Thermodynamics' frenetic founding father

Joseph Fourier: The Man and the Physicist

J. Herivel
350 pp. Oxford U. P., New York, 1975. $31.25

Reviewed by L. Pearce Williams

The life and career of Joseph Fourier (1768–1830) spanned a crucial time in the history of France and in the history of physics. Fourier was an active participant in the dramatic political events of the French Revolution, serving both the revolutionary governments and that of Napoleon Bonaparte. In the course of these political activities, Fourier ran considerable risks and more than once faced the distinct possibility of death as the price for his political activism. Fourier's scientific work was even more important, although it had to be sandwiched in between his political and administrative duties. Broadly speaking, the physics that Fourier learned as a youth was still that "mechanical philosophy" which had inspired Newton and the eighteenth century. It was a physics that usually depended heavily upon mechanical explanations, that appealed to ultimate material particles acting according to some relatively simple force law upon one another. This was, for example, the universe that Pierre Simon Laplace described in his great works of mathematical physics at the beginning of the nineteenth century. Fourier was to do physics in a different way. His most important work, the *Analytical Theory of Heat*, founded the science of thermodynamics and quite explicitly excluded "mechanical" explanations of heat or of anything else. Fourier was the first thorough-going and completely positivist physical scientist, and his impact upon science in France during the rest of the nineteenth century was profound.

Given the importance of Fourier's work, both in physics and in mathematics, it is curious that he attracted no biographer until quite recently. Now we have two accounts of his life and work. In 1972, I. Grattan-Guinness, together with J. R. Ravetz, published Fourier's 1809 *Mémoire sur la propagation de la chaleur*, surrounding it on both sides with an account of Fourier's life before and after 1809. Now John Herivel, the author of an earlier well-received work on Newton's dynamics, has presented us with what will probably be as close to a definitive biography as we are likely to get. Both works are worth reading. Grattan-Guinness is far more the partisan than Herivel, so he should be read for the view he offers of the bitter scientific in-fighting that was characteristic of the Parisian scientific scene in the early 1800's. Herivel is more balanced and more judicious and does not feel as free to discover hostilities and jealousies. Both cover Fourier's scientific work; Grattan-Guinness tends to emphasize the mathematical aspects, whereas Herivel gives us more of the physicist's view. Again, however, it is merely a matter of emphasis.

The great and unique value of Herivel's work is that it is the most complete account we probably will ever have of Fourier. Herivel has dug out every manuscript source and exploited it well.

Joseph Fourier. His political acumen made him Napoleon's scientific advisor in Egypt, while his great physical insight won him supremacy over the other savants of the French analytical school. The original of Claude Gautherot's sketch is at the Municipal Library of Grenoble.

His book begins with a lengthy biographical section based solidly on these sources. A second section, as long as the first, deals with Fourier as a scientist. The final part offers the only extant sustained correspondence between Fourier and another person, in this case his old teacher of mathematics. All this is exciting reading. The scholarship is impeccable, the arguments judicious and solid, and the tale well worth telling. This book should be in every physicist's library, for it is a basic part of every physicist's heritage.

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Electronic Properties of Crystalline Solids

R. H. Bube
524 pp. Academic, New York, 1974.
$35.00

Teaching the theory of solids to electrical engineering and physics seniors and graduate students is a hazardous occupation in these days of student evaluation, because few students have adequate practical experience with either quantum mechanics or phenomena in solids. Hence the teacher must simultaneously develop the students' intuitions in both subjects—and can easily find himself in the position of the novice canoeist who, having put too much weight on either the canoe or the dock, falls into the drink.

Richard H. Bube has come to the rescue of the drowning professors with *Electronic Properties of Crystalline Solids*, a modern introduction to wave mechanics as applied to solid-state problems.

Half of the book contains well-written, but more-or-less standard, introductions to wave mechanics (including perturbation theory), free electrons and band theory. The remaining, and best, sections focus on semiconductor physics, particularly on electrical conduction, impurity levels and statistics, magnetic field effects, optical absorption and photoconductivity. Surprisingly little space is devoted to devices, which presumably are to be treated separately.

I was pleased to see the many graphs of experimental data, the numerous well-thought-out problems, a balance between algebra and physics that should be tolerable to young minds and a level of physical and mathematical sophistication that increases steadily from beginning to end. The detailed discussion of electron scattering mechanisms is especially impressive, and the chapter on photoelectronic effects (a field pioneered by the author) oozes physics and insight. This is a text that students will appreciate because they will find it easy to learn from but still intellectually demanding. *Electronic Properties of Crystalline Solids* provides an excellent introduction to the wave mechanics of semiconductors.

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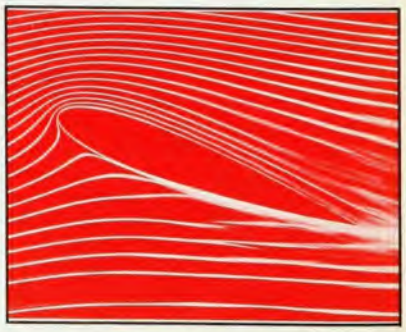
Flow Visualization

W. Merzkirch
250 pp. Academic, New York, 1974.
$26.00

Observation by the unaided eye of flowing, optically transparent or uniformly colored fluids provides limited information concerning the fluid mechanics of a given flow. Desired dynamic and thermodynamic properties of the flow may be obtained through the use of invasive and non-invasive measurement techniques. In the former, not only may it be difficult to construct a probe that will survive in the flow environment, but the presence of the probe may significantly disturb the flow itself. Non-invasive techniques, which depend upon the scattering, refraction, emission and absorption of light, are the subject of this publication.

With regard to the visualization of flow a quick division may be made between incompressible and compressible flow. The first portion of the monograph is devoted to low Mach-number flows where the investigator is able to add to the flow or generate within the flow material that is capable of tracking the fluid motion. For water the author, W. Merzkirch, discusses a variety of dyes in addition to the hydrogen-bubble techniques, whereas for air he gives several techniques for smoke generation. It has been my experience following the



Stream lines appear around model airfoil in wind tunnel. By Educational Services, Inc.