which he was the major sponsor. His book *The Decline of Science in England* was largely responsible for legislative reform of British science.

Babbage also stands out for his commitment to the application of science on behalf of society. He developed the techniques of operations research to apply to the problems of the post office, the railroads, and the factories. He was the inventor of numerous industrial processes and equipment and consultant for many more. More than any other scientist of the time, he was familiar with current industrial practices and was well known to most craftsmen interested in extending Britain's fortunes of the industrial revolution through the application of science.

One of Babbage's inventions, the one by which he is best remembered, on which he spent the most effort and expense, and which is the main focus of this book, is his computing machinery. Actually, he conceived two distinct machines, the difference and the analytical engines, as well as various refinements of each. The difference engine, steadily improved from its conception in 1820, was a machine capable of mechanically calculating polynomial expressions by means of the method of finite differences. The analytical engine, first conceived in 1834, was a mechanical computer theoretically equivalent in processing ability to the general-purpose, stored-program computer of today. Neither machine was fully constructed, and only a section of the difference engine was ever working during Babbage's lifetime, owing to problems of finance, lack of government support, shortage of talented craftsmen, lack of precision in manufacturing skills, and ambitiousness of scale of project.

Hyman's main intention in this biography is to explicate the development of what he considers Babbage's primary concern, his computing engines. In this, he has but mixed success. He does not discuss the mathematical or mechanical details by which the engines were to be constructed and to operate. The lack of these details will be a serious disappointment to the scientific reader. Fortunately, the author is much better at detailing the complex political machinations over the government's responsibility to finance construction of the engines and the significance of this issue to the evolution of the British government's policy on the support of science and technology. The book is useful as well in providing the best available chronological accounting of Babbage's work on the engines and for its inclusion of numerous illustrations and blueprints of the machines.

Superficially, this work has the appearance of an intellectual biography and appears to follow the standard canons of academic biographies. It is well footnoted and includes a thorough, annotated bibliography. The reader is quickly impressed with the wealth of information about Babbage and his circle of friends that Hyman collected over a number of years. Unfortunately, the structure belies the author's apparent intentions. Hyman seems to have included every scrap of information he has located and is often led far from his theme. He includes far more than is warranted or interesting about the lives of Babbage's family and close associates and clutters the text with irrelevant anecdotes for entertainment value.

The historian will be disappointed with Hyman's scholarly analysis. He makes a number of interesting and controversial claims about British and Continental science, often contrary to current historical consensus, without providing adequate argument or fact to support them. In the first chapter, for example, he claims that 18th-century British science was not as stagnant as current scholars believe; that before the 1830's there was no clear line demarcating science from technology; and, ignoring for example the 18th-century engineering schools, that not until Napoleon's time was science seriously employed for practical aims. All these claims are made without an attempt at substantiation.

The book is considerably more successful at portraying the social and intellectual life of the intellectual and political elite in Britain and on the Continent from 1820 to 1860. Babbage traveled widely and was familiar in literary and political as well as scientific circles. His associations with William Herschel, Louis Napoleon, and Charles Dickens, for example, are ably illustrated and punctuated by charming anecdotes. Though the book does not accommodate the scientist's interest in technical details, studiously ignores Babbage's pure scientific and mathematical accomplishments, and is less than satisfactory for the scholarly historian, it does provide several pleasant evenings of reading and paints a detailed portrait of the interchange of science, technology, and intellectual life of Babbage's time.

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Celestial Mechanics

Applications of Modern Dynamics to Celestial Mechanics and Astrodynamics. Proceedings of an institute, Cortina d'Ampezzo, Italy, Aug. 1981. VICTOR SZEBEHELY, Ed. Reidel, Boston, 1982 (distributor, Kluwer Boston, Hingham, Mass.). xviii, 374 pp., illus. $43.50. NATO Advanced Study Institutes Series C, vol. 82.

Celestial mechanics contains a diversity of research interests ranging from practical problems of astrodynamics and orbital mechanics to theoretical dynamics. Yet these proceedings of a NATO Advanced Study institute highlight certain themes uniting these different topics.

