peptides, and miscellaneous other compounds and pigments. Each chapter has a brief summary, and the whole is summarized in a final chapter.

As a result of having been written by a single author—no longer a common practice in our scientific community—the book is not only well balanced but also enjoyable reading. It will be a guide to many investigators in this field and also an interesting reference book for general scientists. It deserves a warm recommendation.

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A Principle of Physics

The Discovery of the Conservation of Energy. YEHUDA ELKANA. Harvard University Press, Cambridge, Mass., 1974. x, 214 pp. $8.50.

The principle of the conservation of energy was a surprisingly late addition to the principles of classical mechanics. Elkana argues that neither the conservation principle nor the concept of energy itself was firmly fixed until 1847, when Helmholtz gave them precise meaning in his paper "Über die Erhaltung der Kraft." Until then the concept of energy was in a "state of flux," and one cannot talk unambiguously about "discoverers" of the conservation law. Furthermore this state of flux is characteristic of the creative stage of conceptualization in science. Once a concept is fixed by careful definition and mathematical formulation, it becomes a part of working science, and no longer serves the same creative function as before. A concept in a "state of flux" is valuable precisely because of its indefiniteness. The principle of the conservation of energy resulted from a general metaphysical presupposition that *something* in the physical world must be conserved through all physical changes. The long history of the principle was an attempt to determine precisely what that "something" might be.

The problem as Elkana poses it is an interesting one, but his own presentation is often confusing. In his introduction he outlines a sequence of historical events which he believes must also be the *logical* sequence of discovery. He follows the historical sequence with another list of factors that "constituted a solid basis for the enunciation of the conservation principle." Since this list is quite different from the "historical" or "logical" list, the reader is left to wonder how he should weld the two together.

The list of factors that constitute the basis of the conservation principle appears somewhat suspicious. It consists of the following four items: (i) an a priori belief in general conservation principles in nature, (ii) a realization that the Newtonian and Lagrangian formulations of mechanics must be correlated not only mathematically but also conceptually, (iii) a belief that the organic "forces" of animal heat and vital forces are reducible to the laws of inanimate nature, and (iv) the certainty that whatever is conserved in nature must be expressible in mathematical terms. If these are taken to be the necessary conditions for the discovery of the principle of the conservation of energy, then the author has preselected Helmholtz as the discoverer, for Helmholtz was the man with precisely these interests, attitudes, and skills. As might be expected, the author attempts to demonstrate the relative unimportance of two other factors that Thomas Kuhn emphasized in his paper "Energy conservation as simultaneous discovery" (*Critical Problems in the History of Science*, M. Clagett, Ed., University of Wisconsin Press, 1969, pp. 321–356), that is, the "availability of new conversion processes in the 19th century" and a "concern with engines."

After the statement of the problem, the book continues with chapters on mechanics, thermodynamics, and physiology, a chapter analyzing Helmholtz's paper, and chapters on the institutional setting and the philosophical background. Each of these chapters points toward Helmholtz as the man who finally succeeded in demonstrating the principle of the conservation of energy in its greatest generality. One curious problem appears in the chapter analyzing Helmholtz's paper. The author shows quite conclusively that Helmholtz did not distinguish between "force" and "energy" as we now understand those concepts. Sometimes *Kraft* meant one thing, sometimes another, and Helmholtz did not realize that there was any ambiguity in his use of the word. We are asked to believe that this was necessary as long as he was still struggling to analyze the concept. But if, as the author asserts, the concept of energy as we know it today emerges from that paper, one would expect Helmholtz to have resolved the ambiguity. We can still ask the question: "When were the concept of energy and the conservation principle firmly fixed?"

In addition to the ambiguity and confusion in the presentation of the argument, the book suffers from a large number of errors that seem to be the result of carelessness. In the chapter on mechanics, Lagrange's equations of motion are stated incorrectly. There follows a derivation of the equations taken from Dugas's *History of Mechanics*. The derivation contains at least eight errors. These errors may be from Dugas (I have only the French edition, which gives the derivation correctly), but they remain a puzzle for the reader to unscramble. The chapter also contains a long quotation from Cavendish in which a crucial diagram is missing, so that it is impossible to follow Cavendish's argument. In the chapter on heat and energy, the basic laws of thermodynamics are taken from a modern text, but they are not quoted correctly, and the reader will struggle to give some significance to the expression $dW = -dW$, where dW is the work done by an adiabatic system. The notes present further difficulties. Some quotations have no citation at all, and when a citation is provided, as often as not there is no page reference.

There is some useful information in this book about the history of the concept of energy and the principle of its conservation, but one must be prepared to work through a great deal of confusion in order to find it.

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Fluorocarbons

Fluorine in Organic Chemistry. R. D. CHAMBERS. Wiley-Interscience, New York, 1973. xviii, 392 pp., illus. $19.50. Interscience Monographs on Organic Chemistry.

Fluorine is a unique element, and highly fluorinated organic compounds are usually considered to belong to a separate field that has little relation to normal organic chemistry. Most earlier texts and reviews in this field have concentrated on collecting data illustrating the novel properties and chemistry of fluorocarbons. A major achievement of the present book is that it effectively discusses the unique properties and reactions of organic fluorine compounds in terms of modern mechanistic organic chemistry.

