Book Reviews

The Picaresque in Science

Count Rumford, Physicist Extraordinary. Sanborn C. Brown. Doubleday, Garden City, N.Y., 1962. xv + 178 pp. Illus. Paper, 95¢.

The career of Benjamin Thompson (1753–1814), Count Rumford (from 1792), is outstanding as an example of the picaresque in science. It took him from his birthplace, a farm in Woburn, Massachusetts, principally to Concord, New Hampshire, to London, to Munich, to London again, and finally to Paris. His chief distinction is the battle he fought, from 1778 to the end of his life, single-handedly, unremittingly, and unsuccessfully, against the prevailing caloric theory of heat, and in favor of the kinetic theory. In this connection he is best remembered for his experiment on the heat of cannon-boring, which was carried out in the 1790's at the arsenal in Munich. He deserves to be known also as the discoverer of convection. He was, further, a successful early practitioner of the application of science to technology, and the application to economic and social problems of methods that may strike present-day observers as totalitarian. In London he founded the Royal Institution and launched Humphry Davy. In Munich he created the English Garden and saved the city from becoming a battleground between the French and Austrian armies. In both cities he rose to positions of power, only to become, in the end, *persona non grata* through his arrogance, obsessiveness, and perfidy. He was variously a spy for England against the Colonies, for England against the Empire, and probably for France against England. He had two brief and unsuccessful marriages, of which the second, in his fifties, was to the brilliant Madame Lavoisier. He ended his days in a fever of experimentation and an aura of eccentricity, in Auteuil. These are only the highlights.

To give this flamboyant story the popularization for which it so clearly calls, without falling into an induced flamboyance, is a difficult feat. This Sanborn Brown has accomplished, I believe for the first time, and beautifully. Since his book is an essay rather than a comprehensive biography, it has involved the problem of selection. Brown's solution shows that he possesses a superb command of the facts. In particular, the balance between the scientific and the other aspects of Rumford's career seems excellent. The book is intended for high school students (it is a volume in the PSSC Science Study Series), and the author has evidently been at pains to make his account correspondingly simple. This has not been a drawback, but on the contrary, supplemented by the author's tact, humor, and refreshing lack of pretentiousness, it has produced a result that I find very beguiling. The book should give pleasure and profit to all, young or old, scientist or nonscientist.

In two respects I think the book could have been improved. The first, and lesser, is that it might have been instructive to mention Rumford's erroneous conclusion that in fluids thermal conductivity is zero and convection is the *only* mode of heat transport. The second has to do with Rumford's relation to the theory of heat, and I will elucidate under three headings: (i) The author mentions that Rumford learned of the kinetic theory of heat from Boerhaave's "Treatise on Fire," but he does not tell us that this theory was the *generally prevailing* one in the century or so preceding Rumford's birth. Once this is realized, one sees that Rumford was scientifically a reactionary as well as a radical; he was, to borrow Nietzsche's phrase, "of day before yesterday and day after tomorrow, only not of today." (ii) I think the epilog, and especially the statement that "the result of Rumford's antisocial attitudes was to cut him off from the very fame he sought," is misleadingly moralistic. Suppose Rumford had been successful in putting over the kinetic theory of heat. He would of course have become and stayed famous had he been twice the rogue he was. A case in point is Rumford's younger contemporary, Dalton, who, though no rogue, was notoriously antisocial and obsessive, but whose ideas were accepted. Why wasn't Rumford successful? The reason is that he was fighting, as Dalton was not, the caloric theory, which was, on the whole, doing very well, and which was to do even better before it died in the 1840's. [See T. S. Kuhn, "The caloric theory of adiabatic compression," *Isis* **49**, 132 (1958) and "Energy conservation as an example of simultaneous discovery," in: *Critical Problems in the History of Science*, M. Clagett, Ed. (Univ. of Wisconsin Press, 1959).] (iii) This leaves us with some interesting psychological questions. Why, although he could not convince his contemporaries, did Rumford keep fighting the battle for decades? Is this perhaps a further expression of his general need to dominate by proving people wrong? And in turn, could this need be his equivalent of the colonial farm boy's struggle for independence: the return—in Freudian terms—of the repressed idea in the repressing one?

I hope Brown will entertain such questions in the comprehensive biography of Rumford promised in the preface of this excellent study.

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Demonstration Models

Teaching Chemistry with Models. R. T. Sanderson. Van Nostrand, Princeton, N.J., 1962. ix + 175 pp. Illus. $5.75.

Those who have followed Sanderson's many articles on chemical bonding or who have made use of his lecture-demonstration films will welcome this presentation, in permanent and expanded form, of the subject to which he has devoted much of his career. This short, informal volume, which follows closely upon the author's *Chemical Periodicity*, is obviously a labor of love. It demonstrates admirably and in simple language the versatility and scope of the model approach to teaching chemistry, an approach applicable not only to freshman courses but to high school and advanced inorganic and organic courses as well. Sanderson, who believes that students have been expected to memorize far too much material without understanding it, states in the preface the pedagogic philosophy reflected on every page of this book: "My major interest . . . has been to find reasonable, yet relatively simple explanations of common chemistry, and to devise methods of increasing student understanding through visualization."

