BOOK REVIEWS

Selection of books for review is based on the editors' opinions regarding possible reader interest and on the availability of the book to the editors. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

Symmetries and Quark Models

Editor Ramesh Chand

Publisher Gordon & Breach Science Publishers

Pages 406 + Preface and Introduction

Price $27.50

Reviewer D. C. Peaslee

This book is a summary of a conference under the given title held at Wayne State University, Detroit, Michigan, on June 18-20, 1969. The conference was mainly devoted to the theory of elementary particles and high energy reactions; only 2 reports out of 23 dealt directly with measurements. One of these is what one might have expected to see near p. 1 of the volume instead of p. 225: "Status of the Experimental Search for Physical Quarks," by L. W. Jones. This is a succinct review of the search for free quarks up to that time: not excessively numerous and uniformly negative. The author concludes, "At this time, I suspect that most experimentalists feel that physical quarks are either unobservable or do not exist." Indeed, this spirit informs the whole proceedings that quarks are sometimes used as a *model,* but never really taken seriously. The conference was essentially a review of selected subjects in high energy physics, the selection principle being a more or less close connection with the quark model.

The most comprehensive discussion of the strengths and weaknesses of the quark model is Lipkin's review discussion following the experimental summary of Jones. It is made clear from the outset that the strength of the model is in providing a simple picture of symmetry properties in the coordinates isospin, baryon number, and hypercharge (IBY). Its weakness is in the dynamics of constructing observed particles from quarks, as becomes progressively clear in the Appendix. The real embarrassment is the quark mass (pp. 261 to 262); already the mass of a single quark must empirically exceed that of a nucleon by a factor of at least 5, and the model requires three quarks to compose a nucleon! At this rate there is a real question whether the discovery of a physical quark with very high mass might not raise problems more difficult than it solves.

Two or three other papers concern the quark model and its variations directly; the rest are simply expositions of current topics, valuable as introductions since they are very well documented. Another feature is that the quark model is a relatively concrete approach to elementary particles and therefore attractive for those who are only partially familiar with the subject.

On the whole, however, this book will not appeal to the complete novice in high energy physics. He who cannot read Jones' and Lipkin's articles with ease will probably find little else accessible. Also, the other papers are predominantly theoretical in character—with the exception of the nice survey of Ξ spectroscopy by Yodh. They are, therefore, likely to become dated a little faster than their experimental counterparts at, say, the contemporaneous Lund Conference.

People whose knowledge is at about the stage of a PhD student in high energy physics would find *Symmetries and Quark Models* of the greatest value. The book is excellently produced, with discussions and references, and provides a good introduction to interesting and still vital problems on the subject.

D. C. Peaslee received his AB from Princeton University in 1943 and his PhD from Massachusetts Institute of Technology in 1948. After working for a year on nuclear reactors at the Kellex Corporation of New York, he was an AEC Postdoctoral Fellow at the ETH in Zurich, Switzerland. Subsequently, he held academic posts at Washington, Columbia, and Purdue Universities. After a Fulbright Fellowship at the Australian National University in 1958, he accepted a permanent position and is now professor of physics. His primary interest is in high energy physics.

Annual Review of Nuclear Science, Vol. 20 (1970)

Editor Emilio Segrè

Publisher Annual Reviews, Inc.

Pages 613

Price $10.00

Reviewer R. L. Macklin

Of the (baker's) dozen topics covered in this Annual Review, roughly half should be of direct interest to

nuclear technologists. Many of the chapters are far more than mere reviews of the literature; they include much that could well be termed "Worldwide Progress Report." Plans and ambitions that may never see print in the scientific literature provide stimulating insight into ongoing fields.

Post's article on fusion follows an eleven-years-earlier one in the same series and the circumstance affords him a fine occasion to consider just what has been accomplished in the decade of the 60's. It turns out to be quite a bit. Ten years ago it was enough to discover plasma instabilities in magnetic confinement systems. That gave way to discovering cures and methods of avoidance till now nothing serious is left. Post sees a demonstration of scientific feasibility of fusion reactors by 1975 at present research levels. Strangely, 50 to 60% of the effort is in the USSR, 25% in the USA. He points out that many of the engineering problems already are being tackled in the research phase, in contrast to fission, where reactor engineering followed scientific feasibility by a decade and more. All this is nicely woven into a balanced presentation of the place of fusion in man's future with emphasis on care for the environment while providing bountiful energy.

Diven's article on nuclear physics with bomb shots provides a wealth of incidental information on transuranium production, neutron time-of-flight design, etc., which will be very valuable if plans mature to invite worldwide participation by outside scientists. A very fair exposition of both the unique advantages and especially the limitations of the method is given. One point of terminology seems confusing to me: "...spontaneous fission in all known resonances of ^{240}Pu was demonstrated...." (p. 98). It seems hardly fair to call fission induced by the flood of neutrons from a bomb shot "spontaneous." The term "sub-threshold fission" used elsewhere in the chapter, though traditional, also seems poor as there is no energetic threshold for fission beyond the rare earths. Perhaps we should speak of "Fission Barrier" heights in analogy to the term "Coulomb Barrier" used for charged particle nuclear reactions.

Motz's chapter on Neutron Capture Gamma Ray Spectroscopy easily wins the reference prize. Allowing for the size of type, the 452-item reference list is over half the length of the text (exclusive of figures and tables). Seriously, though, he uses his favorable official position to let us in on the status of new techniques and applications in this highly sophisticated field around the world. He mentions among results (p. 25), observed departures from statistical "one degree of freedom" distributions for partial radiative widths. For ^{239}U* at least, more recent high resolution work (G. G. Slaughter et al.) has shown agreement with the expected distribution.

Firk's chapter on photoneutron reactions has much more discussion of models and their (generally) qualified failures. Major emphasis is on work of interest to the Yale laboratory and little more than passing mention is given to rapidly developing sub-fields like threshold photoneutron studies and analog states. The ^{165}Ho alignment effect "...beautifully demonstrated..." in Fig. 3 is marred in the printing by near indistinguishability of the open and closed plotting points.

Haefele's review of fast breeder reactors is from the point of view of a major strategist on the global scene. Microscopic experiments and computer calculations are well covered and compared with integral experiments. The evaluation shows weaknesses on both sides. Major engineering problems (coolant, void coefficients, fuel element construction) also receive full converage. There are very few spots where one can recognize the Germanic language background of the author.

The chapter on heavy cosmic ray nuclei provides a discriminating review and evaluation aimed at the best values of abundances, but also discusses theories of origin, interstellar path lengths, etc. An origin in supernova outbursts in our own galaxy within the past few million years is favored.

Among the other chapters, that on Spark Chambers gives a useful review of the formulas useful in proportional counter design. "Quantum Electrodynamics" almost restores one's faith in physics as an exact science. Results are now so good the author can chide experimenters for not separating their systematic error and precision estimates or setting them at the 95% probability level instead of 1 standard deviation. "Pionic Atoms" includes interesting and still up-to-date comments on lithium-drifted germanium and silicon detector techniques for timing and simultaneous good energy resolution.

Typographical and grammatical errors run about ten pages apart or, say, 40 parts per million (ppm), making the book "purer" than most of the materials we choose to work with.

R. L. Macklin has spent most of his professional life at Oak Ridge, working successively in radiation monitoring, uranium radioactive decay studies, radiation detector development, nuclear reaction cross-section measurements, neutron time-of-flight experiments, stellar nucleosynthesis, trace element analysis by proton reactions and gamma-ray astronomy. Dr. Macklin attended Yale University, receiving both his BS (1941) and PhD (1944) degrees in organic chemistry.