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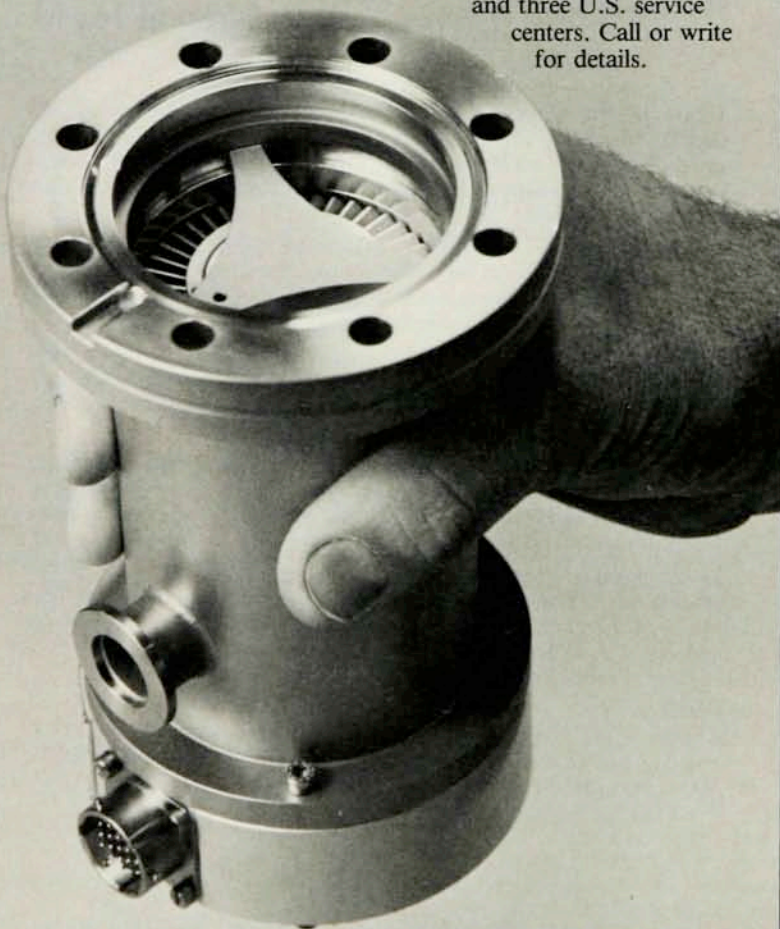
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understand in some depth the physical behavior of molecules and cells; it will also be useful to physicists who wish to dabble in biology. Berg deals with a number of topics that Purcell's talk did not cover such as the theory of some of the standard tools used by biochemists for separating organic molecules: sedimentation, electrophoresis and partition chromatography. Each of these tools exploits the random motions of molecules to achieve separation. To see why and how well the tools can work, it is necessary to understand the random motions in detail.

Berg's book is clearly written, concise and accurate. Unfortunately it lacks the charm and vividness of Purcell's descriptive account. It would have added greatly to the accessibility of Berg's argument, to physicists at least, if Purcell's article had been included in this book as a preface. If the book is used as a text for a course in biophysics, for which it is well suited, the defect can be easily remedied by asking the students to read Purcell's article first.

There are three minor blemishes in an otherwise well-designed exposition. First, the pin-ball machine illustrated on page 117 is supposed to achieve mechanically a succession of uncorrelated left-or-right bounces. Any student who thinks seriously about the working of the machine will realize that the lack of correlation from bounce to bounce is in no way guaranteed by the physics. Second, the law of viscous drag is here repeatedly referred to as Stoke's law instead of Stokes's law. Third, I was disappointed with the ending of Chapter 6, where Berg barely mentions the power of the run-and-tumble strategy in enabling a bacterium to find its way by following a chemical gradient. A detailed analysis of the run-and-tumble model could easily have been included, using the mathematical apparatus that Berg already provides. A quantitative derivation of the efficiency of this method of seeking greener pastures would have been the best possible demonstration of the importance of random motions in biology. But these are small blemishes in an otherwise admirable book.

FREEMAN DYSON

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Complex Systems— Operational Approaches in Neurobiology, Physics and Computers

Edited by Hermann Haken
365 pp. Springer-Verlag, New York, 1985.
\$39.00

This book is another addition to the explosive literature exploring the

archipelago of self-organization where, among others, the following interlocked ideas live: complexity, self-organization, learning, adaptation, nonlinearity, cooperative phenomena, synergetics, autopoiesis and dissipative structures. If the reader feels a slight dizziness at this awesome roster, the feeling is appropriate: The land is wild, diverse and almost uncharted. Apparently the issues are more clearly formulated in their generic fashion, regardless of whether they arise in the brain, computers, ecology or physics. The fertility and validity of this view seem plausible—and are far from established.

The book is one more addition to this blossoming field, no more, no less. It contains an array of ideas and research representing the choices of Hermann Haken, the organizer of the International Symposium on Synergetics at Schloss Elmau in Bavaria in May 1985. Haken is well known for his contributions to laser physics and his tireless efforts to further research in the above-mentioned archipelago (which he calls synergetics—not an unfortunate name, but not one that everybody agrees on). As is obvious, this book does not (and does not claim to) provide a unified view of all these diverse trends, from brain to computers.

