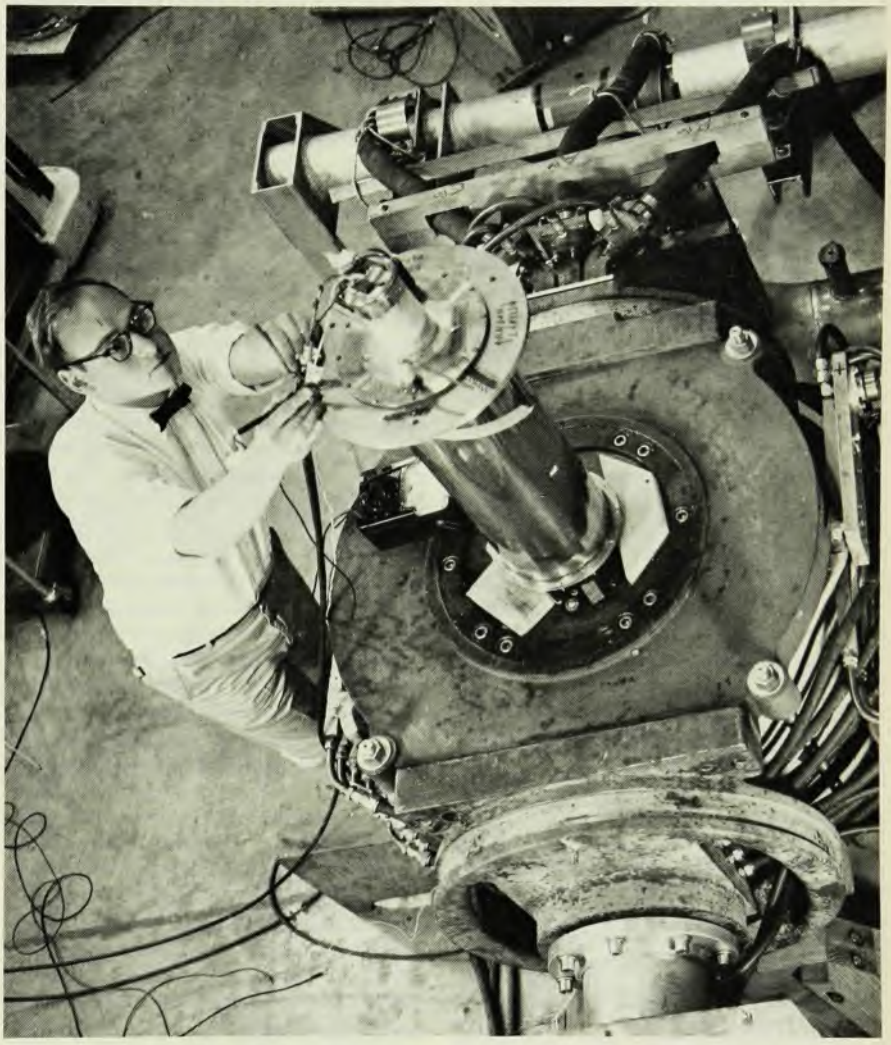
One-man exposition on magnetic field monopolized?

Magnetism

S. V. Vonsovskii
1256 pp. Halsted, New York, 1975. $99.50

Reviewed by Brian Schwartz



World's strongest direct-current magnet (22 Tesla) is used by experimenter Bruce Montgomery to make a low-temperature measurement. Photo by Francis Bitter National Magnet Laboratory.

For a single author to cover the field of magnetism in a single treatise is a monumental task. Great stamina, patience and care over many years would be required for developing, reviewing and organizing the material. Such a book has been written by S. V. Vonsovskii, the dean of Soviet magneticians; his two-volume *Magnetism* attempts to cover the whole field in a single coherent presentation, and the attempt is successful.

The branch of solid-state physics called "magnetism" is unusually diverse. Solids have electrons and nuclei. The electrons have both spin and orbital magnetic moments; the nuclei also have magnetic moments. The spin response of electrons can be ferromagnetic, antiferromagnetic, ferrimagnetic, weakly magnetic, paramagnetic, diamagnetic, spiral and many more complex patterns. The interactions responsible for the magnetic behavior can be due to direct, indirect, itinerant or super-exchange. The magnetic solid can be conducting, semimetallic, semiconducting, superconducting or insulating. The magnetism can be localized or itinerant, or associated with impurities. Add to this such diverse magnetic behavior as domain walls and hysteresis, magnetic techniques such as resonance and the Mössbauer effect and one quickly sees that magnetism has a right to be called a field of physics and not simply a branch of solid-state physics.

Vonsovskii's book first appeared in a single volume in Russian in 1971. It was translated by Ron Hardin and appears in two volumes with a total of over 1250 pages. Volume 1 contains two parts: part I consists of 6 chapters, which essentially define the magnetic properties of electrons and nucleons and detail the role of magnetic fields in electrodynamics and in thermal and statistical mechanics. It is brief and comprises about 5% of the total work. Part II, consisting of 10 chapters, is about one third of the treatise and deals with the magnetic properties of solids without magnetic order. This part could easily be considered as the main part of a textbook on graduate solid-state physics, since it includes such topics as electrons in a metal, semiconductors, superconductors, the effects of magnetic fields on solids, dia- and paramagnetism, cyclotron resonance, and so on. Part II ends with a discussion of galvano- and thermomagnetic properties, magneto-optical phenomena and magnetic cooling. The text is more detailed than a normal graduate solid-state physics book in that more history, experimental data and references are included. Part III, in Volume 2, is the major part of the book; it consists of 10 chapters and deals most directly with the properties of ordered magnetic materials, including metals, crystals and alloys. The chapters on the transition metals and on magnetic ordering in alloys are exceptionally clear. The book does not emphasize applied magnetism, although it does include the basic physics the applied magnetician will require. The book ends with a list of general references, including other treatises or series on magnetism and a listing of Soviet and international conferences on magnetism since 1946.

