cepts to the general public, probably accounts for this omission.

Given the growing tendencies of the Federal Government to reduce the amount of information it releases to the public and to impose restrictions on the flow of information from nongovernmental sources, particularly in the realm of science and technology, this book is most timely. It is a valuable source of data and ideas on a topic that concerns all scientists and engineers, both as professionals and as citizens.

• • •

Stephen H. Unger is a professor of computer science at Columbia University and chairman of the Subcommittee on National Security and Scientific Communication of the AAAS Committee of Scientific Freedom and Responsibility.

High-Energy Astrophysics: An Informal Introduction for Students of Physics and Astronomy

M. Longair
412 pp. Cambridge U. P., New York, 1981.
$49.95 cloth, $19.95 paper

From the early 1900s until about fifteen years ago, the field of high-energy astrophysics consisted of the study of cosmic rays. The problems encountered in the attempts to measure them and explain their origins and propagation stimulated a great deal of research, and although some questions remain, especially in regard to the origins of cosmic rays, many interesting results have been obtained. In the last ten to fifteen years, however, the ability to make x-ray and γ-ray observations from above the atmosphere has led to a number of exciting discoveries of highly energetic astrophysical phenomena. In our own galaxy, x-ray observations have indicated the existence of well over a hundred compact stars (primarily degenerate dwarfs and neutron stars, and perhaps one or two black holes), in which accretion of matter into the extremely deep gravitational potential results in energies of the order of 100 MeV per nucleon. Satellite observations have also detected many extragalactic sources of high-energy photons, especially active galactic nuclei such as quasars and Seyferts. Models for these phenomena usually involve black holes with masses from a million to a billion times the mass of our sun. Further, the high-energy astrophysics of the hot big-bang model provides a great deal of information about particle physics and field theory. In short, future prospects have expanded dramatically over those envisioned when cosmic rays occupied the entire field.

In *High Energy Astrophysics*, Malcolm S. Longair has chosen to introduce the field by means of the rather large body of cosmic-ray studies. His descriptions of the physical processes involved are clear and concise. Further, his book provides a welcome updating of the knowledge of cosmic rays in both observations and theory found in previous texts. It is well organized, and the references and suggested further readings are exhaustive. Because the book has been prepared from a series of lecture notes, its style is somewhat different from the tone of the usual text: Longair has included a sprinkling of personal remarks and opinions. As a textbook for advanced undergraduates or for beginning graduate students, this personal quality conveys the author's keen interest and excitement and should prove very encouraging to students.

A serious shortcoming of the book is its neglect of the more recent developments in the field. The author devotes only a few pages each to cosmology and galactic x-ray sources. Further, in view of the fact that Longair, Astronomer Royal for Scotland and Director of the Royal Observatory at Edinburgh, has concentrated his research efforts on extragalactic radio sources, the rather minor treatment this subject receives (one chapter—and that in the context of cosmic-ray sources) is surprising. In summary, the clarity of the book and the ease with which it can be read should make it valuable as an introduction to high-energy astrophysics, even while it might be desirable to augment it with more recent work.

ROGER W. BUSSARD
University of Illinois

A Search for Structure: Selected Essays on Science, Art, and History

C. S. Smith
410 pp. MIT Press, Cambridge, Mass., 1981.
$30.00

From Art to Science: Seventy-Two Objects Illustrating the Nature of Discovery

C. S. Smith
118 pp. MIT Press, Cambridge, Mass., 1980.
$25.00

Look through the side of a glass of beer at the foamy head. The apparent chaos of bubble cells of different sizes and numbers of faces actually reveals great structure upon close scrutiny. The faces meet at 120°—a consequence of the liquid seeking the minimum area consistent with the volumes of the individual cells. Topological laws that relate the number and types of vertices, edges, and faces imply that there will be an average of $5\frac{1}{7}$ edges per face. Together these local and global constraints assure that at least some of the faces must be curved, which, in turn, indicates a pressure difference between neighboring cells. In the presence of diffusion, then, the system is unstable: One by one some bubbles shrink and others grow until your beer head falls flat.

