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

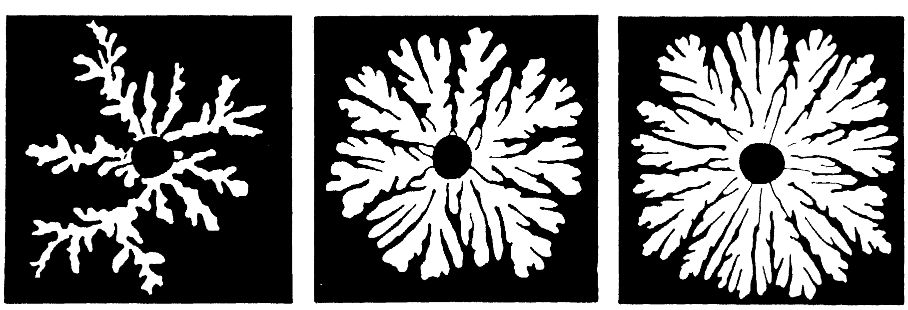
Fractal Growth Phenomena. TAMÁS VICSEK. World Scientific, Teaneck, NJ, 1989. xii, 355 pp., illus. $67; paper, $28.

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.



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]

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

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