

comes most noticeable. The list of lasers does not contain some of the most interesting and most recent laser developments, but this is only to be expected in a field moving as rapidly as laser development.

In general the book is a remarkable accomplishment for its extensive and voluminous bibliography—910 references! A majority of these are in the Russian literature, but most of them are available in translation journals. The translation of this book by D. Lederman and P. Greenberg (Israel Program for Scientific Translations) is entirely adequate. I would recommend this book for the reference shelf of anyone who periodically finds himself involved in evaluating the expected effects of the atmosphere on optical propagation. The book is a welcome contribution to the available body of knowledge in this area.

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Particle-Interaction Physics at High Energies

S. J. Lindenbaum
526 pp. Oxford U. P., New York,
1973. \$48.00

This long awaited book has two aims—to serve as a reference book, and to be used as a graduate text. It will serve its first purpose well; I know of no other single tome (as opposed to a plethora of review articles) that covers as much material with as many references to the original literature. On the other hand the style of the book is such that it could be used only for rather advanced and extensive courses without considerable amplification. Experimentally oriented students might find it too highbrow, and theoretically-oriented ones might find the derivations too sketchy.

One general remark imposes itself (at least to me) before presenting a detailed review: The book is a solace to those who feel a malaise about current progress in particle physics. Many of the most exciting recent developments in the field—deep inelastic lepton scattering, partons, Bjorken scaling, unified gauge theories, rising cross sections, to name just a few—are often not mentioned at all or merely alluded to. This regrettable circumstance must no doubt be traced to the fact that it may take longer to turn a manuscript into a book than to produce important discoveries. This fact is good for physics, but bad for the reader.

Sam Lindenbaum has been a leader in experimental physics (as well as an

author of excellent summary articles) for almost two decades. His personal interests have focused mainly on hadron physics, a field to which he and his collaborators at Brookhaven have contributed seminal technical innovations. He has, in particular, pioneered the on-line approach to high-statistics scattering, which has not only yielded important results at BNL, but inspired many experiments elsewhere. The book reflects the author's interests, but not his talents. While many graphs of experimental results are presented, experiments as such are rarely illustrated or described.

The bulk of the book (400 pages) is devoted to hadron physics, including chapters on symmetry groups and "high-energy" behavior. Low-energy pion physics receives an emphasis that today no longer appears appropriate; in fact it is surprising that the vector mesons (ρ, ω) are first and only briefly discussed in a chapter on "Pion production."

The chapter on dispersion relations is, as one would have expected, the most instructive. Theory is constantly being compared with fact through numerous graphs of experimental data. It is however regrettable that even this chapter lacks proofs or even heuristic "derivations." Thus, for example, the Kronig-Kramers dispersion relation for the classical index of refraction is simply posited, and not deduced from the causality postulate.

The chapter on pion production contains a discussion of Fermi's early statistical model. Aside from defining a relativistically correct phase-space, Lindenbaum presents no further developments (Hagedorn, Frautschi and others), and he makes no comparisons with experiments. Today's readers will certainly miss this topic.

I am most critical of chapter 10, "Elementary Particle Classifications." The quark model receives very short shrift. Group-theoretical jargon is liberally used, and the simplest facts are derived from (unproven) decompositions of direct products of irreducible representations rather than by elementary arguments. The familiar figures for the representations are nowhere to be found, nor are such useful notions as U-spin ever introduced. The celebrated Johnson-Treiman relations for meson-baryon scattering which follows quite simply from the quark model, are traced (page 297) to the relation $143 \oplus 364 = 364 \oplus 752 \oplus 16016 \oplus 35100$ valid for $IU(6,6)$! Thus, frequent references to Feld's book are not only helpful, but necessary. Furthermore, while futile efforts to wed $SU(6)$ and relativity are reviewed in some detail, Gell-Mann's current algebra (1964!) is discussed in haste and not even indexed.

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Solvable Models in Algebraic Statistical Mechanics

D. A. DUBIN. The study of exactly solvable models contributes to the understanding of theoretical structures devised to explain physical phenomena. The structure examined in this book is quantum statistical mechanics, adapted to systems with an infinite number of degrees of freedom. The book will be of value to post-graduate physics students, to research workers in statistical mechanics, and to functional analysts who are interested in applications of their subject. (Oxford Science Research Papers) 1974 128 pp. \$17.00

Noise and Fluctuations in Electronic Devices and Circuits

F. N. H. ROBINSON. By relating the practical effects of noise to basic physical laws, this study provides an understanding of the physical origins of noise and its consequences in electronic systems. Chapter topics include noise in vacuum tubes, transistor amplifiers signals and noise, and mixers and phase-sensitive detectors. A bibliography and index are included, plus an appendix on the current induced by a moving charge. (Monographs in Electrical and Electronic Engineering) 1974 254 pp.; 76 figs. \$27.25



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have traditionally served as the model theory in particle physics, are treated in a single chapter, exclusively devoted to elastic electron-nucleon scattering. A serious blemish of this chapter is the allegation that Mott's formula applies to scattering from Dirac protons. The form-factors are neither introduced by the usual optical arguments nor connected with the vertex modifications discussed elsewhere in the book. Photoproduction of hadrons, electromagnetic decays of mesons and so forth are subjects that I would like to have seen discussed, with or without vector dominance.

