building a careful foundation and filling in most of the details of the formalism, the authors have been admirably successful in creating an excellent text which can serve not only as a basis for a lecture course but could be picked up by the beginner in the field and read from cover to cover as a thorough introduction to the subject matter. In their preface the authors "anticipate that many nuclear experimentalists will feel more at home with a book which puts in the intermediate steps; . . . when the details are left out ostensibly to simplify the account, this omission usually only succeeds in mystifying." With this philosophy, for example, the transformation of the quadrupole collective Hamiltonian to intrinsic coordinates (the Euler angles and shape defining parameters) is carried through in much more detail than can be found in the original literature. The peculiarities of the transformation from the laboratory to the intrinsic system associated with the lack of 1:1 correspondence between the intrinsic coordinates and the variables in the laboratory system is treated with much care. The resultant symmetry properties of the wave function have undoubtedly been one of the "mystifying" points to which the authors refer. These symmetries are carefully established and discussed in detail, first for the vibration-rotation wave functions, and in later chapters for the cases where the vibrating-rotating nucleus is strongly coupled to the independent particle motion and the various giant multipole modes.

After an introductory chapter on the varieties of collective motion, the collective variables for the nuclear shape deformations and the local density fluctuations of protons vs neutrons (giant resonance motions) of definite multipolarity are established in completely parallel fashion in Chap. 2. The next two chapters give a detailed account of the theory of quadrupole vibrational spectra including the effects of large anharmonicities on the collective potential energy surfaces. Chapter 5 on the quantum mechanics of the rotator is distinguished by the care with which it compares and contrasts the operator calculus for the angular momentum components with respect to laboratory and intrinsic body-fixed systems. It gives a working introduction to the rotation matrices, the D functions. (In some of the earliest sections of this volume a familiarity with the transformation properties of spherical tensor operators, angular momentum calculus, nine-j transformations, etc., seems to be implied; all these topics, however, could perhaps be mastered by the beginner with appropriate sections of this work itself, including, besides this chapter, an appendix on angular momentum calculus in Vol. 2 of the series.) In Chap. 6, the Rotation-Vibration Model, the approximate separation of the Hamiltonian into vibrational and rotational parts and the perturbation expansion of the vibration-rotation interaction term together with its solution is treated in considerable detail, with an account of some of the successes of the model. After a brief account of the asymmetric rotator model in Chap. 7, the text turns to the single particle models. The scope of Chap. 8 on the spherical shell model is that of the monograph by Mayer and Jensen, though in abbreviated form. (This is not a textbook in the techniques of shell model calculations. The only shell model "calculation" performed is that for the quadrupole moment of a system of identical nucleons, j^n, in the low seniority model.) Chapter 9, the Deformed Shell Model—Unified Model, gives a discussion of the Nilsson model and its generalizations as well as a treatment of the coupling of the independent particle motion to the vibrating-rotating system. Compared with some other sections, this latter topic is discussed in relatively less detail (although the basic phenomena, for example first-order Coriolis decoupling and band mixing, are discussed). The remaining third of the text deals mainly with giant resonance phenomena. Chapter 10, Nuclear Hydrodynamics, first gives an elegant treatment of the classical theory of the neutron-proton fluid model and the associated classical electromagnetic absorption cross section. The subsequent quantization of giant resonance modes of definite multipolarity builds beautifully on the earlier treatment of the surface degrees-of-freedom. In Chap. 11, the Dynamic Collective Model, the authors give a very detailed account of the coupling of the giant resonance and surface quadrupole modes. In this chapter, in particular, the authors take the opportunity to present and summarize many of their own original contributions to the field. (A microscopic description of the giant resonances in terms of particle-hole excitations and subsequent thermalization via more complicated nuclear excitations is not to be found in this volume but is promised for Vol. 3 of the series: Microscopic Theory of the Nucleus.) A final chapter, the Application of Nuclear Models to Heavy Ion Scattering, takes up two topics. The first, the classical mechanics of two ions in collision, under Coulomb repulsion with internal degrees-of-freedom consisting of quadrupole plus octupole surface and giant dipole resonance modes is very much within the scope of this volume. The physical insight brought to the discussion of this problem is characteristic of much of this text. The second topic, quasi-molecular states, perhaps hangs somewhat by itself.

A long list of references to the literature is given. These include the historically important ones and many other detailed ones as they are needed to reinforce specific points in the text. This particular reader has found among the many references to the German literature, including theses, some which have previously escaped his notice. Nuclear model theorists who look to Copenhagen as their Mecca will undoubtedly be missing some favorite references. However, this should not detract from the enjoyment of an excellent book which can be recommended to both student and lecturer in the field.

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August 17, 1971

About the Reviewer: The reviewer of NUCLEAR THEORY is professor of physics at the University of Michigan where he completed his graduate studies in 1955. Although his dissertation concerned theoretical molecular spectroscopy, his most recent research interest has been in the theory of nuclear structure. Dr. Hecht was at the Oak Ridge National Laboratory during the 1970-1971 academic year as a senior Post-doctoral Fellow of the National Science Foundation.

Radiation Heat Transfer. (Rev. ed.) By **E. M. Sparrow** and **R. D. Cess**. Brooks/Cole Publishing Company, Belmont, California (1970). 340 pp.

