

## Particle Physics in Retrospect

**Inward Bound.** Of Matter and Forces in the Physical World. ABRAHAM PAIS. Clarendon (Oxford University Press), New York, 1986. xvi, 666 pp., illus. \$24.95.

*Inward Bound* is an account of "particle" physics from X to Z—from the discovery of x-rays by Roentgen in 1895 to the discovery almost a century later, by Rubbia and 135 collaborators, of the neutral boson that mediates the weak interactions. Two books really make up *Inward Bound*. The first, constituting the first two-thirds of the volume, is a history of the period from 1895 to 1945; the second, which Pais calls a memoir, covers the postwar years. The distinction is of importance. A memoir, as Pais indicates by quoting the *Oxford English Dictionary*, is a record of events that have come within the personal knowledge of the writer. What Pais means by a history was defined in his superb biography of Einstein, *Subtle Is the Lord*. It is an account based on an unavoidably subjective selection of information from a pool that can be assumed to be incomplete. Pais there also noted that though questions like "Why did A create what he did, why did B readily accept what A created, why did C resist A's new ideas?" can be distilled from the historical record their answers are beyond history. Somewhere between the question and the answer lies what Pais has called the edge of history.

In *Subtle Is the Lord*, Pais was willing to indulge in such "extrahistorical" speculations, and that epic work was humanized by his willingness to trespass at the edge of history. The same is true for the first part of *Inward Bound*. The memoir, on the other hand, is a depersonalized—one might almost say dehumanized—account of the great advances that have taken place in high-energy physics in the last four decades, in which the building blocks of matter have been uncovered and the dynamical laws describing their interactions, laws valid to distances of the order of  $10^{-17}$  centimeter and energies of the order of 100 billion electron volts, have been established.

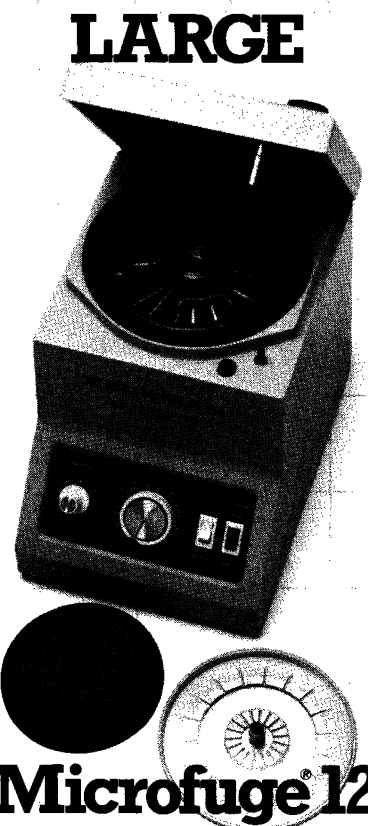
Both periods are illuminated by Pais's felicitous style, his extraordinary scholarship, and the wealth of detail he has incorporated in the text. The references alone make *Inward Bound* an invaluable historical document. But above all it is the quality of Pais's mind that makes it memorable. Pais is a deeply learned authority who writes with lucidity and avoids frills but also shows an

acute aesthetic sense and a fine sense of humor. His own accomplishments in physics, moreover, are such that he properly appreciates the achievements he writes about.

The book is admittedly a Whiggish history, but then I do not believe one can escape some Whiggism in the history of science. The Whiggish idea of progress must, since there has been progress in science, come into the writing of its history. Moreover, the illumination of later theories helps make the earlier landscape clearer, demarcate boundaries and approaches, and organize the narrative.

The concerns of Pais's own research are reflected in his selection of topics: beta-decay and the weak interactions receive dominant emphasis in the historical section of the book. The heroes of the pre-1945 account are Rutherford and Dirac, and of the two Rutherford is the more fully (and lovingly) portrayed. Both are supremely intuitive and fearless physicists. Others are as insightfully drawn—for example, Thomson, Planck, Bohr, Pauli, Heisenberg—yet somehow Rutherford represents a *beau ideal* for Pais. The historical segment is humanized by these portraits; it also is enlivened by Pais's judgments and insights. For Pais, "progress in science depends vitally on a backlog of experimental data in need of interpretation." His treatment of the period prior to about 1905 is intended "to demonstrate that in all of the twentieth century (to date) the experimental backlog in physics was never greater than during its opening years." Similarly, the greatness of Thomson and the reasons he is credited as the discoverer of the electron are masterfully detailed: not only did he determine the ratio of charge to mass for these particles, he also a few years later measured their charge. Additionally, the historical part of the book is peppered with stimulating and controversial statements: on the pitfalls of search for general patterns of laws of history, and more specifically laws of the history of discovery, on the influence of Zeitgeist, on the role of individuals in history, and much else.

Whereas one might have inferred that the title of the book alluded to an inward journey, Pais's account of the events that have occurred during his own career refers only to quarks, gluons, leptons. Here Pais avoids discussing individuals. The memoir is primarily a history of ideas, with some attention to the instrumentation that has made it



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possible to observe the new phenomena. It is difficult to discern from Pais's account the influence Gell-Mann and Weinberg have had as theoreticians. Similarly, the experimental practice of the 1970's, with the change that occurred in the kind of high-energy events looked for, is not contrasted with that of the '60's. Nor is the sociology of the high-energy physics community taken up. But as Pais emphasizes in his introductory chapter, he has written one man's account of particle physics. We have other accounts to enrich our understanding: Pickering's *Constructing Quarks*, Galison's article "How the first neutral current experiment ended," and Brown and Hoddeson's histories of particle physics in the '30's and the '50's.

