place in mythology, religion, history, art, and letters. Even if the author chooses to confine himself to the scientific aspects of lightning alone, as Uman has done, he must choose from a formidable mountain of observations, data, theories, and speculations. Some readers may be disappointed to find that this book scarcely mentions unusual lightning phenomena, such as those associated with volcanoes, tornadoes, and nuclear explosions, that it has nothing to say about the role of lightning in anthropology, ecology, biology, atmospheric chemistry, and cloud physics, and that it does not deal with such topics as whistlers, spherics, lightning control, or the effects of lightning on animals, buildings, and airplanes.

All of this is, of course, expecting far too much. If the author had chosen a more restrictive title that better described his book, for example, "Physics of the Lightning Flash," there would be little to criticize. He has done a solid and useful piece of work to provide a clear, authoritative, and up-to-date exposition of many of the physical phenomena associated with lightning. Until now this material has not been available in a single text.

One of the particularly useful portions of this book is the introductory chapter, which provides a condensed version of the detailed discussions that follow. The first table, which gives minimum, maximum, and representative values that have been measured for more than a dozen important variables associated with the lightning flash, is a valuable compilation. The six chapters that follow, treating in detail such subjects as lightning photography and spectroscopy, electrical measurements, thunder, and the theory of discharge processes, will be useful for the advanced student and the scientist working in this field.

Two appendices provide an introduction to the very puzzling literature of bead and ball lightning, which, as Uman notes, is voluminous enough to fill a book of its own. Two other appendices bring lightning research up to date with a discussion of recent developments and project it into the future with suggestions for further studies. The value of the book is enhanced by comprehensive lists of references and detailed author and subject indexes.

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A Technique

Chemical Applications of Mössbauer Spectroscopy. V. I. GOLDANSKII and R. H. HERBER, Eds. Academic Press, New York, 1968. xiv + 701 pp., illus. $29.

The phenomenon of recoilless emission and absorption of nuclear gamma radiation, reported by R. L. Mössbauer in 1958, has now taken its place alongside other nuclear phenomena such as nuclear magnetic resonance as an important and unique method for investigation in several branches of physics and allied fields. Thus, as an addition to the excellent account by G. K. Wertheim (*Mössbauer Effect: Principles and Applications*, Academic Press, 1964) there has been a need for a comprehensive treatment of the subject at the research level. The proceedings of several conferences and the now-yearly reports of the Mössbauer symposia (*Mössbauer Effect Methodology*, vols. 1–4, I. J. Gruverman, Ed., Plenum, 1965–1968) have partially filled this need. The present volume, edited by V. I. Goldanskii and R. H. Herber, should go a long way toward providing a satisfactory one-volume reference work. The title of the book is too restrictive; it could, justifiably, have been called "Applications of Mössbauer Spectroscopy."

In a field that has developed as explosively as has Mössbauer research, it is probably inevitable that a useful book would consist of a series of articles contributed by a large number of workers. The editors have sought to overcome the resulting lack of continuity and uniformity by means of numerous and detailed footnotes. These notes also often serve as addenda to bring the text up to date.

The book covers the important applications of the Mössbauer effect to nuclear, solid state, and atomic physics and to pertinent problems in biophysics. Chemical applications are indeed stressed, after suitable introductions, in the treatment of the Mössbauer effect in ^{57}Fe, ^{119}Sn, xenon and iodine, the rare earths, and the heavy elements. Some special effects are described and an excellent treatment of spin relaxation phenomena in solids is included. The only serious drawback to the use of the book as a general reference work on the Mössbauer effect is the omission of applications to relativity and resonant time effects and to mineralogy and geophysics, where Mössbauer spectroscopy is increasingly used. Topics such as the implantation of Mössbauer nuclei in various environments are too recent to have been included.

In summary it should be stressed that the book does provide the first comprehensive treatment of the applications of Mössbauer spectroscopy to chemical problems. The impressive amount of research reported in this area supports the early prediction that this may be where the Mössbauer effect will make its greatest contributions in the long run.

This reviewer has already had occasion to consult the book in the course of research and found it very helpful. The hackneyed phrase of the reviewer seems especially appropriate: no serious research worker in this field should be without access to this book.

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Crystallography

Molecular Crystals. Their Transforms and Diffuse Scattering. JOSÉ LUIS and MARISA AMORÓS. Wiley, New York, 1968. xxiv + 479 pp., illus. $22.50. Wiley Monographs in Crystallography.

This is the second book in a series, Wiley Monographs in Crystallography, edited by Martin J. Buerger, the first of which was *Polymorphism and Polytypism in Crystals* by A. R. Verma and P. Krishna.

The book is essentially divided into two parts. The first three chapters deal with the theory of scattering of x-rays by atoms and molecules, by an ideal periodic structure, and by a real crystal. The remaining three treat applications to the diffuse scattering of molecular crystals, diffuse scattering by thermal waves, and temperature dependence of diffuse scattering. In the theoretical treatment an important place is taken by the Q-function (self-image of the electron density) and by the difference Fourier transform (the difference of the molecular Fourier transforms at temperature $T = 0$ and temperature T). There is also a great deal of emphasis on optical analogs, particularly Fraunhofer patterns obtained by representing atoms by disks of varying size and recording the diffraction pattern of the assembly. The text is supplemented by a large number of excellent illustrations.