This is much more than a how-to-do-it book; most of it is devoted to a consideration of the more effective ways in which teachers can use models in lecture, laboratory, and displays. Although such ideas are regarded as directions by novice teachers, they will probably provide points of departure for experienced instructors. The styrofoam models, whose colors vividly depict electronegativity, partial charge distribution, and bond polarity, were originated by Sanderson, and they may be used to predict, verify, and explain not only structures but also physical properties and chemical reactions. When these models are used, students see that many familiar generalizations and "rules of thumb," previously learned by rote, are logical and consistent consequences of atomic, ionic, molecular, or crystal structure.

The final chapter presents specific instructions (including complete details) for constructing more than 400 models with a minimum of materials, time, money, and skill. Thirty-two pages of well-composed photographs of 250 atomic, molecular, and crystal models (half are in full color), 21 tables of data, and a selected bibliography supplement these directions. The order of the plates is confusing, and the tables are reproduced from typewritten copy; both detract from an otherwise superbly organized volume.

Although he is a firm advocate of the use of models, Sanderson readily admits their limitations and provides ample justification for all points that may be considered in the least controversial. His one lapse from this scrupulous objectivity is his failure to note that his own electronegativity scale is only one of several alternatives currently in use.

Teaching Chemistry with Models will be of great value to every instructor interested in making chemistry a meaningful, logical, and exciting experience for his students.

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Magnetohydrodynamics

Radiation and Waves in Plasmas. Morton Mitchner, Ed. Stanford University Press, Stanford, Calif., 1962. 156 pp. Illus. $4.50.

This collection of papers, which were presented at the fifth annual symposium on magnetohydrodynamics (sponsored by the Lockheed Aircraft Corporation) is an unmistakably good buy for the bookshelf devoted to plasma physics. Five of the seven chapters are theoretical, generally useful but of special interest to thermonuclear researchers. The book's title encompasses two principal problem areas in which theory might contribute to the goal of fusion power: loss of plasma energy by radiation and loss of plasma particles (and energy) by interaction with unstable, growing oscillations.

The symposium, which was held in December 1960, marked a climax in understanding the first problem. The clue, recognized first by the Russian theoretician B. A. Trubnikov, is that, contrary to earlier conclusions, a hot, magnetically confined plasma of anticipated densities is transparent to its own (electron) synchrotron radiation. The consequence is greater radiation loss than had been hoped. However, W. E. Drummond has found that, even with the correct radiation formula, the critical diameter of the fusion reactor is only one meter, less with reflectors to feed back radiated power. His calculation is appended to D. B. Beard's review of radiation theory in the Vlasov approximation, but it neglects all but an average interaction among particles. In another chapter, A. Simon lays the groundwork for the first-order correction to this theory by deriving Fokker-Planck equations coupling particles and fields. Since the symposium, Simon has been able, with his more elaborate theory, to confirm Trubnikov's radiation formula in the thermonuclear regime.

The second problem, instabilities, remains a challenge. Two chapters of this book are, in part, aimed at broadening the methodology of stability analysis. I. B. Bernstein attempts to extend conventional modes of analysis to spatially nonuniform cases. O. Buneman obtains a systematic derivation of plasma conservation laws (energy and the like), known, for example, to account for stability of the Maxwell distribution.

In other chapters, J. E. Drummond examines wave propagation in plasmas, with emphasis on the coupling between plasmas and radiation fields. G. S. Kino discusses experiments designed to test the theory of plasmas in thermal equilibrium, and the laboratory observation of Alfven waves is discussed by J. M. Wilcox, A. W. DeSilva, W. S. Cooper III, and F. I. Boley.

The well-made book contains numerous references (an average of 17 per chapter), but, regrettably, no index.

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Observation, Not Speculation

Fact and Theory in Cosmology. G. C. McVittie. Macmillan, New York, 1962. 190 pp. $3.95.

G. C. McVittie's *Fact and Theory in Cosmology* is the third in a series of books edited by Colin A. Ronan and designed to fill the gap between the many elementary astronomy books, on the one hand, and the numerous advanced monographs, on the other. McVittie, an expert in the fields of cosmology and relativity, effectively presents this difficult material on an understandable level. He bases his discussion on observations rather than on airy bubbles of pure speculation, and one gets the impression that he, like Herbert Dingle, prefers "calling a spade a spade and not a perfect agricultural principle." The observables in question are: the red-shift in the lines of the spectra of galaxies; the optical apparent magnitudes of galaxies; the flux-densities of those galaxies which are radio sources; the numbers of galaxies; the diameters of extragalactic radio sources; and the characteristics of clusters of galaxies. The observable data, however, are often all too scanty or imprecise and frequently subject to unknown systematic errors and to errors of interpretation. But McVittie is director of the most powerful radio telescope in this country (the recently dedicated instrument at the University of Illinois), and this instrument, which consists of a parabolic cylindrical reflector 400 by 600 feet, should soon provide accurate new observations of thousands of distant radio galaxies.

An introductory chapter on the nature of cosmology is followed by a discussion of distance in the universe and then by a chapter on the system of galaxies. The next three chapters, which are the most difficult, deal with cosmo-