A welcome aspect is that the papers are, for the most part, expository surveys of recent developments in the field, not research reports. Nevertheless, I seriously question the advertisement that this work is "suitable for use as a textbook in graduate and advanced undergraduate courses in the fields of astronomy and aerospace engineering"; it requires more sophistication than that. (Advanced graduate students could handle some specialized topics.) On the other hand, although the title implies that the book is intended for a certain interest group, other researchers may find it of value.

Several themes unite the "theoretical" and the "practical" papers in the book, and one is random behavior—ergodic and chaotic motion. A selective theoretical survey of this topic is contained in a paper by R. W. Easton on "twisted link mappings." He reviews his own and others' research concerned with the existence of orbits in which the closure of the orbit has positive Lebesgue measure and with maps that are close to twist maps. A related paper by T. Petrosky and I. Prigogine examines the Kolomogorov-Arnold-Moser invariants in light of the statistical mechanics developed by Prigogine and his co-workers. L. Galgani examines the dynamical foundations of classical statistical mechanics. The practical applications of some of these ideas are underscored in a paper by J. D. Hadjidemetriou in which he discusses destabilizing factors in planetary and asteroidal orbits and in a paper by Szebehely warning of some of the practical difficulties caused by problems in celestial mechanics. Somewhat related is a paper by O. Gürel, which is a review of part of the developing subject of dynamical bifurcation (for example, the Lorenz attractor in turbulence theory and the Rossler attractor. As a balance

to the references in the paper, I would like to call attention to work by J. Guckenheimer and by R. Williams).

A large number of fields that rely upon models of nonlinear differential equations are plagued by resonances; celestial mechanics definitely is one of them. As just one of many examples, the planet Mercury, in its rotation about the sun and about its own axis, is in a resonance state; is this an accident, or did the dynamics force this behavior to be "captured into resonance"? There are several emerging ways to attack various resonance questions, and one is represented here by J. Henrard's development and application of the adiabatic invariant. Other more specialized treatments are represented by P. J. Message's analysis of planar three-body problems and by B. Garfinkel's review of his "ideal resonance problem" and his work on the Trojan asteroids. (These are the asteroids that are strongly influenced by the Sun-Jupiter system. The key members of this family are located at the vertices of the equilateral triangles in which both the plane of motion and the base of the triangle are defined by the motion and the locations of the Sun and Jupiter.) K. Aksnes relates resonances to other problems coming from astronomy in his paper on that most current topic, the rings of Saturn and of Uranus. (A companion paper by G. Colombo considers satellites of Saturn.) As part of his discussion, Aksnes reminds us of the Kirkwood gaps; these are gaps in the distribution of asteroids that are described in terms of resonances. Some of these resonance zones are populated whereas others are avoided. Why? Hadjidemetriou's paper sheds some light on the problem, but it remains unresolved.

The conference also included topics more specialized to celestial mechanics. I'm not familiar with lunar theory, so I found J. Kovalevsky's introduction to some of the modern problems very interesting. (I was unaware of how fast technology had outstripped theory—lunar laser technology demands an analytic theory with internal precession of better than 10 centimeters. This demands a theory that will include even relativistic corrections. As a result, I was intrigued by a related paper by S. Coffey, represented in the book only by an abstract, in which he claims to have developed a higher-order analytic satellite theory.) Other more specialized topics are discussed in papers by C. Marchal and J. Waldvogel on the behavior of collisions, A. E. Roy on the possible ways to interpret n-body hierarchical systems, and U. Kirchgraber on invariant manifold theory. More practical concerns are raised by R. O. Vicente, who outlines the merits of an agreed-upon reference system for Earth dynamics, and P. van de Kamp, who describes perturbations in stellar paths.

The book is a potpourri of topics, of approaches, and of research interests. Some of the papers trace their birth to practical considerations, others to more theoretical ones. Yet, similar themes tie papers and their various concerns together.

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Cyanocobalamin

B_{12}. DAVID DOLPHIN, Ed. Wiley-Interscience, New York, 1982. In two volumes. Vol. 1, Chemistry. xvi, 672 pp., illus. Vol. 2, Biochemistry and Medicine. xvi, 506 pp., illus. The two-volume set, $130.

