Book Reviews

Earth Dynamics

Rotation of the Earth. Proceedings of a symposium, Morioka, Japan, May 1971. PAUL MELCHIOR and SHIGERU YUMI, Eds. Reidel, Boston, 1972. xxii, 244 pp., illus. $19.50. International Astronomical Union Symposium No. 48.

The publication of the proceedings of the International Astronomical Union symposium on the rotation of the earth once again emphasizes the pervasiveness of the subject of the earth's rotation in geophysics, geodesy, and astronomy. Papers dealing with creep in the earth and planets (invited lecture by Sir Harold Jeffreys), spectral analysis (Pedersen and Rochester), separation of secular polar motion and continental drift (Mueller and Schwarz), determination of polar motion by laser ranging to satellites (Smith, Dunn, and Kolenkiewicz), motion of the equator and ecliptic (Fricke), changes in the geomagnetic dipole moment and the spin rate (Yukutake), and the evolution of the earth's core (Jacobs) illustrate the range of topics encompassed. In all, there are 54 contributions.

The symposium took place at a time of very rapid development in earth dynamics. The emergence of plate tectonics had finally given a kinematical explanation of continental drift, and the techniques of latitude and longitude determination used in the study of the earth's rotation seemed to be the only methods of providing real time measurements of the plate motions. Theoretical and observational evidence had been presented that earthquakes might excite the Chandler wobble or free polar motion, and indeed some evidence of premonition had been found. The realization that classical measurement methods were probably incapable of providing the needed accuracy to adequately check these geophysical theories had led to experimentation with new techniques, ranging to lunar laser retroreflectors, very long baseline radio interferometry, and satellite tracking. Finally, the International Geodynamics Project sponsored by the International Council of Scientific Unions promised renewed interest and cooperation in geodynamics.

Because the symposium took place at a time of such rapid development, very few conclusive answers are given, but many theories, suggestions, and intriguing bits of evidence are presented. The material ranges from exhaustive analysis to raw speculation. Nearly all the great questions in the earth's rotation are dealt with: What is the source of the excitation of the Chandler wobble and the nature of its damping? Is there more than one Chandler period? Is the diurnal wobble due to the presence of the earth's liquid core detectable? What is the history of the spin rate? Are polar wandering and mantle convection connected? Shimazaki and Takeuchi give results which they conclude are in agreement with the hypothesis that large earthquakes excite the Chandler wobble; Chinnery and Wells are more skeptical. Jeffreys takes the damping of the Chandler wobble as a key piece of data on the inelastic behavior of the mantle, but the observed damping time depends drastically on the resolution of the question of whether the Chandler peak is split. Gaposchkin concludes that it is, Rochester and Pedersen that it isn't. In any case, the seat of the damping mechanism is still unsettled. Both Débarbat and Yatskiv find evidence for the diurnal wobble in latitude and time observations. Newton reports on his exhaustive study of ancient astronomical observations, which has resulted in a more reliable measure of the earth's rotational deceleration. The lack of measurements for long time scales is reflected in speculative papers on polar wandering and mantle convection.

Indeed, in considering the whole of the proceedings, it is evident that few conclusive answers will be found until the new generation of measurement techniques now being developed takes hold and provides some critical tests of the many theories that abound in this field.

Meanwhile, any reader interested in geophysics, geodesy, or astronomy will find a gold mine of intriguing questions and speculations in this book. Attempting to resolve them would provide a nearly complete education in all three sciences, but would surely take more than one lifetime.

D. E. SMYLIE
Department of Physics,
York University,
Toronto, Ontario

Essays by a Physicist

Physics in the Twentieth Century. Selected Essays. VICTOR F. WEISSKOPF. M.I.T. Press, Cambridge, Mass., 1972. xvi, 368 pp., illus. $7.95.

"A gentleman," it used to be said, "is never unintentionally rude." On the same principle: "A scientist is never unintentionally obscure." After reading a collection of articles so notable for their lucidity, one begins to ask: how is this achieved?

There are some elementary principles, such as the use of simple words and short sentences. Despite his upbringing in German, and half a lifetime in America, Weisskopf's vocabulary is direct and unpretentious. Every word is bare and robustly unqualified. Each sentence is a precise logical statement carrying the argument one firm step forward. As we read, we move forward in understanding, knowing that we are with an experienced and confident guide.

Some scholars, indeed, abuse this style. By a succession of bold and apparently simple assertions they thoroughly lead us up the creek of their own fantasies. The shock of realizing that one is actually lost is then more devastating than with a more obscure author. On this point Weisskopf records Bohr's remark on the complementarity between clarity and truth and the charming story of the young man listening to the rabbi. To be really convincing, it is rather necessary to know what one is talking about; but the attempt to express the inexpressible is not always vain!

The main theme of these essays is quantum theory, to which Weisskopf has made such notable contributions, especially in quantum electrodynamics and nuclear structure. Having himself climbed what he calls the "quantum ladder," from crystal structure through chemical bonds and nuclear matter to the exotic behavior of elementary particles, he can tell us how it all fits to-

gether. The unity of concept and theoretical technique in atomic, nuclear, and subnuclear physics is emphasized. This is brought out very clearly by comparisons of atomic and nuclear excitation spectra and by the uncanny resemblance of the curves for inelastic scattering of electrons by helium atoms at 120 ev, by lead nuclei at 600 Mev, and by protons at 16 Gev. This is the sort of thing that Weisskopf understands and teaches us perfectly.

