cies succession and suggests that what is observed is the net result of small-scale perturbations in time and space superimposed on large-scale changes. From my viewpoint as a physiologist who normally deals with one perturbation at a time, the complex world of phytoplankton portrayed by Smayda will never be understood until we can make accurate measurements of each of the parts.

Overall, the book is an outstanding source of reference material for student and researcher alike. As a testament to the current renaissance in phytoplankton ecology, the book (which covers for the most part research through about 1977–1978, and in some chapters through 1979) already seems to be approaching obsolescence when compared with the recently published proceedings of the 1980 Brookhaven symposium, *Primary Productivity in the Sea* (P. G. Falkowski, Ed., Plenum, 1980; see review in *Science* **212**, 794 [1981]). The two volumes nonetheless, considered together, provide a comprehensive synthesis of the state of the art and define in explicit terms the scope and limits of our understanding of how very small organisms exist in the aquatic environment.

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Nuclear Shells

Theory of the Nuclear Shell Model. R. D. LAWSON. Clarendon (Oxford University Press), New York, 1980. xii, 534 pp., illus. $129. Oxford Studies in Nuclear Physics.

The goal of nuclear shell theory is to describe the energy levels of nuclei and transitions between these levels. Ideally the theory is based on known nuclear forces. In practice, however, a phenomenological description, in which the interactions between nucleons in various shells are parameterized, may be all that we can realistically hope for. The pioneering book on this subject is de Shalit and Talmi's *Nuclear Shell Theory*, published in 1963. Lawson continues their phenomenological approach in a more up-to-date treatment.

The technical apparatus of the subject has changed little since 1963, but more complete experimental data are now available. Lawson takes advantage of this to illustrate each idea with concrete examples from nature. Specific cases range from the lightest nucleus having more than one energy level, ^{4}He, to the heavy Pb nuclei. The experts in the field may know most of these examples, but few are found in previous textbooks on nuclear theory.

In principle, all nuclear states can be described by the shell model, but the number of configurations is generally too large to handle—even with the most powerful computers. Successful theory blends art and luck. The theorist must truncate the set of shell configurations that will be used in the calculation, and nature must provide him or her with nuclei that have limited numbers of active shells. Lawson progresses from the simpler "magic" nuclei to the more complex, mindful of the validity of the truncation approximations.

The calculational tools of nuclear shell theory are the angular momentum algebra and the fractional parentage expansion of wave functions. Lawson's step-by-step examples show how to use the angular momentum algebra. The most useful formulas needed for reference are compiled in appendixes. The fractional parentage expansion, which allows the theorist to isolate individual nucleons in a many-nucleon wave function, is thoroughly treated. The author is particularly careful in explaining sign conventions in the definition of wave functions. These conventions can be a stumbling block for those who want to apply the wave functions to experimental measurements.

The interaction between nucleons is best studied in nuclei with only two active particles. Lawson takes examples of these to deduce important characteristics of the interaction, such as pairing and the nearly perfect isospin symmetry. A major experimental tool for nuclear shell studies is the particle transfer reaction, because it is sensitive to the particular shell of the particle transferred. Taking examples of reactions on Ca isotopes, Lawson shows how to test the theoretical wave functions by calculating the reaction strengths, or spectroscopic factors.

Truncation of the shell configuration basis is not the only approximation technique at the theorist's disposal. Lawson discusses the weak coupling approximation, the seniority classification, pairing theory, and the projected Hartree-Fock approximation. Lawson demonstrates both the usefulness and the limitations of the approximations, with detailed examination of the wave functions and predictions for various nuclei.

Lawson's treatise does not cover vibrations or deformed nuclei, topics in which the shell structure is blurred. Most shell model calculations rely heavily on computers, and this numerical technology is not discussed or referenced. The useful techniques based on SU(3) and other higher symmetry groups are barely mentioned. Finally, Lawson's case method of approach can be disconcerting: the subject of beta decay is introduced during a discussion of the pairing approximation for In isotopes. These are minor shortcomings in view of what Lawson accomplishes in bringing together abstract theory and actual nuclei.

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Glaciers and Climate

The Last Great Ice Sheets. GEORGE H. DENTON and TERENCE J. HUGHES, Eds. Wiley-Interscience, New York, 1981. xviii, 484 pp., illus., + loose maps. In slipcase, $95.

Interest in the ice sheets of the world has rapidly increased during the last decade as the intimate relationship between glaciers and climate has become clear. For that reason the CLIMAP program of the National Science Foundation included a project to produce an analytical reconstruction of the late Pleistocene ice sheets. Even if it were viewed only as a report on that work *The Last Great Ice Sheets* would be extremely interesting and valuable; however, the book includes not only extensive and well-documented tabulations of data on the evidence relating to the areal distribution of the late Pleistocene ice sheets but speculations on glaciological theory as well.

It was not originally intended to publish all the papers contained in this volume together. As a result, the book is intermediate in nature between a collection of papers and a monograph. The closely related chapters (three on the areal distribution of ice during the last ice age, two on numerical methods of reconstructing glacier elevations, and three on ice sheet models) exhibit substantial redundancy (for example, entire maps are repeated with only the caption changed) and some inconsistencies in notation (for example, isostatically depressed levels are denoted by a prime in one chapter and an asterisk in another) and in spelling (Taimyr; Taymyr). Some of the figure legends are incomplete, and at least one map presents improper contouring. The absence of any list of figures and tables is a serious deficiency in a book having so many of them.

The authors' "most important conclusion is that the distribution of late Wisconsin-Weichselian ice sheets is not well