cating the essence of field ethology to students, but this is a hard case to put in a book chapter. Just as only seeing one of his films can really illustrate this aspect of the Tinbergen legacy, the other contributors to this slim volume have to be judged against Tinbergen's own writings; all in all, I think most students will learn more from the seemingly timeless *Study of Instinct* than from this or any other retrospective.

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Faraday at Home and Abroad

Michael Faraday: Sandemanian and Scientist. A Study of Science and Religion in the Nineteenth Century. GEOFFREY CANTOR. St. Martin's, New York, 1991. xii, 359 pp., illus. $45.

Experimental Researches in Chemistry and Physics. MICHAEL FARADAY. Taylor and Francis, Philadelphia, 1991. xviii, 496 pp., illus., + plates. $55. Reprint, 1859 ed.

Michael Faraday and the Royal Institution. (The Genius of Man and Place) JOHN MEURIG THOMAS. Hilger, Philadelphia (distributor, American Institute of Physics, New York).

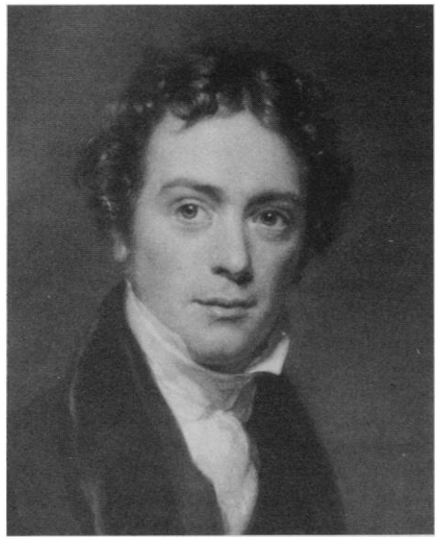
Curiosity Perfectly Satisfyed. Faraday's Travels in Europe, 1813–1815. BRIAN BOWERS and LENORE SYMONS, Eds. Published by Peregrinus in association with the Science Museum, London, 1992 (U.S. distributor, IEEE, Piscataway, NJ). xviii, 168 pp., illus. $33. IEE History of Technology Series, 16.

The Correspondence of Michael Faraday. Vol. 1, 1811–December 1831, Letters 1–524. FRANK A. J. L. JAMES, Ed. Institution of Electrical Engineers, London, 1991 (U.S. distributor, IEEE, Piscataway, NJ). I, 673 pp., illus. $95.

Michael Faraday is surely one of the best-known scientists of the 19th century. His discovery of electromagnetic induction in 1831, his early steps toward field theory, his great talents as an experimenter, and the romantic story of his rise from humble beginnings to the pinnacle of fame have made him one of the great heroes of science. In recognition of his status—not so much as father but as patron saint of the electrical age—the British Post Office issued a stamp last year to honor the 200th anniversary of his birth in 1791, and his portrait now graces the Bank of England's new £20 note. Scholars have honored Faraday's bicentenary in their own way with a whole series of conferences and publications, and the five works under review represent just part of the recent production of the Faraday industry.

Despite their diversity, these five works have a common thread: all bring out relatively unfamiliar aspects of Faraday's personality and achievements. He appears here not just in his usual guise as the brilliant electrical experimenter who could seemingly sniff out the truth or as the eloquent lecturer who enthralled fashionable audiences at the Royal Institution. We instead see Faraday as a young man making an extraordinary scientific tour of the Continent at the height of the Napoleonic Wars; as a chemist, doing both original research on new compounds and workaday analyses of water and ore samples; and as a deeply committed Christian, a member, as he told Ada, Countess of Lovelace, of "a very small and despised sect of Christians, known, if known at all, as Sandemanians."

Geoffrey Cantor's *Michael Faraday: Scientist and Sandemanian* is the first full-length study of Faraday to focus primarily on his religion and its role in his life and thought. Indeed, Cantor's opening chapters are in effect a history of the small Sandemanian sect (it never numbered more than about a thousand members) from its beginnings in Scotland in the 1730s to its gradual dissolution in this century. Although they professed a simple Biblical faith and demanded strict adherence to the literal word of Scripture, the Sandemanians were perhaps not quite as dour as they have sometimes been depicted as being; indeed, their practice of serving Scotch broth at their weekly Love Feasts won their church the popular sobriquet of the "Kail Kirk."



