 27), with them out of south-east Asia. For good measure, Watson throws in a perfect storm of interlocking astronomical cycles, provoking 'very dramatic and very sudden climate change' (p. 30), including floods, around 22-23,000 years ago. It's fun, but speculative, a kind of Velikovsky rewritten for today's era of Global Warming.

Watson is on surer ground when discussing ideological inheritance and natural history. The shamanism of Asia was carried through Beringia into the New World. Shamanism is marked by the presence of special individuals who, often assisted by various means of mind-changing practices, can travel between this world and the other worlds, of gods and spirits, to intercede on behalf of their human clients. Hallucinogens, which as we have seen were stronger in the New World, assisted the shaman's flight. In North America, the humans , as they travelled rapidly east and south, met creatures that never been hunted. These chapters provide a good summary of ancient American history.

Watson alternates between New and Old World developments, always combining environmental, social and intellectual history. The contrast between patterns of domestication is perhaps the most important factor in the great divide. There is an interesting argument that relates the loss of innocence to the domestication of dogs: ancient humans may not have realised the link between sex and birth until relatively late. There must have been a time when our animal ancestors were not conscious of this link, and there's certainly a time later when we are, so when was the knowledge gained? Watson suggests it became obvious with the domestication of dogs. The consequences were social (ancestors are personal in a new way) and cultural (myths of the fall).

Domestication of animals and cereal plants, the Neolithic revolution, may have been precipitated by climate change (drying land producing more non-wooded land amenable to work before metal tools), population crisis (combined with over-hunting), or perhaps increased disease (as warming combined with the disappearance of megafauna hosts meant that humans suffered more infections) which forced the hunter-gatherers to adopt sedentary life if they were to reproduce in sufficient numbers to survive. Furthermore, in Ed Sherratt's very useful term, there was a 'secondary products revolution' (p. 139). Domestication did not just mean a new, and perhaps a larger and more reliable food supply, but also a sparked a chain reaction of technological developments of a secondary character, from pottery, ploughing, chariots, milking and riding – the last being, in Watson's words 'four things that never happened in the New World' (p. 139). And with sedentary domestication came the fertility gods.

In the New World, however, patterns of life based on hunting were either sustainable (as was the case with the plains Indians and the bison), or were replaced with sedentary civilisations that had to draw upon a much smaller repertoire of domesticated organisms. Furthermore, the environment was more hostile and the drugs stronger. Watson provides a clear overview of some of the new, and very exciting, archaeological discoveries that have added the Aspero/Caral Norte Chico and Chavín de Huántar cultures to the more well-known Olmec, Aztec and Inca stories. Ritualised, extreme violence emerges as a common theme.

Watson's next major phase in human history is substantially indebted to Karl Jaspers' 1949 notion of the 'axial age', the broadly contemporary emergence of systems of thought in the Old World that encouraged restraint, including Confucianism, Daoism, Buddhism, Jainism, Upanishadic Hinduism, prophetic Judaism and Greek philosophical rationalism. Watson, an intellectual historian, considers these intellectual developments to be more significant than technological ones:

> Many innovations – innovations in ideas and knowledge rather than technology – occurred during these years and, for the thesis of this book, this is when a big gap opened up between the two hemispheres. A series of interlinked changes … transformed humankind's understanding of itself in the Old World in a way that had no parallel in the Americas (p. 324).

In fact, Watson contradicts himself here, albeit slightly. He offers the figure of Ce Acatl Topiltzin Quetzalcoatl, who proposed substituting human sacrifice with animal sacrifice, as a 'parallel of sorts' (p. 472) with the Old World axial age prophets. However, as Watson notes, 'in Mesoamerica Topiltzin failed: he lost the argument and he lost his position' (p. 473).
In summary, Watson concludes:

> We can now see that the main difference between the Old and the New World civilisations … is in their patterns of adaptation to different environmental circumstances, and that the Old World ideologies changed more often and more radically than did the ideologies of the Americas. And that while this was due to some extent to differences in climate and geography – the weakening monsoon in the Old World and the increasing frequency of El Niño in the New World – it also had a great deal to do with the role of the domesticated mammals and in the New World of hallucinogenic plants. We may therefore say – exaggerating only slightly – that the core of Old World history was defined

largely by the role of the shepherd, whereas in the New World an equivalent role was fulfilled by the shaman (p. 519).

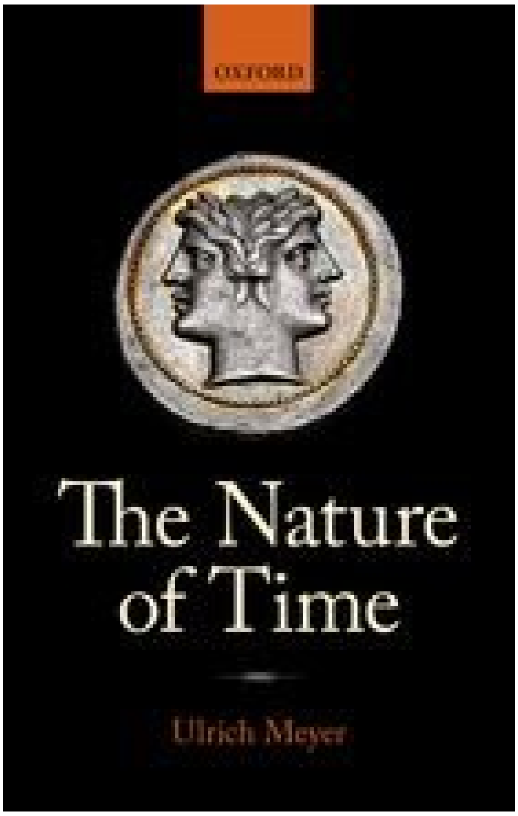
Conclusion

There are necessarily weaknesses in such a sweeping text. China, for example, while making a few, comparative appearances, is not placed in the centre of global history in a way that, arguably, it should be. In terms of originality and conciseness, the Watson's Great Divide is not as exciting a reading as Diamond's Guns, Germs and Steel. However, it is an engaging guide to a mass of recent scholarship across a range of disciplines.

The length of *The Great Divide* means that it is unlikely to be used for teaching. Indeed the market for the book is more general than a narrowly educational one. It is a trade book not a text book. However, I think there will be classes where parts of the text may well be used with benefit. First, as a global history, Watson offers both a good and readable synthesis. Second, with the specific influence he attributes to environmental factors such as violent nature or the biogeography of hallucinogenic plants, *The Great Divide* offers a distinctive thesis that might be summarised and contrasted to others' work.