The chief merit of the book is that it is practically the first one available

which offers an extensive treatment of diffuse scattering as caused by disorder and thermal motion. This is a rather difficult subject in an area in which the authors have considerable experience. It is a pity that the book does not quite come out as well as might have been expected. The authors do not quite manage to get the subject across. The mathematics in the first three chapters is treated perfunctorily and nonrigorously, derivations are frequently left incomplete, and statements beginning "it is easily seen that. . ." occur rather too often in cases where the next step is not at all obvious. Proceeding to the next three chapters the reader will find that there is in fact rather little correlation between the theory he has just worked through and the applications he now finds. These last chapters, which occupy roughly the second half of the book, are suddenly quite descriptive, as if there were no real connection between this part and the first part of the book. In the many examples cited there is not a single case where a complete interpretation based on the preceding theory is given.

Added to this is the problem that the book contains an unacceptable number of mistakes, ranging from typographic errors, through references to wrong equations, to mistakes in the equations themselves.

Altogether this makes the book rather hard going. For those physicists and crystallographers who are intimately involved with the subject of disorder and diffuse scattering it will be a useful additional source of information, and the list of references is excellent.

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Astronomy in Britain

Astronomers Royal. COLIN A. RONAN. Doubleday, Garden City, N.Y., 1969. xiv + 226 pp., illus., + 16 plates. $5.95.

As a popular history of British astronomy, this volume has much to commend it. An engaging mixture of science and biography, the story is populated by first-rate characters such as Issac Newton, Edmond Halley, and William Herschel. Here are excellent reviews of material not readily found elsewhere, such as the introduction of Copernicanism into England or the development of photography; even often-retold tales such as the Neptune scandal achieve a commendable freshness, and Airy—who is generally portrayed as the villain—wins a balanced presentation.

The original English title, *His Majesty's Astronomers,* was considerably more honest than the book's present appellation. This work does not attempt to cover each Astronomer Royal—for example, the enigmatic Nathaniel Bliss, who held the office for two years between Bradley and Maskelyne, is written off with the remark that his sole claim to fame is that his only known portrait is inscribed on a pewter tankard with the legend "This sure is Bliss, if Bliss on Earth there be." Happily, instead of the text's being limited to the lives of the Astronomers Royal, vital and lively sections are included on William Huggins, Arthur Eddington, and William Herschel.

The opening chapter on the Copernican revolution is unfortunately the weakest in the book. Ronan augments and perpetuates the traditional fallacious mythology. We find such statements as "Copernicus was not a good observer—the poor accuracy of his measurements of planetary positions proves that—but even his fumbling efforts made it clear to him that the theory and observation were poles apart. Predicted and observed positions were in wild disagreement." In fact, Copernicus worked basically from the time-honored positions of Ptolemy's *Almagest,* adding his own quite reasonable observations only occasionally. Whether the positions predicted from the Ptolemaic theory were "in wild disagreement" with the observations depends on one's point of view. Certainly severe discrepancies could sometimes be found —but predictions with the Copernican system fared little better. Indeed by the end of the 16th century, Tycho Brahe had occasion to complain that the Copernican tables were often worse than their predecessors.

Barring the first chapter, the presentation is generally accurate with regard to overall emphases as well as specific details. Ronan has a flair for popular science writing, and his narrative is both readable and informative.

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Stellar Events

Supernovae. I. S. SHKLOVSKY. Translated from the Russian by Literaturprojekt. Interscience (Wiley), New York, 1969. viii + 444 pp., illus. $20. Interscience Monographs and Texts in Physics and Astronomy, vol. 21.

At its maximum, the luminosity of a supernova equals that of an average galaxy. An event of such magnitude is important from many points of view, ranging from stellar evolution to the chemical composition of galaxies and to the origin of primary cosmic rays. Remnants of supernovae are an important class of radio sources. This wide range of problems is undoubtedly the reason why there have been review articles or chapters in compendia dealing with one or another aspect but never before a book presenting all observational information and the many theoretical discussions and speculations to which Shklovsky has made many important contributions.

Supernovae are rare, occurring at a rate of roughly one every several hundred years in an average galaxy. There has been no observed outburst in our own Galaxy in modern times. Data on the outbursts thus are obtained by observations of supernovae in external galaxies. Nebular remnants formed after the outbursts are found in our Galaxy, but only few can be connected with outbursts for which there are—necessarily crude—historic data. A gap of hundreds of years separates observations of the outbursts and of the remnants. Only one remnant, the Crab Nebula, is bright enough to be accessible to detailed observations. One third of the book is devoted to this object.

Shklovsky was well aware that a monograph in a rapidly evolving field is in great danger of becoming obsolete. The list of references has no entry later than 1965. The Russian edition was still essentially up to date at the time of publication, 21 September 1966. The translation, published more than two years later, is already seriously out of date in some respects. Since the translation was made from the original manuscript, one wonders why the delay was so long.

The translation is poor. There are too many differences between the English and Russian editions, some trivial—for instance, "astronaut" instead of "astronomer" at the end of the introduction—but some material—such