Michael Faraday. Portrait by H. W. Pickersgill, engraved by Samuel Cousins. [From *The Correspondence of Michael Faraday*, vol. 1]

A striking feature of the Sandemanian sect, emphasized by Cantor, was its members' strong sense of being set apart from "the world" and of forming a community unto themselves. This was reinforced by close family ties, for Sandemanians—including Faraday and his siblings—tended to marry fellow Sandemanians. As Cantor makes clear, though Faraday had many friends, particularly fellow scientists, who were outside the Sandemanian circle, his most intimate relationships, and the center of his own identity, lay firmly within his church. It formed, both literally and figuratively, his extended family.

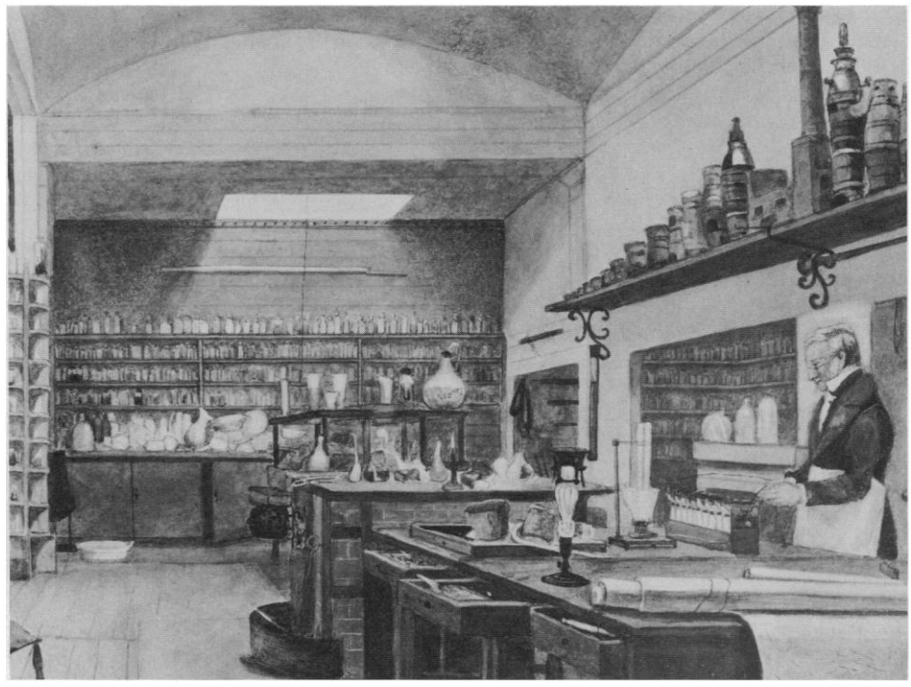
Cantor's compelling portrait of Faraday's personality is intended, he says, not as "a reductive exercise but . . . rather as an attempt to show why he was so strongly attracted both to a peculiar religious sect and to science, or, more precisely, an idiosyncratic conception of science" (p. 10). Regrettably, Cantor gives a sustained picture of Faraday's personality only in his final chapter; this might best be read first, to provide a connecting thread as the successive aspects of Faraday's life and thought are examined. Cantor's Faraday emerges as a man with a deep fear of "confusion" of any kind and a strong need to order his environment, themes that pervaded both his science and his religion. Cantor also makes a persuasive case that Faraday's religion affected his science more directly as well, notably in his conviction that nature was orderly and "economical" and that divinely ordained natural powers were indestructible, and in his caution about the speculative interpretation of experimental facts—a caution that paralleled the Sandemanians' adherence to the literal word of the Bible, without interpretation. Indeed, Sandemanian "exhortations" consisted of (carefully chosen) Biblical passages strung together with a minimum of connecting material, just as Faraday's scientific papers ideally consisted of (carefully chosen) descriptions of experimental facts strung together with a minimum of speculative interpretation.

