Book Reviews

Life and Work of Fourier

Joseph Fourier. The Man and the Physicist. JOHN HERIVEL. Clarendon (Oxford University Press), New York, 1975. xii, 350 pp. + plates. $31.25.

It is a matter of great good fortune that Fourier's famous *Analytical Theory of Heat* reached the light of day. Now recognized as a masterpiece of mathematical analysis and theoretical physics, it was not highly admired by the leading mathematicians at the Academy of Sciences, Laplace, Lagrange, Poisson, and Biot. They seemed to be unable to recognize Fourier's merit and worked to delay, if not actually to prevent, the publication of his work. As if this were not obstacle enough, the guillotine almost took Fourier before he even began his research. He survived because his great administrative skills were in demand and because he was able to change sides deftly as the Revolution oscillated between terror and reaction. Even so, he was in prison twice during the Terror and twice afterward. He would almost certainly have been guillotined if Robespierre had kept his head for a few more days.

Fourier held a series of positions that reveals the breadth of his competence. He taught at the newly founded Ecole Polytechnique, and was called by Napoleon to be a scientific leader in the Egyptian campaign (Fourier was editor of the *Description of Egypt*, which laid the foundation for the field of Egyptology). He then became prefect of Isère under Louis XVIII and prefect of the Rhône under Napoleon. After Waterloo he survived as director of the Statistical Bureau of the Seine, and finally became permanent secretary for the mathematical sciences at the Academy of Sciences.

The drama of this story comes out well in Herivel's straightforward reporting of it. By careful scholarship he has made it much more complete than any previous account, and he has resolved some of the ambiguities in Fourier's own recollections. Fourier always seemed to be explaining his actions after the tide of battle had turned, and it was frequently necessary for him to color the facts a bit. For instance, Napoleon's triumphant return from Elba passed through Grenoble where Fourier was situated as prefect, and where he supposedly served as a loyal subject of Louis XVIII. When Napoleon seized the city, Fourier found it expedient to flee, but he left accommodations prepared for Napoleon and his staff. Later he returned to Grenoble; but was it as an old friend, or was he captured by Napoleon as he claimed? Herivel weighs the conflicting evidence and concludes that Fourier joined Napoleon voluntarily when the royal cause was clearly lost.

Fourier's career had other oddities. He did not begin his study of heat conduction until about 1804, when he was 36, and he worked on this one problem to the exclusion of almost everything else. Because of this single-mindedness, Herivel has chosen to divide his biography into two parts: Fourier the man and Fourier the physicist. The two parts are not very well matched. The reader who has enjoyed the biographical section may find himself in difficulty when he comes to the section on Fourier's scientific work, particularly if he is not already familiar with the *Analytical Theory of Heat*. Herivel has wished to avoid duplicating the work on Fourier's mathematics done by I. Grattan-Guinness and others, and has therefore limited his treatment to Fourier the physicist. But since the physics and mathematics are so closely related the exclusion of mathematics produces some awkwardness.

Rather than attempt a general description of Fourier's contributions that would be more helpful to the reader unfamiliar with the subject, Herivel has concentrated on the development of certain specific problems in Fourier's physics. Thus he stresses the importance of the concept of heat flux developed by Fourier in his prize essay of 1811, a concept that his detractors could not seem to understand. Equally important in Herivel's judgment was the transition in Fourier's treatment of heat conduction from consideration of the heat exchanged between slices of the material of infinitesimal width to consideration of heat flow across a *section* or geometrical *surface* within the medium.

Herivel attributes much of the advance in Fourier's work to a better understanding of the physical phenomena of heat conduction. An early draft indicates that Fourier already had command of his famous trigonometric series in 1804, but it was only in 1807 after a long series of experiments that he began to understand the underlying physical processes, which he then described mathematically.

In his concluding chapter Herivel raises several interesting points, all of which merit further development. Fourier insisted that the science of heat conduction was independent of any atomic model or other mechanism for heat transfer. His contemporary Augustin Fresnel approached the wave theory of light in the same way. It may be significant that neither man made any important contribution to analytical mechanics, and they both suffered from the hostility of Laplace, Poisson, and Biot. In many ways their careers show interesting parallels and indicate a new nonmechanical approach to theoretical physics in the early 19th century. Fourier's reluctance to create atomic models is sometimes regarded as "positivistic," but what kind of positivism? He knew August Comte, who dedicated the first volume of his *Cours de philosophie positive* to Fourier. One wonders to what extent positivism has its origins in these new nonmechanical physical theories.

The final third of Herivel's book is devoted to a collection of 27 highly illuminating letters, mostly unpublished, to which the author has added explanatory notes and short biographies of persons mentioned.

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Origins of Social Science

Condorcet. From Natural Philosophy to Social Mathematics. KEITH MICHAEL BAKER. University of Chicago Press, Chicago, 1975. xiv, 538 pp. $22.

Condorcet is often the point of departure for discussions of the origins of sociology and positivism and the general development of 19th-century social science. Keith Baker's book, however, clearly shows Condorcet as the last gasp of the Enlightenment and only incidentally the first breath of the 19th century. Baker does not make a great deal of this point, although he is careful to show that St. Simon and Comte did considerable violence to the spirit and meaning of Condorcet's work as they translated it into their own idiom, for he is really more interested in social science than he is in Condorcet the man. And if social science had its beginning in the Enlightenment, then the great break of the French Revolution is a mere incident in its

growth and a sharp differentiation between the Old Regime and post-Revolutionary Europe would be of little relevance. Baker tends to view history as a continuum, emphasizing the idea of the "social field" which comes into existence through a set of polar tensions, rather than the idea of a social science assembled from a series of architectural building blocks.

