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Robert E. Bradley
Department of Mathematics & Computer Science,
Adelphi University,
Garden City, NY 11530, USA
E-mail address: bradley@adelphi.edu

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Kelvin: Life, Labours and Legacy
Edited by Raymond Flood, Mark McCartney, and Andrew Whitaker. Oxford (Oxford University Press). 2008. Hardback. ISBN: 978-0199231256. 352 pp. £55.00.

Packaged in a sleek book jacket and printed on fine glossy paper, *Kelvin: Life, Labours and Legacy* appears from the outset to be a well-developed contribution to the historiography of Lord Kelvin, previously William Thomson (1824–1907)—a historiography that has increasingly sought, over the past two decades, to rehabilitate the reputation of a major 19th-century figure in natural philosophy, engineering and mathematics. As Brian Pippard explains in the foreword, Whig-oriented histories have all too often eclipsed Kelvin's brilliance by elevating in his place actors such as James Prescott Joule (1818–1889), Rudolph Clausius (1822–1888) and James Clerk Maxwell (1831–1879). Pippard tells the reader:

> Nowadays Maxwell's researches are revered and form an essential part of every physics student's lecture course, while Kelvin's hardly get a mention. To be sure, we still have the Kelvin temperature scale, but to most physicists this is little more than a token, his pioneering ideas on thermodynamics have been overshadowed by those of his friend James Joule and his German contemporary Rudolph Clausius.

Pippard therefore wonders:

> How is it that in this, and other fields where his innovations were so important, the memory of one who had been the unquestioned leader of science and technology, the versatile and prolific inventor, should fade so soon after his death? (p. v)

Presumably, one of the book's objectives is to answer that question by refocusing the light of historical analysis on Kelvin's productive and influential labour. Various contributing authors also aim to highlight the misinformed reasons for which Kelvin's reputation has so often been swept under the rug over the course of the past century. Thus, in their editorial roles, Flood, McCartney and Whitaker have attempted to produce a compendium of literature that adds to that laudable historical effort initiated two decades ago by Crosbie Smith and Norton Wise in *Energy and Empire: A Biographical Study of Lord Kelvin* [Smith and Wise, 1989], which offered a detailed and socially-aware account of Kelvin's lifetime contributions.

Indeed, in its efforts to continue debunking superficial accounts of 19th-century natural philosophy and science, *Kelvin: Life, Labours and Legacy* is a welcome addition to the history of science, particularly due to the fact that many of the contributing authors attempt to discuss Kelvin's actions, choices and scientific accounts as reasonable products of the socio-political, economic, religious and institutional contexts within which he operated. Yet, as I will discuss shortly, the book falls short of meeting its objectives in a number of important ways, rendering its price tag a questionable sum to pay in exchange for what ought to have been a more holistic and thematically unified production.

The book is set up as a tripartite analysis of Kelvin. The first section explores Kelvin's "life"; the second section explores his "labours"; the third section explores his "legacy". Each theme serves as the organizing principle for four to six individually authored essays. The range of contributing authors encompasses mathematicians and engineers, such as Sir Bernard Crossland, as well as historians of science, such as Elizabeth Garber and Peter Bowler.

In the first section, Mark McCartney, Alex Craik and I. Grattan-Guinness offer chapters that cover the basic life details of James Thomson (William's father), from his impoverished upbringing in Northern Ireland to his later efforts at self-education and promotion. Those authors also discuss James Thomson's later professorship in Glasgow, which helped to pave the way for the young William, whose appointment to the Chair of Natural Philosophy at the University of Glasgow in 1846, at the age of 22, was due in no small part to his father's institutional and academic machinations. In another chapter, the highly respected historian of science, Peter Bowler, offers an account of the engineering profession into which William's brother, James, was inculcated at the same time that William was being trained in Cambridge's analytical curriculum in mathematics. Bowler identifies James as the paradigmatic Victorian engineer, who offered a conduit through which William was able to access mechanical conceptions in hydrodynamics and engine operations. Also included in this section is a chapter on the long-running Thomson–Stokes friendship by Alastair Wood, who argues that the profound relationship between those two men, which lasted just under six decades, played an undeniable role in shaping Thomson's technical outputs, especially as they related to the transmission of signals through long underwater cables.

