to him that, if one demanded that the full weak currents, including the strongly interacting particles, obeyed, or were made to obey, the same algebraic relations as the leptonic currents, then this could constitute a new interpretation, or definition, of the universality of the weak interactions. Moreover since these commutation relations are nonlinear—the commutator of two currents is proportional to a third—they might be used to set the scale of the effective coupling constants in the various weak processes relative to the constant that governs muon decay, the only decay that involves leptons alone. From these fundamental and elegant ideas has come the whole explosive development of current algebras that is the subject of two books discussed in this review: *Current Algebras and Their Applications* by Bruno Renner, who was at Cambridge University in 1966 when he gave the lectures on which his book is based, and *Current Algebras and Applications to Particle Physics* by Stephen Adler and Roger Dashen of the Institute for Advanced Study, Princeton, N. J. All three authors have been active workers in this field, and Adler and Dashen are responsible for several interesting recent developments. The most notable developments are the Adler–Weisberger sum rule, which is the quantitative expression of Gell-Mann's idea of using the commutation relations to set the scale of the coupling constants, and the Dashen–Gell-Mann attempt to find a complete phenomenological model of hadrons by studying matrix elements of current commutators between states with infinite momenta.

Both books cover about the same material. Neither one is, strictly speaking, useful for what Renner refers to as the "uninitiated reader." Renner provides, however, a brief introductory chapter in which he sketches the highlights of such basic notions as SU(3) and the quark model. This chapter is probably not enough of an introduction to be really useful to someone coming to these notions for the first time. Renner also gives a bibliography that covers the relevant papers up to approximately the spring of 1967. Renner's list includes no less than 516 papers and is a testimony to the sort of gold mine that this field has been to otherwise unemployed theoretical physicists.

Adler and Dashen are more selective and give a bibliography of about 60 papers. In addition 22 papers—the *crème de la crème*—are reproduced in the book. Many of them, like the Gell-Mann–Levy paper of 1960 on PCAC, appear, like good wine, to have improved with age. In some cases the authors of these papers have added footnotes and corrections to the originals. Such an opportunity for second thoughts on one's physics papers is rarely available in this life. Adler's and Dashen's text—about 200 pages worth—is a model of critical exposition in theoretical physics. A reader who works through it carefully will have a relatively complete grasp of the status of current algebras, at least as it was a year ago.

Both books suffer, as do all books in physics that deal with current events—no pun intended—from the inevitable time lapse between the time the book is written and the time it is published. With these books much has happened in this dynamic field in a year. There have been the Weinberg sum rules, the phenomenological Lagrangians, and the algebra of fields, all of which will, no doubt, be included in the next edition. Even so, when one is able to obtain the sort of synoptic view of this field that these books give, one is led to wonder what it all means. Are the currents really the fundamental objects (a view that has been taken to its logical limit by Hirotaka Sugawara and others who attempt to construct the stress tensor of the world out of products of weak currents), or are the currents really a superficial manifestation of an underlying stratum of vector mesons (a view taken by T. D. Lee and others), many of which have not yet been found? In these matters theorists may well be in the somewhat passive position of the secretaries in William Wotton's description of Sir Francis Bacon: "My Lord Bacon was the first Great Man who took much pains to convince the World that they had hitherto been in a wrong Path, and that Nature herself, rather than her Secretaries, was to be addressed to by those who were desirous to know much of her Mind."

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Fields, forces and material media

ELECTRODYNAMICS OF MOVING MEDIA. By Paul Penfield Jr, Hermann A. Haus. 276 pp. MIT Press, Cambridge, Mass., 1967. $12.50

by James B. Kelley

At the very outset, it should be noted that Paul Penfield and Hermann Haus do something almost no authors ever take the trouble to do; in an excellent preface, precise introduction and fine concluding chapter, they tell why the book is being written, what questions are involved and at whom the book is aimed, and give a general review of the literature followed by a first-rate list of references. As the authors point out, no really complete survey of literature in electrodynamics could ever be given in a book of this size or scope. But if such books as this served no other purpose than to bring up to date work in a field of speciality, particularly one so fundamental as this one, they would be worthwhile contributions. Of course this book does more.

For one thing, it concerns itself with the dispute between Lan Jen Chu at MIT and others concerning his formulation of electrodynamics of moving media. It also develops new material in several areas, notably in connection with Hamilton's principle and a new "principle of virtual power." The development of the material in the first few chapters is not much different from other developments of similar material. As the authors point out, however, this must be done as part of the necessary background.

In chapter 3, after giving us the usual basic Maxwell equations and the principles of conservation of momentum and energy, the authors discuss the so-called "Minkowski" (1908) and "Chu" (1960) formulations. The conclusions they reach on these two formulations is that they are essentially equivalent to their field predictions for **E** and **H** fields outside a polarized body even though they predict different fields inside the polarized body. Since these fields cannot be subjected to direct experimental verification, the differences are of lesser

importance. Essentially the difference is that Minkowski assumes the same form for Maxwell's equations in moving media as for stationary media, while Chu showed that although his formulation and Minkowski's agreed in predicting electric and magnetic fields in vacuum, there were large nonrelativistic differences in the two force expressions.

The principle of virtual power, which the authors have developed, and which is based on the principle of virtual work, is described in chapter 4 for nonrelativistic cases, and illustrated with two previously considered problems: inviscid fluid with no heat flow and a quasi-static electric-field system. This principle is then applied to new problems for which solutions are not known, and the results worked out. The following chapter treats the relativistic principle of virtual power and some of the same problems as the previous chapter. There is also a good section on four-dimensional notation.