When Cantor discusses Faraday's scientific work, he focuses on his electromagnetic researches—an understandable choice, given the undoubted importance of Faraday's contributions to electrical physics. But one of the striking points about the other works under review is the extent to which Faraday appears, especial-

ly early in his career, not as a physicist but as a chemist. This is hardly news to Faraday specialists, but it deserves to be more widely appreciated. As long as Faraday is viewed primarily as a physicist, several aspects of his work (notably his ignorance and ignoration of mathematics) are bound to appear somewhat eccentric. But when we instead view him, as he viewed himself, primarily as a chemist, many of his methods and actions, including aspects of his electromagnetic researches, begin to make more sense. When Faraday began his career, electrical phenomena had not yet been firmly placed on the physics side of the disciplinary boundary, and the study of voltaic currents and their effects was a fertile and legitimate field for chemists to cultivate. It is not so much that Faraday moved from chemistry into physics later in his career, as it might now appear, as that he continued to work in a field that was being subdivided and redefined beneath his feet.

Faraday's identity as a chemist comes across especially strongly in the reprint of his *Experimental Researches in Chemistry and Physics*, a collection of his papers on non-electrical subjects. Many readers will no doubt turn first to Faraday's "Thoughts on ray-vibrations" (1846), often seen as adumbrating the electromagnetic theory of light, or his famous "Observations on mental education," delivered before Prince Albert in 1854. But they should not overlook the numerous papers reporting on the properties of new compounds or on the liquefaction of gases, or the long memoir, the product of dogged labor over many years, on the manufacture of optical glass. J. M. Thomas, the current holder of Faraday's old Fullerian professorship of chemistry at the Royal Institution, emphasizes the importance of Faraday's chemical work in his introduction to the reprint of *Experimental Researches*, and also in his short *Michael Faraday and the Royal Institution*. The latter is not intended to add much new to our knowledge of Faraday, but it offers a lively and accessible introduction to his life and work, and especially to his relationship with the Royal Institution, which was his home, workplace, and public stage for nearly 50 years.

Faraday first came to the Royal Institution in 1813 as Sir Humphrey Davy's chemical assistant, and later that year he embarked with Sir Humphrey (and the odious Lady Davy) on an 18-month tour of the Continent, visiting scientists and geological sites in France, Italy, and Switzerland. In *Curiosity Perfectly Satisfyed*, Brian Bowers and Lenore Symons publish the journal Faraday kept of the first part of the journey (the manuscript now at the Institution of Electrical Engineers in London breaks off in April 1814, while Faraday was in Rome), together with letters and other materials that carry the story through the party's return to London in 1815. The trip was a great adventure for Faraday, who had never before been more than a few miles from London, and he showed himself to be a keen observer and a strong partisan of things English. His remarks on French cookery, as first encountered at Morlaix in Brittany, are characteristic: the hotel kitchen was primitive, he said, and "I think it is impossible for an English person to eat the things that come out of this place except through ignorance or actual and oppressive hunger and yet perhaps appearances may be worse than the reality for in some cases their dishes are to the taste excellent and inviting but then they require whilst on the table a dismissal of all thoughts regarding the cookery or kitchen" (p. 7). It is fresh and unaffected comments like these, together with his accounts of chemists he met and experiments he and Davy performed during their travels, that give Faraday's journal its value and interest.



Faraday's magnetic laboratory, with his assistant, Sergeant Anderson, at work. [Watercolor by Harriet Moore; by courtesy of the Royal Institution]

The most important recent product of the Faraday industry—in part because it is just the first installment of a massive project—is volume 1 of Frank James's edition of Faraday's complete correspondence. Selections have been published before, but James's edition is the first attempt to collect and publish all known letters to and from Faraday, omitting only those "which simply say what an excellent lecturer, chemist, philosopher, man, etc. Faraday was, or the very few that are critical of him" (p. xv). Such completeness enables us to reconstruct Faraday's life and work in considerable detail and to trace, for instance, how his scientific ambitions rose, fell, and rose again in the 1820s, or the extent of his involvement in commercial chemical analyses and other practical tasks. The editing of the letters is very thorough; indeed, it sometimes goes a bit overboard, as when a passing reference to Shakespeare in a letter of 1826 draws the footnote: "William Shakespeare (1564–1616, DNB). Playwright." For the most part, however, the notes are clear and unobtrusive, and the many letters Faraday received from Continental men of science are usefully given both in their original languages and in excellent translations by Joasia James.

The letters gathered together in this and future volumes will provide the raw material for historians' analyses and assessments of Faraday for years to come, and the availability of a compact yet complete edition of his correspondence will no doubt contribute greatly to giving us an even deeper and more rounded picture of one of the most remarkable figures of the 19th century.

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