

useful service by concentrating on the mathematical underpinnings of supermathematics, and making a good job of the exposition. There are a number of other books available that give adequate coverage of field-theoretical supersymmetries and the supergravities; this book does not attempt to duplicate such coverage. I would expect this book to be most useful for mathematicians interested in an introduction to the field, for graduate students who already know the relevant "non-super" mathematics, or as a reference for physicists already acquainted with the field.

MATT VISSER
University of Southern California

Random Walks in Biology

Howard C. Berg

144 pp. Princeton U. P., Princeton, 1983.
\$16.50

This is an attractive little book. It is an elementary exposition of the theory of random motions, written for biologists and biochemists. Random motions are important in biology on two levels. On the level of molecules, random motions are essential to give every molecule in a cell a chance to encounter every other molecule. Only because of the high speed of molecular diffusion over short distances is it possible for a few molecules of DNA to organize the entire metabolism of a cell. On the level of organisms, random motions are essential in enabling cells to find food. Only because of the efficiency of cellular chemotaxis over short distances is it possible for a sperm cell to find an egg.

The classic reference in this field is a talk given by Edward Purcell with the title "Life at Low Reynolds Number" and published in the *American Journal of Physics* in January 1977. Purcell summarized in eight scintillating pages the phenomenology of fluid motions as they are experienced and manipulated by small creatures. If you read Purcell's talk, you will see that he gives credit for all the main ideas and discoveries to Howard Berg. In particular, it was Berg who deduced from the observed motions of bacteria that they must swim by rotating their flagella like the propellers of a ship and not by waving their flagella around like oars. This deduction was later proved correct by direct experiment.

Here we have Berg speaking for himself. A large part of his book is an expanded version of Purcell's talk, with the colorful language replaced by exact analysis: Berg provides the detailed statistical theory and the mathematical equations to justify Purcell's arguments. The book will be useful to biologists and biochemists who want to

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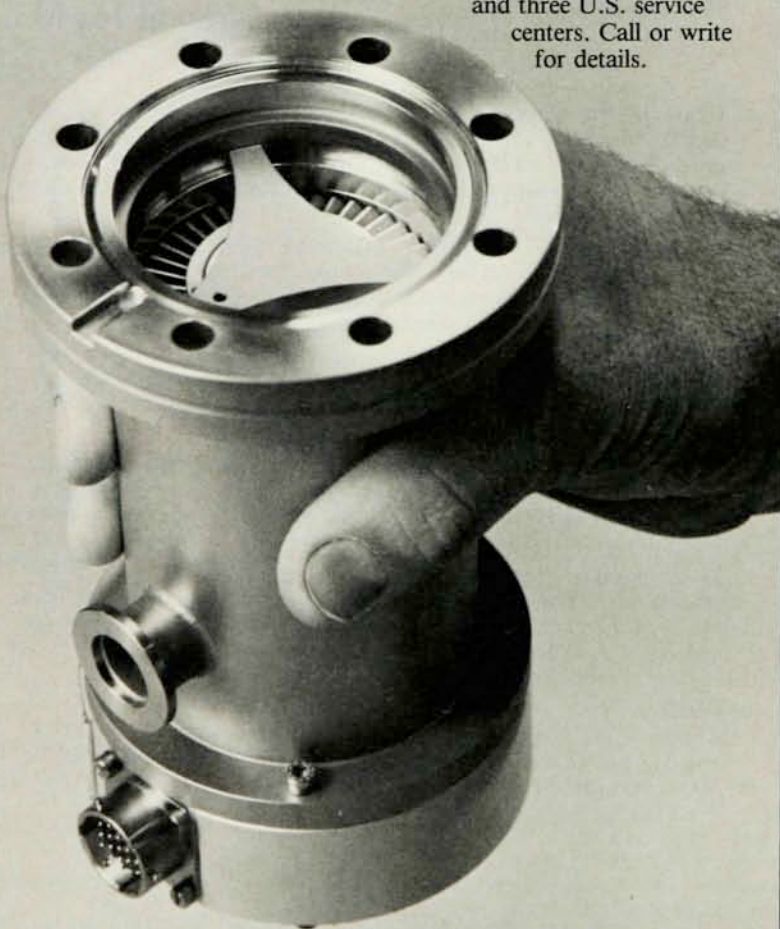
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understand in some depth the physical behavior of molecules and cells; it will also be useful to physicists who wish to dabble in biology. Berg deals with a number of topics that Purcell's talk did not cover such as the theory of some of the standard 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

*Institute for Advanced Study
Princeton, New Jersey*

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