(ii) Ulrich Meyer (2013) *The Nature of Time*, Oxford University Press, Oxford, ISBN 9780199599332, 161 pages, price: £35.00

Reviewed by: Ileana M. Greca, Departamento de Didácticas Específicas, University of Burgos, Burgos, Spain, ilegreca@hotmail.com.



In physics teaching, time is a common place: we divide or multiply by *t*, we ask students questions about how the movement of objects change in certain time intervals. . . . Nevertheless, neither physics teachers nor textbooks commonly define time, neither physically nor philosophically; this can make students confused about it, especially when they have to deal with time in problematic concepts such as simultaneity or spacetime. Moreover, although aware of the historical debate in physics about time, we usually have a very superficial notion of it.

In *The nature of Time*, Ulrich Meyer discusses what he considers the central question in the philosophy of time: namely the nature of instants of time. In doing so, he examines and rejects various spatial accounts of time, in particular, the ones that consider that instants of time are similar to locations. Temporal substantivalists, as Newton, sustain metaphysically basic times, independent of objects or movement and not related to changes.

In the opposite side, temporal relationists, like Leibniz, argue that time does not exist independently of objects and that temporal relations have to be defined related to events that stand in temporal overlap or precedence to one another. Meyer defends a quite different position, addressing the idea that times are linguistic entities and adhering to modal views of time that relate instants of time and the possible worlds in modal logic. As he notes, spatial views of time try to reflect the use of spatial metaphors in our ordinary speech. In turn, modal views focus on another aspect of natural languages, the fact that verbs are tensed. Meyer's central point is tense primitivism, the view that the tense operators of tense logic are conceptually primitive. These tense operators are used to construct linguistic ersatz times, which seem to help solving problems of expressive power for tense logic.

Chapters 2 and 3 critically examine the spatial accounts of time, stressing the ontological difficulties these views carry. From chapters 4 to 10, he presents his view, arguing how it can face and solve several problems such as, for example, presentism or the flow of time. Related to presentism, that is, the problem of whether there is anything metaphysically special about the present moment, he defends a version of eternalism, namely that all times are metaphysically on the same footing, which fits with his modal view of time. This is compatible with the theory of relativity, something that does not occur with other views holding that only present objects exist.

As we know, the theory of relativity have influenced not only physics but also several branches of knowledge, in particular, philosophy, and any theory of time has to reconcile its proposals with it. Meyer addresses this point in chapters 11 and 12, which go by relatively quickly, having in mind, as Meyer correctly points out, that modal accounts of time seem to be worse candidates to discuss spacetime than spatial views. Surprisingly, Meyer argues that the spacetime picture, although helpful for representing real physical processes, is not necessarily fundamental for describing the nature of space and time. For this, he first discusses why it is not conclusive the supposed prohibition by relativity from splitting spacetime into a spatial and a temporal component. After building this argument, he proposes a hybrid, which uses tense primitivism for the metaphysics of time and spatial substantivalism for the metaphysics of space, and could make sense of spacetime from a metaphysical point of view, recovering it at a higher level of abstraction. Although being an intriguing form to understand spacetime, these chapters, as said before, are quite brief, and a more detailed discussion would be beneficial.

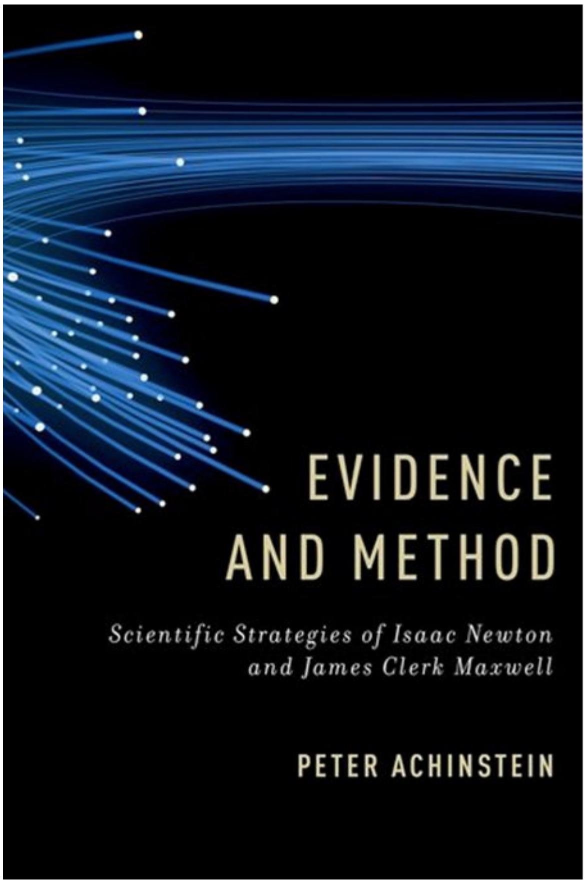
Summing up, *The nature of Time* is an important book for those working on the philosophy of time, since it offers an interesting and substantiated new view about time. But it is also an interesting read for those who want to understand the philosophical discussion about this topic because, although in some passages it could be somewhat difficult for the non-expert in philosophy, it is a very well written book, with an updated and compact review about the philosophical debate about time.

(iii) Peter Achinstein (2013) *Evidence and Method: Scientific Strategies of Isaac Newton and James Clerk Maxwell*. Oxford University Press, New York. ISBN: 978-0199921850, 177 pp., $ 22.46

Reviewed by: Ricardo Karam, Faculty of Education (Physics Education Group), University of Hamburg, Hamburg, Germany, email: ricardo.karam@uni-hamburg.de

Introduction

In his book *Evidence and Method: Scientific Strategies of Isaac Newton and James Clerk Maxwell* the renowned philosopher of science Peter Achinstein focuses on the question whether observed phenomena constitute evidence that a theory is true. Analyzing two central historical cases, he has mainly two goals: 1) To argue that by using his "Rules for the Study of Natural Philosophy" Newton was able to establish a universal law of gravitation to explain a range of phenomena, and 2) To describe three methods used by Maxwell when there were no sufficient evidence to establish a theory (or there was no theory available). The book is clearly written, aims at a general audience and provides valuable insights into the works of these two major exponents of modern science. Thus, it is warmly recommended for the readers of *Science & Education*.