The second section of the book, on Thomson's "labours," covers the gamut of Thomson's scientific, mathematical and engineering efforts—most of which Thomson himself would not have viewed as being distinct disciplinary engagements. Thomson's "labours" are accounted for by a number of historians of science, including John Roche, Iwan Rhys Morus, Elizabeth Garber and Raymond Flood. In a chapter on "Concepts and Models of the Magnetic Field," for instance, Roche accounts for the role that analogy played in helping Thomson advance his understanding of particular phenomena within other natural philosophical domains of inquiry. For example, Thomson developed a number of models of "magnetic effect," later electromagnetic "energy," from imagery and mechanical models he had previously used in his accounts of heat and work. Roche also provides a useful backgrounder to vying concepts in ether theory. Thomson's argument, that the twist of the ether is the magnetic field itself, becomes a historically reasonable claim for him to have made, emerging, as it did, from his work in vortices in the 1880s. Importantly, this chapter undoes Whiggish accounts that chastise Thomson for so dearly hanging on to a concept of the ether that is so evidently "wrong" from a contemporary standpoint. Far from being unreasonable or quasi-scientific, Thomson was in fact operating at the forefront of developing notions in dynamics.

The reader will also find in this section a succinct and enjoyable account of Thomson's thermodynamics, as it developed from the early 1850s through to the 1870s. In "'A Dynamical Form of Mechanical Effect': Thomson's Thermodynamics," Morus presents the story of a relatively unknown Mancunian experimentalist, James Joule, and a French Republican military engineer, Sadi Carnot (along with his later propagandist Émile Clapeyron), in order to juxtapose their differing conceptual terrains with Thomson's. Thomson engaged with both of those actors (with Joule in person and with Carnot through Clapeyron's publication), but he did so within his own contextual milieu. The varying conceptual terrains within which each actor operated goes a fair way to explaining why Joule, Clapeyron and Thomson all held differing beliefs about the specifics of heat, work and mechanical effect. It also helps to explain Thomson's motivations, especially as they related to his efforts to legitimate particular stories about the universe that supported his theological predispositions. Similarly, Bernard Crossland's contribution, "Kelvin and Engineering," offers a detailed account of Thomson's role in developing navigational tools for ships, as well as his industrial engagement with telegraphy in Britain and North America. Not only did those engagements make Thomson a relatively rich man, but they also motivated his development of a plethora of marketable tools for use by sailors and experimentalists alike. Crossland's chapter leaves the reader with an undeniable sense of the deeply industrial and profit-driven nature of mid- to late-19th-century science.

Meanwhile, in "William Thomson's Determinations of the Age of the Earth," by Patrick N. Wyse Jackson, the reader gets a survey of Thomson's three-pronged foray into the dating of the Earth—an intellectual adventure that was motivated, primarily, by Thomson's opposition to emergent Darwinist geology, which had posited excessively long time-periods for the evolution of species into complex hominoids. Thomson's efforts to offer alternative aging hypotheses were based, respectively, on the origin and nature of the Sun's heat, the slowing of the Earth's rotation due to tidal friction, and the secular cooling of the Earth itself. In the same section, Raymond Flood offers a chapter exploring the relationship between Peter Guthrie Tait (1845–1901) and Thomson, as manifest in their hugely popular work, *Treatise on Natural Philosophy* (1867). The author explains the historical development of the concept of "energy"—a concept that was deeply tied to debates over the nature of matter. Elizabeth Garber concludes the section with an engaging account of "Kelvin on Atoms and Molecules." In her contribution, Garber makes clear that Thomson's engagement with theories of atomic and molecular structures was not just another interest the natural philosopher picked up. It was a pursuit that tied into Thomson's overarching desire, which was to establish a unifying physical theory of natural phenomena. Garber contends,

> It is only in the context of [Thomson's] search for a grand theory connecting these disparate phenomena that his pursuit of these elusive structures begins to make sense. His ultimate goal of uniting all optical, electromagnetic, and even gravitational phenomena in one theoretical net was truly a grand theory of everything physical. (p. 192)

Thus, rather than viewing Thomson as a historical figure that dabbled in many different research projects, some of which were more lucrative and productive than others, Garber suggests his scientific engagements were part of a grand project aimed at explaining the foundations of the universe. Wittingly, or not, Garber aligns herself with Crosbie Smith, who put forward a similar thesis a decade ago in *The Science of Energy Physics in Victorian Britain* [Smith, 1998].