Instead of trying to provide a comprehensive treatise, which would require many large volumes, Chambers has selected important and current topics to review so that an organic chemist can quickly obtain the basic information he needs to utilize fluorinated materials in his research. In the early chapters the effects of fluorine substitution (particularly on reaction centers) are clearly explained and methods of introducing fluorine are covered. These chapters are excellent. In the subsequent chapters the mechanistic approach is successfully applied in discussions of displacement reactions and of the synthesis and chemical behavior of various classes of highly fluorinated organic derivatives.

A few typographical errors are apparent even to a casual reader. Also, some references cited in the text appear to have been omitted from the reference lists, and a colleague found that several references he consulted had no relation to material discussed in the text. The index is inadequate, but from personal experience I blame this on the publisher rather than the author.

The book is readable and interesting. It is indispensable for organic fluorine chemists and should be read by most other organic chemists and by graduate students. It should be a valuable reference work in teaching because perfluorinated systems provide examples of limiting cases of certain reaction mechanisms.

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The Sun

The Solar Chromosphere. R. J. BRAY and R. E. LOUGHHEAD. Chapman and Hall, London, 1974 (U.S. distributor, Halsted [Wiley], New York). xx, 384 pp., illus. + plates. $30. International Astrophysics Series.

Although the authors argue that the energy balance in the solar chromosphere and corona is of wide interest outside of solar physics, the amount of detail in which they present the subject will limit interest in this book to specialists in the field and to students seeking definitions and an overview of chromospheric physics. Because the book collects material widely scattered through the literature, it certainly has its place in institutional libraries.

Approximately two-thirds of the book is devoted to detailed discussion of the morphology of solar spicules and the fine structure of the solar disk as defined by one observing technique: the use of the narrow-band birefringent filter to record solar structure as seen in the Hα line of neutral hydrogen. Results obtained by spectroscopic observations are hardly touched on. The concentration on the Hα chromosphere results, however, in a much-needed discussion of the many different fine structures observed in the chromosphere. The comparison of measurements obtained by many workers allows one quickly to judge for himself the reliability of empirical results. The influence of instrumental properties on the visibility of solar fine structure embedded in a semitransparent medium is not adequately discussed.

The remainder of the volume is devoted to two major topics: the construction of chromospheric models from continuum observations, and the production of the chromosphere and corona through dissipation of mechanical energy carried by waves in the solar atmosphere. The second is central to an understanding of the origin of the high temperature in the outer solar atmosphere. The chapter presenting the background theory of wave propagation and dissipation has been a useful reference for the reviewer. As the authors point out, the applicability of this theory to the energy balance problem in the chromosphere cannot be established since the requisite wave periods are not observed directly at the present time. Some of the difficulty lies in the choice of atmospheric model and the knowledge of the radiative loss function throughout the solar chromosphere. Our ability to derive reliable atmospheric models and to compute the radiative losses accurately rests squarely on the theory of radiative transfer in nonequilibrium atmospheres, but this large part of chromospheric physics is neither reviewed nor used by the authors.

The authors define chromospheric height regimes in a way that is at variance with the common designations. They define the "low chromosphere" as lying between 0 and 5,000 kilometers, the "middle chromosphere" as between 5,000 and 10,000 kilometers, and the "upper chromosphere" as between 10,000 and 20,000 kilometers. These scales give an erroneous impression of the vertical extent of the chromosphere as defined by structures other than spicules. There is ample observational and theoretical evidence that the depths of formation for the strong chromospheric lines (Hα, CaII, H, and K) lie below 2500 kilometers and that the sharp rise to coronal temperature begins at about the same height. It is this reviewer's belief that the important instabilities and energy dissipation in the solar chromosphere occur at heights below 5000 kilometers. Likewise, much of the fine structure on the disk, in both active and quiet regions, must lie at these relatively low levels; whereas we see the effects of momentum transport and, perhaps, extension of the magnetic field to the higher layers as the solar spicules. This difficulty with the geometrical scale affects the chromospheric models put forward by the authors; the temperature minimum is too broad and the temperature rise into the corona is too slow to fit spectroscopic observations. A more reasonable geometrical picture identifies the "upper photosphere–low chromosphere" as the region between 0 and 1000 kilometers where the medium is approximately homogeneous and in hydrostatic equilibrium. The "middle chromosphere" between 1000 and 4000 kilometers is the inhomogeneous layer where the Hα line begins to become optically thin and also where the rapid rise in coronal temperatures ($T_e \sim 10^6$ °K) occurs. From 4,000 to 10,000 kilometers we observe spicules and other manifestations of the chromospheric network as the characteristic features of the "upper chromosphere."

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Marine Sedimentology

Recent Sedimentary Carbonates. Part 1, Marine Carbonates. J. D. MILLIMAN. Springer-Verlag, New York, 1974. xvi, 376 pp., illus. $25.50.

During the past decade, the carbonate minerals, sediments, and rocks have been the subject of an intensive but generally uncoordinated investigation of almost unparalleled extent. They have been studied by oceanographers, chemists, mineralogists, geologists, biologists, physiologists, thermodynami-