On the other hand, the book lacks historical grounding and its argumentation, at some points, appears to be based on personal convictions. The general feeling is that Achinstein has clear views regarding scientific evidence and methods, and looks for examples that corroborate them in the works of Newton and Maxwell.

Chapter 1 – Definition for Evidence

If one says that a particular fact or phenomenon is *evidence (e)* that a *hypothesis (h)* is true, what is actually meant by that?

Chapter 1 is dedicated to answer this question in a very general manner. Considering two usual dichotomies related to the notion of evidence (*objective-subjective* and *empirical-a priori*), the author argues in favor of the *objective* and *empirical* perspectives, and provides certain criteria to formulate a precise definition of evidence[1]. For Achinstein, evidence is both a serious ("you get my hopes up", p. 15) and threshold ("a certain amount of probability is needed for something to count as evidence", p. 16) concept. According to him, in order for *e* to be considered objective evidence that *h*, it has to fulfill the following principles: 1) Reasonable Belief 1 - "*e* is a good reason to believe in *h*"; 2) Reasonable Belief 2 - "*e* cannot be a good reason to believe a hypothesis incompatible with *h*"; and 3) Empirical Evidence - "whether *e* is evidence that *h* is an empirical, not an a priori, question". These principles are then used to sustain the following conditions for "potential" evidence:

$$\text{(i)}\quad p(E(h,e)/e) > ½$$

meaning that *e* must have an explanatory connection with *h* and the probability of *h* given *e* is bigger than ½, since *h* must be more probable on *e* than its denial on *e* (Reasonable Belief 2);

[1] This chapter is based on Achinstein's previous works on evidence (e.g. Achinstein, 2001, 2010).

(ii) *e* is true

since the claim that *e* is evidence of *h* presupposes that *e* is true;

(iii) *e* does not entail *h*

because then *e* would be "too close" to *h* to be considered evidence that *h*.

The argumentation in this initial chapter is quite general and contains everyday life situations (e.g., "if I own a 95 lottery tickets, is this evidence that I will win?", p. 19). One rarely finds arguments related with scientific theories and the few presented are too briefly analyzed to be convincing. Another trademark is an overall opposition to the standard hypothetico-deductive method. In the end of the first Chapter, the author recognizes that the non-specific character of his argumentation is a typical problem perceived by scientists ("The Dean's Challenge"). This leads to the specific goal of the book, namely to analyze two case studies: Newton's path to the law of gravitation and Maxwell's strategies to investigate electromagnetic and thermodynamic phenomena. In Newton's case, Achinstein aims at presenting a general "scientific method" that consists of "rules for determining how to make non-deductive inferences from observable phenomena to more general propositions" (p. 40).

Chapter 2 – Newton's path to the law of gravity

In Chapter 2 the author analyzes the set of four *Rules for the Study of Natural Philosophy* presented by Newton in the beginning of Book III of the *Principia*. Because of the central role played by the rules in Achinstein's line of reasoning, it seems appropriate to reproduce them here (pp. 43-44):

Rule 1) No more causes of things should be admitted than are both true and sufficient to explain their phenomena.

Rule 2) Therefore, the causes assigned to natural effects of the same kind must be, so far as possible, the same.

Rule 3) Those qualities of bodies that cannot be intended and remitted [qualities that cannot be increased or diminished[2]]*, and that belong to all bodies on which experiments can be made should be taken as qualities of all bodies universally.*

Rule 4) In experimental philosophy, propositions gathered from phenomena by induction should be considered either exactly or very nearly true notwithstanding any contrary hypotheses, until yet other phenomena make such propositions either more exact or liable to inspection.

After a succinct clarification of the meaning of the rules, the author presents Newton's argument for the law of gravity in Book III, which starts from six phenomena that, according to Newton, we know from astronomical observations[3]. In sum, these phenomena say the following:

Phen. 1 & 2: Kepler's 2nd and 3rd laws[4] are valid for Jupiter's and Saturn's satellites (in respect to the planets' centers).

Phen. 3-5: The five primary planets (Mercury, Venus, Mars, Jupiter and Saturn) orbit around the sun according to Kepler's 2nd and 3rd laws.

Phen. 6: Kepler's 2nd law is valid for the moon's orbit around the Earth.

[2] e.g. extension, hardness, impenetrability, mobility, inertia, etc. [RK]

[3] However, astronomical data are provided by Newton as evidence only for phenomena 1, 2 and 4.

[4] Kepler's 2nd law: In their orbits (planets or satellites), a line drawn to them from the orbited body sweeps out equal areas in equal times. Kepler's 3rd law: The square of their periods of revolution is proportional to the cubes of their respective distance from the orbited body.

In the *Principia,* the presentation of these six phenomena is followed by a set of propositions that state the inverse-square force law, its dependence on the quantities of matter and the general character of gravitation. Taken together, the first seven propositions synthesize what we know today as Newton's law of universal gravitation. Achinstein describes Newton's path to this law in 4 steps as follows (pp. 54-58):

Step 1: All the observed planets and their satellites obey Kepler's 2nd and 3rd laws (Empirical fact).

Step 2: Since the centripetal force keeping the moon in its orbit and the force of gravity are both directed toward the earth and have equal magnitudes, they are the same force (By Rules 1 and 2).

Step 3: Since the motions of the planets with respect to the sun, and their satellites with respect to their planets, is the same in the above respects as the motion of the moon with respect to the earth, we infer that these motions have the same cause, viz., an inverse-square force proportional to the masses of the bodies (By Rule 2). Since one force suffices for all these phenomena, we should infer that this is the only force acting (Rule 1). We should assert the truth of this conclusion by Rule 4.

Step 4: By methodological Rule 3 (induction), all bodies gravitate toward each planet, and, even more generally, all bodies gravitate toward all others, in proportion to the quantity of matter (mass) in each. And by Rule 4, these inductions can be considered true or very nearly true, until other phenomena show the need to make the conclusions more precise, indicate exceptions (or, presumably, reject them).

By this point it should be clear to the reader that the author's intention is to sustain that Newton's four rules served as a *methodological guide* for him to discover the law of gravitation. This view has received strong criticism from philosophers (e.g. Whewell, Feyerabend and Norton) who argue that Newton formulated the rules *a posteriori*[5] to protect and strengthen the inference of gravitation, and that they are worthless as a means of testing or justifying inferences. Achinstein wants to refute this criticism by stating that the rules "do have justificatory force and no stifling effects" (p. 63). The author's personal opinion is then stated: "Whether this is Newton's own way of understanding the rules I hesitate to say, but *I would be happy to attribute this to him, since I think this interpretation makes them plausible*" (p. 63, my emphasis).

