

FOREWORD

The first half of this century witnessed the creation of relativity and quantum mechanics. The two critical paradoxes of the last century — the absence of an absolute inertial frame and the conflict of the dual wave-corpuseular behavior of particles — were thereby resolved. Their solutions will serve forever as a testimonial to the highest intellectual achievement of humanity.

By 1925, the theoretical foundations of these two milestones were firmly established. All the modern scientific and technological developments — nuclear energy, atomic physics, molecular beams, lasers, x-ray technology, semiconductors, superconductors, supercomputers — only exist because we have relativity and quantum mechanics. To our society and to our understanding of nature, these are all-encompassing.

After 1945 the world of physics again encountered a series of crises and successes. The complexity of the subnuclear world offers challenges that are at least as great as our predecessors faced. At present our theoretical framework, based on QCD for strong interactions, the standard model for the electroweak forces and general relativity for gravity, appears to be phenomenologically successful. Yet, there are deeply disturbing features which suggest that we are still in the transition period. In order to apply the present theories, we need about seventeen *ad hoc* parameters. All these theories are based on symmetry considerations, yet most of the symmetry quantum numbers do not appear to be conserved. All hadrons are made of quarks and yet no single quark can be individually observed. Now, fifty years after the beginning of modern particle physics, our successes have brought us to the

deeper problems. We are in a serious dilemma about how to make the next giant step. Because the challenge is related to the very foundation of the totality of physics, a breakthrough is bound to bring us a profound change in basic science. If we are successful, this will be our legacy to the civilization of the next century.

Just before Robert Marshak left on a trip to Mexico with his family to celebrate his and Ruth's fiftieth wedding anniversary, a trip that ended tragically with Bob's death, he completed the final manuscript of this book on modern particle physics. He was proud and happy about what he had achieved in tracing and analyzing its conceptual foundations.

Only a true master and a creative participant could record with accuracy the genesis of the field from its early days through the major events culminating in the formulation of the standard model of strong and electroweak interactions, and then move on to the experimental test of the theory and today's speculations that go beyond it. All the important ideas and the related mathematical techniques were treated from a fresh perspective that is a delight to the reader, and will be extremely helpful to researchers and students.

Indeed Robert Marshak grew up with the field. His life was closely interwoven with the history of modern particle physics. When I first met Bob in 1947 at the American Physical Society meeting being held at the University of Chicago, I was very much impressed by his presentation of the two-meson theory that he and Bethe had just proposed. Later on, my work on white dwarfs was inspired by his pioneering papers. Nearly a decade later, his formulation of $V - A$ theory gave the important next step to the idea of parity nonconservation. When he came to New York to be the President of the City College, we quickly became good friends. Among people of high intellectual power, it was rare to find someone with Bob's warm feeling towards people and straightforward approach to science as well as life.

The whole scientific community owed much of its international unity to Bob. In 1950 he started the first Rochester meeting on High Energy Physics. This was so successful that now the major bi-annual international symposium in the field is always called the Rochester Conference, even though it has not been held there for three decades. Appropriately, just before his untimely death, the American Association for the Advancement of Science named Bob as the first recipient of a new prize to be given for contribution to international scientific cooperation.

It was an honor to know Bob. While we will always miss him, through this book he leaves us a legacy that will impact on the course of the future development of particle physics.

T. D. Lee