Although the first part of *Inward Bound* should be understandable to a layperson the book is largely addressed to the physicist and mathematician with good background in relativistic quantum mechanics. It should become required reading for graduate students in physics, as it offers a lucid map of the road taken in arriving at the present understanding of the fundamental laws of nature. It is regrettable, however, that the book does not contain a single illustration, not even a Feynman diagram. An illustration of Geissler's pump, for example, would have made the discussion in the text much clearer.

Undoubtedly, exception will be taken to some of the emphasis in Pais's presentation. Some might have put greater emphasis on nuclear physics during the '30's—in particular, nuclear reactions and their theoretical descriptions. Others might weigh the role of renormalizability or of symmetry breaking differently. It is, however, unlikely that a more careful or a more masterful presentation will be forthcoming soon.

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## Australian Bird Populations

**Birds of Eucalypt Forests and Woodlands.** Ecology, Conservation, Management. A. KEAST, H. F. RECHER, H. FORD, and D. SAUNDERS, Eds. Illustrated by D. McFarland, D. Milledge, and J. Trompp. Published in association with the Royal Australasian Ornithologists Union by Surrey Beatty, Chipping Norton, NSW, Australia, 1985. xvi, 384 pp., illus. \$43.

In Australia, perhaps more than elsewhere, the biology of birds and the structure of bird communities are influenced by the dominant plants. These plants, the eucalypts,

are a uniquely Australian tree lineage including over 500 endemic species. In addition to abundant nectar and sap, eucalypts produce manna in response to insect attack, and lerps and honeydew are secreted by sap-sucking insects. These carbohydrate resources and the unique arthropod communities of eucalypts have been instrumental in molding the adaptations of eucalypt forest birds. Knowledge about the birds of eucalypt forests is provided in this valuable compendium with emphasis on three general topics: ecology and behavior of bird species, dynamics of bird populations and communities, and responses of birds to selected human impacts. Many authors incorporate information about eucalypts and the arthropods associated with them into their presentations.

Some papers resurrect old saws, but many explore ecological pattern with depth and insight. For example, the complex interactions of food supply, interspecific competition, population dynamics, and community structure are clearly illustrated by the bell miner (*Manorina melanophrys*) studied by Loyn and others. Bell miners aggressively exclude other birds from their territories, which generally support large populations of psyllid insects, the primary food of the bell miner. Upon removal of bell miners from their territories, an immediate influx of other birds occurs and, within a few months, psyllid populations crash. Many colonizing bird species then disappear from the area.

Many papers focus on the relationship between food abundance and bird densities (Pyke, Paton, Bell, Woinarski, and others). No general conclusions emerge. Birds undoubtedly do respond in very complex ways to changing food abundances, and likely respond differently at different times under varying circumstances. Thus simple univariate relationships between bird populations and their food supplies are elusive.

Species respond individually to produce communities that vary with latitude (Milledge and Recher), elevation and microtopography (Loyn), vegetation structure and plant species composition (Gilmore), temperature, rainfall, and food resource pattern (Pyke), and nest site availability (Noske). Birds may even regulate insect populations and thus determine aspects of tree health (Ford).

Autecological studies of Australian birds contain many lessons in evolutionary biology. The importance of carbohydrate resources such as those available to the Australian avifauna is unprecedented on other continents, and—a matter not discussed in this book—plantations of introduced eucalypts outside Australia typically support few birds

and arthropods because species that have coevolved with eucalypts are not present. Cooperative breeding systems predominate among Australian birds more than among birds in other geographic areas. In eastern yellow robin (Marchant), for example, clutch size is higher for pairs with auxiliary helpers than for pairs alone, perhaps because auxiliaries provide extra food supplies during courtship feeding.

Many authors discuss methods for ameliorating effects of such modern perturbations as clearfelling for timber and woodchips, altered fire regimes, and land clearing for agriculture. One especially interesting chapter by Loyn examines the population dynamics of forest island relict birds. He found that the number of forest species preserved by a complex of small reserves was similar to the number preserved by a large reserve of similar total size, an observation very germane to the "SLOSS" (single large or several small preserves) controversy. However, he also showed that populations in the most fragmented combinations were very low in density and consisted mainly of transient individuals. Thus, although the birds occur in small forest patches, their presence may not indicate viable populations.

The volume concludes with high-quality color photographs depicting both eucalypt forest habitats and birds. Regrettably, no effort was made to cross-reference the photographs with papers in the text. The extensive data tabulations included will be valuable long after the theoretical ideas presented have passed.

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## Angiosperm Reproduction

**Plant Breeding Systems.** A. J. RICHARDS. Allen and Unwin, Winchester, MA, 1986. xiv, 529 pp., illus. \$75; paper, \$34.95.

A. J. Richards, well known for his research on breeding systems of vascular plants, particularly the genetics of agamospermy in dandelions and various facets of floral heteromorphism, has written a book he describes as a textbook, but one that will interest advanced researchers in a field that has witnessed an "explosive expansion" of activity in recent decades. The plants of its title are almost exclusively angiosperms. Richards includes a diversity of topics beyond reproductive systems, such as theoretical matters, genetic structure of populations, resource allocation, foraging theory, and