Book Reviews

Theory of Beta Decay: An Exposition and a History

The phenomenon of nuclear beta decay reflects the workings of interactions which are very weak on the scale of those forces which determine the structure of the nucleus itself. Precisely for this reason beta decay provides an admirable probe for the study of nuclear structure. On the other hand, for those whose interest lies with the weak interactions in themselves, nuclei are admirable objects only insofar as they undergo beta disintegration. A generation ago weak-interaction physics was coextensive with nuclear beta-decay physics; today the subject ranges over a much wider domain.

E. J. Konopinski's **The Theory of Beta Radioactivity** (Oxford University Press, New York, 1966. 413 pp., illus. $12) is in fact oriented toward the larger questions of weak-interaction theory, but the context is predominantly that of nuclear beta decay. This is a rich arena and serves to introduce and illustrate many of the general elements of weak-interaction physics: the breakdown of various strong-interaction symmetry principles, the peculiar and distinctive properties of neutrinos, the principle of lepton conservation, the conserved vector current nature of lepton interactions, and so on. Moreover, the discussion is extended in later chapters to other branches of the subject, such as mesonic (pi- and mu-meson) beta decay. Nevertheless, the major emphasis, as I said, is in the nuclear arena; and such other phenomena as nonleptonic weak decays and beta decay of strange particles are not treated at all. This restriction is a matter of legitimate choice; and I call attention to it only because the discussion of fundamental weak-interaction matters is by and large so lucid that a broader overview of the whole subject would have been especially welcome.

In a certain way of looking at things, a nuclear beta-decay process has a *form* which depends in part on the fundamental nature of the weak interactions themselves and in part on the kinematics of the process; that is, on those aspects which reflect the restrictions imposed by conservation laws, whose detailed workings depend on the spins and other quantum numbers of the nuclei and leptons involved in the reaction. Since beta-radioactive nuclei come with a variety of combinations of these quantum numbers, the kinematic aspects can become very complicated, especially when decay correlation effects are of interest; and they have to be organized if one is going to exploit nuclear beta decay to learn either about nuclear structure or about the nature of the fundamental weak interactions themselves.

The early chapters of the book are devoted to a gradual elaboration of these largely kinematic matters, the author's aim being to display the forms with a maximum of physical insight and minimum of formal "Dirac-ology." In pedagogical matters of this kind tastes can differ. What is physical insight to some can appear to be labored to others; conversely, what seems to be arid formalism to some can appear to others a way of getting quickly and directly to the heart of the subject. In my own view the present treatment is lucid, enlightening, and often novel. It necessitates, however, a rather slow pace and a round of successive generalizations, so that general results emerge only gradually. But they do emerge, and one gets to see why nuclear beta decay is so important both for nuclear physics and weak-interaction physics.

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In the preface to their book **Beta Decay** [Interscience (Wiley), New York, 1966. 410 pp., illus. $16] C. S. Wu and S. A. Moszkowski confess that "the last chapter of this book was written with great emotion and enthusiasm." This is an understatement. The entire book, from the first chapter's historical introduction to the detailed mathematical exercises in the appendices, radiates a warmth and excitement that are not very often found in such a technical and specialized volume. It is quite obvious that the authors have participated deeply in the slow but steady progress of both the experimental and theoretical developments which have led to our present detailed understanding of the very fundamental process of beta decay and the so-called weak interactions.

Although other treatments of the subject, such as Konopinski's recently published *The Theory of Beta Radioactivity* (reviewed above), may be more rigorous and profound, this book presents a tantalizing interweaving of the key experiments and theoretical interpretations which should send the graduate student running to the original literature asking for more.

The story of the various aspects of the radioactive transformation of radium E is unfolded like a novel and ends with the following summary and admonition: "Altogether, it now appears that the decay of RaE is finally understood, after almost 40 years. Still we should not be complacent. When we consider the past history of RaE, it is quite possible that further surprises await us in the study of this fascinating nucleus."

Again, on page 284, one finds evidence of the stimulating enthusiasm of the authors. "It is an amusing exercise to speculate on further implications of a hypothetical universe in which there is conservation of axial-vector current."

In addition to dealing effectively with beta decay itself, parity nonconservation, the neutrino, the *CPT* theorem, lepton conservation, and other related topics such as double beta decay and inverse beta decay, the book also briefly discusses other weak interactions involving leptonic decays. There are also discussions of the conserved vector current and the question of an intermediate boson.

The book has appeal for both the specialist and the neophyte. After providing the initial pleasurable reading, the book will, for a long time, occupy its own proper place on the reference shelf.

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