determine whether a species will be an invader or not? and What are the site properties that determine whether an ecological system will be relatively prone to, or resistant to, invasion? Answers to these questions would be invaluable to efforts to prevent invasion and to control invasive species.

Each chapter grapples with one or both of these questions from the standpoint of the expertise of its authors. Some chapters focus on the taxon or the biogeographical origin of the invader, others on the character or community structure of the invaded system. Some chapters are conceptual; some stress models. Unfortunately, in chapter after chapter failure to answer the key questions is variously acknowledged. There are complaints that insufficient information has been collected concerning failed invasions or introductions. There are references to the inherent complexity of ecology. Some think that the timing, location, and initial population size of the invading propagule are important considerations. Brown sees an unbridged gulf between academic ecologists who are satisfied with generalities and applied ecologists who must manage on a case-by-case basis.

Nonetheless, many authors remain hopeful. Ehrlich is pleased that we have some generalities about invasion, viz., that mammals are more likely invaders than monophageous arthropods but do not necessarily have less serious effects. And in their concluding chapter, Mooney and Drake also remain optimistic: in a section headed "good intentions are not enough," they comment that "as our understanding of biological systems becomes more complete we should be able to reduce the probability that an intentional introduction will have an adverse effect."

I find this ambiguity unsettling; the participants in this thorough study have reached a conclusion they seem unwilling to accept. Population biology has always had difficulties with prediction, even for the simplest single-species systems within undisturbed environments. The problem of predicting invasion success stretches its capacities beyond the breaking point. Species X of ecological system Y is to invade ecological system Z—will it succeed? A major misconception is that species X has intrinsic properties or factors independent of its resident ecological context (system Y). Also, we must understand that we have never characterized any ecological system, Y or Z, at the level of species-species interactions; that is, we cannot predict the dynamics of an undisturbed Y or Z. In any case, X invading system Z is a complete unknown. We have no knowledge of the coupling parameters between X and Z, and we are also ignorant of the nonequilibrium dynamics that will result from the initial growth of X in Z.

To underscore this fundamental ignorance concerning invasion, I and others have shown that we cannot predict, from summary statistics alone, species-invasion success for differential-equation systems modeled on a computer. The same is true for well-characterized *Drosophila* species in laboratory ecosystems. Though field ecologists are right to be suspicious of the "successes" of such models, they should not let the lessons of the limits and failures of these models be lost on them: we are never going to have a scheme to predict the success of invading species.

Given that we must renounce our quest for case-by-case predictability, what should we do? There is pattern in the data we possess on invasions. The next efforts in the study of invasion should be self-consciously statistical, with an emphasis on characterizing the probability distribution of outcomes for classes of invasions. But for this we will need the raw data on-line in computer databases accessible to all researchers.

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New View of the Ionosphere

The Earth's Ionosphere. Plasma Physics and Electrodynamics. MICHAEL C. KELLEY, with contributions from Rodney A. Heelis. Academic Press, San Diego, CA, 1989. xii, 487 pp., illus. $89.95. International Geophysics Series, vol. 43.

Known for decades as an electromagnetically active layer of the atmosphere with dramatic effects on human radio communications, the ionosphere has in more recent times been investigated with incoherent scatter radars and scientific satellites. This has resulted in a new view of the ionsophere as the "battleground between the earth's neutral atmosphere and the sun's fully ionized atmosphere," in which large-scale atmospheric flows and the solar wind vie for influence and control. In this new view, the emphasis has shifted from the causes and structure of the ionosphere to its dynamical behavior in response to various forms of energy input and dissipation.

This book represents an effort to synthesize these new thrusts of ionospheric research into the plasma physics and electrodynamics of magnetized, partially ionized gases in relative motion. It is written on the level of a literature review but includes a tutorial introduction and is suitable for graduate students (though no end-of-chapter problems are provided).

The struggle between atmosphere and solar wind unfolds across a region that is demarcated by altitude as much as by latitude, the solar wind dominating at higher latitudes and altitudes. The region considered for this book extends from the equator to the poles but in altitude is limited to the region between 90 and 2000 kilometers. The chapter organization is by latitudinal region, with chapters on electrodynamics and plasma physics for low- and for high-latitude regions. Appendixes provide discussions of measurement techniques and reference data that will be useful shortcuts for the newcomer to this field. The tutorial sections, which outline the gross nature of the electrodynamic interaction between the solar wind and ionosphere, are among the most physically satisfying and lucid I have seen. The treatment of the magnetosphere as a region through which solar wind motions are communicated to the ionosphere is cursory, but commensurate with the emphasis of this volume.

