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physics for the minimum mathematics. Naturally the full machinery of the quantum theory of radiation is necessary in a large fraction of the book's efforts, but even in the most technical cases he has represented the material in a clear, concise and pedagogically appealing fashion. This book should be of interest to the beginning student and should have appeal to the researcher wishing to review certain aspects of quantum optics. This timely book promises to have enduring value over the next years and fully deserves the warm reception that I believe it will be accorded.

MARLAN O. SCULLY
*University of Arizona
Tucson*

The Discovery of the Conservation of Energy

Y. Elkana
213 pp. Harvard U. P., Cambridge, Mass.,
1974. \$8.50

Particularly for the teacher of physics, Yehuda Elkana's new and important book is a carefully documented treatment of the physics, biology and philosophy that was brought to bear on trying to understand the nature of force, heat, and energy and their conservation. It is a highly useful study, and Elkana, who is in the department of history and philosophy of science at the Hebrew University in Jerusalem, pursues the subject in an interesting and clear manner.

The main theme of Elkana's thesis centers on the work of Hermann Helmholtz, but he carefully lays the foundation for his discussion of Helmholtz's 1847 paper "Über die Erhaltung der Kraft" by first analyzing the tradition in mechanics, then discussing various studies in heat and energy and he includes a chapter devoted to explaining the contribution of physiologists in their search for the origins of animal heat.

Elkana analyzes Helmholtz's work in depth both from a physics and philosophy point of view, and taking as his motto a quote from H. A. Kramer: "In the world of human thought generally and in physical science particularly, the most fruitful concepts are those to which it is impossible to attach a well-defined meaning."

The book concludes with a discussion of the origin and growth of Helmholtz's scientific metaphysics and its influence on the maturation of the concept of the conservation of energy.

Students of nineteenth-century physics may quarrel somewhat with Elkana's enthusiasm for the pioneering contribu-

tions of Helmholtz to the detriment of James Joule, Couling and J. R. von Mayer, but the careful documentation he presents is persuasive in its detail and useful in its commentary. The analysis of the work of Count Rumford, Sir Humphrey Davy and Michael Faraday in particular, I found very interesting. Elkana emphasizes the lack of any conservation concepts in Rumford's contributions, Faraday's commitment to the conservation of force and gives rather more credit to Davy than many students of the subject would feel to be appropriate. The author has a very gentlemanly style of presentation and appears to be much more tolerant of Davy's early experiments on the nature of heat than most physicists who have analyzed their details would accept.

One rather odd coincidence is illustrated by the book's dust jacket. It features a large steam engine with the quote "Science owes more to the steam engine than the steam engine to science." Yet in the discussion of the "simultaneous discovers" of the energy conservation principle Elkana specifically rejects the thesis that a concern with engines was an important factor, particularly in the work of Sadi Carnot, and throughout the book relies much more on the philosophic conceptions of the scientists than any technological influences.

The book is a stimulating addition to the literature of 19th-century physics and should prove interesting to historians of science, physicists and philosophers alike.

SANBORN C. BROWN
*Massachusetts Institute of Technology
Cambridge*

Experimental Principles and Methods Below 1 K

O. V. Lounasmaa
316 pp. Academic, New York, 1974.
\$20.25

It boggles the imagination to contemplate the thousands of manhours of wasteful, redundant effort that this book will eliminate. In a pioneering research area such as millikelvin cryogenics, where the basic impediment to progress is experimental technique, the appearance of a book such as this one is a godsend to the experimenter. Even an inferior book written by a novice would be useful because it would invariably contain at least a few hints or tricks that would save untold effort. Hence Olli Lounasmaa should be applauded for merely undertaking the project. The fact that he is an expert in the field (he has established in Helsinki one of the world's leading low-temperature