The revised edition of this popular text, first published in 1966, differs from the earlier edition only in two aspects: the elimination of misprints and the addition of Appendix C, which lists 10 to 20 problems for each chapter. A solution manual is also available for the instructor's use. Since the basic technical content remains unchanged, my review of the earlier edition (*Nucl. Sci.*

Eng., **32**, 280, 1968) applies equally well to the revised edition.

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About the Reviewer: C. L. Tien is a professor of mechanical engineering and chairman of the Thermal Systems Division at the University of California at Berkeley. He received his BS degree from the National Taiwan University, MME from the University of Louisville, and MA and PhD from Princeton University. His main research interest lies in the various areas of heat transfer.

Nuclear Heat Transport. By M. M. El-Wakil. International Textbook Company (1971). 502 pp. $16.50.

This book is one of two contemporary volumes by the same author which, taken together, represent an expansion of his earlier book *Nuclear Power Engineering*, published in 1962. The companion volume titled *Nuclear Energy Conversion* takes over where the present one leaves off. The present volume covers a wide range of subject matter. The first three chapters cover the topics of nuclear and reactor physics, while the fourth treats the conversion of the energy sources in fission and radioactivity to heat. The rest of the book is devoted to the problems of transferring that heat to the reactor coolant and then transporting it from the reactor to the energy-conversion system.

The material in the four introductory chapters is presented in a concise and simplified form, which makes it a quick and useful reference for the thermal engineer who is more concerned with the heat transfer than the reactor physics. It is also helpful for the engineering student who has not had a course in reactor physics and who uses the book as a text in a nuclear heat transfer course. The essential features of reactor physics are covered in appropriately simplified form for a text book on heat transfer, with many useful equations, quantities, and graphs given. However, the condensed nature of those chapters occasionally leads to hard going for the reader unfamiliar with reactor physics. Also, there are a few parenthetical statements that may be misleading, because the author was unable to qualify them, for lack of space. These are minor complaints, however; taken as a whole, the four-chapter section is well written, moves along at a competent pace, and contains a good deal of handy reference material. In this section, a substantial list of references is given, among them being BNL-325, the classic Brookhaven reference on cross sections. However, to the chagrin of the present reviewers, it is credited to the Argonne National Laboratory.

Chapters 5 through 8 deal with the general problem of heat conduction in reactor fuel elements. The material is presented in a logical order, starting with the treatment of the more simple one-dimensional steady-state cases and ending with the more difficult two-dimensional, complex-geometry, unsteady-state cases. The theory is presented clearly, derivations of basic heat transfer equations are given, and practical methods of solution are detailed; but (with the exception of that in Chap. 6) most of the material is little different from that found in published heat transfer texts.

Chapters 9 and 10 cover the problems of single-phase convective heat transfer, the former dealing with ordinary fluids, and the latter with liquid metals. In the opinion of the present reviewers, the overall quality of the presentations in these chapters (particularly Chap. 10) does not keep pace with that in Chaps. 5 through 8. For example, the treatments of the hydrodynamics and thermal-entry problems and that of the effect of axial variation of wall heat flux in Chap. 9 are both limited and out of date.

The descriptive introductory material in Chap. 10—dealing with the neutron-absorption capacity, induced radioactivity, and transport properties of liquid metals, and their compatibility with materials of construction—is considered to be quite adequate for such a book. It is covered in eight and one-half pages. However, the five-and-one-half-page treatment of the heat transfer characteristics of, and correlation for, liquid metals is entirely too short, considering the importance of sodium-cooled reactors in the present and future American power pictures. Only ten lines of text are devoted to the paramount topic of heat transfer to liquid metals flowing longitudinally through rod bundles, while there is almost enough material in the open literature on this topic to make a volume all by itself. On the other hand, seven pages were devoted to the heat transfer characteristics of liquid-metal reactor fuels and ten pages to liquid-metal pumps—too much, in the opinion of the present reviewers.

In Chap. 11, a very extensive subject—Heat Transfer with Change in Phase—is covered in just 32 pages. Such a short treatment permits touching the high spots only. Both boiling and condensation heat transfer are discussed, with boiling taking about 80% of the space. The pool boiling and forced-convection boiling topics are discussed together. It would have been better to separate them, for in their thermal-hydrodynamic behaviors they are quite different. Also, the reviewers felt that the information in this chapter could have been more up to date.

Chapter 12, on two-phase flow, is felt to be one of the better chapters. The subject matter is well organized and the presentation is up to date and sufficiently extensive for a book of this type. Chapter 13 is a very readable discussion of the general principles underlying and practical approaches to the thermal-hydrodynamic design of nuclear reactor cores; finally, Chap. 14 treats some of the special topics encountered in the design of boiling-reactor cores.

The Preface to the book states that it was written primarily as a text for senior and graduate students in engineering, chemistry, and physics, but also for the practicing engineer. It should serve quite well as a college text; but the reviewers are of the opinion that the practicing (or design) engineer would be well advised to supplement it with additional, more up-to-date material found in monographs and the engineering journals. Probably a better approach would have been to write the book for seniors and graduate students in engineering only who would have already had a course in heat transfer. This would have allowed the author to eliminate much of the elementary material and replace it with more advanced, up-to-date material, which would have also made the book more useful to the design engineer.