The sections on equatorial ionospheric dynamics proceed from a physical description of the equatorial dynamo driven by atmospheric motions to accounts of the formation of dynamic structures by hydrodynamic large-scale instabilities, such as ionization "fingers" formed by variants of the Rayleigh Taylor instability, and of the short-scale phenomena such as the gradient drift instability. Throughout these sections, and the rest of the book, a nice balance is struck between descriptions based on first-principle derivation and actual observations, at times of active perturbation experiments designed to make ionospheric motions visible.

The high-latitude region may be usefully defined in terms of the dominance of solar- and magnetospheric-driven flows of the ionospheric plasma. Similar patterns are seen in the neutral winds as well, albeit without the high degree of variability seen in the plasma flow. Ample attention is given to observations of plasma flow, which are used to illustrate the features thought to dominate the global convection within the polar regions. The inference of magnetic "field-aligned current" systems is outlined; but disappointingly, the fundamental role of plasma flow shear in generating such currents is lightly treated so that the flow and field-aligned current patterns are poorly related to each other.

A chapter is devoted to the effects of horizontal and vertical transport of plasma within the ionosphere. The local effects of features such as convection stagnations or supersonic flow channels are outlined (notably absent here is the Post-Rosenbluth lower hybrid instability). In addition, a summary is given of the types of vertical flows that can occur in the topside ionosphere, particularly involving mass transport into the magnetosphere. This section is disappointing in its outdatedness. The most recent reference is from 1982, and much of the recent literature on heavy-ion outflow perturbations of the topside ionosphere is ignored.

Again, the high-latitude dynamical processes are described both theoretically and observationally, from largest to smallest scales, including the global structure of the aurora, gradient-drift, current-driven, and flow-shear-driven instabilities, all as candidates for the generation of observed structures and fluctuation spectra within the ionosphere.

Overall, this book will be an extremely useful teaching tool and research summary for workers in ionospheric plasma physics. It provides an excellent blend of theory and observational data, thereby making evident those areas that hold promise for future research.

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Nuclei and Particles

Weak Interactions in Nuclei. BARRY R. HOLSTEIN. Princeton University Press, Princeton, NJ, 1989. x, 247 pp., illus. $49.50. Princeton Series in Physics.

Holstein's aim in this book is to demonstrate the usefulness and excitement of recent developments in weak interactions and their applications to nuclei, which can serve as testing grounds of the fundamental physics involved. He succeeds in this multiple endeavor. In addition, the book shows the rapprochement of nuclear and particle physics.

The author assumes that the reader has a sound knowledge of quantum mechanics and the foundations of nuclear and particle physics. Detailed derivations sometimes are lacking, but numerous references are included. The monograph is thus aimed at advanced graduate students and researchers, particularly those in nuclear physics. Holstein does not attempt to cover all of weak interactions in nuclei but concentrates mainly on those aspects that have a connection to fundamental interactions and concepts or to particle physics. The choice of topics is directly related to his own research work. He often gives insightful and instructive descriptions and order-of-magnitude arguments.

The book begins not with weak interactions but with the strong ones, that is, with a description of the quark model. This introduction is followed with the basics of weak interactions, and particularly the Weinberg-Salam model. Gauge invariance and spontaneous symmetry-breaking are included in this description, but the reasons for an $SU(2) \times U(1)$ model or for a Higgs *Doublet*, for example, are not given but assumed to be known.

Symmetries, particularly those relevant to weak interactions, are introduced early. The evidence for parity (P) and combined charge-conjugation and parity invariance (CP) is presented. Indeed, the close relationship and complementarity of theory and experiment are highlighted throughout the text; many good examples appear, such as nuclear studies of the non-leptonic weak interactions through parity violation.

Neutrinos, their interactions and their importance, are stressed in a chapter that includes astrophysics and the solar neutrino problem. Here the author clearly shows the relations among various fields—astrophysics and particle and nuclear physics—and the present interest and excitement in this area.

Finally the book introduces exchange currents for strong, electromagnetic, and weak interactions and ends with a description of some open problems where these currents are important.

The reader who has a reasonably sound basic knowledge of nuclear and particle physics will find this book particularly helpful. She or he will need to consult some of the references at the end of each chapter to fill in some of the missing details. The lively description of the physics makes this book appealing and welcome.

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