a silver-plated spoon in his mouth, he could pay a fellow candidate in Wundt's lab for help with his experiments (making sure, as his father had impressed on him, to avoid claims to coauthorship) and another student to grind out the calculations. (Later, taking stock of his baggage in Cambridge, he counted 15 suits and 20 pairs of footwear.) And most importantly, his father, president of Lafayette College, was pulling strings incessantly, and successfully, during these years to promote his son's career.

Still, though floundering initially and troubled by attacks of Weltschmerz, Cattell had been quick to seize opportunities. Only weeks after first stepping into a psychology laboratory (in Baltimore), he thought up an experiment that was later published. After only one month in Wundt's lab in Leipzig, he designed a novel piece of apparatus enabling him to carry out his Ph.D. research. Worried one year about producing acceptable work, he had Wundt "willing, indeed anxious" to publish his research the next. It appears also that Wundt, on his own initiative, made Cattell his first Assistent—contrary to the story repeated in most histories of psychology, that Cattell had gone to Wundt and said: "Herr Professor, you need an assistant. I will be your assistant."

This anecdote appeared first in English in E. G. Boring's magnum opus, *A History of Experimental Psychology* (1929; second edition 1950), long the standard source on this subject. The major part of Boring's work, for a book covering the psychology of two centuries and two continents, was done in one year. Sokal's book, dealing with eight years in the life of a single psychologist, is the fruit of a decade of work—standards of scholarship in the history of psychology have changed in a few decades. The change was brought about largely by a handful of professional historians (and a few psychologists) willing to take the history of psychology seriously and involved, among other things, the idea of archival research and the need for a critical perspective on sources.

Yet the book is certainly not just for psychologists. In fact, the technical material is fairly limited. As Sokal's introduction points out, the documents bear on several topics in the intellectual and social history of the period. And Cattell was an important man, involved not only in early psychology but also in the organization of science and in debates about faculty governance and academic freedom in America. The book is not always easy reading (though surely easier than deciphering hundreds of handwritten letters). It is helped, at least most of the time, by extensive scholarly footnotes provided by Sokal, who winnowed 1600 documents down to the 400 printed—surely a labor of love of the subject matter if perhaps not of the subject. The effect of this selective process is hard to judge, although one wishes at times that some other material had been added. And one discovers, again, that even such extensive personal documents do not tell the whole story.

In fact, several issues of importance to historians of psychology remain unresolved, though Sokal supplies some information and opinion, for example concerning Cattell's metaphysical views, where Sokal's label of "physicalism" does not quite convince me; or on the "Galton connection," that is, Cattell's early contacts with Galton's work and their impact on his interest in individual differences, although here Sokal and the documents convince me that Cattell did not bring, ganz amerikanisch, this interest full-blown from Baltimore to Leipzig (another standard textbook story shown to be an "origin myth"); and most of all the as yet unexplained mystery, how a fledgling experimental "psycho-physic" could muster the support to equip laboratories and establish positions at a time when the "hard" experimental sciences had only a toehold in American universities and psychology had produced only the most esoteric bits of information. The notion that practical interests produced such investment seems problematic, in view of recent claims that even hard-science research aroused serious interest in only a few industries of the period. Following Sokal's hint about England, one wonders what role wealthy donors' concerns with spiritualism, psychic research, and the like played in the funding (though not founding) of the "new" psychology. Cattell's chair at Penn was not the only one to receive funds from such sources.

Finally the last mystery: Cattell the man. Here readers are explicitly left to their own devices. A brief postscript outlining Cattell's life after 1888 ends the book rather abruptly. Though the original documents make extremely interesting reading and provide valuable source material for historians, Sokal's self-effacement seems regrettable. One can only hope that a further volume will give us in more explicit form the benefits of his intimate familiarity with the life of James McKeen Cattell. In the meantime, the present volume gives us plenty of material for speculation.