In reading the book one realizes Achinstein's intention to draw general conclusion from the analysis of this case study. In fact, in this chapter the author presents what he calls "Newton's general strategy" (p. 65):

1. Start with observed phenomena (in this case, observed Keplerian motions of the planets and their satellites)
2. Infer a cause of these phenomena (in this case, a gravitational force), and if possible, a unique cause, from the phenomena themselves, making use of empirical propositions derived earlier.
3. Generalize this cause (gravitational force) to as large a class as possible (e.g., to all bodies) so that a general law can be formulated mathematically.
4. Regard the strategy outlined above as successful if in using it we arrive at a general causal law that can be accepted as true, or approximately true.

In the last section of Chapter 2 the author defends his general Newtonian inductive strategy by contrasting it with both Cartesian rationalism and hypothetico-deductivism. Concerning Descartes' Rules, a deep analysis is not made, since only *Rule 3* (among 21) is mentioned and a very superficial criticism of Descartes' focus on the role of intuitions is provided. The analysis of hypothetico-deductivism is also quite brief and centrally based on the idea that hypothesis are not empirically established. In sum, Achinstein's central argument against these two philosophical

[5] It is quite well known that these rules appeared in their final version only in the third edition of the *Principia* (1726), which seems quite a strong argument in favor of the *a posteriori* thesis. Unfortunately, no mention or discussion about this fact is found in Achinstein's book.

currents is that it is impossible to explain phenomena only by *a priori* calculations. In fact, the author constantly contrasts mathematics (*a priori* calculations) with physics (causal and inductive).

Even though the reader has no doubt that Achinstein is defending a general Newtonian methodology, Chapter 2 pleasantly finishes with a summary of three possible ways to argue against the usefulness of Newton's rules (p. 80):

1 – By showing that following them cannot achieve the aim Newton seeks.

2 – By agreeing that the aim in using the rules is a good one and is achievable, but arguing that there are better strategies for achieving it that do not involve following these rules.

3 – By claiming that the rules are trivial and uninformative.

All these three ways seem plausible refutations of Newton's rules, but a deep analysis of these possibilities for the gravitation law is not provided.

Chapter 3 – Extensions of Newton's Method

This chapter starts with extensions of Newton's method that involve adding steps or rules that complement the pure inductive (from data to law) approach. Without investigating any specific example in depth, Achinstein quotes a passage from Newton's Optiks in which he distinguishes between "Analysis" - the set of four rules previously mentioned - and "Synthesis" - involving (theoretical) proofs and refinements of the explanations. This is followed by a brief presentation of Mill's "Deductive Method" (Induction - Ratiocination - Verification). One important aspect of Mill's framework is that Induction - understood as "that operation of the mind by which we infer what we know to be true in particular cases, will be true in all cases which resemble the former" (p. 88) - is more general than Newton's rule 3. Gathering Newton's idea of Synthesis and Mill's "Deductive Method", Achinstein proposes to add a fifth rule to the previously mentioned Newtonian method. Rule 5 is presented as follows (pp. 89-90):

Rule 5 (Synthesis): Using rules 1-4, suppose you have determined (i) that phenomena in a given set have multiple causes, (ii) what these causes are, and (iii) what laws govern these causes. Then, assuming these laws can be combined, do so, and by calculation determine whether propositions describing the phenomena with which you began, as well as others, can be derived from this set. Determine by observation and experiment whether, and to what extent, actual phenomena that occur conform to the observational conclusions derived.

It seems that some features of deductive reasoning are beginning to be recognized as important for Newton's achievements. Nevertheless, the order in which the steps are taken (first induction) is clearly maintained. What follows in this chapter is an analysis of concurrent methodologies to Newton's and Mill's (from data to generalization), namely Whewell's and Lipton's "Inference to the Best Explanation" (IBE). The core aspect pointed out by Achinstein is that methodologies similar to IBE allow one to infer that a hypothesis is true based on non-empirical criteria (e.g. explanatory depth, simplicity, coherence, consilience), whereas Newton's and Mill's methodologies "require that the hypothesis or law be inferred using inductive and causal reasoning" (p. 96). One crucial concept of Lipton's IBE terminology, namely the "loveliness of an explanation", is strongly criticized by Achinstein in a detailed examination. The essential message is that "loveliness" should be related to "likeliness" (truth) to be considered a solid criterion to accept an explanation. In my view, in the lack of a deep analysis of historical case studies, it remains a matter of opinion whether you prefer one or the other.

The last section of this chapter is central for the book. In it, Achinstein comes back to his definition of evidence (Chapter 1) to compare them with Newton's scientific method (Rules). In sum, the author questions whether or not the six phenomena presented by Newton in Book III constitute evidence (*e*) for the law of gravitation hypothesis (*h*). His positive answer is given based on his conditions for evidence as follows (p. 121):

1. Given the phenomena *e*, the probability is high (greater than ½) that there is an explanatory connection between *h* and *e*. This is because, if we follow Newton's strategy, we will generate a causal law that will explain the phenomena, and we will do so in an empirically defensible way (in a nonrelativized sense). Hence, the probability will be high that there is an explanatory connection between the law and the phenomena[6].

2. *e* is true. Newton's strategy starts with phenomena that have been established as true (Here I [PA] will follow Newton and consider as true propositions ones that are "exactly or very nearly true")

3. *e* does not entail *h*. Otherwise, the argument leading from *e* to *h* will be an a priori one, not an empirical one subject to Newton's four rules.

The chapter finishes with the conclusion that "Newton followed the rules, understood pragmatically, and gave empirical arguments that he believed established the law of gravity" (p. 124). In other words, Newton did perform in an "empirical defensible way". The absence of phenomena that contradicted the law of gravitation (e.g. Mercury's precession or energy's dependence on velocity) at Newton's time justifies his belief in the truth of his law. According to Achinstein, had Newton had access to these phenomena, he would have adjusted or altered his explanatory law (following Rule 4).

A personal defense of the importance of Book I

There is an abrupt change in the book here because the last chapter concerns Maxwell's work. Thus, this seems to be the appropriate place for a short appraisal/reflection regarding Achinstein's claims about Newton's path to the law of gravitation.

