ecologically. That pervasive ecological agent natural selection hovers over every population geneticist's "machine." In both nature and laboratory, it guides the genetic system at every turn. Will a population geneticist who denies this please identify himself?

HAMPTON L. CARSON
Department of Genetics, University of Hawaii at Manoa, Honolulu, HI 96822

The Hard Science of Fractals

Fractal Growth Phenomena. TAMÁS VICSEK. World Scientific, Teaneck, NJ, 1989. xii, 355 pp., illus. $67; paper, $28.

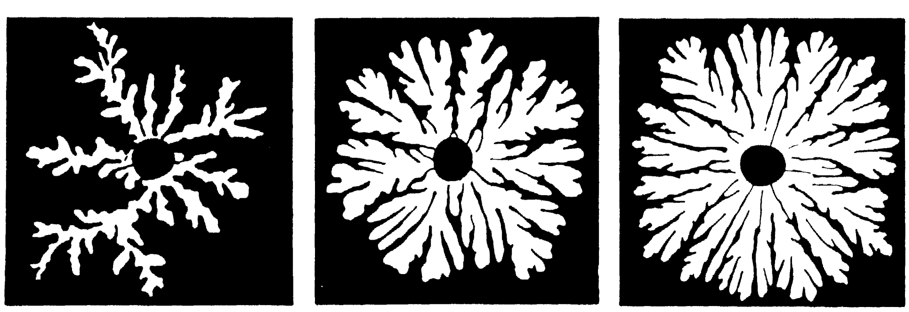
It has been said many times in recent years, perhaps because it continues to be true, that fractals enjoy widespread attention not only in science, but increasingly even in popular culture. Or maybe it's the other way around. Fractals are showing up in everything from computer graphics and science fiction films to strange attractors living in the phase space of a dynamical system and the characterization of the properties of porous media or of the processes of dielectric breakdown. The outside observer, especially a scientist, may want to know more precisely what the fuss is really about. A rich variety of applications of fractal ideas has been set forth persuasively, sometimes eloquently, in Benoit Mandelbrot's books and lectures. Now Tamás Vicsek has provided a much-needed new resource, a nice vehicle for gaining entry into the gradually developing hard science of fractals.

The ubiquity of the fractal seems to have deep origins. There may be many settings in nature for which a framework for a geometry of the irregular is more badly needed than is recognized. For example, the geometry of cloud morphology is surely tied up very deeply with physical processes. It is possible that new basic insights into cloud dynamics may emerge through imaginative use of fractal ideas. Perhaps there will be significant overlap with turbulence theories. Another example may be the hydrodynamics of the ocean surface shape or of the surface of a lake on a windy day.

Of those fields that are amenable to fractal applications, the study of kinetic growth phenomena is perhaps the most developed. Vicsek's book covers a good sample of it, including percolation, diffusion-limited aggregation, the Eden model, and cluster-cluster aggregation, as well as random walks of many stripes (self-intersecting, self-avoiding, and others). There's actually much more in the book. The position space renormalization group application is discussed for percolation; there's a nice section on multifractals; and Laplacian growth processes, such as viscous fingering, crystallization, and dielectric breakdown, get a section to themselves.

Vicsek's style, though in no way pedantic, is logical and precise. His general discussions mesh nicely with numerous examples and accounts of numerical and experimental results. The book contains a very good accumulation of references, although a notable omission is the early paper of Broadbent and Hammersley (*Proc. Cambridge Philos. Soc.* **53**, 629–41 [1957]), the intellectual ancestor of the modern study of kinetic growth phenomena or at least percolation theory. And, despite a good section on fractals themselves and fractal dimensions, we shall still have to wait for a definition of Hausdorff dimension, a matter that ought not to be avoided as religiously as it is by physicists and other writers on fractals. The book has numerous typographical errors and, it appears, at least one error of substance, in equation 5.27, which seems to allow for probabilities larger than 1. Finally, I thought the discussion of fractional Brownian motion was too casual and would have been better omitted. These are mostly small complaints, and I have another one or two, with which virtually no one in the fractal physics community would agree. In spite of these really very minor matters, I think the book is excellent and likely to be interesting and informative to a wide class of readers.