Weak interactions are covered in a single, albeit long, chapter. The original Fermi beta-decay interaction is written down (in field-theoretic form) by "analogy with quantum electrodynamics"—a topic barely mentioned elsewhere in the book. After following the meanderings of pre-1957 experiments for several pages, the reader is suddenly presented with lepton conservation, helicity and V-A theory. It is surprising that the beta-decay of the free neutron should never be discussed in a book on elementary particles—after all, it is the prototype of all leptonic baryon decays. One cryptic sentence (page 325) probably refers to this process, but only authors looking for quotations of their work (such as I) could grasp its subtle meaning. Considerable confusion is created by the "helicity rule." First, it is correctly concluded that a neutrino accompanying $\pi^+\mu^+$ decay has, from the observed polarization of the μ^+ , positive helicity (and vice-versa for $\pi^-\mu^-$ decay). The μ^+ (μ^-) is however produced left-(right)-handed, in obvious contrast to the "helicity rule" (that particles have negative helicity) stated later. It is of course well known that the leptons are born in this case with the "wrong" helicities, and that π -l decay is forbidden in the limit of vanishing charged lepton mass.

One could wish for a less cursory discussion of the current-current interaction, on which most of our present understanding rests. It is for instance not pointed out that the test of this hypothesis lies in the so-called "self-terms," although effects (presumably) due to P-violating nucleon forces are mentioned earlier.

Cabibbo theory is also treated in a cursory fashion. First, the hadronic current is expressed in terms of "the SU(3) generating currents" but these are not defined elsewhere. Next, the Cabibbo angle θ is extracted from meson decays. Finally, by reference to a review article, we are informed that hyperon decays yield about the same θ . Many readers could miss the point that this theory unifies our understanding of the leptonic decays of all hadrons. A presentation in terms of the quark

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model would have made things much clearer.

The last section of this chapter brings the greatest surprise. Here we are told that elastic (ν, e) scattering is "almost pure s-wave" while elastic ($\bar{\nu}, e$) scattering is "almost pure p-wave." Since orbital angular momentum is, for relativistic particles, a meaningless concept, one is puzzled.

Since Lindenbaum was "present at the creation" of modern particle physics, his book—in particular the early chapters—is written with an effort to give history its fair due. The historically interested reader is, however, often puzzled by the text; thus Fröhlich, Heitler and Kemmer are supposed to have introduced (1938) a $T = 1$ triplet of pions *once* the existence of charged pions was discovered (1947). One might be lead to believe that Fermi died (1954) without realizing that he and his co-workers had discovered the (3,3) resonance. The historical emphasis appears often distorted: Early Japanese workers on SU(3) are properly mentioned, but Feynman and Gell-Mann (not to speak of Theis) are not quoted at all where V-A is discussed.

All in all, this book contains many facts and is a good guide to the reference literature. Proofs are however so rarely given in it, that the reader will indeed need such a guide. In fact a possible title for it might have been "Everything you always wanted to know about particle physics, and now won't be afraid to ask."

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Spectral Line Broadening by Plasmas

H. R. Griem

408 pp. Academic, New York,
1974. \$31.50

The problems that arise in the analysis of spectral-line shapes have been intriguing physicists and astronomers since the late nineteenth century. Whilst the effect of the motion of the emitting atoms on the observed lines is easily understood, the broadening and shift of spectral lines produced by the presence of many particles in the plasma that interact with the emitting atoms, gives rise to a number of problems that remain unsolved. Information on this pressure-broadening effect is extremely useful in plasma diagnostics, whether it is a relatively high-density laboratory plasma that is being studied, or a low-density astrophysical plasma such as the interstellar medium.

In this book, Hans R. Griem reviews

the recent work on spectral lines emitted by atoms and atomic ions in plasmas. A considerable amount of progress has been made in this field since the author's earlier book, *Plasma Spectroscopy* (McGraw-Hill, 1964). He discusses both the theoretical and experimental advances in the subject, and there is a final chapter on applications to density and temperature measurements, to stellar atmospheres and the radiofrequency lines. Data on lines in hydrogen, helium and various atomic ions, many of astrophysical interest, are included in tabular form in seven appendices.

The author has been a very active research worker in plasma spectroscopy for the last 20 years, and has made many contributions to our understanding of spectral line broadening. Other workers in this field who are already familiar with Griem's many papers will recognize immediately the author's inimitable style. The book should be a useful reference work for all people interested in line broadening, including graduate students who are starting to do research in this area. For those who are predominantly interested in the theory, it will probably be necessary to look up the original references in

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