The central question is: How did Newton arrive at his universal law of gravitation? Or maybe before: How are we to answer this question? In Achinstein's book (Chapter 2) the author focuses exclusively on Book III of the *Principia* and argues that, based on four methodological rules and six phenomena, Newton was able to establish a general law that invokes a cause to explain a range of phenomena. Most importantly, Achinstein's thesis is that Newton's evidential claims are essentially empirical (6 phenomena) and *not* a priori ("calculations").

In my view, some important questions arise: What about Book I? What is the role of all those mathematical "calculations" for the Newtonian enterprise? Don't they also count as evidence for the general law? In the following, I will present three propositions (*Principia*, Book I, Section II) and briefly explain their meaning. Contrary to Achinstein's position, my goal is to argue that these "a priori calculations" *did* play an essential role and *should* also be considered as evidence for the law of gravity. Well, if one adopts Achinstein's definition of evidence and argues that it is essentially empirical, then our discussion remains in the territory of terminology. Nevertheless, my main point is to stress the importance of these theoretical derivations for Newton's work, which I believe is somehow neglected/undervalued in Achinstein's book.

Proposition I: Central force and Kepler's 2nd law

In the first proposition of Section II, Newton presents a mathematical[7] proof of the connection between a central force and Kepler's 2nd law. In sum, he proves the following:

Condition: Given that the force acting on orbiting bodies is *central* (always directed to an immovable point), then

[6] In mathematics, probability is defined as the ratio of the favorable cases to the whole number of cases possible. It is therefore, a *number* that varies from 0 to 1. Having this mathematical definition in mind, speaking about the "probability that there is an explanatory connection between *h* and *e*" does not make sense to me. How can one calculate such probability?

[7] By mathematical I mean essentially geometrical. Newton's style in Book I resembles a lot a geometry book like Euclid's Elements.

Conclusion: A line segment joining the body and the fixed point sweeps out equal areas in equal times.

In order words, if the force is central, the elapsed time is proportional to the area. This is very important because it gives Newton a geometrical interpretation of time.

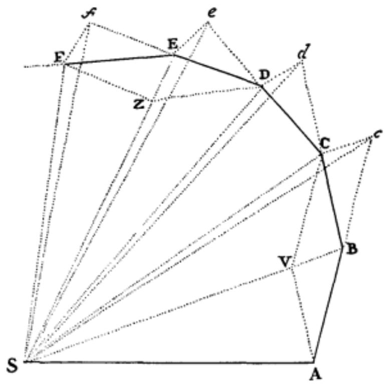


Figure 1: Proposition I, Book I, Section II (Principia)

Figure 1 is provided for the demonstration[8]. The curvilinear movement of the body is divided into infinitesimal line segments (*ABCDEF*) traversed in equal time intervals. The segments *Bc*, *Cd*, *De*, and *Ef* represent the inertial trajectory of the body. They show where the body would be if there were no force acting on it.

In sum, Newton first shows the equivalence (equal areas) between the triangles *SAB* and *SBc*. Then, he proves that the triangles *SBc* and *SBC* have also the same area, and therefore the areas of the triangles *SAB* and *SBC* are equal. Crucial for the demonstration is that the force, which is proportional to the deviation *BV*, is *central* (i.e. *BV* is parallel to *Cc*). Here we see that for Newton, force is a *mathematical concept* that describes the change of motion. It is mathematical (geometrical) because it is proportional to a segment that represents the body's deviation from the inertial trajectory.

This proposition is very general. It does not matter whether the trajectory is a circle, an ellipse, a parabola or other curve. The force law (*F* proportional to ,—,√ or some other relation) is also irrelevant. If the force is central (independent of the location of the immovable point), the area is proportional to the time elapsed. Thus, Kepler's 2nd law is not only valid for elliptical orbits, but actually for all kinds of trajectories and force laws. Therefore, if our experimental data is in accordance with Kepler's 2nd law, we can only infer (theoretically) that the force is *central*.

Proposition VI: A "mathematical machine" to calculate the law of centripetal force

A crucial (theoretical) step to the law of gravity is presented in Proposition VI. Figure 2 shows a body located at position *P* of some curvilinear trajectory. After an infinitesimal time interval (measured by the area of the triangle *SPQ* according to Prop. I), it arrives at position *Q*. The force that acts on it is central (always pointing in the direction of *S*). Point *R* locates the position of the body if there were no force (inertia). The segment *QR* is the deviation from the inertial trajectory (*QR* is parallel to *SP*).

[8] The interested reader can find a detailed explanation at Feynman (1958, pp. 41-45).

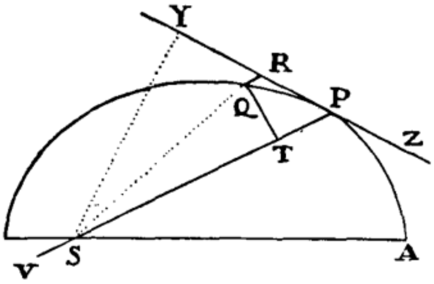


Figure 2: Proposition I, Book I, Section II (Principia)

The goal is to find an expression for the force acting on the body (force law). Here, Newton applies a fundamental principle of the infinitesimal reasoning, namely that a magnitude can be held constant if we consider very small intervals. In this case, the *force* is said to be constant from *P* to *Q*. Using our current terminology, the argument goes as follows[9]: If the force is constant, the acceleration is also constant and the kinematic formula $= -$ can be applied. Because $=$, is directly proportional to and inversely proportional to . The distance traversed in the direction of the force is *QR* and the time is proportional to the area of the triangle *SPQ*. Thus, the expression for the force is[10]

$$\propto \frac{}{} .$$

This relation provides a general differential rule for determining the law of centripetal force. According to the geometry of a curve (e.g. circle, spiral or ellipse) and the location of the immovable point (center, focus, etc.) different relations between these three segments (*QR*, *SP* and *QT*) are obtained. When these differential relations are "integrated", they will generate different force laws. In fact, Proposition VI is followed by several problems in which Newton obtains force laws for different orbits. He shows, for instance, that $\propto 1/$ for a circular orbit around a point located on the circumference (Prop./Prob. VII) and that $\propto 1/$ to for an spiral orbit around its pole (Prop./Prob. IX).