ROBERT CAWLEY
Naval Surface Warfare Center, Silver Spring, MD 20903-5000



Patterns made by injecting gas into a layer of smectic A liquid crystal. For low pressures (left; p = 30mmHg) the interface has a fractal structure analogous to that of DLA clusters, whereas the patterns become homogeneous (non-fractal) for large pressures (right; p = 70mmHg). [From *Fractal Growth Phenomena*; Horváth *et al.*, 1987]

Hot Halos

Cooling Flows in Clusters and Galaxies. A. C. FABIAN, Ed. Kluwer, Norwell, MA, 1988. xiv, 391 pp., illus. $99. NATO Advanced Science Institutes Series C, vol. 229. From a workshop, Cambridge, U.K., June 1987.

The last ten years have seen the steady growth of interest in the existence and long-term evolution of the hot gas surrounding some galaxy cluster cores and some field galaxies. This gas is detected through its x-ray emission, and interest in it has been, for the most part, confined to the x-ray astronomy community. This collection of papers can be read simply as a summary of our current understanding of the topic, but it has a more important mission. A number of the contributors are convinced that their work is providing important clues to the processes of galaxy formation and evolution, clues that need to be taken more seriously by the astrophysical community at large.

What is a cooling flow? From the observational point of view it is the detection of an extended region of x-ray–emitting gas whose temperature decreases toward the center so that its cooling time drops below the age of the universe. The most straightforward interpretation of the observations is that gas is cooling and condensing in the central regions and is being replaced by a steady flow of gas from larger radii. The observations may be used to estimate the rate at which mass is disappearing from the flow. The resulting estimates are surprisingly large, sometimes hundreds of solar masses a year, although more usually the derived accretion rates are a few solar masses a year. In any case, the obvious conclusion is that the mass of the central galaxy is often dominated by material that has condensed out of the cooling flow.

How firm is the evidence? A number of the papers include attempts to rule out alternative hypotheses and provide quantitative estimates of cooling flow parameters. Most of the papers are directly concerned with x-ray observations, which provide fairly accurate density profiles but somewhat more uncertain temperature estimates. Still, a fair number of the contributions address the evidence for warm gas from radio, optical, and infrared observations. I found the papers on optical emission lines particularly interesting inasmuch as they show that conditions at the center of the cooling flow are much more complex than a naive interpretation of the x-ray data would indicate. In short, attempts to keep the core region hot by plausible processes, such as radiation from regions of star formation, shock heating, and conduction of heat from the outer regions, appear to be inconsistent with the observations or are more likely to produce thermal instabilities (adjacent regions of intense cooling and rapid heating) than a smooth, stable core. A large amount of gas has to be cooling, although its ultimate fate is unknown.

One final uncertainty is the persistence of the cooling flows. Although the cooling times in the core region are shorter than the age of the universe, they are not particularly short by anyone's standard. Estimates of the total mass accreted from these cooling flows necessarily invoke an age for the flow which can only be considered approximate. A few papers attempt to estimate the time variability of specific flows using model-dependent arguments. No consensus has emerged on whether the flows are increasing or decreasing in intensity, but it does appear that no allowable variation could alter the conclusion that a substantial amount of, mass is dropping out of the flow at small radii.

On the whole, I would recommend this book to anyone with a serious interest in the origin and evolution of galaxies. The observational papers included here provide a fairly impressive case for the widespread existence of cooling flows. The theoretical papers are not as conclusive but do strongly suggest that alternative models of the observations are not plausible. It is clear that the addition of matter to galaxies through cooling flows is a widespread phenomenon, which may dominate the evolution of a substantial number of galaxies. It may even be true that the problem of dark matter in galaxy clusters will find its resolution here. This is not necessarily welcome news for cosmologists, who need more exotic forms of dark matter to explain galaxy formation and to close the universe.

This book suffers from a few minor, but irritating, problems. It is a little jarring to find pages transposed at the very beginning of the papers. In addition, it is peculiar that a book intended to interest a larger audience does not open with a general review of the topic.

ETHAN T. VISHNIAC
Department of Astronomy,
University of Texas,
Austin, TX 78712

Conduction Electrons

Magnetoresistance in Metals. A. B. PIPPARD. Cambridge University Press, New York, 1989. xiv, 253 pp., illus. $59.50. Cambridge Studies in Low Temperature Physics, vol. 2.

