Theory of the Nuclear Shell Model

Author	R. D. Lawson
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Reviewer	D. A. Bromley

Since its introduction (independently by Mayer, and by Haxel, Jensen, and Suess) in the early 1950s the nuclear shell model has played a central role in the understanding of nuclear structure. Beginning with extreme single-particle motion in spherical potentials, only the addition of relatively strong spin-orbit coupling was required to permit reproduction of a wealth of data for nuclei near the nuclear magic numbers—near closed nuclear shells. With the pioneering work of Bohr and Mottelson a few years later it was recognized that nonspherical nuclear shapes, hence potentials, were characteristic of the regions between magic numbers and the Nilsson model. Much used by experimentalists was the corresponding independent particle shell model based on spheroidal potentials. It, too, was remarkably successful in reproducing nuclear data. It was soon evident that the independent particle assumption was too extreme and that the residual interaction between valence nucleons outside the closed core were of great importance in determining the detailed nuclear structure.

R. D. Lawson, of Argonne National Laboratory, the author of this volume, has been a major contributor to our understanding and use of these more sophisticated shell models and is internationally recognized as a leading figure in nuclear structure physics. The book developed from a series of invited lectures that he presented over an extended period at a number of different institutions. It is his stated goal to have produced a "how to do it" book for calculating those observable quantities that are frequently encountered in the study of atomic nuclei. In this he has succeeded admirably. At each stage, when a new technique is introduced it is immediately followed, not only by an example of its use, but also by a comparison of the results obtained with actual experimental data so that the reader obtains a direct measure of the success—or lack of it—attained. I know of no comparable reference for anyone interested in learning how to actually *use* the nuclear shell model; it will be a frequent choice as a textbook for graduate courses in nuclear physics.

Seven appendixes provide a very concise and useful reference on Racah algebra, fractional parentage coefficients, and rotation matrices as well as quasispin and seniority.

While this book is destined to become a standard reference in graduate nuclear physics and a most useful reference for working nuclear physicsts, it is written at a level of detail and is so focused in its treatment of the nuclear shell model that I would question its usefulness to nuclear technologists to the extent—if any—that they can be separated from nuclear physicists.

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