The famous inverse-square law is derived in Propositions/Problems XI-XIII. Using the same "mathematical machine", Newton shows that if a body revolves in an ellipse (XI), hyperbola (XII) or parabola (XIII) around one focus, the centripetal force acting on it is proportional to $1/$. In sum, this means that the inverse-square law is valid for movements around the conic sections, where the center of force is located in one focus. In the inversed direction, "if any body goes from the place P with any velocity in the direction of any right line PR, and at the same time is urged by the action of a centripetal force that is inversely proportional to the square of the distance of the places from the centers, the body will move in one of the conic sections, having its focus in the center of force" (Cor. I - Prop. XIII). Therefore, if we see Kepler's 1st law (elliptical orbit with the sun at the focus) in the phenomena, with all the limitations associated with this possibility (e.g. the need of triangulation), and assume a central force we can infer (theoretically) an inverse-square law.

Proposition XV: Deriving Kepler's 3rd law

Using geometrical relations between elements of an ellipse (including the axes and the latera recta)[11], Newton shows in Propositions XIV and XV that the periodic time of bodies revolving around a common center and "urged" by a centripetal (inverse-square) force is proportional to the

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[9] The whole argument is far from being trivial. For the interested reader (especially the interested physics instructor), I strongly recommend the didactical approach proposed by Prentis et al. (2007).

[10] Newton concludes that the centripetal force is inversely proportional to the volume of the solid $\frac{\cdot}{}$. This stresses how *mathematical* is Newton's concept of force.

[11] This demonstration demands a profound knowledge of the basic elements of conic sections and their properties.

3/2th power of their greater axes. In other words, he proves, geometrically, that Kepler's 3rd law follows from the inverse-square law.

Does that mean we should assign a minor importance to the phenomena mentioned by Newton in Book III? Certainly not. Empirical data definitely played a central role in Newton's path to the law of gravitation and we learn a lot about this in Achinstein's book. But, in my view, the analysis remains one-sided if the importance of theoretical reasoning is neglected. It seems that this is related to the same old induction problem: Does the inverse-square law come directly from the data? Evidently not. Are the experimental data dispensable? Of course not!

A distinguished physics professor once told me: "Physics is like walking. One leg is experiment and the other is theory. You cannot walk with only one leg, you need both!" Newton's path to the law of gravitation seems the perfect opportunity to highlight this dual character of modern science. This duality is, of course, also of major importance for Science Education.

Chapter 4 – Maxwell's Methods

A considerable qualitative difference is noted in the beginning of Chapter 4. Suddenly, a pleasantly more objective (straight to the point) argumentation is found. Another major difference is the absence of passionate criticisms to hypothetico-deductivism. While beginning to read this chapter, I kind of got the feeling that another book (from another author) has started. In my view, Chapter 4 is the book's most relevant contribution for the Science Education community.

Achinstein begins this chapter by clearly justifying his focus on Evidence. For him, whether you are a Realist ("science aims at giving a literally true story of what the world is like") or a Constructive Empiricist ("science aims at giving us theories that are empirically adequate"), you do want to arrive at a theory you can accept. Therefore, "obtaining evidence sufficient to convince you of the truth or empirical adequacy of your theory is what you need" (p. 128). But what can you do if you are not in a position to confirm (or even to establish) a theory?

According to Achinstein, this was the situation faced by Maxwell when he tried to investigate both electromagnetic and thermodynamic phenomena. In the following sections of this chapter, Achinstein analyzes important case studies of Maxwell's work[12] with the goal of illustrating three methods used by the British theoretical physicist. These are defined as the *Method of Physical Analogy* (On Faraday's lines of force - 1855), an *Exercise in Mechanics* (Illustrations of the Dynamical Theory of Gases - 1860) and the *Method of Physical Speculation* (On the Dynamical Evidence of the Molecular Constitution of Bodies - 1875).

In Section 2 we find a comprehensive and informative (although not technical) account of Maxwell's strategy to conceptualize/mathematize Faraday's lines of force by means of his incompressible fluid analogy. Several quotations from Maxwell make clear how he consciously used this analogy as a reasoning guide and did not attempt to depict what was *actually* going on: "By a physical analogy I mean that partial similarity between the laws of one science and those of another which makes each of them illustrate the other" (Maxwell's citation on p. 132).

A crucial aspect for the usefulness of Maxwell's fluid analogy is its *mathematical character*, since it enables one to quantify the electrical force (at a point in the field) by drawing an analogy with the velocity of the fluid (at a point in the fluid). Achinstein reinforces this importance by comparing the fluid analogy with associating the motion of molecules in a gas with a "swarm of bees". The bees analogy may provide you with an image to reason about thermodynamic phenomena, but if it is not expressed mathematically it won't provide the necessary structural relations that enable you to "derive equations governing the imaginary fluid that are analogues of ones governing electrical and

[12] These case studies are certainly relevant, but they are far from being sufficient to provide a general view of Maxwell's work. Moreover, no explicit justification for choosing these particular manuscripts is offered. Overall, it seems that Achinstein knows in advance the aspects he wants to discuss and looked for Maxwell's papers that contain them.

magnetic fields" (p. 134). In my view, this aspect has been somehow neglected by educators interested in the pedagogical role of analogies in learning physics (e.g. Aubusson et al., 2006).

The following advantages of Maxwell's *Method of Physical Analogy* are presented:

1) Solving a mathematical problem in a system with which we are familiar may make it easier to solve the problem in the less familiar system.

2) A fully developed analogy can be an important device for teaching and learning science, since "the recognition of the formal analogy between the two systems of ideas leads to a knowledge of both, more profound than could be obtained by studying each system separately" (Maxwell's citation on p. 139)[13].

3) The analogy may suggest the existence of as yet undiscovered laws and properties of the original system on the basis of the ones present in the analogue system.

This section ends with an important (yet too brief) comparison between Newton's and Maxwell's goals and methods. For Achinstein, while Newton's aim is to "establish a general law that invokes a cause to explain a range of established phenomena", Maxwell's aim is to "understand a range of established phenomena without invoking a causal theory to explain them" (p. 141). It seems plausible to assume a significant difference between Newton's law of gravity and Maxwell's synthesis of electromagnetism, but I believe more effort is needed to clarify what is meant by "causal theory" and "explanation". If we consider, for instance, Rivadulla's (2005) view that a "physical construct has received a theoretical explanation when it can be deduced mathematically in the framework of a more general construct" (p. 169), it appears that both Newton and Maxwell do provide theoretical explanations. Another question not touched upon by Achinstein concerns the originality of Maxwell's method of analogy.

