quired a too-narrow idea of how to teach this subject. One of the most important concepts for the understanding and practical application of quantum mechanics is angular momentum. The treatment of this concept could have been more extended. There is, for example, no reference in the book to the fact that the angular momentum operators are the operators of infinitesimal rotations. The addition of angular momenta as applied to many-particle problems is mentioned, but has not received a very thorough discussion. This textbook, as well as most of the others, refer the reader to the book by Condon and Shortley, whose treatment, however, is much too exhaustive—the reviewer has found that it frightens away most of the students who want to study it. It is hoped that some textbook will provide an elegant and simple treatment of this field. The spin of the electron does not get the attention it deserves. The fact that the electron wave function has two components is derived in too formal a manner. A discussion of the transformation properties of these components, if the coordinate system is rotated, is necessary for the understanding of the spin.

Schiff's book has many values for teachers and students, not the least of which is its collection of first-rate problems. Too few textbooks on quantum mechanics can be used for a graduate course. There are many ways of teaching the subject and there is a great need for textbooks with different approaches. Although the present book in many respects follows the conventional lines, it does bring in new ideas and approaches and will contribute to a better understanding and better teaching of quantum mechanics.

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Physical aspects of colour: an introduction to the scientific study of colour stimuli and colour sensations. P. J. Bouma. New York: Elsevier (U. S. distributors for Philips Technical Library, Eindhoven, The Netherlands), 1948. Pp. 312. (Illustrated.) $5.50.

It is a pleasure to review this remarkable summary of the principles and techniques of modern measurement of color. Dr. Bouma spent the last two years of his life to produce what he knew would be his last work, and he has achieved a brilliant climax to a distinguished career in illuminating engineering.

Starting from a novel yet perfectly sound approach, Dr. Bouma presents the concepts and laws on which the measurement of brightness is based—the Maxwell color triangle and the standard ICI colorimetric coordinate system and its relation to dominant wavelength and purity, to color temperature, to boundary, ideal, optimal, and full colors, and its use in the reduction of spectrophotometric data. He then passes to visual colorimetry, defective color vision, discrimination of color differences, the Munsell color system, and hue and saturation of object colors in connection with chromatic adaptation of the eye.

Dr. Bouma does not skip over the hard parts, but goes in simple language to the knot of each problem, often with a mathematical proof. The book is further remarkable for its completeness. All important colorimetric techniques are not merely described; they are appraised with consummate skill and judgment.

In spite of the direct style and excellent translation into English, the book is not easy reading. It has to be studied, not merely read. The facts and concepts of modern colorimetry cannot be adequately grasped by the layman, however intelligent he may be, in a few hours. Here is a clear account of these facts and concepts by a world master whose comprehension of the recent extensive American literature will probably not be matched by an American author for some years to come. Dr. Bouma's book meets a unique and long-felt need, and should be available to every serious student of color.

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Practical spectroscopy. George R. Harrison, Richard C. Lord, and John R. Loofbourow. New York: Prentice-Hall, 1948. Pp. xiv + 605. (Illustrated.) $6.65.

The authors of this extremely useful and interesting reference book have operated in recent years the spectroscopic laboratory of the Massachusetts Institute of Technology and have felt (quoting from the preface) "the need of a text and reference book that would help the worker in any branch of science to evaluate the aid which the techniques of spectroscopy might lend to the solution of his problems. In our attempt to fill this need, we, as a physicist, a chemist, and a biophysicist, respectively, have tried to synthesize our three viewpoints in a way that would be useful to all who use, or might use, the techniques of experimental spectroscopy."

They have produced a book that will be valuable and interesting to all of us who have made constant use of the spectrograph, and will fulfill the requirements of the beginner as well. For example, in the chapter on the photography of the spectrum (page 154) I find a suggested routine to follow in transferring a plate from the box to the plateholder in a perfectly dark room, in order to be spared the embarrassment of finding, on turning up the lights, an open box of plates awaiting disposal.

The beginner will find in the first chapter a very brief history of the development of the spectroscope, its construction and operation, and its use in physics, chemistry, biology, medicine, metallurgy, food research, and criminology. Chapters 2 to 5 are devoted to the selection of spectroscopic instruments and the use of prisms and diffraction gratings, together with the fullest details on their adjustment and methods of illumination.

Chapter 7 covers the photography of the spectrum, dealing with practically everything connected with the selection and development of plates and with common defects in spectrum photographs and how to avoid them. Chapter 8 offers a very full description of the various types of light sources for spectroscopy, low temperature thermal emission, metallic arcs, high and low pressure mercury arcs, spark discharges, and vacuum tubes.