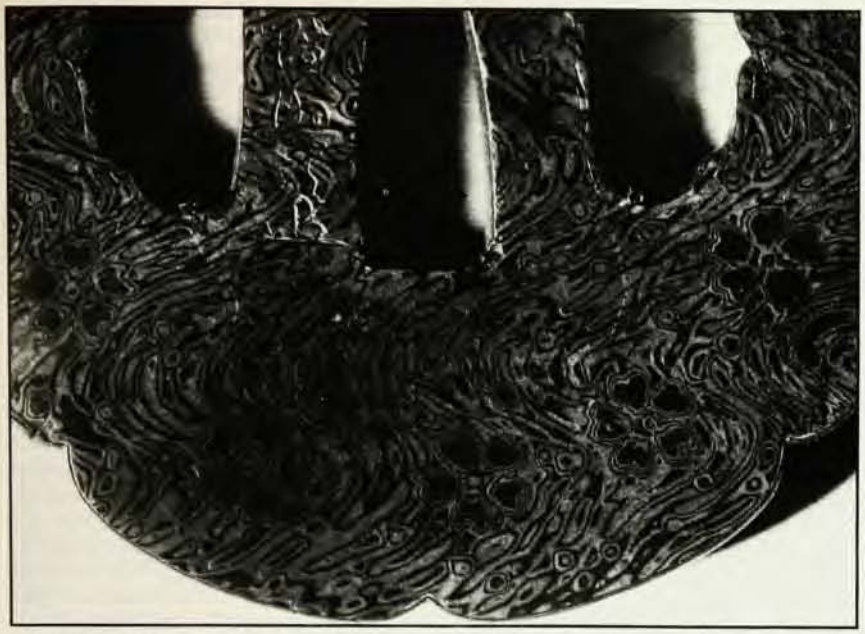
This application of physics and topology comes from the first essay in *A Search for Structure*, a collection of 14 papers culled from the nearly 200 written by the distinguished materials scientist and generalist Cyril Stanley Smith. The first is the only strictly scientific essay in the book, however; the others deal with more general topics associated with science, art and history.

The structure of the beer foam is governed by both local and global constraints, or "forces." Smith's primary thesis is that structure in other fields such as art and history also results from interplays of forces acting on different levels. These fields therefore share common patterns of structural hierarchy—patterns that are manifest in the material world as well.

He states that aesthetic pleasure comes from simultaneous recognition of structure on many such levels. Further, as science deals less and less with simple, isolated systems, and more and more with systems possessing many levels of hierarchical structure, aesthetic judgments will become more important. They will be quite preponderant, for instance, in solid-state physics, where one must consider not only an electron's spin, but also its interaction with the nucleus, the resulting orbital structure, the crystalline structure and the placement of any doped atoms, as well as the large-scale structure of the material. Smith maintains that the concept of symmetry has been overemphasized in science; its main value lies instead in giving meaning to its absence, *dis*symmetry—the prerequisite for hierarchy.

In art, too, any particular work is affected by the basic levels, the medium, as well as by the cultural environment and the prevailing aesthetics. The dynamics and morphology of a field of art can be likened to those in a crystal: Just as a fault in a crystal begins as a localized discontinuity, so too, major changes in artistic styles begin with small enclaves of artists and propagate throughout the entire system, to result in paradigm shifts, in the words of Thomas Kuhn. At times Smith's analogies are a bit simplistic; yet they yield new insights.

Smith's interests in the history of materials science (the precursor to solid-state physics) has taken him to many fine art museums, where he can "read" the history of an artifact by scientifically analyzing its makeup. For instance, he shows a figure of a 19th-century



Nineteenth-century Japanese swordguide made of nonferrous metal. The cherry blossom design was achieved by cutting away the surface plane of a composite sheet. Illustrated in *A Search for Structure*, the object is in the Bigelow Collection of the Museum of Fine Arts, Boston.