In the third section of the book, on Kelvin's "legacy," the reader is presented with four chapters that attempt to account for the lasting influence that Thomson's work had in various fields, as well as his role as a prominent teacher and experimentalist at the University of Glasgow. The most engaging of the four chapters is Colin Latimer's contribution, entitled "Kelvin and the Development of Science in Meiji Japan." Latimer accounts for the undeniable role that Thomson, later Kelvin, played in training some of Japan's first natural philosophers and scientists, as patronized by the Emperor Meiji, who declared the restoration of Imperial rule in 1868, and who sought to modernize his country through the development of a scientific and technological research culture. Between 1885 and 1912, Latimer highlights, nearly 1000 Japanese students were sent abroad, the majority of whom studied science, engineering or medicine. In part due to Thomson's reputation from the laying of the Atlantic telegraph cable, and in part due to the reputation of Scottish universities as being at the forefront of the Clydeside's industrial boom, many of those Japanese students headed to northern Britain. A number of them studied directly under Thomson. Those students sent to Britain to train in Thomson's laboratory would later constitute Japan's first generation of scientific experts. They included practitioners such as Aikitsu Tanakadate, one of Japan's most renowned physicists. Thus, although Thomson never travelled to Japan, his approach to natural philosophic experimentation did, as his Japanese students returned to take up top posts in the country's fledgling university system.

In the same section, C.W. Francis Everitt offers a chapter that highlights the degree to which Maxwell's electromagnetism was dependent upon Thomson, thereby debunking the mythical historical line often drawn between Faraday and Maxwell as the "conceptual ascent in electromagnetism" (p. 229). Everitt accounts also for Thomson's engagement with ether theories and his continual efforts to quantify and measure the phenomenon. Importantly, Thomson's deliberation on the nature of the ether and its quantification constituted an important theme in his lectures at the Johns Hopkins University in Baltimore, Maryland, in the 1880s, where two of his "students" were Albert Michelson and Edward Morley—the experimentalists whose now famous Michelson–Morley experiment was later used as proof against the existence of the ether. Everitt suggests it was Thomson who had urged the two students (or "coefficients," as they were known at the Baltimore lectures) to engage in further research on ether as part of Thomson's own desire to ultimately quantify the elusive substance.

The final section also includes a chapter entitled, "Kelvin and Statistical Mechanics," by Oliver Penrose, in which the author offers an account of probability theory and of Thomson's early probabilistic musings (though Thomson would not have spoken about his considerations as being "probabilistic"). As Penrose explains, Thomson's belief in the dissipation of energy was, in part, based upon his view of the unlikelihood of reversibility in natural phenomena, in particular those phenomena that involved the transformation of potential energy into kinetic energy. Without using the language of probability theory, Thomson made a number of considerations that were proto-probabilistic, Penrose argues. Indeed, Penrose goes so far as to suggest that in an 1874 paper, Thomson offered what is "perhaps the first statistical mechanics calculation" (p. 260) to be found in the history of mathematics or natural philosophy. In that paper, Thomson had queried the "chances against one" (p. 260) that a jar of oxygen and nitrogen would, after a long period of time, naturally segregate, with nitrogen at one end and oxygen at the other. The unlikelihood of such an event occurring constitutes Thomson's "quasi-determinism" regarding large systems. Though he did not deny outright the possibility of such events, Thomson denied that they were likely to occur. Penrose locates a "legacy" of Thomson's in this—one that would unfold to become statistical mechanics in later years.

Kelvin: Life, Labours and Legacy offers a wide-ranging survey of Thomson's productions and natural philosophical outputs from his early career to his death in 1907. Yet, despite its broad appeal, or perhaps because of it, one of the failures of this compendium is its inability to identify a distinct audience. It is nowhere clear whether this collective contribution is intended for university students studying the history of science, professional researchers in the field, or historically untrained physics students who might not realise the role that Thomson had to play in establishing the foundations of some of the notions they study in their undergraduate textbooks. I suspect the intended audience is, in fact, physics students for whom the many short chapters in this book would constitute entirely new knowledge. It is unlikely that the collection is meant to serve as a textbook for advanced history of science students, or for professional researchers, as little new archival material is presented. In addition, many of the historical, sociological and political points made regarding Thomson's actions are summarized quickly and presented as side-stories to the main tale of his theoretical or intellectual developments, rather than as constitutive of those developments. Notable exceptions include Bowler's chapter, which situates James Thomson firmly within the Victorian culture of engineering, and Garber's chapter, which accounts for Thomson's various models of atoms and molecules by appealing to his overarching aim of constructing a grand unifying theory. But, for the most part, the book is composed of a series of chapters that largely offer succinct reviews of already published and, in some cases, well-known material. That is not to say there are not certain chapters in this compilation that would not be of interest to the professional historian of thermodynamics, mathematics, or 19th-century science in general. However, the lack of significant literature review in any of the chapters indicates that the book is intended for those with an interest in Thomson, though not necessarily a scholarly one.