Chapter 9, on the identification of spectrum lines, measurement of wavelengths, and the determination of minute traces of impurities with the comparator, closes with a description of Harrison's remarkable automatic comparator, used at the Massachusetts Institute of Technology since 1938. This machine is capable of measuring in two minutes a spectrum plate 20 inches long on which are recorded as many as 2,000 spectrum lines. It records on a motion picture film, to seven-figure precision, the wavelengths in Angstrom units of all of the lines, along with a curve of density showing their position and intensity. Unfortunately, the record on the strip of film reproduced is on such a small scale that the numerals can't be read. This is also the trouble on page 163 in the case of the sensitivity curves of various emulsions.

Chapter 10 covers very fully the modern quantum theories of atomic spectral series, energy levels, and the Zeeman and Stark effects (the former effect furnishes a method of classifying lines into series). The chapter closes with a treatment of the Pauli exclusion principle and the periodic table.

Chapter 11 is devoted to describing the highly complicated fine structure of the spectra of molecules (their rotation and the vibration of their atoms give rise to corresponding energy levels, superposed on the electronic levels), and to explaining the part these energy levels play in producing various types of absorption spectra.

In Chapters 12 to 14 we are back again in the laboratory with 420 pages devoted to methods for measuring the intensities of spectrum lines or absorption bands by means of radiometers, photoelectric cells, and photographic emulsions. Some of the instruments are automatic, like the extremely complicated photoelectric spectrophotometer of Hardy, and the instrument of Harrison and Bently previously mentioned.

Chapters 15 and 16 deal with the qualitative and quantitative analyses of materials. In the two following chapters the treatment of infrared and "Raman" spectroscopy is far more extensive than is usual in books on general spectroscopy, and Dr. Lord's contrast and comparison of these two types of observation will be of great interest to everyone engaged in the study of molecular structure and in qualitative and quantitative chemical analyses.

A minor mistake was made on page 474 in crediting E. F. Nichols with the invention of the widely used method of residual rays, and not mentioning Rubens, who originated the method and named the radiations "rest strahlen." Nichols, who was working under the direction of Rubens, had found that a quartz plate had a very high coefficient of reflection in the region between 8 and 10 microns, but it was Rubens who foresaw that multiple reflections from a number of plates would eliminate all of the very intense radiations of shorter wavelength. Rubens developed the method and published it under joint authorship with Nichols. The description of the method of "focal isolation" of a narrow region in the remote infrared (described on the next page) omits mention of the very essential circular metal disk covering the center of the quartz lens or the fact that two such lenses are usually employed.

Chapter 19 covers the spectroscopy of the vacuum ultraviolet and presents diagrams of the vacuum chambers housing the optical parts. The final chapter offers a much longer treatment of interferometric spectroscopy than is usual in textbooks, covering the Lummer Gehrcke plate, Fabry and Perot's etalon, the Michelson transmission echelon, and the reflecting one of W. E. Williams.

The very complete references to specific points, in the form of footnotes, and the general references at the end of the chapters supply the details, often desired, but usually found wanting in a book like this, for lack of space.

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Handbook of radioactivity and tracer methodology. William Siri. (With contributions by Ellsworth C. Dougherty, *et al.*) (Air Force Technical Report No. 5669.) Washington, D. C.: Office of Technical Services, Department of Commerce, 1948. Pp. 867. (Illustrated.) $20.00.

This handbook should be an invaluable aid to the many scientific specialists who wish to apply the use of radioactive or stable isotopes to the investigation of their special interest. I should say that it would be particularly useful to the biologist or chemist who needs these techniques but who has been handicapped by a lack of information about the physical methods which must necessarily be used for measurement of the appropriate rare isotope. Such an individual will find the necessary background information on nuclear physics in the first section of this handbook. This section also contains a wealth of range and cross section data which will be of particular interest to the physicist or biophysicist. The second section of the handbook is devoted to a discussion of the various instruments used for measurement of isotopes. The information in the chapter on calibration and use of G-M counters, as well as the detailed discussion on preparing biological samples for counting, is indispensable to the novice and probably could be read with profit by many of the more experienced workers in the field. The chapter on autoradiography is somewhat general and, in view of the rapidly expanding interest in this technique, the next edition of the handbook should perhaps treat it in greater detail.

A third section deals with the biological and medical applications of isotopes. The useful isotopes are discussed as regards their use in both tracer experiments and therapeutic applications. A chapter on the biological effects of natural radioactive elements closes this section.

The fourth section consists of an extensive bibliography including some general references and a complete list arranged according to the elements investigated.

In general it may be said that this handbook contains information available in no other single source. While particular stress has been laid on its usefulness to the biologist or chemist, it should be an invaluable reference