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Book Review: Elementary Particle Physics, by David C. Cheng and Gerard K. O'Neill

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The past decade has been one of continual ferment and extraordinary achievement in high-energy physics. The constituent (quark model) picture of the strongly-interacting particles has steadily gained experimental support from the pointlike character of inelastic electron-proton scattering, the jet structures observed in electron-positron annihilation, the atom-like spectra of the ψ/J and Υ families of resonances, and more. Simultaneously, confidence has grown in the view that interactions among the fundamental constituents are described by gauge field theories. Prominent examples are the Weinberg-Salam model of weak and electromagnetic interactions, and quantum chromodynamics, the gauge theory of strong interactions among quarks and gluons.

The new perspective has been shaped by both theoretical and experimental advances: the proof that the Weinberg-Salam theory is renormalizable, the discovery of weak neutral currents, and the observation of charm; the recognition that gauge theories may be asymp-

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totically free, the measurement of Bjorken-scaling violations in inelastic lepton-nucleon scattering, and the evidence for gluon jets. With this new perspective have come new experimental initiatives, including imminent searches for the intermediate bosons of the weak interactions, for proton instability, and for neutrino oscillations.

In my view, high-energy physics is defined by what high-energy physicists are doing, and a graduate course should introduce students to contemporary concerns. In a rapidly-moving field, the selection of apposite topics is no easy task for the author of a textbook. David C. Cheng and Gerard K. O'Neill have chosen not to write a thoroughly modern introduction to particle physics, but rather to emphasize time-honored material. Unfortunately time-honored all too often means antique. The book is divided into a brief introduction and major sections on the electromagnetic, weak, and strong interactions. The strong-interaction portion, which makes up 40% of the text, contains but three post-1969 references: passing mention of the papers announcing asymptotic freedom, and a citation of the 1978 Review of Particle Properties. The extensive studies of high-energy collisions carried out at the CERN Intersecting Storage Rings, at Fermilab, and at the CERN Super Proton Synchrotron are thus ignored. This is regrettable, even within the authors' selection criteria, because many experiments and analyses of the recent era address traditional concerns more incisively than did earlier work. The rest of the book is scarcely more modern: it contains a half-dozen *en passant* post-1975 references.

Such complaints might be overlooked if Elementary Particle Physics were otherwise well-written. However, David Cheng, a former high-energy experimenter now with Intel Magnetics, and G. K. O'Neill, Professor of Physics at Princeton and a pioneer of colliding beams research, have produced a profoundly disappointing book. It contains many statements that are misleading, and many that are wrong.

In a lengthy treatment of SU(3) and the quark model, there is continual confusion between the terminology "group" and "representation." The difference between SU(3) and the quark model is garbled, it is incorrectly stated that the photon is isoscalar, and it is stated, also incorrectly, that charm as well as color is needed to reconcile the quark model with the Pauli exclusion principle.

A section on Regge theory (the utility of which has been confirmed by the high-energy experiments the book neglects) highlights something called the interference model, which has been discredited since the discovery of duality in the late 1960s. It is stated that the total cross section should decrease as 1/log(center of mass energy). What should be meant is the *elastic* cross section. In any event, the big news of early 1973—not mentioned here—is that both grow with increasing energy.

The section on weak interactions contains a brief resume of the Weinberg-Salam model. A partial-wave unitarity argument is given for the existence of the neutral intermdiate boson Z^0. The mass of the Z^0 is incorrectly stated to be twice the mass of the charged intermediate boson $W^{\pm}$. The Higgs boson, which is required to exist by the same unitarity argument, is not mentioned. The theory is ascribed to Steven Weinberg in

1964 (1967 is correct), but the reference does not exist: it turns out to be a corrupted reference to the work of Abdus Salam and John Ward.

As these examples suggest, Elementary Particle Physics is so consistently unreliable that no student should be forced to struggle with it. I may suggest some alternatives. For a one-year course, the books by Steven Gasiorowicz and by Martin Perl, though somewhat dated, are more scholarly and authoritative, and an excellent short introduction is provided by Donald Perkins' slender volume.