

and their eigenvalues are determined by a Hamiltonian consisting of a single-boson mean field and two-body interactions between the bosons. The IBM has unified the understanding of nuclear collective behavior from spherical through transitional to axially symmetric deformed nuclei and has predicted new types of collective behavior. In its original incarnation Akito Arima and Franco Iachello, co-inventors of the model, were vague about the meaning of the bosons, and it was generally assumed that they resulted from the quantization of the quadrupole liquid drop model of Aage Bohr and Ben Mottelson. However, Igal Talmi quickly recognized that the bosons were pairs of neutrons and protons of angular momentum zero (monopole) and two (quadrupole), highly correlated so that they could be treated as bosons, and thus the IBM was a generalization of the pairing model to include quadrupole pairing. This insight made it possible to connect the IBM to the nuclear shell model. Hence when Talmi set out to revise his very popular *Nuclear Shell Theory*, written with Amos de-Shalit about 30 years ago, the result was this entirely new book.

*Simple Models of Complex Nuclei: The Shell Model and Interacting Boson Model* reflects the approach that Talmi has brought to nuclear structure physics throughout his very influential career. In his view, we can understand low-energy nuclear spectroscopy by assuming that the neutrons and protons inside a nucleus, like electrons in an atom, move in spherical orbits produced by a static central field. Whereas in atoms the central long-range Coulomb field is produced by protons in the nucleus, inside the nucleus the nuclear central field is a mean field the source of which is the very strong short-range, spin-dependent interactions between the nucleons themselves. As a result, in contrast with the atomic shell model, the nuclear shell model lacks a theoretical foundation for finite nuclei, and the "best proof for the validity of the shell model is the good agreement of its predictions with experiment" (p. 4). One of these predictions follows from the fact that the mean field produces sets of quasi-degenerate orbits separated by an energy gap. Because of the Pauli exclusion principle, the  $N$  neutrons and  $Z$  protons occupy the lowest  $N$  and  $Z$  orbitals, respectively, and at the  $N$  and  $Z$  for which the lowest quasi-degenerate orbits are filled the nucleus is particularly stable because of the energy gap. Such nuclei are called "doubly magic" and have been observed throughout the periodic table. The neighboring nuclei are then represented as having neutrons and protons (called valence nucleons) in the valence orbits outside the doubly magic core, and excited states are composed primarily of

excitations within these orbits or from the core. The energy levels and eigenfunctions are calculated from a Hamiltonian that takes into account the energies of the orbitals and the effective two-body interactions between nucleons in these orbitals. Talmi extracts these orbital energies and effective interactions from the one- and two-valence nucleon systems and then predicts the many-nucleon system by diagonalizing the Hamiltonian matrix in a basis of antisymmetric wave functions with definite total angular momentum. He gives some examples of this approach and explains in detail the technology necessary for calculating the matrix elements for many-particle antisymmetric states with definite angular momentum.

This approach is viable for a few valence nucleons and for light nuclei. However, for medium and heavy nuclei the number of basis states becomes too large to diagonalize, leading to models that isolate a few important degrees of freedom. One of these models is the generalized seniority model pioneered by Talmi that isolates the pairing degree of freedom. The motivation for this model is the observation that, for nuclei with an even number of either neutrons or protons filling the valence shells (that is, singly magic nuclei), the excitation energy of the excited states is constant as the number of valence nucleons changes by two, suggesting that the nucleons in the ground state have strong pairwise correlations and the excited state comes from the breaking of the last pair. The generalized seniority model assumes that the ground state of a singly magic nucleus is a condensate of  $N$  pairs of valence nucleons with angular momentum zero correlated over a major shell outside a doubly magic core. Talmi derives the conditions on the Hamiltonian such that this condensate is an eigenstate and that the excited states with one pair broken are also eigenstates. He then proves that such a Hamiltonian will have two-nucleon separation energies varying linearly with valence nucleon number, which has been observed in a number of singly magic nuclei, and will also lead to a constant excitation energy as the valence nucleon number is varied. For the nickel isotopes, where shell model calculations have determined the ground state wave functions, these wave functions are well approximated by the generalized seniority wave functions; for the heavier nuclei such as the tin isotopes no such shell model calculations are available to test the generalized seniority wave functions.

When protons and neutrons are filling the same valence orbitals, the long-range effective neutron and proton interaction produces deformed nuclei and the ground state is no longer a condensate of correlated angular momentum zero pairs. It is for these nuclei

that the IBM had its great success. In fact, describing generalized seniority as a condensate of angular momentum zero pairs suggests that one can approximate these correlated pairs as bosons, since it is bosons that condense. Adding a quadrupole correlated pair or boson furthers our understanding of the connection between nuclear collective motion and the shell model. Talmi gives a fluent description of the IBM, including many details about Hamiltonians, transition operators, symmetries, spectra, and applications to real nuclei. He also discusses fermion shell model Hamiltonians that have a subset of eigenstates with only monopole and quadrupole pairs. Using these models he gives a rudimentary description of how to map the fermion shell model Hamiltonian to the boson Hamiltonian—rudimentary because this relationship between the shell model and the IBM is not yet fully understood.