The book must be viewed as a landmark summary of the field of magnetism up until the late 1960's. It can be used as a source book for Russian references in the field of magnetism. One

must still ask, is the treatise by a single author the best method to review the vast subject of magnetism or would a better approach be a treatise by many authors sharply edited, or perhaps a continuing series like the Rado–Suhl series on magnetism? The gain in coherence and viewpoint make Vonsovskii's single-author approach a success. In this jet age of international meeting, big-science administration, teaching, committee responsibilities, it seems unlikely that a capable physicist will be able to "break away" and devote the energy, intelligence and time to write another treatise on magnetism. With Vonsovskii's book, however, I see no reason why another single-author treatise on magnetism should be undertaken in the near future.

I strongly recommend that libraries or other research institutions buy this book. The coherence of the approach, the inclusion of many historial Russian references and clarity of the presentation in the books are outstanding features. It would certainly be wise to use specific chapters in this book as one of the first references for any graduate student or researcher about to enter a specialized research area in magnetism. A suggestion to the publisher: It might be worthwhile to republish specific parts of the book in paperback, including only a few chapters. For example, chapters 20 and 21 on transition metals and magnetic alloys would make a convenient 200-page monograph in paperback for, say, less than $10. Other chapters could also be regrouped into similar coherent subjects.

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Finite Groups and Quantum Theory

D. B. Chesnut
254 pp. Wiley, New York, 1974. $14.95

Group Theory and Quantum Mechanics

B. L. van der Waerden
211 pp. Springer-Verlag, New York, 1974. $23.00

An English version of *Group Theory and Quantum Mechanics*, a classic work on the subjects, is most welcome. The style and choice of subject matter are very much those of a prominent mathematician—as B. L. van der Waerden indeed is—who has studied and researched the field over its full span of development. D. B. Chesnut, the author of *Finite Groups and Quantum Theory*, is a physical chemist. He has written for students of physical chemistry at roughly the senior or beginning-graduate level. Judging from the treatment of Venn diagrams, sets and mappings, and matrices, he does not expect from these people the same mathematical background as would be appropriate to physics students at this level.

In van der Waerden's book, quantum mechanics is set within the framework of Hilbert-space theory, with careful distinctions between bounded and unbounded, symmetric and self-adjoint operators. The hydrogen atom, an electron in a central field, is worked out fully. The author also supplies a full exposition of group theory, group rings and finite-dimensional representation theory, and he applies this in detail to translations, the rotation and Lorentz groups, and the symmetric group.

Aiming at his less advanced audience, Chesnut covers standard ground from group theory to the theory of finite-dimensional representations. The coverage is distinctly introductory and a little sparse in places, with emphasis on elementary calculations. There is a good account of direct products of groups and the use of projection operators based upon the group-representation orthogonality relations, together with character tables for the deducing of irreducible components.

Van der Waerden considers physical applications in depth with accounts of angular momentum and spin from both the nonrelativistic and relativistic points of view. The symmetric group and the exclusion principle occupy a whole chapter, in which the Young operators are used to classify the irreducible representations of the symmetric group. Throughout, care is taken to derive the classification of quantum-mechanical states and their selection rules due to angular momentum and spin for many-electron atoms and diatomic molecules. Perturbation theory for the energy levels is sketched as well. All applications in *Finite Groups and Quantum Theory* are for point groups.

Later chapters of Chesnut's text deal with elementary applications to symmetry in quantum mechanics, the exclusion principle, molecular orbitals and chemical bonding. I would have enjoyed expansion of this later part to include some of the underlying physical chemistry that is frequently quoted as justification for a given remark or calculation. Surprisingly, notation used for the point groups, which first appears on page six, is never explained in the text proper, though many examples and exercises depend on it. Solutions to exercises close each chapter and are presented in detail; this is a good feature, which should prove useful for most of his readers.

Chesnut's volume is perhaps best used as a supplement to a course in physical chemistry, but the lack of any treatment of the rotation group and angular momentum precludes its usefulness in most physics classes. The charming little book by van der Waerden recalls the spirit of the golden age in quantum theory and takes a worthy place in the literature. Its economy of exposition allows surprising scope and depth in a few pages. Mathematicians should find *Group Theory and Quantum Mechanics* a good place to learn some quantum mechanics, as should physicists who can look elsewhere for calculations but who wish to see the subject on a firmer mathematical footing than in most physics texts.

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Objections to Astrology

B. J. Bok, L. E. Jerome
62 pp. Prometheus Books, Buffalo, N.Y., 1975. $2.95

The survival of astrology in an age that we would like to regard as "scientific" has long been a source of embarrassment to astronomers and physicists.

Periodically, some of us become sufficiently alarmed at this evidence of rampant superstition that we decide the time has come to "do something about it." Such is the origin of this slim volume under discussion.

Objections to Astrology begins with a short manifesto—some 400 words or so—signed by 192 luminaries of science, primarily astronomers but representing nearly all disciplines. The body of the text consists of two articles. All three excerpts manage to avoid the obvious temptation to shrill polemic. Instead, they show some sensitivity to the psychological appeal and historical role of a system that has, for better or worse, outlived by millenia the cultures that gave it birth.

The first article is by the distinguished astronomer Bart J. Bok, who has trod this path many times since 1940. It might well bear the title "A Scientist's Primer of Astrology." In the spirit of the proverbial injunction to "know thine enemy," Bok briefly dem-