The part played by "pictures" in the exposition of scientific ideas is also recognized—especially in the more recent essays. Weisskopf describes his type of explanation as *anschaulich*, meaning "plainly visible for the mental eye." An actual drawing, however metaphorical, may convey more of this abstract image than any amount of talking. The algebra of the review of "The compound nucleus" suddenly comes alive in the graphic representation of the course of a nuclear reaction in the later article "Problems of nuclear structure."

To be intelligible, you must know whom you are addressing. These essays originally appeared in various journals, ranging from *Reviews of Modern Physics* to *Scientific American*, and are more or less specialized in proportion. Most of them were written for such an audience as the readers of *Science*, presumably professional scientists but not necessarily knowledgeable about physics. As a physicist, I find it difficult to judge whether they could all be understood by, say, an associate professor of botany, but they are ideal for the student at the first stage of a course on atomic and nuclear physics. The article "Quality and quantity in quantum physics" tells him (qualitatively!) exactly what he will have learned in all the drudgery that will follow.

The supreme factor in clear writing cannot be communicated, and is not always learned in a lifetime of experience: it is wisdom. A science exists as a vast depository of facts and theories, from which must be chosen a few significant and central themes. To shape a subject in the mind requires more than technical knowledge: it demands that "desire and pursuit of the whole" called natural philosophy. The style is the man. The ultimate reason why many physicists will want to read these essays—whose subject matter, after all, is not unfamiliar—is that they are written by one of the most admired and loved scientists of our times, a man who has lived in obedience to the highest ideals of the scientific community: modesty, internationalism, high critical standards, recognition of the priorities of others, and service to humanity.

In the essay "My life as a physicist," the author tells us how he got that way. How jealous we must be of that Golden Age: the new physics, the Open Sesame to every hidden treasure of nature; Heisenberg, Bohr, Pauli; Göttingen, Copenhagen, Zürich. But remember also the poverty, the temporary jobs, the sinister political backdrop of Germany in the '30's. It was by no means all cakes and ale—or, indeed, all IBM cards and Xeroxed reprints. Follow this by teaching in an upstate American university, and the pressure and drama of Los Alamos. In what high-powered graduate school, through what munificent fellowships, at the feet of what sage, can the modern young scholar acquire the same combination of intellectual and spiritual strength, without arrogance or pretense? In the '50's, Weisskopf withdrew from all the national defense activities of the scientific community, and devoted himself to international causes. CERN, the model institution of international science, is a reflection of his personality. We do not, perhaps, recognize how far we are still governed, in our scientific and moral standards, by the example of that small group of "elders" of which Weisskopf is so distinguished a member. Who will replace them?

In his final essay, "The significance of science," Weisskopf discusses all those issues of the "relevance" of science that are so widely debated. As one might expect, he states clearly and concisely the characteristic arguments on every side, notes inconsistencies, and pricks follies. He emphasizes the social obligations of the scientist and the dangers of overspecialization and technical arrogance. But fundamentally he is a rational humanist with a decent bias toward optimism. As Hans Bethe says of him in his foreword, "All his life he has sought and contributed to knowledge, and all his life he has shown compassion." This mixture, like the book here reviewed, is much to be recommended.

JOHN ZIMAN

H. H. Wills Physics Laboratory, University of Bristol, Bristol, England

Aerosol Research

Aerosols and Atmospheric Chemistry. Proceedings of a symposium, Los Angeles, March 1971. G. M. HIDY, Ed. Academic Press, New York, 1972. xviii, 348 pp., illus. $14.50.

This volume contains 30 papers presented at the 1971 American Chemical Society Kendall Award Symposium honoring Milton Kerker. The contributors are all well known in the field, and the reader receives an excellent status report on a few selected topics in aerosol physics and chemistry, such as aerosol formation and growth, optical properties of aerosols, and specific techniques for determining aerosol mass, size, and chemical composition. Furthermore, the editor has devoted almost half the book to a detailed presentation of the "classical" 1969 Pasadena Smog Aerosol Study.

In a series of 12 articles, the reader is made familiar with the history, the approach, the techniques used, and the major results of this first attempt to investigate urban atmospheric aerosols involved in photochemical reactions. This section not only is of interest to specialists concerned with similar problems, but it more importantly reveals to the general chemist, physicist, and atmospheric scientist the extreme complexity of an aerosol system, as well as the sophistication in instruments required to obtain information on the physical and chemical properties of particles suspended in and interacting with a continuously changing gaseous environment.

The book has already found its way to the library of almost every researcher working with atmospheric aerosols. However, what might benefit this rather small group of specialists does not necessarily meet the needs of general scientific readers. The reader should not on the strength of the title expect a comprehensive, critical, and uniform presentation of "aerosols and atmospheric chemistry." He should not expect to find a ranking or classification of specific topics discussed in the book in terms of overall importance or relevance to atmospheric processes. And least of all should he expect a textbook-style overview of the field wherein each topic is given a lengthy general introduction. Those scientists who are interested in the present state of the art in aerosol physics and chemistry, or who wish to acquaint themselves with the methodology and the research tools