Faraday, Maxwell, and the Electromagnetic Field- How Two Men Revolutionized Physics
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Science history as it should be written: engrossing, concise, and satisfying to the knowledgeable reader

Combining two biographies, those of Michael Faraday and James Clerk Maxwell, is a good device for telling the story of an era in science. The subjects' working lives span most of the 19th century. Though they came from different backgrounds, the two had quite a bit in common. They were incredibly hard-working. The authors go out of their way to tell how genuinely kind they were. They had a true knack for making friends and avoiding long-lasting enmities. The third virtue was of course incredible intelligence. But it seems hardly likely that Englishman of the 19th century alone her were more gifted than other populations and times. Something about that epoch allowed genius to flourish, to reveal itself fully. That epoch is the subject of this rather remarkable book.

Faraday was born as of a poor second generation blacksmith from the North Country. He had the good fortune to arrive in London at a time when the city was intellectually very alive. He could bounce between low-paying jobs giving people a chance to notice and take advantage of his talent. One of the most fortunate postings was as a book binder. The work was not mentally demanding, but it put young Faraday in contact with books. He loved to read, and quickly became quite well informed. It also put him in such with the customers for the books, some of whom took note of the young man's alertness and talents. It was not too long before he became an apprentice to the famous scientist Humphry Davy, who brought him along rather quickly

Among Faraday's attributes was being meticulous, faulting himself deeply when he failed to put out work of the quality he expected of himself. He was kind and generous, and extremely apologetic when he accidentally gave offense, as he did one a couple of occasions. It was a Christian era, and although his religiosity does not appear to have expressed itself as such, it was expressed through the way he interacted with his fellow man. The authors do not report any conflicts between science and religion in Faraday's life.

Faraday lived a long life, toward the end of which he dealt with increasing lapses of memory. It did not affect his character; he remained conscientious to the end.

The second subject, James Clerk Maxwell, was born into more comfortable circumstances, in Scotland. His accent set him apart throughout his life. He had more easy access to the university, but still had to be propelled by mentors who were attracted to his talent and guided him to the very center of intellectual life of the times, Cambridge, where he truly shone.

Maxwell, per the book, had manifested great intellect at an early age. He was extremely close to his father, who guided his early education. He published his first paper, on the use of string and fixed foci to draw complex geometric figures, when he was only fourteen. He continued to work a number of areas, including his of light, vibration, and eventually electricity and magnetism. Another early paper

won him a prize while at the university: he concluded, using an elaborate mathematical argument based on the physical properties he could assume for solid disks, liquid, and independently orbiting rocks, that Saturn's rings had to be formed from the latter. Later, one of his mentors introduced him to Faraday's writing, the deeply perceptive observations in which had yet to be explained mathematically.

Each of the men had shortcomings. Faraday never mastered mathematics. He was never able to find a mathematical language to as a vehicle to express his marvelous intuitions and the observations made in the course of his many experiments. Maxwell, on the other hand, was a great natural mathematician, preferably effortlessly coming in second in the manual mathematics competition at Cambridge, to E. J. Routh, a man who later became -renowned as a mathematician.

Maxwell's shortcoming was his inability, despite the generous good nature, to express himself cogently in an oral presentation. He wandered. He compensated for this with the precision of his writing, which the authors say made his observations of pleasure to read, and attracted him a great worldwide base of admirers.

The book does not budget many words for describing the men's personal lives. Both were married, Faraday quite happily and successfully, Maxwell to a women with whom others found to be rather shrewish but took good care of her husband. One of the young Faraday's nemeses was the wife of his mentor, Humphry Davy. She was a snobbish, overbearing and even jealous woman who made a point of putting Faraday down for his peasant roots. It is a credit to the young Faraday that he accepted all of this for general good humor. That said, the stories of personal lives are rather brief, and one should look to other biographies for more depth.

Where the authors shine is in presenting the scientific work of the two men. A temptation with a work like this would be to dumb down the explanations in the expectation that the average reader will not understand them. That expectation would be valid with respect to me. I know quite a bit about science, but many of the explanations went over my head. I only half grasped them. I'm confident, however, from the part that I do grasp and from the style in which it is written that it is a thorough and competent exposition of the ideas of these great men. I expect that it will be a satisfaction to people who have a better grounding in science see these thoughts so well expressed.

The latter chapters of the book discuss the great names in physics who built upon Maxwell's theories. An initial inertia followed Maxwell's death. He had not sought to confirm his theories by experiment at the Cavendish. His thousand page treatise on electricity was rather daunting, the field notes of the first explorer and a new field, not organized well for study.

However, a handful of scientists, here called the Maxwellians, plowed through Maxwell's work and devised experiments to validate his theories. Two of the theories which had to be laid to rest were the idea of action at a distance, exemplified by gravity, then the existence or nonexistence of the aether. The series of brilliant experiments proved Maxwell to be right, and expanded his ideas to make them the foundation of physics.

Let me note one error which escaped the technical editors. The speed of light is 300 million meters per second, not kilometers.

There is a quote from Einstein. Given the proposition that he had stood on the shoulders of giants such as Newton he replied, no, he had stood on the shoulders of Maxwell. Maxwell had stood on Faraday's shoulders, and Faraday on Newton's. The final chapter puts Einstein into the context of his time. Others were working with ideas such as the special theory of relativity, but Einstein had had the insights required to distill it down to very succinct formulations and proofs. In retrospect Einstein is often portrayed as a solitary genius. No, he was in the midst of contemporary streams of thought, distinguishing himself as a man who could see more and clarify things better than others, but strongly helped by the fervid climate of experimentation and the discoveries of others.

It is extraordinary that England's produced so many great men in the 19th century. Producing great science is a matter not only of genius, but of opportunity. One of the observations the authors make is that both these men were polymaths. They succeeded a number of fields, some quite practical such as architecture, and in several different disciplines within the sciences. This was not uncommon. Benjamin Franklin in the previous century had likewise been a great natural scientist, biologist, and physicist, among many other things. Such was the nature of the times that there was a small enough body of knowledge that it was possible to be really well read in a number of branches.

The author describes at some length how the men's experiences in different branches of science reinforced their intuitions electricity and magnetism, which is the main focus of this work. They were men who were used to working with their hands. They observed electricity in living fish and dead frogs. They were of course familiar with Newtonian physics, and with Bernoulli's fluid dynamics. James Clerk Maxwell wrote a philosophical article in his college days on the use of analogy in explaining the natural world. He made extensive use of analogies, such as between the flows of electricity and water.

An altogether engrossing book. It raises questions in my mind comparing the science of today with that of the 19th century. We seem not to be producing many young scientists of this caliber anymore, despite the fact that the schools have constructed a virtual dragnet to identify talented minds at the earliest possible age. Why not is the subject for an essay, which I may latter append to this review.