Section 3 is dedicated to a method called by Achinstein "An Exercise in Mechanics". The author focuses on Maxwell's first paper on kinetic-molecular theory, namely "Illustrations of the Dynamical Theory of Gases". Following other authors (e.g. Bernoulli, Krönig, Joule, Clausius), Maxwell assumes that gases are composed of spherical molecules that move uniformly in straight lines and collide elastically both with each other and against the sides of a container. Achinstein's main thesis is that there are important differences between this and the previous method (Physical Analogy).

Achinstein concentrates on Proposition IV of Maxwell's paper in which he derives his *velocity distribution law* that determines the average number of particles moving in a given range of velocities. Two theoretical assumptions are central for this derivation: i) the directions of the coordinates (i.e. velocity components) are arbitrary and ii) the existence of a velocity component x does not affect that of the velocities y or z, since these are all at right angles to each other and independent. By representing these assumptions mathematically, Maxwell is able to derive the desired expression[14].

For Achinstein, Proposition IV illustrates that Maxwell aimed at a "theoretical development" of the theory, since simplifications that were not justified empirically were made to facilitate calculations and there was no experimental way, at least in Maxwell's time, to test the velocity distribution law. In sum, what Maxwell wanted was to "lay the foundations of his investigations into the properties

[13] Another pedagogical reason for using analogies in teaching and learning physics is due to different types of learners. According to Maxwell "for the sake of persons of these different types, scientific truth should be presented in different forms, and should be regarded as equally scientific, whether it appears in the robust form and the vivid colouring of a physical illustration [or analogy] or in the tenuity and paleness of a symbolical expression" (p. 140).

[14] This is the first time in the book that a relatively technical derivation is presented and explained. Achinstein, however, does not seem to regard this derivation as essential, since he recommends his readers who "want to avoid formulas and get to the bottom line" (p. 146) to move directly to the last expression. In my view, Achinstein could have been more honest to his readers and make them aware of the limitations involved in avoiding formulas and geometrical derivations when trying to understand the "Scientific Strategies of Isaac Newton and James Clerk Maxwell".

of matter on strict mechanical principles – that is, principles, mathematically expressed – that govern bodies in motion subject to forces obeying Newtonian dynamics" (p. 151). According to the author, here lies the essential difference between "An Exercise in Mechanics" and "Physical Analogy": the former "provides a way of understanding phenomena in terms of a causal mechanism responsible for them" whereas a physical analogy "provides a way of understanding the phenomena by conceptualizing those phenomena in a useful way without necessarily indicating a cause or a causal mechanism" (p. 153)[15].

The fourth section of this chapter is dedicated to the "Method of Physical Speculation". As an exemplar of this method, Achinstein chooses Maxwell's paper entitled "On the Dynamical Evidence of the Molecular Constitution of Bodies". When seeing the word "Evidence" in its title, we can understand the reasons behind this choice. According to Achinstein, this method contains elements of the previous "Exercise in Mechanics", but a very important addition, namely that now Maxwell is worried about finding evidence to justify his use of dynamical assumptions in the explanations of observed properties of gases. Indeed, Maxwell explicitly states that "we have experimental proof that bodies may be divided into parts so small that we cannot perceive them" (p. 159). Achinstein sustains that this "experimental proof" is based on Maxwell's Theory of Heat, in which he assumes that heat is a form of energy and justifies that it has to be due to the "motion of parts too small to be observed separately" (p. 160).

Stressing Maxwell's rejection of the "method of hypothesis", Achinstein summarizes the following criteria that justified the British physicist to assume a molecular constitution of bodies: 1) *Independent warrant*: 1a) Appeals to experiment results and observations, 1b) Methodological appeal to the "fundamental" character and simplicity of the principles, 1c) Appeal to the success of these principles in other domains (e.g. astronomy or electricity). 2) *Theoretical development:* Eliminating the assumptions that molecules are spherical and collide elastically, Maxwell used one of Clausius' relation derived from classical mechanics to investigate the consequences of considering an interaction (attraction or repulsion) between the particles, and 3) *Hitherto unconquered difficulties*: Maxwell explicitly mentions theoretical results that are inconsistent with observations (e.g. law of molecular specific heats), showing his concern about the empirical validity of the theory. In sum, Achinstein concludes that "Maxwell's own belief state with regard to his kinetic-molecular theory was a confident one" and characterizes this belief as follows (p. 168):

1. He [Maxwell] believed that molecules exist and that the independently epistemically warranted dynamical assumptions about them were true.
2. He believed that he was justified in so believing.
3. He believed that neither he nor anyone else had sufficient experimental evidence to demonstrate that the assumptions he was making in the theory are true.

With these three methods it appears that Achinstein is implicitly trying to depict a chronological evolution of Maxwell's reasoning, which begins with uncompromised structural similarities (Physical Analogy), is followed by mechanical descriptions (Exercise in Mechanics), and comes closer and closer to the phenomena (Physical Speculation). As previously mentioned, the text is quite informative and insightful. However, it does not seem possible to extrapolate these case studies to a more general picture, especially without analyzing other crucial exemplars of Maxwell's work such as his *A Treatise on Electricity and Magnetism.* In particular, I wonder which one of Achinstein's methods could be applied to interpret Maxwell's displacement current, since the addition of this term to Ampère's law could hardly be justified by any sort of accessible phenomena[16].

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[15] Achinstein sustains that Maxwell also employs "An Exercise on Mechanics" (and *not* Physical Analogy) in another seminal paper on electricity (On Physical Lines of Forces), since the British physicist "shows how a purely mechanical fluid containing rotating vortices to act as idle wheels could produce electromagnetic properties." (p. 153).

[16] Readers interested in this episode can consult Chalmers (1975) or Bork (1963).

