(that is, $\sum_{i=1}^{n} i^k$); of Napier's calculation of logarithms; of Newton's formulation of the binomial series; of Leibniz's "arithmetical quadrature of the circle" (that is, $\pi/4 = 1 - 1/3 + 1/5 - 1/7 + \ldots$) by means of transmutation of areas.

On the one hand, then, Edwards's books adds nothing new to current understanding of the history of the calculus. Drawn substantially from secondary literature in English, it portrays the same figures and, for the most part, the same aspects of their work as any one of several standard histories (such as that of Carl B. Boyer); here as elsewhere the rich problem structure of early analytic mechanics remains untouched. Yet, on the other hand, the book stands on its own as a contribution to the literature, especially to that part of the literature addressed to the use of history in the mathematics classroom. For in his emphasis on problem-solving rather than on theory-building, Edwards treats past methods as serious mathematics in their own right, worthy of detailed and sympathetic exposition aimed at showing what they accomplished rather than at judging their limitations in comparison with more recent techniques. Edwards encourages his readers to explore the material for themselves by tackling exercises either drawn from the historical sources or designed to point up special features of the technique in question. As perhaps no other book outside the monographic literature does, Edwards's survey shows vividly that doing the history of mathematics means doing mathematics, often with challenging variations in the rules of the game.

But doing history of mathematics also means doing history, and at a certain point Edwards ceases to meet that challenge. It is the point at which, to convey the content of past mathematics, he strips it of its context, most notably by translating it entirely into modern notation, and hence inevitably into modern concepts. One example will have to suffice here. On p. 15 Edwards begins his presentation of examples from Book XII of Euclid's *Elements* with a proviso:

> In order to spare the reader a heavy burden of geometric algebra and Eudoxian proportions, our exposition will make free use of real numbers and modern algebraic notation. However, in order to preserve the original flavor and spirit as carefully as possible, we will follow closely both the geometrical constructions and the logical sequence of the proofs presented by Euclid.

The original flavor and spirit of Book XII of the *Elements* rest on Eudoxus's and Euclid's elaborate circumvention of the conceptual hurdles that in Greek mathematical thought separated discrete number from continuous magnitude. To sweep those hurdles aside by the free use of real numbers is to abandon both flavor and spirit and to make the logical sequence of the proofs seem strained at best.

MICHAEL S. MAHONEY
Program in History and Philosophy of Science, Princeton University, Princeton, New Jersey 08540

Chain Polymers

Scaling Concepts in Polymer Physics. PIERRE-GILLES DE GENNES. Cornell University Press, Ithaca, N.Y., 1979. 326 pp., illus. $38.50.

Pierre-Gilles de Gennes is a master of the simple, apparently easy, explanation of complex phenomena, and this book shows off his skills in a brilliant fashion. The systems treated, chain polymers, include molecules with very complex chemical structures. Yet, as was shown by the early workers in the field, notably Flory, when the molecular size is large enough new simple features emerge. In particular there appear univeral laws describing the static and dynamic properties of the system. This is somewhat reminiscent of the universality embodied in the thermodynamics of macroscopic systems. Our understanding of these universal laws has been greatly extended, experimentally and theoretically, in recent years. De Gennes has played a key role in these developments, and in this book he tries to describe them in an intuitive, albeit mathematical, form. In this he greatly succeeds, and the book is a most welcome addition to the literature on the subject.

The book is divided into three parts: Static Conformations, Dynamics, and Calculation Methods. The first part, which makes up about half of the book, consists of chapters on single chains, polymer melts, polymer solutions in good solvents, incompatibility and segregation, and polymer gels. As may be seen from the chapter headings, the book deals primarily with the theoretical aspects of the physical properties of long flexible chains in solution, melts, and gels; crystallization kinetics and glass transitions are examples of subjects not treated at all because "in these areas we do not know whether or not scaling concepts will be really useful."

The key to the understanding and derivation of universal laws for polymer chains as developed in the book is indicated in the title. It is the concept of scaling, which is used over and over again in a variety of forms. An example of a scaling law, first discovered by Flory, that plays a central role in all parts of the book is the power law dependence of the size R (root mean square of the end-to-end distance) on the number N of monomer units in the chain. For N large enough $R = KaN^{\nu}$ with ν a universal exponent very close to its Flory value of .6. It is the same for all kinds of polymer chains in a good solvent at very low concentrations, ideally an isolated chain. A good solvent is one in which there is a net repulsive force between two monomers that depends on their spatial distance from each other—no matter how far their chemical distance along the chain. This repulsion is further assumed to be characterized fully by a single "excluded volume" parameter ua^3; u enters into the coefficient $K(u)$ and a is the coherence length in a chain without excluded volume interactions (a = unit size in a completely flexible ideal chain) when $R = aN^{\frac{1}{2}}$. Note here the supposed abrupt change in the exponent ν at $u = 0$; it is $1/2$ for an ideal chain and $3/5$ for a chain with excluded volume. This is of course possible only because the scaling law refers to the asymptotic, very-large-N, behavior of the size R.

