Criticisms leveled in past years (crude technique, absence of statistical evaluation, irrelevant references to Pavlov and to the state) seem largely inapplicable to this collection. If one wants a pleasant introduction into modern Soviet neuroscience, and the names of some investigators that are worth the trouble to follow, this work will supply both. The book is attractively printed and the illustrations are of good quality. The translation is competently done, so far as I can tell. I must also express my appreciation to Livanov for having provided the occasion for this publication.

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Molecular Electronic Spectra

Low Temperature Spectroscopy. Optical Properties of Molecules in Matrices, Mixed Crystals, and Frozen Solutions. BEAT MEYER. Elsevier, New York, 1971. xii, 654 pp., illus. $33.50.

It possibly would have been a mistake for Meyer in his *Low Temperature Spectroscopy* to be too meticulous about historical priorities in this field. In the first place, almost every physical chemist, photochemist, or solid state physicist has found himself doing a low temperature spectroscopic experiment at some time or other. In the second place, the numerous streams of low temperature research in optical spectroscopy have frequently isolated themselves from one another, not by virtue of any serious differences in cryogenic technology but simply because some workers have been interested in atoms, others in large molecules, others in *d*- and *f*- electrons, others in free radicals and unstable molecules, others in molecular crystals, and still others in semiconductors, and so on. It would therefore be a monumental operation to present a detailed account of the history of low temperature spectroscopy. Although Meyer has made a modest attempt at providing this background, only the part on matrix isolation spectroscopy of small molecules seems adequately researched.

Most of the book is concerned with just a narrow part of low temperature spectroscopy, and Meyer's term "cryochemistry" might have been a more appropriate title for a book that deals with mainly molecular electronic spectra and avoids the temptations to explain much of the physical meaning either of the spectra or of their modifications due to the states of the various matrices in which the molecules are studied. These matrices are organic glasses, vapor-deposited matrices of small molecules or atoms, and mixed crystals. Inert matrices are the author's specialty, and the book is best in the parts dealing with them. Meyer is also at his best in the purely experimental chapters, when he is giving us advice about buying equipment, finding the proper gaskets for cold windows, or how to avoid explosions of liquid helium dewars and numerous other useful hints for the effective running of a cryogenic laboratory. An additional practical feature is the set of useful tables of physical properties for common matrix materials, including glasses and plastics. The only ground rules are that the sample not consist of a neat ionic or molecular solid and that the temperature be less than 100°K.

Although the book contains 654 pages one finds that some 280 of these are occupied by a tabulation of spectral data on atoms, diatomics, and triatomics mostly in inert matrices, and organic molecules in glasses, mixed crystals, and crystals and by some 2200 references to low temperature spectroscopic work on molecules and free radicals. The data on atoms through triatomics are presented in a form similar to that used in Herzberg's compilations (*Electronic Spectra of Polyatomic Molecules,* Van Nostrand, 1966) of gas phase molecular spectra: The energy of the 0,0-band, the vibrational frequencies, and the nature of the electronic state are presented, but intensity data are excluded. Meyer has used a similar but less detailed method in tabulating information on polyatomics ("poly" means greater than or equal to four, according to Meyer, but does not include organic molecules) and organic molecules. Since there are so few definite assignments for electronic and vibrational states of larger molecules the average worker might have wanted to use tables of this sort for no other reason than to find the wavelengths of light that a molecule absorbs and emits, the intensity of these processes, and who has previously worked on low temperature spectra of that molecule. For most molecules Meyer has given only a single wave number [as $(E/hc) \times 10^{-4}$ μm^{-1}], corresponding to the energy of a feature of just one of the electronic states of the molecule. Frequently these numbers are 0,0 band energies, although this is never stated, and for many of the molecules in the tables even such an identification would be questionable.

It would have been especially useful to have more information on such things as the approximate width of spectra at various temperatures, the extent to which vibrational structure is developed in different matrices, and absorption intensity. The tables do include emission lifetimes, so one can guess whether the emitting state has the same spin as the final state of the emission process. In any event, the references are also cited in the tables, and although the reader doesn't know which reference, for a particular molecule, refers to which entry under solvent, temperature, absorption, emission, or lifetime, he is gratified to find that the alphabetically ordered bibliography includes the names of coauthors and the full titles of the papers. Apart from a few data concerning rare gas matrices, Meyer's tables are not an improvement over the Landolt-Börnstein compilations on the luminescence spectra of organic substances (*Numerical Data and Functional Relationships in Science and Technology*, new series, group 2, vol. 3, Springer-Verlag, 1967).

This book does not provide answers for those who want to know the extent to which low temperature spectroscopy has contributed or will contribute to our understanding of molecular structure. It does provide a needed single source of low temperature technical expertise, especially in regard to matrix isolation techniques. Perhaps the slant of the book, and one view of the state of the art, is best conveyed by noting that the number of waves per micrometer is tabulated to four significant figures for diatomics and to only three for polyatomics.

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Chemical Structure

Absolute Configuration of Metal Complexes. CLIFFORD J. HAWKINS. Wiley-Interscience, New York, 1971. xii, 350 pp., illus. $19.50. Interscience Monographs on Chemistry, Inorganic Chemistry Section.

