would be no need for books like the one under review.

ROBERT H. MARCH
University of Wisconsin
Madison

Low-Energy Electrons and Surface Chemistry

G. Ertl, J. Küppers
251 pp. Verlag Chemie, Weinheim, West Germany, 1974. DM 98.00

This book is intended to introduce one to the lengthy concatenation of techniques that employ low-energy electrons to study surfaces. The authors, who have contributed extensively to our knowledge of surface physics and chemistry, have themselves used many of the methods described.

In a little over a decade, the astonishing growth of solid-state electronics has diminished technological interest in the solid–vacuum interface; this interest has been replaced by concern over phenomena occurring at solid–solid interfaces. Meanwhile our response to the new economics of energy is tempered, in such areas as electrochemistry and catalysis, by our limited understanding of solid–liquid and solid–gas interfaces. Yet, it is the solid–vacuum interface that is the primary focus of a burgeoning basic-research effort. The reason is simply that the exposed surface is accessible to the sort of poking and probing that enables us to understand better the force laws governing all interfaces.

The most convenient and versatile probe of the solid surface is the low-energy electron. The change in momentum of an electron elastically scattered from a surface, for example, can provide information on the arrangement of its atoms. Energy losses of backscattered electrons, on the other hand, provide information on such diverse phenomena as vibrational modes of surface atoms, collective oscillations of the valence-electron fluid, and excitations of core-electron states, depending on the energy range involved. These methods have in common a sensitivity to the surface region that is a consequence of the short mean free path for inelastic scattering of low energy electrons. For electron energies of 50 to 100 eV, this mean free path may be only a few Ångstroms. It is a perverse fact, however, that the very inelastic damping that enables us to restrict our view to the surface region renders that view highly distorted, and a complete theoretical analysis of the data is not yet possible. The clear recognition of the limitations this imposes is perhaps the strongest virtue of this book. This is indeed much the best book available covering these topics; its generally uniform treatment is a great improvement over the inadequately edited collections of chapters by separate authors that have appeared.

Events, of course, take no heed of publishing schedules, and it is inevitable in a fluorishing field that reviews will be out of date before the ink dries. There is, for example, no mention of developments in angular-resolved photoemission, or of electron-stimulated desorption-ion angular distributions. Although one should be aware of the possibly brief lifetime of conclusions in this field, there are few experts who would not profit by a few hours spent with this little book.

ROBERT L. PARK
University of Maryland
College Park

Van der Waals Attraction (Springer Tracts in Modern Physics, Vol. 72)

D. Langbein
145 pp. Springer-Verlag, New York, 1974. $31.90

This monograph provides a comprehensive account of the theory of forces between macroscopic bodies, a subject which Dieter Langbein (Battelle Laboratories, Frankfurt and University of Frankfurt) is well qualified to examine: His papers, particularly on the attractions of spheres, are well-known, and he has previously reviewed aspects of the theory in an article (1973) that is the apparent origin of the present monograph. His previous research interests include investigation of transport phenomena in magnetic fields and band-structure calculations, and more recent interests include microscopic theories of electromagnetic-wave propagation in solid surfaces.

The book can be conveniently divided into four sections. The first gives a self-contained qualitative description of fields of applications and theoretical approaches and develops the theory of nonretarded attraction between pairs of microscopic or macroscopic bodies at the absolute zero of temperature on the basis of the so-called "oscillator" model. In the second section, Langbein develops the theory of pair interactions at finite temperatures on the basis of both the fluctuation approach and the oscillator model. He also attacks the important question of the effects of multiplet interactions and applies both microscopic and macroscopic approaches to the treatments of various geometries, including spheres, cylinders, half spaces

and multilayers. The third section includes a detailed treatment of the effects of electromagnetic retardation on the interaction potentials of spheres, cylinders and half spaces. Finally, the fourth section describes the semiclassical Schrödinger formulation and the fully quantized treatment of van der Waals forces, providing partial clarification of the more heuristic approaches given in preceding chapters.

Physicists, chemists, biologists, and other workers in the area of macroscopic van der Waals forces will find Langbein's monograph a useful reference. It will not be particularly suitable for students attempting to enter the field, however. The material is quite difficult, and the manner in which it is presented does not particularly aid in its mastery. Even so, the modern research library will want to acquire this recent addition to the distinguished series of Springer tracts in modern physics.

P. W. LANGHOFF
Indiana University
Bloomington, Indiana

Electronic States and Optical Transitions in Solids

F. Bassani, G. P. Parravicini (R. A. Ballinger, ed.)
300 pp. Pergamon, New York, 1975.
$23.50

In the fifteen years since the invention of the laser, crystal optics has become one of the largest specialities in solid state physics, and subspecialities of crystal optics have in turn become major activities. The present monograph is intended to give a self-contained treatment of electronic structure of crystals and related optical properties, with emphasis on the role of space-group symmetry as an essential and unifying theme. In the reviewer's opinion, Franco Bassani, of the University of Rome, who is a well known and prolific contributor to the field, and his collaborator G. Pastore Parravicini, have achieved a measure of success in their endeavor.

About half this book is concerned with basic group theory and with the basic theory of electronic energy bands in crystals; the remainder utilizes this work in the analysis of optical properties of crystals.

The section on basic group theory is a nice survey—with examples—of the important theorems, none of which are proven. A very useful pedagogical feature throughout is the inclusion of tables that summarize various options and alternatives. For example, Table 1-23 shows the effects of time reversal symmetry for particles of integer or half-integer spin; Table 5-1 deals with the joint density of states near critical points, and others appear in various places in the text.

While summaries of conventional material are rather good, the presentation of general theory is a bit sketchy: one example is the calculation of selection rules connecting different wave vectors, in which the authors focus on cases where simple point group theory suffices. Thus in diamond only the rules $L_j \times L_j = \Gamma_k$ are given but no account is taken of rules such as $L_j \times L_j = X_l$, which involves a deeper analysis and which is needed for investigation of non-trivial phonon-assisted processes. Ray-representation theory is not explicitly mentioned despite the complete discussion, among other things, of representations at X in diamond; actually the "representation group" is introduced de facto as a "new" group in a sudden manner which, after reflection, appears quite reasonable, but this approach is a little unsatisfying for the student seeing the group for the first time. Since essentially none of the standard, important group-theoretical theorems (orthogonality theorems, Wigner-Eckart theorem, idempotent projection operator theorems, and so forth) are proven, the reader will need to consult other literature if any questions arise.

Basic energy band theory is surveyed in a comprehensive fashion with all the principal current methods of calculation discussed and ample references to the literature for details. An important topic is "$k \cdot p$" theory, which is merely sketched. Surprisingly, the authors omit reference to the powerful method of "invariants" discussed and used by Joaquin Luttinger, G. Bir, Gerald Picus and others. Very good coverage and illustration of much of the general band theory is given, with examples taken from crystals of all types—covalent, ionic, and mixed bonding. The factors determining the order of states are set forth in a physically transparent and convincing manner.

The theory of optical processes (mostly absorption) occupies the last half of the book. Bassani and Parravicini treat the radiation–matter interaction in semiclassical approximation, and the "golden rule" is the key ingredient. The one-particle (band–band) transitions are handled first, with careful attention to effects of critical points in the density of states. Exciton effects are then introduced (the electron–hole interaction is turned on). The discussion here is fairly complete and there are many illustrations from spectra (CuI, Cu_2O, argon, and others). A serious omission, in my opinion, is the absence of discussions of the separation of exciton center-of-mass motion and relative electron–hole motion, which means