*Simple Models of Complex Nuclei*, which includes an updated and revised version of the very useful appendix to *Nuclear Shell Theory*, will make a good graduate textbook or research reference. The concept of bosonization of a fermion system has found applications in other fields of physics, and researchers now believe that quadrupole pairing may be essential for understanding high-temperature superconductivity in condensed-matter physics.

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## Other Books of Interest

**Methods in Arabidopsis Research.** CSABA KONCZ, NAM-HAI CHUA, and JEFF SCHELL, Eds. World Scientific, River Edge, NJ, 1992. xii, 482 pp., illus. \$86 or £61; paper, \$34 or £24.

Plant biology has many star performers, among them soybean, maize, tobacco, tomato, and wheat. Now *Arabidopsis thaliana*, a plant of no agronomic importance, has come to center stage. *Arabidopsis* is not a newcomer to botanical research, but it has been rediscovered recently because of its small genome, short generation time, established genetics, and amenability to genome analysis. There are now probably a thousand research groups working with *Arabidopsis*. *Methods in Arabidopsis Research* describes how to work with this crucifer. The book is more than just a book of protocols. Its 18 chapters cover a wide range of topics, from the history of *Arabidopsis* research, to yeast artificial chromosome cloning strategies, to subtractive library construction, to mutagenesis and cultivation.



## Vignettes: Around the Campuses

The University of Arizona is a real Ken and Barbie kind of place, with frats and sororities and lots of beautiful people.

—Chris Langton, as quoted by M. Mitchell Waldrop in *Complexity: The Emerging Science at the Edge of Order and Chaos* (Simon and Schuster)

A visitor . . . accustomed to the look and traffic patterns of major universities might find the grounds of the MIT campus remarkably underpopulated. Responsible people can speedskate over the sidewalks and do.

—Fred Hapgood, in *Up the Infinite Corridor: MIT and the Technical Imagination* (Addison-Wesley)

I don't like it here in Palo Alto. . . . I am in the academic demimonde. I am an editor and manager for a marginal publisher of doctoral dissertations languishing because they're too specialized or because they fall outside the desiderata of the regular university presses.

—The sometime-anthropologist main character in Norman Rush's novel *Mating* (Knopf, 1991; Vintage paperback)

The initial chapter, by George Rédei, is a fascinating account of past *Arabidopsis* research (including the author's difficulty in publishing some of his original studies on *Arabidopsis* mutants). The technical chapters on transformation using *Agrobacterium*, the establishment of linkage maps, genome mapping, analysis of proteins, and plant-pathogen interactions are interesting and clearly written, giving a context for the protocols. The protocols themselves are presented in such a useful way that postdoctoral staff and graduate students rushed to take my review copy of the book to use for our soybean research. I believe the volume will be valuable as well to those studying other plant species. In it we have a book that belongs on the desk of every molecular plant scientist. —Peter M. Gresshoff, University of Tennessee

**The Maize Handbook.** MICHAEL FREELING and VIRGINIA WALBOT, Eds. Springer-Verlag, New York, 1993. xxvi, 759 pp., illus., + plate. \$79 or £55. Springer Laboratory.

"In modern times, the view that other scientists are cooperators rather than competitors is unusual," write the editors of this volume, "but it is a key part of the maize community of scholars." Produced in this spirit, *The Maize Handbook* "represents the collective efforts of the maize research community to enumerate the key steps of standard procedures and to disseminate

these protocols for the common good," including that of those working with other higher plants to which the procedures may be applicable. In all, 129 authors have contributed 133 items to the enterprise. The volume opens with nine brief contributions setting forth the basics of maize development and morphology. Another ten papers under the heading Cell Biology deal mainly with techniques related to microscopy, rather than with cellular processes per se. The remaining 640 pages of the text are given over to the protocols, among which are interspersed some not strictly methodological discussions of various features of maize such as the anthocyanin gene system. Of the items in this part of the book 63 are categorized as genetics, 37 as molecular biology, and 14 as cell culture. In length they range from one page (for instance, Birchler on ring chromosomes) to 17 (Chang and Neuffer on chromosome behavior during microsporogenesis). Illustrations include a 10½-page table of reciprocal translocations between A chromosomes (Coe) and a color plate showing results of gene tagging involving *Ac* and *Ds* transposable elements (Dellaporta and Moreno). Reference lists are appended to the individual contributions, and a 34-page subject index is included at the end of the book. In the preface the editors provide as other aids to the reader information about the Maize Genetics Cooperation Newsletter and a list of other books that should be in a "robust" library of the subject.

