zation of long chain polymers, and the thermal reactions of solids. In general, the articles collected give an overall though spotty view of the current status of our knowledge of the properties of molecular crystals. I am confident that the second volume of this series will fill in the gaps, thereby making the set an indispensable aid to all those investigators interested in the properties of these substances.

Methods of Quantum Field Theory in Statistical Physics. By A. A. Abrikosov, L. P. Gorkov, and I. E. Dzyaloshinski. Revised English edition translated and edited by Richard A. Silverman. 352 pp. Prentice-Hall, Englewood Cliffs, N.J., 1963. $16.00.
Reviewed by George H. Weiss, Rockefeller Institute.

The technique of representing terms of a series by diagrams was first developed for the solution of problems in statistical mechanics. Although the most spectacular advances in the mathematical techniques were made by field theorists, events have come full circle and it is statistical mechanics that reaps the greatest benefit from those advances. The present book gives an account of the considerable contributions made by Russian workers in the systematic application of field theoretic techniques to problems in statistical mechanics.

To this reviewer the outstanding virtue of the book is its emphasis on the role of physical insight as an aid to the usual heavy mathematics. The first chapter, for example, introduces the reader to the concept of elementary excitations in liquids without any formalism. After some of the physical ideas are presented, the authors give an account of the mathematical techniques necessary to treat in detail, the problems suggested by the first chapter. Not surprisingly the authors emphasize the Green's-function approach of Migdal and Galitskii rather than methods more popular in Western research. Further, the book is concerned only with equilibrium problems rather than with any of the more vexing transport questions.

Aside from their presentation of the bare bones of the theory, the authors discuss several interesting applications which are not usually found in texts of this sort. Among these are the

calculation of thermodynamic properties of electromagnetic fields in absorbing media, and the application of statistical mechanics techniques to calculate interaction forces between solid bodies. Besides these, there is an account of the statistical mechanics of Fermi and Bose liquids, and of the theory of superconductivity.

On the whole, the book is well written and superbly produced. Although it is by no means easy reading, it can be warmly recommended as an introduction to a fast growing field.

The Adiabatic Motion of Charged Particles. By Theodore G. Northrop. Number 21 of Interscience Tracts on Physics and Astronomy edited by R. E. Marshak. 109 pp. Interscience, New York, 1963. $5.95. *Reviewed by Ernest P. Gray, Applied Physics Laboratory, The Johns Hopkins University.*

The subject of charged particle trajectories in magnetic fields has a long history. Particularly noteworthy are the pioneering investigations by Störmer since the turn of the century, and the work during the past twenty-five years by Lemaître and Vallarta and by Alfvén. Despite their very substantial achievements, both through analytical and numerical studies, the subject is far from depleted. Much remains to be learned, and the recent abundance of digital computers gives one hope that more can now be accomplished. This hope, together with the recently heightened interest in charged particle trajectories by plasma physicists, makes the appearance of Northrop's book especially timely.

The particular topic which Northrop has chosen to treat concerns adiabatic charged particle motion in time- and space-dependent electric and magnetic fields. The motion is termed adiabatic if the fields change sufficiently slowly, i.e., if they remain steady over times of the order of a particle gyroperiod and uniform over distances of the order of a particle gyroradius. When these conditions are satisfied, one may carry out an asymptotic expansion of the motion in powers of the ratio of the particle gyroradius to a characteristic length over which the fields change significantly. (It is worth noting that this is the real meaning of the frequently encountered expansion "in powers of the ratio of the particle mass to charge".) Such a procedure leads to the equations of motion of the guiding center, the name given to the instantaneous center of curvature of the particle trajectory. The result is a perturbation expansion representing the corrections to the well-known helical charged particle motion in a constant magnetic field (cycloidal, if a constant electric field is also present). The utility of this approximation was first perceived by Alfvén in the early 1940's. Since then it has been developed by a host of investigators, among whom Northrop has been in the forefront.

The core of this book is a careful, detailed derivation of this asymptotic expansion, correct to the first order. Both the relativistic and nonrelativistic cases are treated. The guiding center motion is explored in detail, and adiabatic invariance is discussed at length. An adiabatic invariant is an approximate constant of the motion which results when the asymptotic expansion of the Hamiltonian is independent, to some given order, of one of the particle coordinates (entirely analogous to the appearance of a true constant of the motion when a coordinate is truly ignorable). The number of adiabatic invariants is always less than or equal to the number of degrees of freedom of the system. At most three can therefore exist in the motion of a charged particle. They are: the magnetic moment, the so-called longitudinal invariant, and the flux invariant. The actual number that will exist in a given field depends on the number of periodicities of the motion. Thus the magnetic moment is always an adiabatic invariant in a slowly varying field because of the cyclic motion of the charged particle about its guiding center. If in addition, the particle oscillates between two magnetic mirrors, the longitudinal invariant, $\oint p_{11} ds$, appears, where p_{11} is the component of the particle's momentum parallel to the magnetic field, and the integral is taken along a field line between the reflection points of the motion. Finally, if the lines of force across which the particle drifts in its oscillatory motion between the mirrors form a closed surface, the magnetic flux enclosed by that surface is also an adiabatic invariant.

A conscious and largely successful effort has been made, wherever possible, to interlace the unavoidably lengthy algebraic manipulations with a discussion of the physical meaning of the resulting equations, in order to help the reader attain an intuitive understanding of the subject, so easily lost among the mathematical minutiae. Nevertheless, the text remains difficult to read. Thus the casual reader who would like to learn something about adiabatic particle motion without digesting all the mathematical detail is likely to find himself continually stymied; he would probably do better to read the simpler and more illuminating account in Chandrasekhar's volume *Plasma Physics*. On the other hand, those who are working in the field or want to enter it will find this book an invaluable aid, in that it synthesizes much of the relevant periodical literature into a coherent account, cementing some of the loose ends with interesting, previously unpublished material.

The treatment of the peripheral material which Northrop has added to his central subject matter is largely superficial and incomplete. Here he considers some of the applications of the adiabatic theory, such as loss-free geometries and geomagnetic particle trapping, as well as nonadiabatic behavior. Very little detail is given, either through a mathematical treatment or by a trenchant physical argument. An exception to these unsatisfactory accounts is the discussion of plasma stability, which provides a remarkable amount of insight and understanding in a comparatively brief space.

In summary, the book is to be wholeheartedly recommended for those who want to master the detailed theory of adiabatic charged particle motion, but is not suitable for those who have only a cursory interest in the subject. It might be added that this book is far more specialized than any of the other volumes in the series of Interscience Tracts on Physics and Astronomy; also, that the price appears unreasonably high for a bare 100 pages of text.