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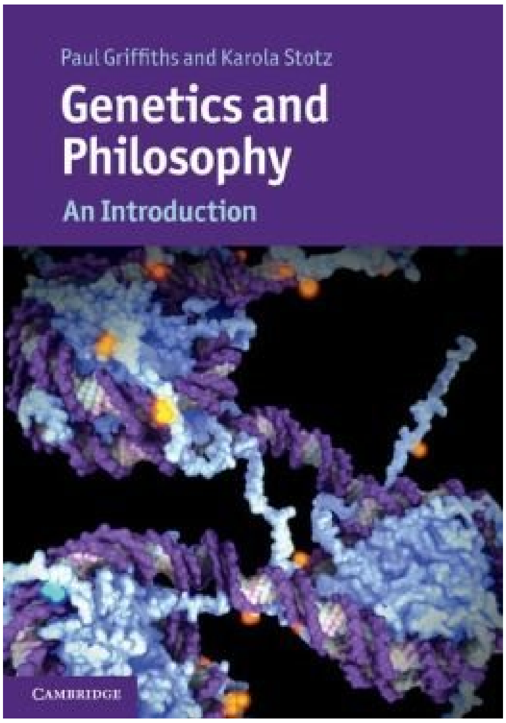
(iv) Paul Griffiths and Karola Stotz (2013) *Genetics and Philosophy: An Introduction.* Cambridge University Press, Cambridge. ISBN: 9780521173902, 278 pages, price: $ 29.99 (Paperback), $ 90.00 (Hardcover), $ 24.00 (eBook)

Reviewed by: Mike U. Smith, Department of Community Medicine, Mercer University School of Medicine, Macon, GA, U.S., email: SMITH_MU@mercer.edu



I was very eager to review this book by two of the world's leading philosophers on the subject. As the back cover says, the book is indeed a "rich" treatment of the subject; it is much more than just "An Introduction" to the field. I am always amazed at the depth of knowledge that experts in this field must have, not only in philosophy but also in biology. The biology content here is just as thorough and up-to-date as the philosophy. In fact, even though I have taught genetics and development at the medical school level for almost thirty years, there were still things I learned! In some ways, the book reminds me of a seminar for doctoral students in genetics. There are a few genetics errors, but they are of small consequence in this setting.

Depth is also a shortcoming of the book because it would be easy for the non-biologist to get lost in the detail. Thus, although the back cover also claims that the book is "accessible", I must disagree. Yes, the treatment of the philosophical issues is quite accessible (which is often not true of philosophical writing), but the biology can be tough slogging. I must wonder who the audience for this book is. Obviously, the text would be invaluable for a doctoral seminar in philosophy. Some researchers will have enough background and interest to work through the details, but this seems to be a very limited market. Readers would do well to pay particular attention to the Introduction, which gives an extended summary of each chapter's content.

As is obvious from the chapter titles (each of which includes the word "gene"), the theme of the book is the concept of the gene and how it has changed over time. The last chapter presents implications of the work in the preceding chapters for understanding the mechanism of evolution. As with so much writing in this field, the history and the philosophy necessarily go hand in hand. Perhaps a more accurate title would be something like: "History and Philosophy of the Gene". The philosophical touchstone of the text is reductionism and the question of whether early genetic understandings can be seen as a being reduced into more recent understandings (especially molecular constructions) or whether Mendelian genetics should been seen as being integrated into modern genetics.

Many readers who are not geneticists will not know that the gene concept has undergone major revisions since Mendel and his re-discoverers, such that scientists are now in a quandary about how to define the term. Some scientists are even adopting the view that it is impossible to arrive at a single definition because of all the exceptions that have been found in the living world. These exceptions have arisen from the Human Genome Project, the ENCODE Project, and their descendants, including genomics, epigenetics, proteomics, systems biology, etc. With the increasing recognition of the environment and all post-transcriptional control, for example, one interesting definition of "genes" is that they "are things an organism can do with its genome" (p. 75). The concept of the gene has indeed become a "moving target" (p. 1), "a set of contextually activated representations" (p. 6); not only is the definition trying to keep up with the literature, but different understandings of the "gene" apply in different contexts.

In terms of overall structure and content, one interesting authorial decision was to exclude any discussion of population genetics. This is regrettable, but understandable, due presumably to space limitations. A suggestion about where the reader might pursue that topic would have been useful. The inclusion of further readings at the end of each chapter is a particularly valuable contribution.

I have only one major philosophical quibble with the authors, which is that their use of the term "genetic" is so much broader than mine and that of most geneticists. The authors rightly expand the meaning to include epigenetic effects such as imprinting as a "parental effect", but I think it is injudicious to also consider nutritional provisioning, social status, language, etc. as genetic effects as well (see Chapter 5).

Therefore, I am happy to recommend this book as an in-depth treatment of the current intersection of philosophy and genetics. The effort required on the part of the reader will be well rewarded.

Offers to review books are welcome. Please send details of interest areas and CV to the Book Review Editor:

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11. Coming Conferences

September 4-6, 2014, European Society of History of Science, 6th International Conference, Lisbon
Details from: http://eshs2014.ciuhct.com/

October 17-19, 2014, 3rd Latin American Regional IHPST Conference, Santiago de Chile
Details from: Mario Quintanilla Gatica (mquintag@puc.cl).
www.sociedadbellaterra.cl/congreso2014

October 30 - November 2, 2014, International Society of Educational Research Conference, Cappadocia, Turkey: 'Science, Mathematics, and Technology Education in the 21st Century: Emerging Paradigms, Pedagogies, and Technologies'
Details at: www.i-ser.net/iser2014/

November 6-9, 2014, Conjoint Biennial Meeting of the Philosophy of Science Association and History of Science Society, Chicago, USA
Details at: http://www.philsci.org/ and http://www.hssonline.org

December 4-6, 2014, Second IHPST Asian Regional Conference, Taipei.
Details from: Dr Shiang-Yao Liu, liusy@ntnu.edu.tw
And: http://www.sec.ntnu.edu.tw/ihpst2014/

March 12-16, 2015, Philosophy of Education Society (USA), annual conference, Memphis.
Details at: http://www.philosophyofeducation.org/

April 11-14, 2015, NARST annual conference, Chicago
Details at: www.narst.org

August 3-8, 2015, 15th Congress of Logic, Methodology, and Philosophy of Science, Helsinki
Details at: http://www.helsinki.fi/clmps

12. IHPST Council (2013-15)

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13. Newsletter Items

This IHPST Electronic *Newsletter* goes direct to about 6,500 email addresses on the IHPST 'colleagues' list (which is considerably larger than the membership list), and it is also posted to various science education, philosophy of education, and HPS lists. Items for inclusion in the *Newsletter* are appreciated. These can be items for the 'Opinion', 'Recent Research', 'Recent Books', 'Books' or 'Conferences' sections.

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