An earlier treatise on vitamin B_{12} (*Second European Symposium on Vitamin B_{12}*, H. C. Heinrich, Ed., Enke, Stuttgart, 1962) is prefaced by the statement "B_{12} is not a vitamin—it is a fraternity." The intervening 20 years bear testimony to a continuing and deepening interest in the multifaceted chemical, biochemical, and medical problems posed by this most complex organometallic natural product. The latest work brings together 29 papers encompassing the literature of B_{12} in a critical and frequently stimulating way. Volume 1, which is largely devoted to structure, synthesis, biosynthesis, and chemical reactivity, provides an encyclopedic account of these topics that will serve as important reference material for both novice and expert. This reviewer particularly enjoyed the more controversial papers in which attention is drawn to the many unsolved problems concerned with the mechanism of action of coenzyme B_{12}, a topic still largely shrouded in mystery. These critical reviews, by B. T. Golding, J. Halpern, and J. M. Pratt, indicate a wide range of fascinating subjects for future investigation. The remaining contributors to volume 1 provide comprehensive coverage of the structural, spectroscopic, and biochemical data, which allows the reader to attempt the solution of the mechanistic puzzles and to follow this exercise with a perusal of the biochemical details fully elaborated in volume 2 without recourse to the primary literature. In fact, volume 2 contains a series of beautifully written and highly detailed papers that not only provide complete background to the ten main biochemical reactions catalyzed by coenzyme B_{12} but in some cases contain sufficient experimental data to allow a reader to perform the requisite enzymology. The volume is nicely balanced, with up-to-date coverage of transport, binding, and analysis. The theme throughout both volumes is one of excitement and challenge in unraveling the synthetic, biosynthetic, and mechanistic problems posed by the corrin family. Since the main structural, stereochemical, and synthetic problems relating to B_{12} itself have now been solved, the whole emphasis of research is on mechanistic details of mode of action (including mimicry), transport, metal-free corrins, and intrinsic factor, all of which are discussed in depth in the book. Some idea of the complexity of studying the cleavage and formation of the cobalt-carbon bond in vivo is conveyed by discussions of the controversial nature of the various model reactions in chapters 10, 14, and 15 (volume 1). Much definitive work is needed on this subject.

In my view, *B_{12}* will find a lasting place not only as a well-thumbed workbook in all laboratories connected with research on corrinoids but as a valuable and comprehensive reference source for organic and inorganic chemists, biochemists, theorists, clinicians, and physicians.

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Books Received

Administrative Law. The Law of Government Agencies. Stanley A. Reigel and P. John Owen. Ann Arbor Science (Butterworth), Ann Arbor, Mich., 1982. xii, 138 pp. $15.95.

Advanced Views in Primate Biology. Papers from a congress, Florence, July 1980. A. B. Chiarelli and R. S. Corruccini, Eds. Springer-Verlag, New York, 1982. x, 268 pp., illus. $45.60. Proceedings in Life Sciences.

Advances in Atomic and Molecular Physics. Vol. 17. David Bates and Benjamin Bederson, Eds. Academic Press, New York, 1982. xii, 434 pp., illus. $58.

Advances in Microbial Physiology. Vol. 23. A. H. Rose and J. Gareth Morris, Eds. Academic Press, New York, 1982. x, 270 pp., illus. $43.50.

Advances in Physical Geochemistry. Vol. 2. Surendra K. Saxena, Ed. Springer-Verlag, New York, 1982. x, 356 pp., illus. $39.80.

Alkalophilic Microorganisms. A New Microbial World. Koki Horikoshi and Teruhiko Akiba. Japan Scientific Societies Press, Tokyo, and Springer-Verlag, New York, 1982. xii, 214 pp., illus. $39.80.

Amateur Astronomer's Handbook. J. B. Sidgwick. Revised by James Muirden. Enslow, Hillside, N.J., ed. 4, 1982. xx, 568 pp., illus. Paper, $7.95. Reprint of the 1980 edition.

Analytical Chemistry in Nuclear Technology. Proceedings of a conference, Gatlinburg, Tenn., Oct. 1981. W. S. Lyon, Ed. Ann Arbor Science (Butterworth), Ann Arbor, Mich., 1982. xii, 402 pp., illus. $29.95.

Analyzing Natural Systems. Analysis for Regional Residuals—Environmental Quality Management.

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