Faithful to the title, it concentrates on one idea: to look for operational expressions for the different beasts found in the archipelago, where "operational" means mathematical, or at least precise enough to be simulated on a computer. This common thread is the strength of the book. Its weakness is that it does not consider the conceptual foundations of the field, nor does it evaluate the methods used. This would have required a different choice of participants, a transcription of the discussions, and more work on the part of the editor.

Let me add a few words about the individual contributions. I can only do this from my own vantage point, that of a neuroscientist and brain theorist; I will venture no judgments about the physics section dealing with order and chaos in convective and turbulent systems.

The contributions are uneven but some are quite novel and interesting. In particular I would single out the related papers of Jürgen Krüger and G. Gerstein and their coworkers on multineuron experiments, surely one of the most interesting and difficult issues in neurobiology. The basic idea is to treat neurons as if they were point sources in a gravitational field, thus introducing a theoretical basis for analyzing a massive amount of otherwise uninterpretable data. Similarly, two papers by I.

Tsuda and his colleagues on pattern recognition appear fresh and relevant. The main issue here is the need to work with an environment that is not given, but actively interpreted by the system through its self-organizing capacity.

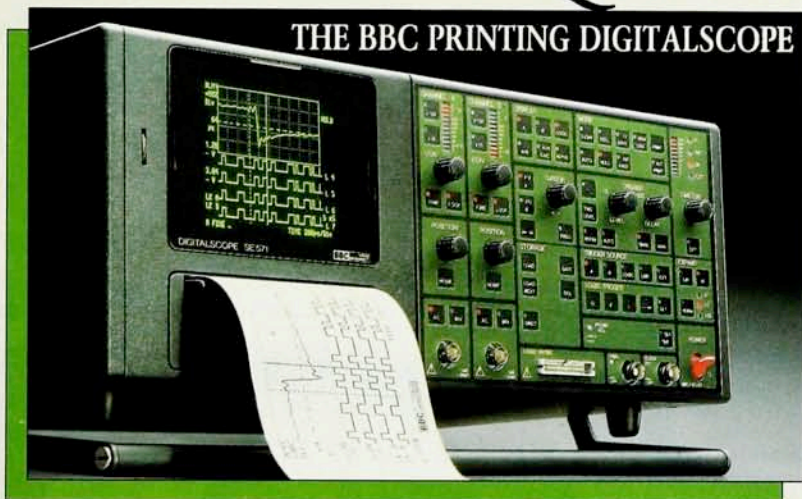
The next category of papers is those that are sound, but not particularly novel, often reviewing work published elsewhere. This is, for example, the case for the papers by Peter Schuster on molecular evolution and Leon Uhr on pattern recognition.

Finally, there is the category of those contributions that don't add anything to the field or the book itself. One typical case is Stan Grillner's contribution on the neural basis of locomotion, which is so sketchy as to be barely beyond an abstract. The other salient example is John C. Eccles's paper describing (once more) his dualistic mind-brain theory. It is so patently outside the scope of this book that only the author's prestige can account for its inclusion, a reason that I find uncon-



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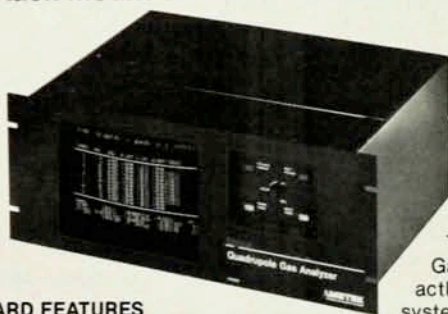
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vincing.

In a word, this new addition to the self-organization archipelago is dignified and moderately interesting, but not outstanding. It is worth having in the library, but don't rush to the bookstore.

FRANCISCO VARELA
*Ecole Polytechnique
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Synergetics: From Microscopic to Macroscopic Order

Edited by Eckart Frehland

259 pp. Springer-Verlag, New York, 1984. \$37.50

This volume is another in the Springer Series on Synergetics, and like many others in the series it contains the papers presented at an international symposium on synergetics—this one held at the Institute for Advanced Study in Berlin in July 1983. It contains contributions on such topics as biological evolution and order and chaos in physical and biochemical systems. There is a section on biological membranes and another on the social sciences. My overall evaluation of the volume might have echoed the comment made by Francisco Varela about the companion volume [see the review above]—"The book is one more addition to this blossoming field, no more, no less"—but in fact a more critical judgment is warranted.

Little effort has been made to give this volume a semblance of unity, with the exception of Hermann Haken's "Introductory remarks on synergetics," which seem to have been added after the fact. Such a shortcoming is all the more telling given that one of the chief aims of synergetics is, as Haken notes, "searching for unifying principles." Yet technical papers are interspersed here with only occasional attempts to refer to the basic categories of synergetics. This is particularly striking in the case of papers dealing with research that has already been the subject of numerous publications (Peter Schuster on polynucleotide replication, P. M. Allen on the application of the formalisms of dissipative structures to human systems, Günther Palm on associative memory, and so on).

Synergetics is in many respects like cybernetics: It exhibits the same goal of unifying disparate avenues of research and is marked by the same contrast between a "holistic" ideology and a reductionist method. Cybernetics had much more rigorous epistemological norms, but ultimately they did not save it from failure.

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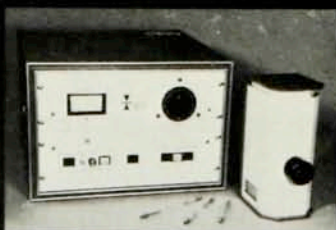
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