ural Sciences was irresistible, and Weaver found himself embarking on the career that was to continue, with interruptions, through his active life. World War II was one of these interruptions, when he worked on fire-control problems for the Office of Scientific Research and Development.

As an officer of the Rockefeller Foundation and later of the Alfred P. Sloan Foundation, Warren Weaver was largely responsible for the administration of more than a $100 million in grants for the support of scientific research, mainly in the life sciences.

In the closing chapters of his book, the author gives his unique, personal views on current science, the arts, and religion, including an intriguing analogy between the relationships of our various realms of experience and multilayered Riemann surface.

Perhaps from excessive modesty, Weaver appears to slight one phase of his activities—his attainments in interpretive science writing for which he was justly awarded the two most prestigious and lucrative prizes in this field: The Kalinga Prize in 1964 and the Arches of Science Award the following year. Anyone—scientist or layman—who has not read his essays on "The Emerging Unity of Science," "Science and People," "The Imperfections of Science," and many others has missed rare creations of graceful, effective prose. Certainly, in this field Warren Weaver is to be ranked with such greats as Arthur Eddington, James Jeans, George Gamow and Bertrand Russell.

Ira M. Freeman
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Concepts of Space: The History of Theories of Space

By Max Jammer

2nd ed. 221 pp. Harvard Univ. Press, Cambridge, Mass., 1969. $5.50

In the fifteen years since the appearance of the first edition of Max Jammer's *Concepts of Space* there has been no challenge to its pre-eminent position. It was and still is the unique contribution.

The intent of the second edition is to add a small amount of recently developed material rather than to present an extensive revision. The introduction contains some brief extensions picturing the preoccupation of modern physicists and philosophers with the problem of temporal order and its relation to the concepts of space and spatial order. The last chapter has been enlarged to discuss the problems posed by the failure of parity conservation and questions on the dimensionality and structure of space. All else in the book is unchanged, and what follows is solely for those not familiar with the first edition.

General perspective is furnished by a useful foreword by Albert Einstein presenting the two classical, conflicting concepts of space and their representation in the viewpoints, respectively of Leibniz and Newton: space as the network of positional relationships of all material objects, and space as an independent entity in which these objects reside.

The first three chapters discuss the development of the Aristotelian concept of space as the "place" of a material object, the theory of Democritus that space was a void wherein resided the ultimate particles of matter, and the Platonic scheme of space as both a receptacle for basic matter and possessed of causal properties for its fashioning. These basic ideas underwent continuous modification. The Christian era with the full development of the concept of an infinite, abstract God invited all manner of speculative fusion of religious concepts with that of space, which continued well into the time of Newton.

In the fourth chapter the refinement of these views into the rival space theories of Newton and Leibniz is considered. Religious influence on theories of space as a serious intellectual manifestation waned, and the influence of quantitative physical theory began to override it. The nature of Newton's scheme of mechanics logically required a space possessed of independent dynamical character, that is, an absolute space, and the enormous success of his mechanics enabled this view to overcome the opposing Leibnizian philosophy.

Next, Jammer considers the synthesis of modern concepts of space. He traces how the ebb and flow of criticism through, for example, the work of Berkeley, Kant and Mach, together with the development of non-Euclidean and differential geometries and the null results of the Michelson–Morley and Trouton–Noble experiments were laying the groundwork for the discarding not only of the concept of an absolute space but also of the introduction of a curved space.

With few omissions Jammer notes the subsequent main developments up to the time of publication. Such problems as the dimensionality of space, failure of the principle of conservation of parity, the possibility of a fundamental length quantum, and the discovery of "anti-Machian" metrics are all noted.

The book would have gained from explicit discussion of the extent to which modern physics is inexorably entwining the concepts of time, mass–energy, and space. It is no longer sensible for any philosopher to claim a "logical priority" of time over space when it is quite clear that, in a general curved space, clocks at separated points not only have different rates depending on the local metric but can not even be coordinated.

The work is meticulously documented but suffers somewhat from the use of citations in the original Latin, French or German. The sense of the quotation is usually mentioned but it would have been more helpful to recognize that, however deplorable, foreign-language requirements are vanishing. If one possesses no prior knowledge of the subject matter this book by itself will not provide the means for self-education. For the person already possessed of some knowledge of the ideas concerned, the author provides an elegant, if succinct, history. For the person who wishes an expert knowledge in this domain, this book is virtually indispensable.

