Standards

The International Bureau of Weights and Measures, 1875–1975. CHESTER H. PAGE and PAUL VIGOREUX, Eds. Translated from the French edition. National Bureau of Standards, Washington, D.C., 1975 (available from the Superintendent of Documents, Washington, D.C.). viii, 248 pp., illus. Paper, $3. National Bureau of Standards Special Publication 420.

All of us know that the United States is at long last about to adopt the metric system, surely by our bicentennial year. Few know, however, that we did indeed legally adopt the metric system over a hundred years ago (in 1866) and then reaffirmed this decision in 1875 when the United States and 16 other countries signed the so-called Treaty of the Meter. At that time the meter and the kilogram became our official standards, but we simply redefined the foot and pound in terms of these metric standards and remained comfortably in "customary" units.

This volume is a history of the first hundred years of the International Bureau of Weights and Measures at Sèvres (just outside Paris), which is the organization charged with maintaining the primary metric standards.

When the French Academy first began debating (in the 1790's) the need for a standard of length, some other scientists (including Huyghens and the British Royal Society) favored the length's being that of a pendulum with a period of one second, but the French Academy preferred the length to be one ten-millionth of the distance from the pole to the equator along the meridian through Paris. This ultimately became the standard meter, although for practical purposes it was defined as the distance between two scratch marks on a platinum-iridium bar housed at Sèvres.

After Michelson had invented his two-beam interferometer, it occurred to him that he could accurately measure the meter by counting the number of fringes of a spectrally pure light source. (That achievement in fact was the principal basis for his Nobel Prize in 1908.) Later we had the much sharper spectral line of a pure isotope, Kr^{86}; and now we have highly monochromatic laser light sources, and the meter is now so well defined that even if some calamity should melt the primary meter we could produce another that would be just as good.

Our standard of mass, the kilogram, is still that arbitrary chunk of metal at Sèvres: there is at present no proper redefinition of this in terms of other physical quantities (although it is rather close to the mass of a cubic decimeter of pure water at

Medal commemorating the centennial of the Convention of the Meter and the International Bureau of Weights and Measures. Designed by R. Corbin, Monnaie de Paris. [From *The International Bureau of Weights and Measures, 1875–1975*]

its maximum density). The unit of time, the second, is even more elusive: it was a certain fraction of a day, and days vary slightly through the year (and years also wobble a little), so the year 1900 was picked to define the second. Should all the clocks stop one night would we have to get the astronomers to go back to 1900 and remeasure the second? Happily we now know the speed of light with sufficient accuracy that we can reconstruct the second of time also from spectroscopic data.

As years went by the standards group at Sèvres added other basic standards to their repertoire: the gravitational constant, the absolute temperature scale, the ampere and related electrical units, standard lamps for photometry and measurements of radioactivity, x- and gamma rays and neutrons. Each of these standards is described in a chapter that tells how the unit was first defined and then what techniques were designed to measure and maintain the standard and to prepare secondary standards.

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Theory of Catalysis

The Mathematical Theory of Diffusion and Reaction in Permeable Catalysts. RUTHERFORD ARIS. Clarendon (Oxford University Press), New York, 1975. Two volumes. Vol. 1, The Theory of the Steady State. xvi, 444 pp., illus. $39.50. Vol. 2, Questions of Uniqueness, Stability, and Transient Behaviour. xiv, 218 pp., illus. $25.75.

One of the central problems for the chemical engineer is the design of catalytic chemical reactors in which a fluid stream of reactants is brought into contact with a solid catalyst, producing chemical products more rapidly than they can be produced in the absence of the catalyst. Since the rate at which the reaction proceeds depends critically on the amount of catalytic surface that is exposed to the reactants, it is customary to impregnate porous carriers with catalytic material. Thus before the reaction can take place the reactants must diffuse through the pores and after the reaction its products must diffuse out. It is this problem that is treated in this book. It is not only an important problem, it is an extremely interesting one. Aris assumes throughout a linear coupling of diffusion and reaction for the isothermal case and a linear coupling of diffusion, heat conduction, and reaction in the nonisothermal case. The interest of the problem resides in the fact that the mathematical models for such systems lead to a system of second-order nonlinear differential equations of boundary value type with enough pathology to interest modern-day mathematicians. This pathology involves unsymmetric, multiple, and oscillatory solutions.

In the first volume Aris discusses in an exhaustive way steady-state time-independent solutions for a single reaction with and without heat effects. The treatment is limited to the case in which the diffusion of the separate species is uncoupled so that a single differential equation needs to be considered. Some attention is given to multiple reactions, the normal industrial case, but here the mathematical complications are severe and the pathology has not been elucidated. The book is rich in graphs, diagrams, and illustrations of the numerical results. The writing is superb, the treatment is rigorous, and the whole is a tour de force that not only should be useful to engineers, but will also be a source for mathematicians and an education to chemists.

The second volume treats the unsteady or transient state, so the mathematical model always leads to nonlinear systems of partial differential equations of parabolic type. Engineers with a bias toward theory and mathematicians should find this volume a fertile field for cultivation, for a variety of tools of modern mathematics are essential for the understanding of the problems. Topics treated are the existence and uniqueness of solutions, solution stability, and general transient behavior. There is also some discussion of the corresponding problems in biological systems, and one would hope that mathematical biologists would dip into these two volumes.

A word should be said about what is absent. There is little or no mention of the multicomponent diffusion case, in which the diffusion of the various species is coupled. Aris considers the uncoupled case, which holds for Knudsen flow. For catalysts with larger pores bulk diffusion prevails, and some recent research indicates that it is essential in some cases to consider the more general and considerably more difficult multicomponent diffusion problem. Problems in which there is Stefan flow are not considered, as is consistent with the Knudsen hypothesis.