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Hamilton

Sir William Rowan Hamilton. THOMAS L. HANKINS. Johns Hopkins University Press, Baltimore, 1980. xxii, 474 pp., illus. $32.50.

Sir William Rowan Hamilton (1805–1865), the most eminent of Ireland's contributors to mathematics and science, has had two biographers. In 1882, the Reverend Robert Perceval Graves, Hamilton's countryman and friend, published the first volume of his massive *Life of Sir William Rowan Hamilton*, which eventually ran to over 2100 pages. Now Thomas L. Hankins has followed with a second. In his biographers Hamilton has been doubly if differently fortunate. Whereas Graves's three volumes were in the chronological life and letters mode, laudatory but not lavishly so, honest but within the limits of Victorian decorum, and giving only such attention to the technicalities of Hamilton's creative work as an erudite clergyman might manage, Hankins's biography is analytic, more concise but comprehensive, and ambitiously aimed at integrating all the facets of Hamilton's richly productive but troubled life.

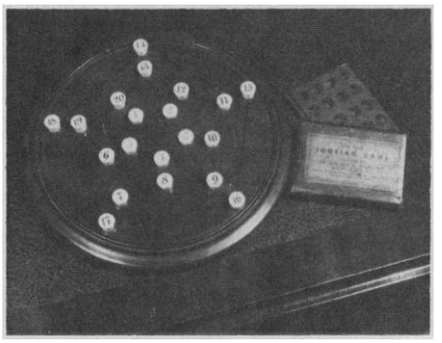
To a correspondent Hamilton once wrote: "I am most anxious that in Dublin I should be looked upon as a perfectly prosaic person, with not a bit of the romantic about him, whereas in fact my life has been a romance." So Hamilton envisioned it; so it was; and thus does Hankins present it.

Master (according to his father) of a dozen languages at 10, orphaned at 14, Astronomer Royal of Ireland and Andrews Professor of Astronomy at Trinity College, Dublin, at 21, married at 27 to the almost continuously ill Helen Bayly, knighted at 30, designated in 1863 the greatest living scientist by America's new National Academy of Sciences, Hamilton died in 1865 with a cabinet full

of medals and a locked desk packed with compulsively collected mementos of his unfulfilled love for Catherine Disney Barlow. Powerfully attracted to poetry, intimate of Wordsworth and disciple of Coleridge and through him of Kant, Hamilton was simultaneously an algebraist of extraordinary talent, a professional astronomer with no taste for observation, a Romantic idealist during the decline of Romanticism, and a husband painfully in love with a woman whose forced rejection of his early proposal of marriage nearly led him, and later did lead her, to attempt suicide. He struggled during his 20's to reformulate mechanics by means of his "characteristic function" and during most of his 30's to discover a three-dimensional analogue to ordinary complex numbers. Upon finding his quaternions in 1843, he began a crusade ending only with his death to win for them a place in the mathematics and physics of his day. A decade later he had completed his lengthy *Lectures on Quaternions*, shown fresh from the press to his dying Catherine in the most emotion-charged of their rare meetings. Convinced despite his admittedly weak and outdated knowledge of physics that they would aid physicists, he ironically failed to see that his discovery that new algebras could be created carried no certainty that his algebra was preferable to others that soon appeared. At last he found a single, distant disciple, P. G. Tait, whose efforts he alternately encouraged and retarded. His algebraic books forbiddingly abstruse, his mechanics excessively abstract, he died with the value of his ultimate contribution very much in question. Gradually, however, Hamilton's "ordered couple" justification of complex numbers became classic, his scalar and vector quaternion products were transformed into modern vector analysis, and his characteristic function and wave-particle analogy found fruitful application in quantum physics.

Victorian delicacy and loyalty led Graves to leave only hints of Hamilton's troubles with alcohol, his deteriorating family life and finances, and his involvement with Catherine, which he compulsively confessed to some and desperately hid from others of his contemporaries. With sympathy, sensitivity, and candor Hankins clarifies these matters while simultaneously sorting out the claims made to place Hamilton among the leading figures of his century.

