Food for thought: Physics from a historical perspective

Theoretical Concepts in Physics: An Alternative View of Theoretical Reasoning in Physics for Final-Year Undergraduates

M. S. Longair
366 pp. Cambridge U.P., Cambridge, Mass., 1984. $49.50 hardcover; $14.95 paper
Reviewed by Emilio Segrè

Undergraduate students in physics who plan to proceed to graduate study and research face a huge amount of mathematics and physics they must assimilate in a relatively short time. This heavy requirement suggests that students acquire the indispensable knowledge in the simplest and most direct way. As the contents of physics increases with time, schools are forced either to increase specialization or to find more economical ways of teaching. This problem is not new, and we can see the simplification in teaching by comparing a modern text with one of the turn of the century. The process is an ongoing one, but it has its pitfalls. Emulsified science is easily assimilated, but it does not stimulate taste, nor does it give vital nourishment. An alternative is to study from the texts of some of the great masters—in modern times, for instance, from Feynman's course.

Longair tries a different and interesting approach to redress the effect of too flat a presentation of physics. He selects a collection of theoretical topics he especially likes and treats them in a way that appeals to him, on the basis of his personality and research experience. Historical considerations and perspective loom important in his choice. The topics he selected are: Newton's law of gravitation, Maxwell's equations, mechanics and dynamics, thermodynamics and statistical mechanics, the origins of the concept of quanta, special relativity, general relativity and cosmology.

The book is derived from a course successfully taught at Cambridge University to strongly motivated students. The reader can feel, even from the written word, the enthusiasm of the teacher and audience. Some of the material is not easily found elsewhere, for instance, the chapter on the origin of the concept of quanta. This material may also not be of immediate practicality, but it gives food for thought and shows the physicist's real-life problems. I enjoyed the chapter devoted to general relativity and cosmology—subjects not too familiar to me, but topics in which the author is particularly active.

I would recommend to all physics students to find time to read at least some of the original papers of Albert Einstein, Niels Bohr, Werner Heisenberg, Enrico Fermi and others. They might learn more than just technicalities. It is also interesting to learn or review a chapter of physics out of a treatise of one of the sires such as Wolfgang Pauli or Max Planck.

This book fulfills the same purpose as a textbook, but on an extended basis, and it offers historically important material usually omitted in standard courses. The introduction carefully delineates the characteristics of the book and should be carefully perused by any prospective reader. I report one of the key sentences: "The reader should be warned of two things. First,

Orion nebula. This photograph was taken by exposing a red-light plate for five minutes in the 3.9-m Anglo–Australian Telescope. Color photography as a scientific tool is the subject of *Colours of the Stars* by David Malin and Paul Murdin (Cambridge U.P., New York, 1984). The Orion nebula is a recurrent theme in this book; the eleven photographs of the nebula range from a photo taken by Ainslee Common in 1883 to a color image obtained by the infrared detector aboard the Infrared Astronomy Satellite in 1984. Besides galactic nebulae and supernova remnants—subjects ideally suited for color photography—the more than 140 photographs include extragalactic systems, the Sun and stars. Chapters in the book discuss the role of color in astrophysics, photographic techniques used by astronomers, and detailed discussions of the photographed objects with physical interpretations of the colors. Appendixes discuss some practical aspects of astronomical color photography, making the book even more valuable to the amateur astronomer.

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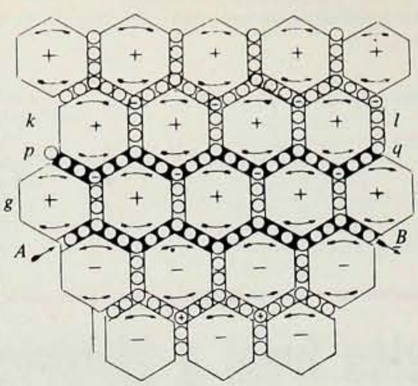

Maxwell's model of rotating vortices and current carrying particles. (Illustration, originally published in *Philosophical Magazine* in 1861, reprinted from *Theoretical Concepts in Physics*).

this is an entirely personal view of the subject. It is quite intentionally designed to emphasize all those aspects which tend to be squeezed out of physics courses because of lack of time." The book has its share of easily detected misprints; the change of Cay into Clay on page 49 is not in this category.

I heartily recommend the book for a profitable vacation reading, and as a help in digesting some of the subjects on which one has passed an examination.

James Clerk Maxwell: A Biography

I. Tolstoy
184 pp. Univ. Chicago P., 1983.
$17.00 hardcover; $6.95 paper

The Demon in the Aether: The Life of James Clerk Maxwell

M. Goldman
224 pp. Paul Harris, Edinburgh (US dist. Taylor and Francis, Philadelphia), 1983.
$30.00

The appearance in the past decade of three new biographies of James Clerk Maxwell testifies not only to growing interest in the history of physics, but also to the realization that this history is continuous: Between Newton and Einstein, there was Maxwell; between the scientific revolution of the 17th century and the advent of modern physics in the 20th century, there was the maturation of classical physics in the 19th century. The authors of the two biographies under review address themselves most urgently—although not exclusively—to the layman, who has usually heard of Newton and Einstein, but tends to know nothing of Maxwell.

Tolstoy's book is the briefer; it furnishes an available and rewarding quick read for the interested student, teacher, or practitioner of physics, as well as for that much-sought-after "lay reader." Tolstoy relies upon the standard Victorian biography, *The Life of James Clerk Maxwell*, by Lewis Campbell and William Garnett, originally published in 1882 (Johnson Reprint, New York, 1969), for the circumstances of Maxwell's life. He retails this material selectively, with appropriate supplement and interpretation, and the result is an appealing and perceptive account of Maxwell's life. The book maintains proper respect for its subject while at the same time dealing with issues that the Victorian biographers tended to suppress. Maxwell's childhood and early schooling are deftly sketched, and the difficulties he encountered in interacting with his peers at school—they called him "Dafty"—are convincingly interpreted. Maxwell's higher schooling at the Universities of Edinburgh and Cambridge, including his introduction to various scientific and philosophical ideas, is given balanced treatment. The puzzling circumstances of his marriage are broached, if not totally elucidated. Also treated well are Maxwell's religious concerns and their interaction with his science; his sense of humor, which was well exercised and occasionally verged on the eccentric; and his academic career, which had its rough spots but ended with a triumphal return to Cambridge.

Tolstoy gives balanced coverage to Maxwell's scientific contributions. Appropriately, kinetic theory and statistical mechanics, and especially electricity and magnetism, receive the most attention. There is, however, a certain tendency throughout the book to isolate Maxwell from his 19th-century context. This is most glaring in the treatment of Maxwell's work on electromagnetic theory. Maxwell, in a manner quite characteristic of British physics at the time, made extensive use of mechanical models in developing his electromagnetic theory, with varying and nuanced degrees of commitment to the reality of those models. For example, in Maxwell's celebrated "molecular vortex" model of the electromagnetic field (which played an important role in the origin of the displacement current and the electromagnetic theory of light), magnetic fields were represented by vortical motions of small, "molecular" portions of the ether, while between these there were interposed smaller, spherical particles, functioning as "idle wheels." Maxwell was careful to distinguish the basic hypothesis of molecular vortices, which he regarded as a "probable" hypothesis and a serious candidate for reality, from the auxiliary hypothesis of the idle-wheel particles, which he regarded