Hamilton's principle is discussed in chapter 6, and several formulations—Minkowski, Chu, Amperian and Boffi—are compared in some detail in chapter 7. As was noted at the outset chapter 8 is a very concise, interesting review and appraisal of electrodynamics literature: This is extremely valuable. Though the book is not a text it may be used as a graduate supplement.

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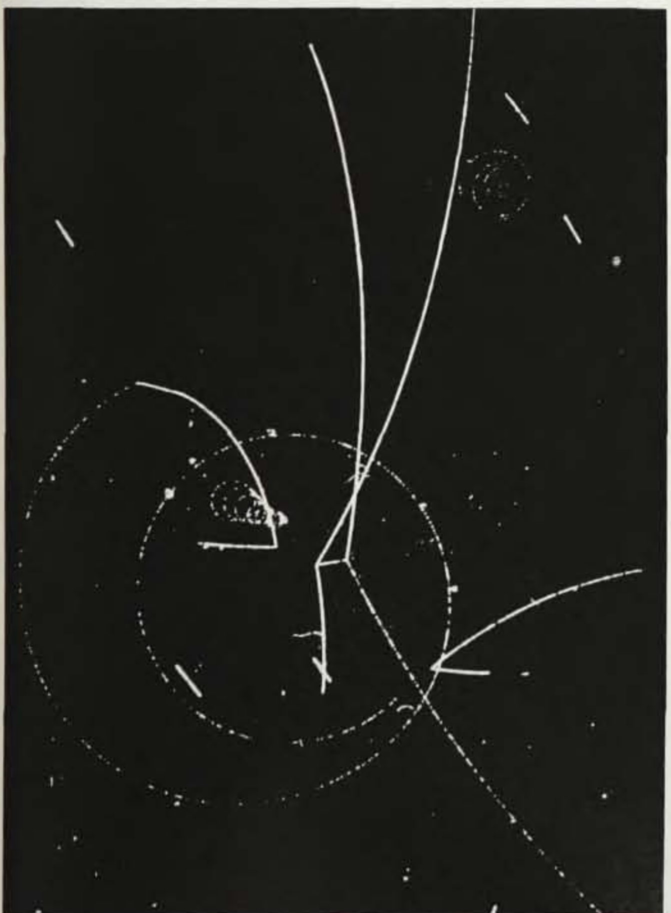
Theory of strong interactions

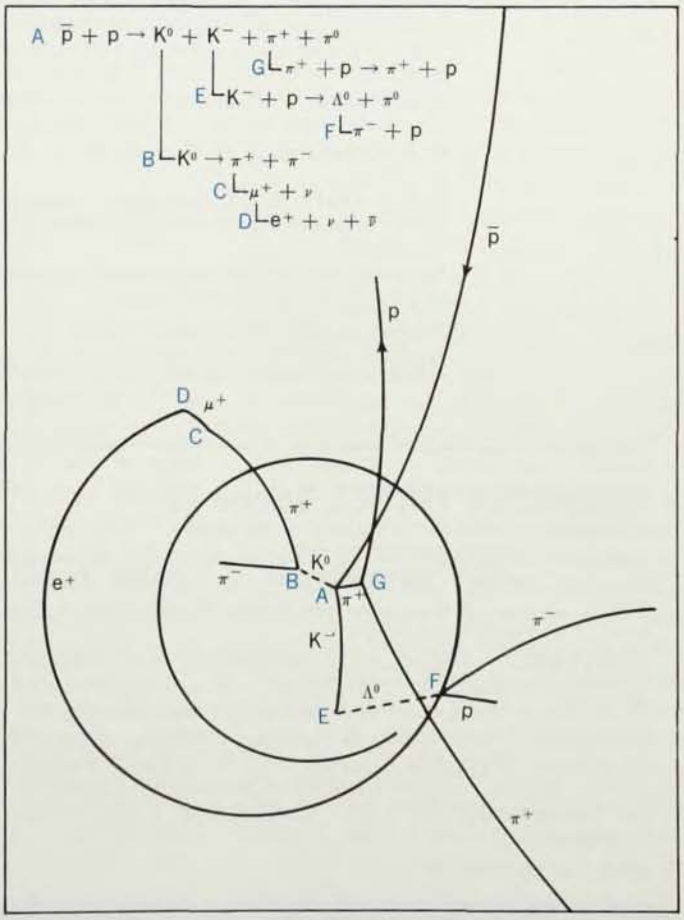
HIGH ENERGY COLLISIONS OF ELEMENTARY PARTICLES. By R. J. Eden. 298 pp. Cambridge U. Press, London, 1967. $9.50

by Maurice Jacob

The scope of this book is actually not as wide as its title may sound. It is primarily devoted to the present analysis and understanding of two-body, and quasi-two-body, high-energy collisions of hadrons, that is, strongly interacting particles. Nevertheless this domain of particle physics has been an extremely active one during the last few years. There was therefore undoubtedly a need for a book that would, at the same time, assess the progress made and also serve as a guide to the abundant and highly specialized literature for the student engaging himself in this quickly developing field. This book certainly meets this need. The very good introduction to the study of the analyticity properties of collision amplitudes, and then to Regge theory, makes it very useful for any graduate student intending to work in theoretical hadron physics, but also for more senior physicists engaged in other fields and wishing to become acquainted with a good mathematical introduction to their colleagues' vocabulary.

It should be stressed, though, that all through the book a very strong





BUBBLE-CHAMBER TRACKS made with the Nimrod 7-GeV proton synchrotron at the Rutherford High Energy Laboratory. *This picture is said to contain "almost the whole of high-energy physics."*