Apart from the ambiguity of audience, there are some other concerns to highlight. The first has to do with grammar and proof-reading. In a work of such glossy design, it is surprising to find that some chapters suffer from a number of grammatical errors. A number of the contributions, and especially Grattan-Guinness's chapter "On the Early Work of William Thomson: Mathematical Physics and Methodology in the 1840s," suffer from missing commas and missing periods, which render parts of the book difficult to read. This leaves the reader wondering whether certain chapters were proof-read with dedicated attention, while others were whisked off to print before due care was taken to ensure homogeneous standards in compositional quality throughout.

A methodological concern to note is that many authors in this collection emphasize Thomson's "genius" and his "discoveries," rather than discussing his idiosyncratic productions or scientific creations. Roche, for instance, declares that

> In certain areas [Thomson] was an opportunist, in that he recognized the cutting edge of a variety of fields and was eager to contribute to each of them. A lesser mind, so driven, might have been an unproductive generalist, but the touch of genius—and unbounded energy—was active in each of his fields. (p. 97)

This is an unnecessary expression of genius idolatry, and references to that black-box of "genius" could have been excised without the historical tale suffering. Indeed, a counter to this genius-talk comes in Morus's chapter on thermodynamics, in which the author speaks of Thomson being in a "unique position to appreciate" (p. 124) particular claims made by his co-contemporaries, and that his "triumph was to produce a new physics that not only explained how to build better steam engines, but accounted for the age of the universe and foresaw its end at the same time." (p. 139) Rather than lauding Thomson's a-historical "discoveries," Morus situates him within his varied conceptual environments such that he becomes a producer of knowledge claims. Unfortunately, many of the chapters approach the matter from Roche's "genius"-viewpoint rather than from Morus's "unique position"-perspective.

In addition, Everitt's contribution, entitled "Kelvin, Maxwell, Einstein and the Ether: Who was Right about What?," is steeped in the language of "right" and "wrong," which is largely useless to the historian of science, as it empties the methodological claims made in the preface by the editors, who say they are searching for the 19th-century context within which Thomson's labours were temporally shaped and rendered reasonable.

One last concern has to do with the holism (or lack thereof) of the book. In the preface, the editors note that each chapter is self-contained. Therefore, they say, some repetition across chapters occurs, although "this small price is worth paying" (p. ix) in return for the diversity of contributions offered. On the contrary, I would argue, this is not a "small price to pay." Self-contained chapters are not, in and of themselves, problematic; but in an edited collection of this sort, the reader is best served by the creation of some holistic integration across sections and chapters. In the present case, the unnecessary repetition of basic life details, including items regarding Thomson's early childhood, his father's career outline, his studies at Cambridge, and his early publications, are repeated *ad nauseam* in differing chapters (in particular in the first section of the book). One is left wondering why the simple technique of cross-referencing between chapters was not employed more thoroughly? Cross-referencing, along with a conscious effort to thematically link chapters, would have helped to create a greater sense of fluid composition, rather than the seeming patchwork of selections that is currently presented. In fact, the only chapter in the entire book that attempts to link the other chapters to one another is Andrew Whitaker's "Kelvin—The Legacy," which appears at the very end as a summary chapter.

While its inclusion of well-informed historical surveys of Thomson's varied works makes *Kelvin: Life, Labours and Legacy* a useful contribution to the history of 19th-century science, the weaknesses of the overall package lead this reviewer to conclude that, at £55, those interested in the history of Thomson would do better to wait until their local library gets a copy.

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Josipa G. Petrunić
Science Studies Unit,
University of Edinburgh,
Edinburgh EH8 9LN, UK
E-mail address: J.G.Petrunic@sms.ed.ac.uk

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Plato's Ghost: The Modernist Transformation of Mathematics

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In this ambitious volume, the prolific historian of mathematics Jeremy Gray argues that mathematics underwent a "modernist transformation" in the period from 1890 to 1930.