for irreducible representations is presented as convenient labels for specific linear combinations of determinantal wave functions, and the Mulliken notation e and t is similarly presented as labels for particular linear combinations of d orbitals.

Some of the authors' nomenclature may be a bit confusing to spectroscopists (spectroscopic *terms*, SL, are here called "states" and "levels," while *levels*, SLJ, are called "sublevels"). The possibility of diagonalizing a matrix rather than solving a secular equation is not mentioned.

While some students may find it helpful to study the present elaboration of Slater's chapters 20 and 21,[1] I suggest that they will find the texts by Edward U. Condon and George H. Shortley,[2] J. H. Griffith,[3] C. J. Ballhausen,[4] B. R. Judd,[5] Bengt Edlén,[6] B. G. Wybourne,[7] R. Stevenson,[8] A. A. Nikitin and I. B. Levinson[9] more useful if their interest lies in the problem of spectroscopic calculations for ions of multielectron atoms.

References

1. J. C. Slater, *Quantum Theory of Atomic Structure,* Vol. 2, chaps. 20, 21, McGraw-Hill, New York, (1960).
2. E. U. Condon, G. H. Shortley, *The Theory of Atomic Spectra,* Cambridge Univ. Press (1935).
3. J. S. Griffith, *The Theory of the Transition Metal Ions,* Cambridge Univ. Press (1961).
4. C. J. Ballhausen, *Ligand Field Theory,* McGraw-Hill, New York (1962).
5. B. R. Judd, *Operator Techniques in Atomic Spectroscopy,* McGraw-Hill, New York (1963).
6. B. Edlén, in *Handbuch der Physik* (*S. Flügge,* ed) Springer-Verlag, Berlin, Vol. 27, p. 80 (1964).
7. B. G. Wybourne, *Spectroscopic Properties of Rare Earths,* Interscience, New York (1965).
8. R. Stevenson, *Multiplet Structure of Atoms and Molecules,* Saunders, Philadelphia (1965).
9. I. B. Levinson, A. A. Nikitin, *Handbook for Theoretical Computation of Line Intensities in Atomic Spectra* (translated from Russian by Z. Lerman) Israel Program for Scientific Translations, Daniel Davey, New York (1965).

* * *

The reviewer teaches atomic structure theory to astromers at Harvard.

Insight to crystals

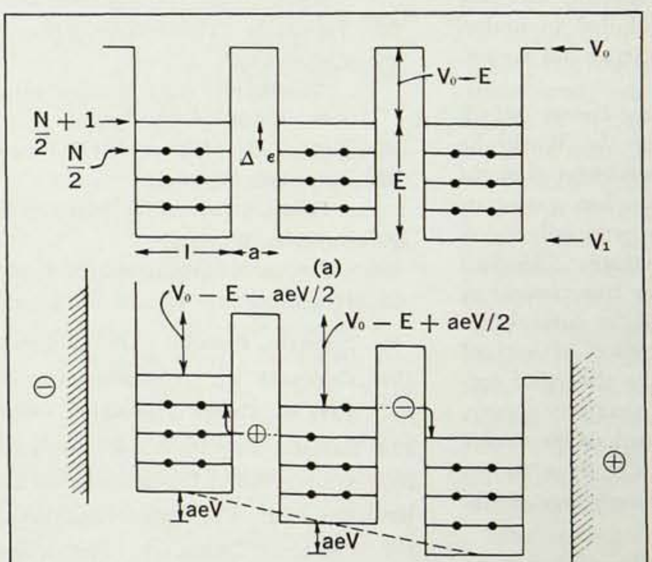
ORGANIC SEMICONDUCTORS. By Felix Gutmann, L. E. Lyons. 858 pp. Wiley, New York, 1967. $27.95

SPATIAL DISPERSION IN CRYSTAL OPTICS AND THE THEORY OF EXCITONS. By V. M. Agronovitch, V. L. Ginzburg. 316 pp. Trans. from Russian. Interscience, New York, 1966. $17.00

by Stuart A. Rice

For about 20 years studies of the properties of molecular crystals (and even more particularly of crystalline organic materials) have increased monotonically both in number and in sophistication of approach and interpretation. However, prior to the publication of the monograph by Gutmann and Lyons, the available information was spread thinly throughout the scientific literature. A student approaching this subject was, therefore, forced to spend considerable effort in finding out what was known and what was not known. The Gutmann and Lyons monograph is an attempt to provide a comprehensive discussion of crystals of aromatic compounds suitable as an introduction to research in the field. At the same time, the compilation of data and the exhaustive literature survey make the book useful to research workers.

The text begins (chapter 1 and also chapter 4) with a review of some relevant topics from solid-state physics. The treatment is clear but elementary and incomplete. Fortunately most of the material omitted is not important (or at least does not seem so at present) for a general understanding of organic crystals. A detailed theoretical understanding does, however, require a more sophisticated analysis. The theoretical chapter is followed by a very good discussion (chapters 2 and 3) of the observable electrical properties and the methods of sample preparation. There is a very welcome emphasis on sample purification procedures, their limitations and successes, with specific cases. Chapter 4, which returns to the presentation of the theoretical analysis, has extensive tabular material as well as a careful comparison of theory and experiment. Chapters 5 and 6 consider the nature of exciton states, both neutral and ionized, and include a good discussion of exciton-exciton interactions. The last of the theoretical chapters (7) considers tunneling and hopping models, again from an elementary point of view. Finally, in addition to the lengthy literature surveys of previous chapters there is an extensive review of published data (209 references) followed by qualitative surveys of the relationship between electrical properties and molecular structure (chapter 9), and of space-charge effects, photo-



TUNNEL MODEL of an organic semiconductor is that of D. D. Ely and M. R. Willis. Three adjacent molecules are depicted: (a) before application of voltage gradient V: (b) after application of V and excitation of an electron in central molecule. (From *Organic Semiconductors.*)

voltaic effects, etc. (chapter 10). There are also 146 pages of tables, buttressed by 1505 references!