—Katherine Livingston

## Books Received

**The Analysis of Natural Waters.** T. R. Crompton. Oxford University Press, New York, 1933. 2 vols. Vol. 1, Complex-Formation Preconcentration Techniques. xii, 216 pp., illus. \$52.50. Vol. 2, Direct Preconcentration Techniques. xii, 249 pp., illus. \$60.

**And Yet It Moves.** Strange Systems and Subtle Questions in Physics. Mark P. Silverman. Cambridge University Press, New York, 1993. xviii, 266 pp., illus. \$49.95; paper, \$24.95.

**Applications of Environment-Behavior Research.** Case Studies and Analysis. Paul D. Cherulnik. Cambridge University Press, New York, 1993. xiv, 342 pp., illus. \$64.95; paper, \$24.95. Cambridge Series in Environment and Behavior.

**Biology.** Exploring Life. Gil Brum, Larry McKane, and Gerry Karp. 2nd ed. Wiley, New York, 1994. Variously pagged, illus. \$58.95.

**Biology of Salmonella.** Felipe Cabello *et al.*, Eds. Plenum, New York, 1993. xii, 470 pp., illus. \$115. NATO Advanced Science Institutes Series A, vol. 245. From an institute, Portofino, Italy, May 1992.

**The Biophilia Hypothesis.** Stephen R. Kellert and Edward O. Wilson, Eds. Island Press, Washington, DC, 1993. viii, 484 pp., illus. \$27.50.

**California's Changing Landscapes.** Diversity and Conservation of California Vegetation. Michael Barbour *et al.* California Native Plant Society, Sacramento, CA, 1993. x, 246 pp., illus. Paper, \$24.95.

**Capillary Electrophoresis of Small Molecules and Ions.** Petr Jandik and Günther Bonn. VCH, New York, 1993. x, 298 pp., illus. \$65.

**Catalytic Asymmetric Synthesis.** Iwao Ojima, Ed. VCH, New York, 1993. xiv, 476 pp., illus. \$110.

**Data Analysis for the Chemical Sciences.** A Guide to Statistical Techniques. Richard C. Graham. VCH, New York, 1993. xx, 536 pp., illus. \$65.

**Digital Woes.** Why We Should Not Depend on Software. Lauren Ruth Wiener. Addison-Wesley, Reading, MA, 1993. xx, 245 pp., illus. \$22.95.

**Dissociative Recombination.** Theory, Experiment, and Applications. Bertrand R. Rowe, J. Brian A. Mitchell, and André Canosa, Eds. Plenum, New York, 1993. x, 282 pp., illus. \$95. NATO Advanced Science Institutes Series B, vol. 313. From a workshop, Saint Jacut de la Mer, Brittany, France, May 1992.

**The Ecology of Commerce.** A Declaration of Sustainability. Paul Hawken. HarperBusiness, New York, 1993. xviii, 250 pp. \$23.

**80 Years of Hashimoto Disease.** Shigenobu Nagataki, Toru Mori, and Kanji Torizuka, Eds. *Excerpta Medica* (Elsevier Science), Amsterdam, 1993. xxvi, 721 pp., illus. \$237.25 or Dfl. 415. From a symposium, Fukuoka, Japan, Dec. 1992.

**The Encyclopedia of Mental Health.** Ada P. Kahn and Jan Fawcett. Facts on File, New York, 1993. xii, 464 pp. \$45.

**The Engineer in the Garden.** Genes and Genetics. From the Idea of Heredity to the Creation of Life. Colin Tudge. Cape, London, 1993. xii, 398 pp. £17.99.

**Epidermal Growth Factors and Cytokines.** Thomas A. Luger and Thomas Schwarz, Eds. Dekker, New York, 1993. xviii, 486 pp., illus. \$165. *Clinical Dermatology*, 10.

**Field Guide to Coastal Wetland Plants of the Southeastern United States.** Ralph W. Tiner. Abigail Rorer, illustrator. University of Massachusetts Press, Amherst, 1993. xiv, 328 pp. + plates. \$50; paper, \$17.95.

**Flora of North America.** North of Mexico. Nancy R. Morin, Convening Ed. Oxford University Press, New York, 1993. Vol. 1, Introduction. xxii, 372 pp., illus. Vol. 2, Pteridophytes and Gymnosperms. xvi, 475 pp., illus. Each vol., \$75.

**G. I. Budker.** Reflections and Remembrances. Boris N. Breizman and James W. Van Dam, Eds. American Institute of Physics, New York, 1993. xviii, 364 pp. + plates. \$45. Translated from the Russian edition (1988).

**Games of Life.** Explorations in Ecology, Evolution, and Behaviour. Karl Sigmund. Oxford University Press, New York, 1993. viii, 244 pp., illus. \$49.95; paper, \$17.95.

**Gene Conservation and Exploitation.** J. Perry