De Gennes gives, in the first chapter, a clear exposition of Flory's derivation of this scaling law. He then outlines in the last chapter a more systematic method for finding R when N is large. The method is based on renormalization group ideas used for critical point phenomena and makes strong use of the idea of scaling; the chain is repeatedly divided into groups of g units, after m steps there are (N/g^m) blocks, and R is assumed to satisfy the self-similar relation for all m

$$R_m = a_m f(N/g^m, u_m)$$

with a_m and u_m determined recursively starting from $a_0 = a$, $u_0 = u$. This leads to a "fixed point" for the block-block interaction $u_m \rightarrow u^*$ and $f(N,u^*)$ = constant $\times N^{\nu}$.

The book's smooth style may sometimes lull the reader into a false sense of confidence in his or her grasp of the material. A true understanding requires diligent reading and much thought—the concepts only appear easy. The author, like many other brilliant expositors, is not above slipping one by the unwary reader. For example, Eq. I.24 defines the probability distribution for the end-to-end distance r for $r >> a$ but the form is then used in Eq. I.29 for $r = a$ to derive relations between certain exponents. These exponents, denoted by Greek letters, ν, α, β, γ, are ubiquitous in the book. They are, of course, very reminiscent of critical phenomena, and in chapter 10 de Gennes very clearly describes the analogy, first discovered by him, between the two. Briefly, N^{-1} plays the role of $(T-T_c)/T$, the deviation of the temperature from its critical value, and R is analogous to the correlation length which diverges at T_c; $\nu = \frac{1}{2}$ then corresponds to a mean field exponent.

The above is intended to give some flavor of the calculational complexity in the book. The book in general contains very few computational details. The author steadfastly keeps his eyes on the universal features and ignores "numerical coefficients in most formulas, where they would obscure the main line of thought." As further stated in the introduction the book "is meant for experimentalists in polymer science who wish to incorporate the recent advances into their modes of thinking." In my opinion "experimentalists" is far too restrictive. I recommend the book to all scientists, experienced or beginning, interested in the subject of polymers.

JOEL L. LEBOWITZ
Department of Mathematics and Physics, Rutgers University, New Brunswick, New Jersey 08903

Control Theory

A History of Control Engineering, 1800–1930. S. BENNETT. Published on behalf of the Institution of Electrical Engineers by Peter Peregrinus Ltd., Stevenage, England, 1979 (U.S. distributor, INSPEC/IEEE, Piscataway, N.J.). x, 214 pp., illus. $35. IEE Control Engineering Series 8.

Applications of the concept of feedback developed in three stages. The first extended from antiquity to the invention of the mechanical governor at the end of the 18th century; the second was the development of control theory as a scientific discipline, before the advent of electronic control; and the third runs from around 1930 to the present. The first period was the subject of Otto Mayr's *Origins of Feedback Control*, which MIT Press published (in translation from the German original) in 1970. The present volume traces the second period, with some overlap at either end. The history of the third period remains to be written.

Although control theory is regarded largely as a branch of electrical engineering nowadays, it is appropriate that this account, which was commissioned by Britain's Institution of Electrical Engineers (IEE), was written by a mechanical engineer. From him we learn that control theory was first elaborated on the basis of mechanical devices such as regulators of the speed of steam engines and other prime movers; that the use of the governor by scientists led them to study its dynamics and to formulate stability criteria; that the first servomechanisms were steam steering engines that came into use in the 1860's, closely followed by hydraulic servos for the control of torpedos and ship stabilizers, decades ahead of the gyroscopes developed by Sperry and others in the early years of the 20th century; and that the first electrical applications were in the control not of rotating machinery but of the gap width of arc lights. To be sure, Bennett does not merely chronicle "firsts" (although they are recounted and meticulously documented), he takes us through a *catalogue raisonné* of the contributions made by Airy, Poncelet, Maxwell, Vyshnegradsky, Stodola, Lyapunov, and above all Edward John Routh (1831–1907), the Canadian-born mathematician who was senior wrangler in the Cambridge mathematical tripos of 1854, the year Maxwell came second. In recent years Routh, who was Airy's son-in-law, has come to be regarded as the founder of stability theory and his *Treatise on the Stability of a Given State of Motion, Particularly Steady Motion* (1877) as a seminal work. In the U.S.S.R., he is recognized as Lyapunov's precursor; and in 1977 the IEE commemorated the centenary of the *Treatise* by a Routh centennial lecture, which was given by E. I. Jury of Berkeley.