Nevertheless, Baker does not relegate Condorcet to a minor position. The result is a book with two subjects, one discrete and the other continuous, reminding historians that they too must learn to live with complementary views of phenomena. What emerges is Condorcet as a focal point within the developing field, a point upon which converge all the tensions caused by the conflicting ideas that surged from the brains of the argumentative philosophes. Condorcet had the fortune, good or bad, to come at the end of an era. It was his task to imbibe all the arguments that preceded him and to attempt to resolve the most glaring conflicts. Whether or not he was aware of his historical position, it was clear that the time had come for some kind of synthesis or the efforts at enlightenment would have simply fizzled out. The outbreak of the Revolution simply made that need more urgent.

A sketch of what Baker finds recalls all the themes of the Enlightenment. Social science was to be built on the principles of human nature, which were to be derived from sensationalist psychology. The rigors of the necessary empiricism led inevitably to skepticism. No knowledge could be certain, but, unlike d'Alembert, who became morose about this outcome, Condorcet welcomed it. It meant that social science and physical science were to be built on the same epistemological bases, and this kind of intellectual consistency was a firm characteristic of French thought since the time of Descartes. Probabilism was turned by Condorcet from a defeat to an advantage, for it led to the mathematics of probability. Politics, after all, was the art of making decisions, and one could use probabilities to test the worthiness of decisions once rendered. Here is where the moral principle entered: if the number of people agreeing on a given decision reached a certain level of majority, then one could expect a corresponding probability of the decision's being the correct one. All this depended, of course, on the decision-makers' being rational, informed human beings. Hence, those who were to be charged with decisions ought to be educated. Condorcet's long preoccupation with education was the direct result. Not the least interesting aspect of Baker's story is the way in which the events of the Revolution forced Condorcet to a rapid democratization of his notions of politics and education.

None of this is very surprising, but it is good to have a steady scholar chronicle these events and ideas for us. Many other familiar themes and familiar persons are of course discussed at length in the book. Probably the best section is that dealing with the *Esquisse d'un tableau des progrès de l'esprit humain* and Condorcet's conception of history—surely a topic to warm the heart of any historian mad enough to pursue historiography. Baker goes with the traditional argument: Condorcet was not a modern historian. Progress as he conceived it had nothing to do with substantial change; it was rather a matter of perfectibility, the avoidance of error.

Now that the main themes of Baker's book have been indicated, let me raise some questions about intellectual histories in general. For intellectual historians have problems. One of them is the tendency to fall into a series of summaries of the great works of the age, and Baker has succumbed to this temptation. No doubt the works do have to be discussed, but unless one is careful the result is repetitiveness and a sense of tedium. I would argue that Baker's book is overdone, a case of scholarly zealousness that becomes self-defeating. There is an intense sense of the need for proper scholarship today, possibly a result of professional competitiveness or just of a society so riddled by double-talk that it seems essential to uphold strict standards, and perhaps I am being unfair to search for gripping interest in a work that must, after all, be true to its sources (and Condorcet was awfully like a schoolmaster). Yet elegance in writing can be found in intellectual histories, and in most cases it is found where the form is essay rather than narrative. One may argue vehemently with Charles Gillispie, with Jacques Barzun, even with the late Alexandre Koyré, but one is usually not bored by them. It is, I think, because they are masters of the situation and do not allow their material to master them. Baker has, I fear, been overcome by Condorcet. Only in the portion dealing with the events of the French Revolution does Baker's story have a compelling character that makes one wish to read faster. It is a shame, for his techniques of research must be nearly faultless, his thoroughness is enviable, and his subject is worthy of the enormous effort he has clearly put in. Baker will write other books, I hope, and if he can add some charm to his expertise he will achieve an enviable goal.

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Collision Phenomena

Atomic Collisions in Solids. Proceedings of a conference, Gatlinburg, Tenn., Sept. 1973. SHELDON DATZ, B. R. APPLETON, and C. D. MOAK, Eds. Plenum, New York, 1975. Two volumes. Vol. 1. xxiv pp. + pp. 1–478, illus. Vol. 2. xvi pp. + pp. 479–942, illus. Each volume, $39.50.

That this meeting record fills two volumes is a testament to the vigor of the field. The volumes are not elegant but serviceable, as befits a rapidly advancing field of research. As is usual nowadays, the price ensures that there will be few individual purchasers, but every research library should have a set and desk copies are recommended.

In the proceedings volumes the invited papers presented at each session of the conference are followed by contributed papers on the same general topic. The papers in one way or another relate to properties of ion beams in solids, channeling phenomena, stopping power, and efforts to probe the basic properties of solids by using energetic charged particles. Practical applications of these phenomena have been dealt with in other recent books and at other conferences convened especially for that purpose.

The first noteworthy point about the present volumes is that they contain substantial contributions by Russian scientists, five papers and two abstracts. All the Russian papers are theoretical, and they provide insight into the relationship between channeling and photon emission, surface scattering, and axial channeling in thick crystals. In fact, channeling phenomena are the subject of four of the ten sections of the book and are an essential part of the investigations reported in several others.

Some of the most interesting sections deal with atomic collision phenomena other than channeling in solids. Section 4 addresses ion screening in solids and the question of what physical mechanisms determine the charge state of an ion in a solid. It begins with an admirable review by Werner Brandt in which the physics of static and dynamic screening is clearly spelled out. Brandt goes on to discuss the consequences of screening phenomena as they influence the stopping power of solids for light and heavy ions, radiative electron capture, x-ray yields, and the charge states of ions emerging from surfaces. It is comforting to note that the basic physical concepts introduced by Niels Bohr in his classic 1948 paper are still valid as a starting point for thinking about the complex interactions that arise from the introduction of