Hankins tells his story in an easy and engaging style; his mastery of detail, everywhere evident, is nowhere burdensome. Frequently it is from the clustering of detail that his vivid portrait of Hamilton emerges, as when he notes that Hamilton "wrote incessantly, usually in notebooks of all sizes and shapes, but also on pieces of loose paper. . . . He wrote on walks, in carriages, during meetings . . . , on his fingernails if no paper was handy, and . . . even on his egg at breakfast" (p. xx). Such sentences suggest as well the difficulties faced by those who have immersed themselves in the sea of papers that inundated Hamilton's library. Graves also went through these, but without Hankins's mathematical sophistication and without the perspective of 20th-century scholarship.



William Rowan Hamilton's Icosian Game, marketed in 1869. Hamilton wrote to John Graves, "I have found that some young persons have been much amused by trying a new mathematical game which the Icosian furnishes, one person sticking five pins in any five consecutive points . . . and the other player then aiming to insert, which by the theory . . . can always be done, fifteen other pins in cyclical succession, so as to cover all the other points, and to end in immediate proximity to the pin wherewith his antagonist had begun. Whatever then may be thought of the utility of these new systems of roots of unity, suggested to me by the study of the ancient solids . . . they will be found to have supplied (a new and innocent) pleasure, not only to algebraists, but even to children." [From *Sir William Rowan Hamilton*; courtesy of Royal Irish Academy]

Definitive no biography can be that takes as its subject a figure so broadly brilliant, so personally complex as Hamilton. Specialists will inevitably dispute some of Hankins's conclusions, but most will probably find, as this reviewer has, that his analyses hold up very well. Some will no doubt wish that more attention had been given to Hamilton's mathematics, his organizational activities, or his literary, philosophical, and religious concerns. This reviewer would have liked more attention to the stabilizing effect of the witty, wise, and constant correspondence of De Morgan, more on Hamilton's apparently not very successful teaching, and more on how Hankins's interpretations differ from those of earlier authors. But few will deny that Hankins has largely succeeded in the immensely difficult task of showing how the different strands of Hamilton's thought interacted. Moreover, future scholars will derive significant benefit from the care with which he has documented his statements.

The range of Hamilton's talents and interests may frighten off biographers, but prospective readers of Hankins's biography should not be intimidated. Hankins has taken pains to ensure that those innocent of Irish politics, Fresnelian optics, Coleridgean philosophy, quaternion and icosian calculi, or the Romantics' ideals of love will not flounder. His expositions of these and other matters are clear, concise, well referenced, and illuminating in themselves.

In the difficult genre of scientific biography, where good books are rare, Hankins's *Hamilton* is excellent. Handsomely printed, generously illustrated, enriched by a useful bibliographical essay and index, this book may be recommended to scholars in a half-dozen disciplines, scientific and humanistic, and to all who enjoy an exciting story well told.

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An Italian Mathematician

Peano. Life and Works of Giuseppe Peano. HUBERT C. KENNEDY. Reidel, Boston, 1980 (distributor, Kluwer Boston, Hingham, Mass.). xii, 230 pp. Cloth, $34; paper, $14.95. Studies in the History of Modern Science, vol. 4.

Giuseppe Peano (1858–1932) is well known for his important contributions to mathematical logic, for his famous space-filling curve and his postulates for the natural numbers. In addition to writing numerous articles and books on the calculus, infinitesimal analysis, geometry, and Interlingua, as well as his influential *Formulario Mathematico* (in which he sought to provide a precise symbolic language to express all of the major results of mathematics), he was one of the founders of and major contributors to the *Rivista di Matematica*. Above all it was the special nature of his thought that led Bertrand Russell to praise Peano's "exactness of mind." Although this biography never really attempts to bring the reader very close to that quality of mind responsible for Peano's importance as a mathematician, it does provide, as Kennedy acknowl-