The principal discoveries are painstakingly traced in two long chapters, "Towards an understanding of the stability of motion" and "The development of servomechanism," which occupy half the book. The book is in no wise a popularized account; differential equations and engineering drawings abound, as do references and notes (216 in these two chapters alone) and extended quotations. Some of the quotations are set rather abruptly at the head of chapter sections, without exegesis; and one could have wished for the dates of birth and death of the engineers and scientists mentioned. But these are minor faults of an otherwise fine book, packed with information and full of illuminating insights by an engineer who is also an expert historian of technology and of one of its parent sciences, mechanics.

CHARLES SÜSSKIND
College of Engineering, University of California, Berkeley 94720

BOOKS RECEIVED

Advances in Microbial Ecology. Vol. 3. M. Alexander, Ed. Plenum, New York, 1979. xii, 226 pp., illus. $24.50.

Advances in Nutritional Research. Vol. 2. Harold H. Draper, Ed. Plenum, New York, 1979. xiv, 250 pp., illus. $27.50.

Advances in Pesticide Science. Abstracts and Addendum from the Fourth International Congress of Pesticide Chemistry. Zurich, July 1978. H. Geissbühler, P. C. Kearney, and G. T. Brooks, Eds. Pergamon, New York, 1979. Two volumes. Variously paged, illus. Paper, $60.

Advances in Polymer Science. Vol. 32. H.-J. Cantow and 12 others, Eds. Springer-Verlag, New York, 1979. iv, 158 pp., illus. $47.50.

Agrometeorology. J. Seemann, Y. I. Chirkov, J. Lomas, and B. Primault. Springer-Verlag, New York, 1979. viii, 324 pp., illus. $53.90.

The Algebra of Econometrics. D. S. G. Pollock. Wiley, New York, 1979. xvi, 360 pp. $45.

Astronomy of the Ancients. Kenneth Brecher and Michael Feirtag, Eds. MIT Press, Cambridge, Mass., 1979. x, 206 pp., illus. $12.50.

Beryllium Science and Technology. Vol. 2. Dennis R. Floyd and John N. Lowe, Eds. Plenum, New York, 1979. xvii, 438 pp., illus. $49.50.

Biochemistry and Physiology of Plant Hormones. Thomas C. Moore. Springer-Verlag, New York, 1979. xii, 274 pp., illus. $22.80.

Chemindustry Experiments. Experiments Based on Industrial Processes and Principles of Applied Chemistry. Brenda W. Hill. Franklin Institute Press, Philadelphia, 1979. vi, 214 pp., illus. Paper, $8.95.

The Chemistry and Physiology of the Human Plasma Proteins. Proceedings of a conference, Boston, Nov. 1978. David H. Bing, Ed. Pergamon, New York, 1979. xii, 404 pp., illus. $40.

A Choice of Catastrophes. The Disasters That Threaten Our World. Isaac Asimov. Simon and Schuster, New York, 1979. 378 pp. $11.95.

Circulant Matrices. Philip J. Davis. Wiley-Interscience, New York, 1979. xviii, 250 pp. $18.95. Pure and Applied Mathematics.

Classical Banach Spaces II. Function Spaces. Joram Lindenstrauss and Lior Tzafriri. Springer-Verlag, New York, 1979. x, 246 pp. $39. Ergebnisse der Mathematik und ihrer Grenzgebiete 97.

The Classification of Endogenous Psychoses. Karl Leonhard. Translated from the 5th German edition by Russell Berman. Eli Robins, Ed. Irvington, New York, and Halsted (Wiley), New York, 1979. xxii, 452 pp. $24.50.

Clinical Genetics. A Source Book for Physicians. Laird G. Jackson and R. Neil Schimke, Eds. Wiley, New York, 1979. xii, 652 pp., illus. $35.

Currents in Submarine Canyons and Other Seavalleys. Francis P. Shepard, Neil F. Marshall, Patrick A. McLoughlin, and Gary G. Sullivan. American Association of Petroleum Geologists, Tulsa, Okla., 1979. viii, 174 pp., illus. Paper, $11; to AAPG-SEPM members, $9. AAPG Studies in Geology No. 8.

The Cyclostomata. An Annotated Bibliography. Supplement 1973–1978. G. Tandler, M. A. Jones, and F. W. H. Beamish, Eds. Junk, The Hague, 1979. xii, 296 pp. $78.95.

The Dangers of Nuclear War. Papers from a