shortest a five-page review of an Arthur C. Clarke science-fiction collection. The title is from an Einstein quotation: " . . . the eternal mystery of the world is its comprehensibility." The introduction, largely an autobiographical view of how Bernstein got into physics, is a tribute to Philipp Frank, to whom the author dedicates the volume. Most of the essays have been *New Yorker* reviews of books (among them Walter Sullivan's *We Are Not Alone*, Morton Grosser's *The Discovery of Neptune*, Marie Boas's *The Scientific Renaissance*, George Gamow's *A Planet Called Earth*, Barbara Cline's *The Questioners: Physicists and the Quantum Theory*). *New Yorker* reviews, though, are no tables of contents; Bernstein achieves rather well the purpose he sets for a reviewer in his introduction: "to call attention to those books that appear to have special merit rather than to attempt to score debating points against the authors of bad books."

Thank goodness the philosophy does not stop him from rising in defense against the machinations of a book he does not wholly admire: Jacques Barzun's *Science: The Glorious Entertainment*. Although he feels the book "serves a real purpose" in expressing the nonscientist's view of science, he accuses the author, accurately, I think, of "some clear-cut misunderstandings about the quality of modern science" and "a lack of appreciation of the connection between the old theories and the new ones." "Barzun has failed to understand what modern science has accomplished," he says.

When he discusses Erwin Schrödinger's *My View of the World* he reminds us of a Schrödinger thought we must often ponder when wave-particle duality seems an especially inelegant description of nature: "Modern science may be as far from revealing the underlying laws of the natural universe as was the science of ancient Greece." After all, the theory of epicycles, like current quantum theory, was one of those "ingenious constructs of the human mind that gave an exceedingly accurate description of observed facts."

Many writers have learned to write of science, and many scientists have written popularizations in an effort to bring their subject down to the level of the layman. Bernstein stands unique among them as a man who practices both his crafts simultaneously at the highest level. One finds no condescension in his writings; he is bringing nothing down; he is, instead, offering something he passionately believes in to readers from whom he expects an enthusiastic reception. He deserves one.

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The reviewer is editor of PHYSICS TODAY.

Much ado about d states

SPECTROSCOPIC CALCULATIONS FOR A MULTIELECTRON ION. By H. H. Theissing, P. J. Caplan. 209 pp. Interscience, New York, 1967. $10.00

by Bruce W. Shore

This monograph presents the results of the authors' calculations on the energy structure of the triply charged chromium atom, Cr IV, both as a free ion (Cr^{3+}) and in a crystalline environment. The authors' goal, in the tradition of the semiempirical method, is determination of angular parts of matrix elements for the Coulomb, spin-orbit and external octahedral-field interaction for a d^3 state, in order to express the energy structure in terms of a few empirically determined parameters. The authors confine themselves to the determinantal method expounded by John C. Slater.[1]

The present monograph, although it exhibits all the laborious details of calculation of determinantal matrix elements, concerns specifically a multielectron ion of d^3 configuration, and provides little immediate assistance in the analysis of, say, d^4. It is not made clear how one can exploit symmetry or invariance properties of the Hamiltonian: There is no mention of the possibility of constructing "coupled" angular-momentum wave functions using Clebsch-Gordan coefficients or projection operators. The useful tensor-operator techniques developed by Giulio Racah are not mentioned. Only oblique reference is made to group theory: The Bethe notation Γ_i

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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.

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Insight to crystals

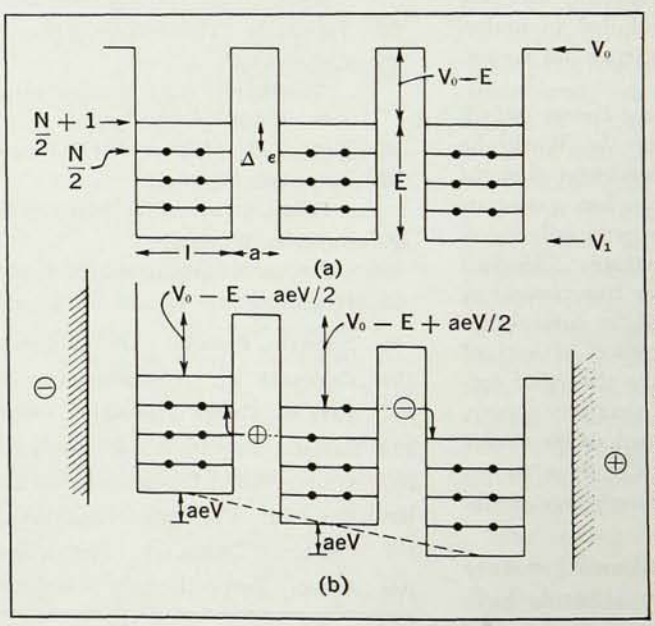
ORGANIC SEMICONDUCTORS. By Felix Gutmann, L. E. Lyons. 858 pp. Wiley, New York, 1967. $27.95

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.*)