In 1965 A. B. Pippard published a collection of his notes under the title *The Dynamics of Conduction Electrons* and provided one of the first sensible discussions of the intricate behavior of conduction electrons in metals. For a generation of students that monograph served as a starting point for learning how the electronic structure of a metal determines the response of electrons to applied electric and magnetic fields. Now Pippard crisply and clearly summarizes what has happened in this discipline since his classic was written. Although the study of the magnetoresistance in pure metals is not usually considered to be in the forefront of research today, the lessons learned from it have often paved the way for the active research on the magnetoresistance and quantum effects in one- and two-dimensional systems that is now fashionable. This fact makes Pippard's book a valuable effort that should be well received by current researchers.

The study of the electrical conductivity tensor as a function of an applied magnetic field, the magnetoresistance of a metal, forms the unifying theme for the book. The various topics discussed adequately represent the wide variety of physical effects that occur when an electric current passes through a metal cooled to liquid-helium temperatures and subjected to an applied magnetic field. The book gives strong emphasis to the interpretation of the magnetic-field–dependent changes in the conductivity tensor in terms of the underlying electronic structure and scattering mechanisms of electrons in metals. It nicely illustrates the change in emphasis from the early exactly solvable, analytical models of magnetoresistance developed by Wilson and the efforts of later investigators to interpret experimental data based on models for the electronic structure of real metals. The book discusses many of the classic problems in the magnetoresistance of bulk metals and analyzes their current status.

After presenting the obligatory treatment of the basic principles for the study of the electrical conductivity tensor, Pippard devotes an excellent chapter to experimental technique. This chapter is a valuable collection of examples that illustrate how wrong things can go when a measurement of the voltage drop across a metallic sample at low temperatures is attempted. The book gives adequate coverage to magnetoresistance effects in real metals and provides the required coverage of relevant Fermi surface details. It discusses the quantum theory of magnetoresistance in a coupled orbit network and reviews the status of this challenging problem. The coupled orbit network is a good example of a traditional (and still unresolved) problem in which the quantum state of the electron is delocalized over a periodic, two-dimensional array of orbits that (in the fully coherent limit) are connected by magnetic breakdown effects. Fundamental questions regarding the flux quantization in such a network and the resulting fractal energy band structure are nicely illustrated. Pippard also reviews the interesting case of potassium but makes no serious effort to include recent evidence from outside the realm of magnetoresistance that supports the charge-density wave model for the ground state in this metal. A topic of current interest, the magnetoresistance in small wires and rings, receives only limited attention. No discussion of magnoresistance effects in semiconductors or a two-dimensional electron gas is attempted. The book contains a list of references that will introduce the reader to a few germane articles on any given topic but that is far from complete and emphasizes the work of the Cambridge group.

Pippard succeeds in producing a readable summary of his efforts to understand the behavior of the magnetoresistance in metals. His analysis coupled with his physical insight makes the book enjoyable reading even when one thinks one knows what the outcome of any of its discussions will be. It will no doubt serve as the traditional introduction to the topic until another author with talents comparable to Pippard's devotes attention to this subject.

R. REIFENBERGER
Department of Physics,
Purdue University,
West Lafayette, IN 47907

Books Received

The Community of Science in Europe. Preconditions for Research Effectiveness in European Community Countries. Mark N. Franklin. Gower, Brookfield, VT, 1988. xii, 359 pp., illus. $58.95.

Computer-Aided Analysis and Design of Electromagnetic Devices. S. Ratnajeevan H. Hoole. Elsevier, New York, 1989. xiv, 497 pp. $39.95.

Computer-Assisted Modeling of Receptor-Ligand Interactions. Theoretical Aspects and Applications to Drug Design. Robert Rein and Amram Golombek, Eds. Liss, New York, 1989. xxviii, 512 pp., illus. $96. Progress in Clinical and Biological Research, vol. 289. From a conference, Eilat, Israel, April 1988.

Computer Simulation in Brain Science. Rodney M. J. Cotterill, Ed. Cambridge University Press, New York, 1989. xvi, 566 pp., illus. $65. From a meeting, Copenhagen, Denmark, April 1986.

Computers, Brains and Minds. Essays in Cognitive Science. Peter Slezak and W. R. Albury, Eds. Kluwer, Norwell, MA, 1988. x, 255 pp., illus. $67. Australasian