The title notwithstanding, only about a third of this book deals directly with absolute configurations. Most of it is devoted to the related subject of conformational analysis. No previous book has covered these two areas of inorganic chemistry, and the present one provides a useful compilation of data and an elaboration of the associated concepts, even though at times the author ignores others' work in presenting his own views.

The first part of the book, dealing with conformational analysis of chelate rings, is expounded clearly and with excellent diagrams. The section on optical activity of coordination compounds is an attempt to present a professional approach to the problem of absolute configurations, a subject in which there are few specialists. Hawkins does an excellent job with the empirical methods, critically examining the evidence for assignments and dealing properly with correlations. The section on nonempirical methods of determining absolute configurations suffers because the uninitiated reader may not know what the argument is about. Here the author does not, as he does in the previous chapters, present the subject from the beginning. Such a presentation would have been helpful whatever the merits of the view he takes. The last part of the book is on nuclear magnetic resonance and is interesting.

On the whole this is a good book, but in order to proceed with equanimity the reader should realize that it has both heroes and villains; the bad guys are treated with Olympian disdain.

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Astrophysics

Cosmic Gamma Rays. Floyd William Stecker. Mono, Baltimore, 1971. x, 244 pp., illus. $12.50.

Astronomy has made tremendous advances over the last two and a half decades as a result of the expansion of the observable range of frequencies from the narrow visible band at 10^{15} hertz. Now almost the entire span from the low end of the radio-frequency region at 10^8 hz through the x-ray region at 10^{19} hz is being utilized. Radio-frequency, infrared, and x-ray radiation from many astronomical objects has been found to have a much greater intensity than had been theoretically predicted. Thus the strong radio sources, quasars, "x-ray stars," and pulsars have been added to the astronomer's lexicon.

Morrison pointed out in 1958 that, since electrons of at least 10^{12} electron volts were necessary to account for the synchrotron radiation observed from many of the strong radio sources, other high energy elementary particle reactions should also be taking place. These could be responsible for the production of the charged particle cosmic radiation and should also produce gamma rays, —that is, electromagnetic radiation above 10^{20} hz. Unfortunately for the experimentalist, in this portion of the spectrum the observed intensities have been much less than originally predicted. Although radiation has been observed up to 10^{23} hz, the experimental situation is still far from clear (Research Topics, *Science*, 24 Dec. 1971).

In this monograph, Stecker gives a very thorough treatment of the elementary particle reactions which produce high energy gamma rays and applies these to various astrophysical situations. Use is made of the recent data for *p-p* collisions available from high energy physics: cross sections, branching ratios, lifetimes, and so on. Above 30 Gev bombarding energy, where accelerator data are not yet available, the fireball models of meson production are used to extrapolate the gamma ray spectrum to higher energy. Inverse Compton collisions, bremsstrahlung, and matter-antimatter annihilation are the other processes most likely to produce cosmic gamma rays, and they are also adequately described. The lowest energy considered is the 0.51 Mev gamma ray from electron-positron annihilation. Not treated is the line gamma-ray radiation produced in nuclear reactions, although some of these rays are in excess of 1 Mev. Their detection would provide valuable information on stellar nuclear reactions and nucleosynthesis.

A less satisfactory part of the book is the discussion of the existing experimental data. Stecker chooses to consider only extended sources such as the interstellar gas in our galaxy bombarded by the high energy cosmic ray protons or the isotropic gamma rays from neutral pion decay at an early age of the universe, which we would observe red-shifted by $Z \sim 100$. Data in support of these processes came from experiments on the satellites OSO-3 and ERS-18, but later experiments have raised doubts about both results. The galactic radiation may be due primarily to point sources, as is the case with the galactic x-ray sources. No mention is made either of the role played by the nonobservation of gamma rays from certain objects in rejecting proposed theoretical models. For instance, the energy source for the quasar 3C 273 cannot be nucleon-antinucleon annihilation because the resultant gamma ray flux would exceed the observed upper limit by a factor $\simeq$ 100.

In summary, this work will be of interest especially to the astrophysicist in providing a compendium of the relevant formulas for cosmic gamma ray production and to the general physicist by showing how the knowledge acquired in elementary particle physics in the last 20 years can enhance our understanding of the universe.

Donald Kniffen has contributed a useful appendix on the experimental techniques which have been used on balloons and satellites.

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Cosmological Physics

Relativity and Gravitation. Based on a seminar, Technion City, Israel, July 1969. Charles G. Kuper and Asher Peres, Eds. Gordon and Breach, New York, 1971. xii, 324 pp., illus. $24.50.

The dust cover of this book contains the statement "This book discusses the most recent developments in the theories of relativity and gravitation, and contains contributions from the leading experts in this field." While it is true that this book does contain contributions from many prominent workers in the field of general relativity, it is also safe to say that few of the contributions have anything significantly new to say. This is not to deny that there are indeed several interesting articles in this collection.

One of the most interesting, significant, and controversial experiments in recent times has been the work of Joseph Weber in detecting gravitational radiation. Weber gives an account of his results heretofore found only in several short articles in *Physical Review Letters*. He discusses the observed events—coincidences between detectors located 1000 miles apart—and by statistical analysis rules out these events' being due to chance. He also describes the reasons why it is unlikely that the events have been produced by non-gravitational phenomena: electromag-