

"function" contains a functional. This leads to Euler-Lagrange equations that are integro-differential and hence non-local in character. There is some discussion of constraints. Edelen indicates that "The basic techniques are obtained from appropriate extensions of the classical variational methods." A substantial portion of the work is devoted to the transformation properties of functional equations. The groundwork for this is a chapter on geometric objects and Lie derivatives, which would seem to have been strongly influenced by J. A. Schouten's "Ricci Calculus."

The treatment is devoted explicitly to relative extrema; no discussion of maxima, minima or problems generally requiring utilization of the second variation is included. Such topics as existence theorems and fields of extremals are also excluded. These exclusions are in proper accord with the aim of the book. There is, however, one topic that might well have been included: the class of problems developed by considering variations of domain boundaries. This would appear to be well within the scope of the work.

It has been stated that the book is self-contained. This is accurate, but the material is not accessible without a good working knowledge of "the classical variational methods" on which the work is founded. A solid mathematical background is also necessary.

Very commonly, advanced texts suffer from an absence of problems. This is not the case here; the author has provided problems for each of the four chapters. There are also a number of examples and problems to illustrate the techniques. Unfortunately, these all deal with local fields and not the non-local variety for which the book is intended. Perhaps these will be included in a later edition.

If the implication of both jacket and preface are accepted, the book is probably the outgrowth of a set of lecture notes. Being such, it has the strengths and faults of such an origin. One of the greatest of the strengths is that much of the material has been battle tested. There are also hazards. The amount of material that can be presented intelligently in a one- or even two-semester course is quite limited and without expansion is almost certainly too meager in scope for other than the narrowest of monographs. Considerable augmentation is generally necessary. Edelen's treatment is somewhat austere and reflects more than is desirable the genesis of the book.

There is yet another hazard. If one starts deliberately to collect material for a book it is routinely simple to keep track of sources; the bibliography is automatically prepared as the work proceeds. In the preparation of lecture notes there is no such compulsion.

Later if the notes are to be converted into a book the exceeding tediousness of tracking down citations often results in an absence of bibliography and an apology by the author. This book unfortunately falls into the latter category.

The term "unfortunately" is deliberately chosen. In a book at the undergraduate level a bibliography may well be an expensive luxury. At the graduate level, or if intended for an audience whose interest in the work is of a research character, it is a necessity. In any case, it affords the author the opportunity of being gracious to his sources.

Despite the several caveats the book should prove useful to the intended audience.

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Cosmic Ray Physics: Nuclear and Astrophysical Aspects

By S. Hayakawa

774 pp. Interscience, New York, 1969.
\$39.50

Cosmic Ray Physics deals primarily with nuclear and astrophysical aspects; it does not cover in any detail the geophysical, geomagnetic or interplanetary features of the subject. But, by confining his attention to a portion of the cosmic ray problem, Satio Hayakawa is able to develop the topics in considerable depth. Following a historical survey, there are two chapters that deal with particle interactions at high energies and at very high energies. Then follows a chapter that describes cosmic rays in the atmosphere and underground, followed by a description of extensive air showers, the highest-energy phenomenon in the cosmic radiation. Finally, there is a chapter on the origin of cosmic rays.

What distinguishes this book from many others is the considerable detail of treatment and the many excellent tables and appendices. It combines many of the aspects of a textbook, a treatise and a handbook, and, in this respect, is a most useful base for the beginning graduate student as well as for the researcher who may come from other branches of physics or from astronomy.

The characteristic aspect of the book is its high competence. This is understandable when one realizes that Hayakawa has personally contributed to so many different topics of cosmic radiation. The book is in the tradition of L. Janossy or D. J. Montgomery, but up-to-date, essentially to 1966. Thus quarks and quasars are absent, but we have particle "strangeness," isospin, supernovae and galactic x rays.

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