Alexander Harvey
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Methods of Experimental Physics, Vol. 8: Problems And Solutions for Students

L. Marton, W. F. Hornyak, eds.

281 pp. Academic, New York, 1969. $14.50

Many of those who are familiar with the well established series, *Methods of Experimental Physics*, edited by L. Marton, will have their curiosity aroused by the *title* of the latest (eighth) volume: *Problems and Solutions for Students*. They may be somewhat surprised, possibly disappointed, by the contents. What makes suitable "problems in experimental physics" for graduate students? The editors suggest they be "... oriented towards the feasibility, limits of accuracy ... kind of information an experiment is likely to yield, signal-to-noise ratio ... " All this is certainly laudable, as such considerations influence the design and interpretation of practically all experiments. Examples of "real" experimental problems—how to interpret unexpected, as well as expected, phenomena, and how to continue the exploration, experimentally, would also be most interesting; but these are hard to invent and still harder to fix in print.

In practice, the "problems" turn out to be predominantly exercises in design of experiments, or specific technical components of such—computation rather than experimentation.

There are 15 contributors and 41 topics (or "problems"), ranging in length from two to 15 pages, and in subject matter from the field of a circular current loop, and a low-frequency loudspeaker design (calculations, not measurements), to measurement of gravitational red-shift and nuclear-reactor regulation and control. A mixed bag indeed. But three quarters of the "problems" are contributed by four of the contributors, and deal with four juxtaposed topics: magnetic fields due to currents, microwave techniques, reactor-associated physics, and nuclear kinematics—a sort of miscellany of technical "hand-book" material. There are some interesting pieces in the remaining quarter—some sixty pages covering a dozen diverse topics—but it is too dispersed and scrappy to be effective.

Samuel Devons
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Gravitation and The Universe

By R. H. Dicke
82 pp. American Philosophical Society, Phila., Pa., 1970. $2.50

In the last decade, some incredibly ingenious experimental tests of Einstein's gravitational theory have been proposed or performed. They involve, for example, Mössbauer methods, radar, supercooled gyroscopes and gravity-wave detectors. Princeton's Robert Dicke has consistently been close to where the action was, and has even sponsored a rival relativistic theory. He is particularly associated with three superb experiments for which he likes to cite the earth and sun as part of his "apparatus" and the universe as his "laboratory." These are: an Eötvös type of experiment that establishes the proportionality of inertia and gravity for gold and aluminum to one part in 10^{11}, improving previous accuracy by a factor of 500; an optical measurement of the sun's oblateness, which, if due to a fast rotation of the core would account for about 10% of the "relativistic" advance of Mercury's perihelion and thus upset general relativity, and the search for, and discovery of, the thermal-radiation fall out from a "big-bang" origin of the universe. The book under review consists of three 1969 lectures to a general audience, and it tells in fascinating detail, with the help of some 40 illustrations, about these three experiments and their theoretical implications, and also some historical sidelights.

Wolfgang Rindler
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Integral Equation Methods

By C. D. Green
243 pp. Barnes & Noble, New York, 1970. $15.00

The subject of integral equations is usually part of a course in mathematical physics, and there are at least two excellent references available: the monographs by F. G. Tricomi and S. G. Mikhlin. It is then natural to ask whether this book by C. D. Green is in any way an improvement over the sources already available. Unfortunately my answer must be a negative one.

Although the author includes all the topics that one would want in a book on integral equations, the treatment is very often superficial, offering little real insight into why methods work when they do, and when they can be expected to fail. No general conclusions are drawn from the few numerical examples presented. Short and confusing discussions are given of several topics, such as stochastic processes, Monte Carlo methods and the steepest-descent method. The latter is covered in a page and a half, leaving the reader with no clue as to the subtleties involved. The only really new textbook material is a chapter on dual-integral equations. There is almost no discussion of purely numerical methods. This is unfortunate since such a chapter would represent a real contribution when digital computers are widely available.

One misses in this book the insight of a master, such as that which characterizes the work of Tricomi. The little additional material included would appear to me to be insufficient for a new work on the subject.

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Advances in Plasma Physics, Vol. 3

A. Simon, W. B. Thompson, eds.
249 pp. Interscience, New York, 1969. $14.95

"We feel a desperate need for some review volume that will present authoritative discussions of advances in the several branches of plasma physics and even perhaps form a channel of communication among plasma physicists with allegiance to CTR, space physics, astrophysics, direct conversion, ion engines, solid state, and so forth." Thus the editors, Albert Simon, University of Rochester, and William B. Thompson, University of California at San Diego, introduced Volume 1 of their *Advances in Plasma Physics.* These review volumes have been coming out quite rapidly in the last year or so, and Volume 3 differs considerably from the other two. The first two volumes covered a fairly wide range of subject matter, whereas this volume is restricted to theoretical papers on kinetic theory and plasma wave phenomena.

The longest paper, which is also the lead article in the volume, concerns kinetic theory of plasma waves in a magnetic field and is a published version of the course that the authors, David Baldwin, Ira Bernstein, and M. P. H. Weenink, have been giving for the past few