cation, which implicitly involve it. Yet this is a matter of taste, and doubtless many readers will welcome the comparative approach.

The exposition is explicit and precise throughout. The results are obtained with a minimum of effort in notations, which in general are as convenient as the context permits. The very complete discussion of Grassmann coordinates in Chapter VII is a novel and welcome feature. The chapter on resultants and allied theorems is very effectively done, and the final chapter on correlations is unusually complete. Needless to say, the appearance of the second volume will be awaited with great interest.

ARTHUR B. COBLE

Haverford College

Integration in finite terms: Liouville's theory of elementary methods. Joseph Fels Ritt. New York: Columbia Univ. Press, 1948. Pp. vii + 100. $2.75.

Two general types of problems are discussed in this monograph, both of them closely related by the methods used: (1) When is the integral of an elementary function itself an elementary function? Here, a function is called elementary if it is constructed with a finite number of operations involving algebraic functions, exponentials, logarithms, trigonometric and inverse trigonometric functions. Of course, by Euler's relations, the trigonometric and inverse trigonometric functions can immediately be deleted from this list of basic expressions. (2) When can certain ordinary differential equations be solved by quadratures? That is, integration is now also considered an admissible elementary operation.

The study of these two types of problems was inaugurated by the great French mathematician, Joseph Liouville, who discussed such questions in 7 fundamental papers during the years 1833–41, developing quite new methods for this purpose. Only a few mathematicians continued Liouville's work; these include Chebyshev, Koenigsberger, Mordukhai-Boltovskoi, the author of this monograph, and, quite recently, Ostrowski.

In the present monograph the fascinating work of Liouville and his successors has been presented in a unified, rigorous and readable manner. The essential ideas have been stressed, and auxiliary information on analysis and algebra has been supplemented.

With regard to the first type of problems mentioned above, for example, the nonelementary character of Legendre's elliptic integrals of the first and second kinds, of the probability integral, of $\int \frac{e^x}{x}\,dx$, and of the (nonconstant) elliptic functions is proved. Among the second type of questions, Riccati and Bessel differential equations, algebraic differential equations of first order, and linear differential equations of second order are discussed. For instance, Bessel's differential equation cannot be solved by quadratures, except for special values of the parameter.

Mathematicians should certainly be indebted to the author for this very valuable monograph on such a beautiful part of analysis which, although often quoted, has been known so far only to a few specialists.

ARTHUR ROSENTHAL

Purdue University

Paramagnetic relaxation. C. J. Gorter. New York-London-Amsterdam-Brussels: Elsevier, 1947. Pp. vii + 127. (Illustrated.) $2.25.

This monograph is concerned with the frequency dependence of the magnetic susceptibility of paramagnetic salts. Prof. Gorter, now director of the Kamerlingh Onnes Laboratory at Leiden, was the first to explore this field and remains its leading experimental investigator. Most physicists and chemists are familiar with dielectric dispersion and absorption in polar substances. The magnetic analogue of this phenomenon, which we meet here, presents a much more complicated picture. The variables at the disposal of the experimenter are the temperature, the frequency of the oscillating magnetic field, and the intensity of a constant magnetic field applied to the specimen. (The important role of the last parameter has no analogue in dielectric relaxation.) The reader new to the field may find the wealth of experimental data assembled in Chapter III a bit bewildering, even after the succinct and illuminating review of static paramagnetism and the thermodynamics of a paramagnetic system contained in the first two chapters. The theoretical discussion of the phenomena observed is reserved for Chapter IV. On all but pedagogical grounds, the author's emphasis on the experimental results is certainly justified. Indeed, theory has by no means caught up to experiment in this field, despite the notable contributions of Van Vleck, in this country, and Casimir, Kronig, Broer, and others in Holland. The subject is very much alive, and Prof. Gorter's authoritative book, written during the dark days of the German occupation, represents a consolidation of ground gained in preparation for fresh assaults.

E. M. PURCELL

Harvard University

New developments in ferromagnetic materials, with introductory chapters on the statics and the dynamics of ferromagnetism. J. L. Snoek. New York-Amsterdam: Elsevier, 1947. Pp. viii + 136. $2.50.

This small book is intended to summarize the research on ferromagnetic materials carried out by Snoek and his co-workers during the war at the Phillips Laboratory in the Netherlands. This group was able to continue under the hazards and inconveniences that accompanied the German occupation and added a very interesting chapter to the subject of ferromagnetism.