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High Energy Astrophysics

X-Ray Astronomy. RICCARDO GIACCONI and HERBERT GURSKY, Eds. Reidel, Boston, 1974. x, 452 pp., illus. Cloth, $50; paper, $24.50. Astrophysics and Space Science Library, vol. 43.

This is the first comprehensive review of x-ray astronomy to appear in book form, and it achieves a good balance among experimental technique, observation, and theory. The only recent comparable works have been the International Astronomical Union symposium volumes. The book not only fulfills well its stated purpose of providing a unified textbook for advanced undergraduates, it also contains much material that will be useful to workers in the field. Since each topic is introduced with an overview, often historical, the book will also be useful for nonspecialists. Certain sections should even be of interest to engineers and managers developing the instruments or spacecraft on which future observations in this field will depend.

The book is a series of chapters by various members of a group that, while at American Science and Engineering, made consequential contributions to the development of the field and was responsible for the Uhuru x-ray astronomy satellite. Most of the authors, who in addition to the editors include Blumenthal, Gorenstein, Kellogg, Tananbaum, Tucker, Schwartz, and Vaiana, are now at the Harvard-Smithsonian Center for Astrophysics. Many of the chapters emphasize the techniques, observations, and discoveries made at American Science and Engineering, and previously unpublished material appears frequently. Although the authors have made some attempt to include the results of others and acknowledge the institutional bias, one gets the impression that outsiders have made only peripheral contributions on many of the topics. Inside knowledge of the personalities and events is particularly useful when reading Giacconi's "History of x-ray astronomy—A personal view."

The chapter on observational techniques is some 70 pages long and includes discussion of both nonfocusing and focusing devices and of ancillary topics such as telemetry, pointing controls, and aspect solutions. The next chapter is a theoretical review of x-ray production mechanisms in cosmic sources. Starting from elementary ideas, the various approximations and regions of validity are indicated, and often a result directly applicable to interpretation of results is expressed in convenient numerical form.

The chapter on solar x-ray emission contains an unneeded review of the general features of the sun and seems not as well focused or as comprehensive as many of the others, although it contains some early results from Skylab. Several theoretical speculations and models are presented as facts. The chapter on supernova remnants, while also of a more general nature, contains a nice table of remnants observed in x-rays and their properties. The chapter on compact x-ray sources, where the discoveries by Uhuru have indeed been outstanding, is excellent. It contains an up-to-date table of the binary x-ray sources, reproductions of the published data that indicated the presence of many of the sources, and a section on theory adapted from a previous review by one of the authors. That Her X-1 and Cen X-3 are discussed more extensively than Sco X-1 indicates a bias toward more recent (and interpretable) results. Even Cygnus X-1, the "black hole" source, is discussed from the viewpoint of the data, and the more speculative interpretations and their bizarre consequences are hardly mentioned.

The interstellar medium is discussed from the viewpoint of x-ray astronomy, but the treatment of the soft x-ray background, the importance of this component in terms of astrophysics, and the difficulties in interpretation of the data is rather short. The chapter on extragalactic sources is based mostly on Uhuru work, much of which is unpublished, and is now somewhat out of date. The final chapter, on the cosmic x-ray background, is much more comprehensive and attempts an evaluation of the various observations and theories. This chapter also contains previously unpublished work. Finally there is a set of appendices that includes the 3U catalog of x-ray sources, which unfortunately contains several typographical errors.

In addition to the institutional bias in the presentation of certain topics, some bias is also evident in the selection of topics: hard x-rays are hardly mentioned, and one gets the impression that all x-ray astronomy is done in the 1- to 10-kev range. In fact the spectral data, important for many sources, are rarely given, and when given they are often expressed only in the mysterious units of Uhuru counts per second. The contributions of balloon x-ray astronomy are often ignored.

Some of the material will be rapidly superseded by results from the latest generation of x-ray astronomy spacecraft, but the view the book provides of the subject as it stood late in 1974 is detailed and nearly complete.

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Books Received

Acute Aortic Dissections. Constantine E. Anagnostopoulos with Constantine L. Athanasuleas, Thomas R. Garrick, and Robert Paulissian. Illustrated by Charles S. Wellek. University Park Press, Baltimore, 1975. xvi, 256 pp. $24.50.

Advances in Communication Systems. Theory and Applications. A. V. Balakrishnan, Ed. Vol. 4. A. J. Viterbi, Ed. Academic Press, New York, 1975. xiv, 312 pp., illus. $19.50.

Advances in Cyclic Nucleotide Research. Vol. 5. Papers from a conference, Vancouver, Canada, July 1974. George I. Drummond, G. Alan Robison, and Paul Greengard, Eds. Raven Press, New York, 1975. xiv, 872 pp., illus. $46.

Analytical Chemistry of Platinum Metals. S. I. Ginzberg, N. A. Ezerskaya, I. V. Prokof'eva, N. V. Fedorenko, V. I. Shlenskaya, and N. K. Bel'skii. Translated from the Russian edition (Moscow, 1972) by N. Kaner. P. Shelnitz, Transl. Ed. Halsted (Wiley), New York, and Israel Program for Scientific Translations, Jerusalem, 1975. xii, 674 pp. $60. Analytical Chemistry of the Elements.

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Applications of Algebraic Topology. Graphs and Networks, the Picard-Lefschetz Theory and Feynman Integrals. S. Lefschetz. Springer-Verlag, New York, 1975. viii, 190 pp., illus. Paper, $9.50. Applied Mathematical Sciences, vol. 16.

Basic Linear Partial Differential Equations. François Treves. Academic Press, New York, 1975. xx, 470 pp. $29.50. Pure and Applied Mathematics.

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