Like all first books in a rapidly developing subject, this book is doomed to rapid obsolesence. Nevertheless, I believe the Gutmann-Lyons monograph to be an extremely valuable addition to the literature. Although the student will have to refer elsewhere to complete his theoretical understanding, this book should stimulate interest in the subject and serve as a useful summary compendium. I can wholeheartedly recommend it to all students and researchers interested in the properties of molecular crystals, as well as to others who wish to see where the subject stands.

The monograph by Agranovitch and Ginzburg is of an entirely different nature. Beginning with the work of Frenkel (1931) and later of Davydov (1946), the Russians have been leaders in the study of the properties of crystals of aromatic compounds. Agranovitch has been in the forefront of one of the more recent theoretical developments: consideration of the effects of variation of the refractive index of the crystal with both wave vector and frequency. The Agranovitch-Ginzburg monograph, written for advanced students and research workers, is entirely devoted to this subject. It may be considered an amplification of the set of review articles which appeared in the *Uspekhi.* The approach used is that of macroscopic electrodynamics, that is, analysis of the dielectric function in terms of symmetry properties, Maxwell's equations, boundary conditions and the Kramers-Kronig transform. The microscopic theory is treated briefly, in chapter 4, from the point of view of calculating the dielectric function. Even a rapid reading of the text is rewarding because of the wealth of new results and for the ideas thereby generated. Unfortunately, the text is extremely difficult to read because the translation is so heavy-handed and, at times, ambiguous. With considerable effort the material can be understood. The publishers should be publicly chided for not providing better editorial control of the translation. Undoubtedly the appeal and utility of the book have been reduced from what they might be had the translation been better.

The Agronovitch-Ginzburg monograph is an important addition to the literature of crystal optics and related subjects. It will be useful to advanced students, but they must be prepared to work for the insights contained in the theoretical analysis.

* * *

The reviewer, director of the James Franck Institute of the University of Chicago, is known for his studies of the theories of liquids and solids.

An appropriate concept

THE CONCEPT OF ENERGY: ITS SIGNIFICANCE IN FUNDAMENTAL THEORY AND PRACTICE. By D. W. Theobald. 192 pp. Barnes & Noble, New York, 1966. $7.50

by R. Bruce Lindsay

The success of physics in achieving an understanding of human experience has depended largely on the appropriateness of the concepts invented for physical theories. Of all physical concepts, that which has shown itself adaptable to the widest range of phenomena is undoubtedly energy. Hence any new work that seeks to assess its role is worthy of attention. The purpose of the book under review, whose author is lecturer in chemistry and the history and philosophy of science in the Manchester College of Science and Technology of the University of Manchester, England, is to present an account of the part the concept of energy plays in the theoretical structure of the physical sciences. It is not intended to be a textbook but might be termed a philosophical or methodological examination of the concept. Its audience is presumably not only undergraduate physics students but also practicing scientists in general.

The author has thought it desirable to include a prefatory chapter on the nature of physical theorizing and concept construction. For the most part this follows conventional lines but may be helpful to the neophyte who is unaquainted with the philosophy of science. The energy idea proper is introduced in the second chapter in the guise of mechanical energy. Here the

The man in the laboratory

He is mortal — like other men. He lives, laughs, loafs and loves like other men.

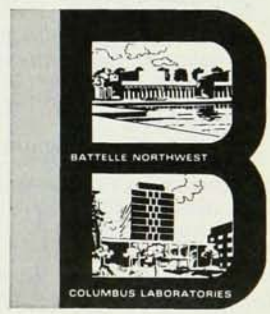
But he is distinguished from others by the use he makes of his mind. He may not view himself as trying to bring order out of chaos — and forever discovering new chaos to replace the old. But that is what he does.

He is perverse and discontented. And out of the full measure of his discontent arise his greatest achievements. He is at war with what he loves most — Nature. He is a dreamer — but one who is not content with a dream.

From out of the fantasy of ideas and whirling atoms he seizes something not yet real, but which holds a promise of fulfillment. Under his sensitive hand gases condense, liquids congeal, currents start to flow, and an idea takes physical form.

He is an explorer, a discoverer. Where he leads, the world will someday follow. Mankind will travel his lonely uncharted path to new realms of peace and happiness.

Are you such a man? There are many like you at Battelle Laboratories who would welcome your contributions to the challenges which research ceaselessly presents. For further facts about Battelle write to Mr. E. P. Galbraith, Battelle Northwest, 3000 Stevens Drive, Richland, Washington 99352; or Mr. L. G. Hill, Battelle Columbus, 505 King Avenue, Columbus, Ohio 43201.



Battelle

MEMORIAL INSTITUTE

Equal Opportunity Employers