Snoek has divided the monograph into three parts: I, Statics of Ferromagnetism; II, Dynamics of Ferromagnetism; III, Development of Ferromagnetic Materials. The first of these parts deals with new discoveries and new viewpoints concerning the properties of ferromagnetic materials under conditions in which

the applied magnetic field is stationary or is varied very slowly. The topics covered are miscellaneous and center about such subjects as the theory of the hysteresis curve, measurements of crystal anisotropy and magnetostriction in ternary alloys, and the permeability and coercive force in the cubic ferromagnetic oxides. The investigation of the magnetic oxides represents the profitable renaissance of a subject that has barely been touched in the past.

The second part, dealing with the dynamics of ferromagnetism, summarizes that class of magnetic properties of steel and related substances which vary with time as a result of the diffusion of the interstitial carbon or nitrogen atoms. One of the most conspicuous of these effects is the decrease with time of the permeability that is observed following a change in magnetization—an effect to which Snoek has given the name "disaccommodation." Snoek presents a closely correlated group of experiments concerning this and related effects and summarizes the very beautiful theory with which he has interpreted the observations.

The third section surveys in considerable detail the properties of the mixed ferromagnetic oxides or "ferrites" which were touched upon in the first part of the book. The influence of temperature and composition are treated. For example, the variation of the Curie temperature with composition is followed for a number of continously varying systems. In addition, there is much magnetic data of technical interest concerning these oxides.

It is safe to say that this small book represents one of the most valuable additions to the subject of ferromagnetism since the volume of Becker and Döring appeared nearly 10 years ago.

FREDERICK SEITZ

Carnegie Institute of Technology

Nuclear physics in photographs: tracks of charged particles in photographic emulsions. C. F. Powell and G. P. S. Occhialini. Oxford, Engl.: Clarendon Press; New York: Oxford Univ. Press, 1947. Pp. xii + 124. $6.00.

One of the oldest and simplest techniques in nuclear physics which has been 'dormant" for many years has suddenly, through some important refinements, come to the forefront of the attention of physicists. Indeed, it has allowed, by the simplest methods, some of the most important postwar discoveries.

The history of the revelation of *tracks* in photographic emulsions is a very old one, going back to Kinoshita in 1909, but before its present blossoming, in part due to the new Ilford and Eastman emulsions, it had not given any results of importance comparable with those reached through the electrical methods of measuring, scintillations or Wilson Chamber.

The book under review shows in an exceedingly beautiful way what can be done at present with photographic emulsions. In this respect it is comparable to the Atlas of Wilson Chamber pictures by Gentner, Maier Leibnitz, and Bothe.

A sequence of striking pictures of nuclear phenomena as revealed by the technique of the tracks in photographic emulsions is used to illustrate an elementary course in nuclear and cosmic-ray physics, but this arrangement and the well-written text is only, one feels, a convenient frame to illustrate the technique.

The climax is reached in plates 42–48, in which evidence is given for the new π mesotrons recently discovered with this technique by a group of physicists, including the authors of this book.

The book contains sufficient technical information to instruct on the methods of use of the photographic plates, which are now commercially available, and, if only for this reason, it is a "must" for every research nuclear physicist.

The reproduction of the photographs and the typographical presentation are excellent—a most important feature for a book of this kind.

E. SEGRÈ

University of California, Berkeley

Techniques in experimental electronics. C. H. Bachman. New York: John Wiley; London: Chapman & Hall, 1948. Pp. vii + 252. (Illustrated.) $3.50.

Asked individually what they would expect to find in a book entitled *Techniques in experimental electronics,* 10 well-qualified persons, including physicists, radio engineers, electronic research engineers, and graduate students in physics, all thought that such a book would include vacuum tube circuits, discussions of electronic measurement methods, and the many other techniques familiarly known as electronic gadgeteering.

C. H. Bachman's book of the above title is, instead, a very good handbook of high-vacuum techniques and of the laboratory arts useful to those who build experimental electron tubes and related electron and ion systems.

One must consequently conclude that the title of the volume is badly chosen, despite the technical justification for the name offered in the introduction. Undoubtedly, many will purchase the book and find it of little use, while others having need of this material will pass it over.

Slightly more than half of the book is devoted to high-vacuum techniques, chapters including pumps, traps and baffles, vacuum gauges, valves and controlled leaks, demountable joints, controls and gadgets, vacuum system techniques, leak detection, and metal versus glass vacuum systems. Other chapter headings are glass-blowing fundamentals, sources of charged particles, utilization of charged particles, assembly and processing of electronic devices, and miscellaneous hints and techniques.

The treatment of high-vacuum techniques is simple and direct and filled with useful practical facts. Gauges are covered a little too sketchily for a novice in the field, and little is said of the temporary vacuum systems utilizing spherical ground joints and flexible tubing, now gaining wide acceptance.

The sections on filaments and cathodes, on electron guns and electron optics, and on ion sources are adequate