Japanese metal sword guard containing a delicate design of cherry blossoms floating on water. The guard was made by first layering several different metals, then hammering this stack to form dimples in the desired pattern, and finally slicing the stack flat. Smith contends that most of the early fundamental advances in materials science were motiviated not by scientific ends but by aesthetic ones—by immediate sensuous responses to the materials. In short, aesthetic curiosity is the mother of invention; necessity is merely the mother of improvement.

As its title suggests, *From Art to Science* explores this progression. The book is a catalog for Smith's 1978 exhibition of artifacts that illustrate the nature of discovery of scientific principles that were first formulated or at least exploited by artists and artisans. Although photographs cannot fully capture the individual sensuous qualities of materials, or the three-dimensionality of the objects from the exhibition, the sumptous color photographs in the book nearly succeed. Short descriptions and analyses of each of the artifacts reveal the ingenuity and insight of their creators.

These two books provide much for both the mind and the eye, especially for those wishing to place science and technology in a broad, human perspective.

DAVID G. STORK
University of Maryland

Weather and Climate on Planets

K. Kondratyev, G. Hunt
755 pp. Pergamon, New York, 1982. $95.00

In 1951 Seymour Hess and Hans Panofsky, active in an imaginative program of analysis of observations taken at the Lowell Observatory at Flagstaff, Arizona, wrote in the *Compendium of Meteorology*: "The study of planetary atmospheres is a relatively new field of meteorology. Its main impetus comes from the likelihood that the behavior of the several planetary atmospheres, with their varying masses, rotations, constituents and other physical parameters, may yield important evidence bearing on the general laws which govern our own atmosphere." These prophetic comments have been verified by the explosive increase in planetary observations during the past 30 years. Many of the observations were made from new and improved ground-based telescopes. The most dramatic source of new information, however, has been the various space platforms launched over the last two decades. Since 1962 there have been about 20 US and USSR space missions to the planets.

In addition to providing new factual information, both ground-based and space-derived observations exposed problems of interpretation that led inevitably to consideration of the similarities and differences among the planets. It is natural that most of these interpretations are based on experience with observed terrestrial processes. The planetary observations and theories are summarized, reviewed and discussed in the monograph *Weather and Climate on Planets* by K. Y. Kondratyev and G. E. Hunt, meteorologists of international repute. The book is an encyclopedia of information on the surfaces and atmospheres of the most intensely observed planets: Venus, Mars and Jupiter.

The authors describe the physical and chemical properties of these three planets (with occasional references to other planets), including recent ideas of their origin and evolution. Some of the main problems they treat in the book are the composition and structure of the cloud layers on Venus, Mars and Jupiter; the greenhouse mechanism for establishing the high surface temperature on Venus and the "anti-greenhouse" mechanism involving the dust storms on Mars; the importance of water vapor on the photochemistry of ozone on Mars and the contributing roles of water vapor and carbon dioxide in the periodic advance and retreat of the Martian polar caps; the origin and color of the Great Red Spot of Jupiter; the fundamental differences among the fluid dynamical properties of the three planets and comparison of these properties with those of the terrestrial atmosphere. The three planets involve basically different distributions of energy sources and sinks and rotation rates, so that the driving and modifying influences on their large-scale planetary circulations are distinct. The discussion of these influences by Kondratyev and Hunt is, in many ways, unique and represents an important contribution toward understanding the meteorology of these planets.

The authors seem to have read and reviewed everything that has been written about Venus, Mars and Jupiter over the past 20 years. It is particularly pertinent that much of the summarized information comes from Russian publications. Of the almost 1400 reference citations, approximately 20 percent are to papers published in Russian.

Despite the publisher's disclaimer concerning "typographical limitations" in the interest of rapid distribution, there are too many needed corrections to go unnoticed. These include incomplete sentences, misspelled or incorrect words, inconsistent tables and diagrams without reference to the original source. In addition, a lack of editing has resulted in the persistent misuse of the definite and indefinite article so characteristic of raw translations from Russian into English. The book also suffers somewhat from redundancy. Much of the material could profitably have been combined or more succinctly summarized to reduce the text to about two-thirds of its present size with no loss of information.

Although this book must have been