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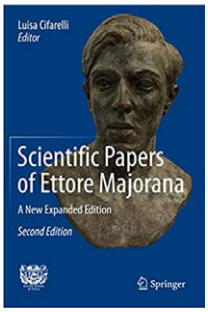

Luisa Cifarelli (Editor)

Scientific Papers of Ettore Majorana
A New Expanded Edition

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The Italian Physical Society has edited the scientific papers by Ettore Majorana. The present New Expanded Edition contains the original papers translated into English and each commented by an expert of the field. In addition there are biographical notes provided by Guerra and Robotti and three essays by Zichichi, Bettini and Benedek.

The book is of great value, since it shows how our Standard Model began as seen by Majorana as a witness from 1928 until his disappearance in 1938. When Majorana started his carrier as physicist in 1928 only the gravitational and the electromagnetic forces were known. The puzzling results of beta-decay experiments challenged unconventional solutions. Within a few years the foundation of two novel forces was established: the weak force and the strong force. Pauli postulated a new particle, the neutrino, in addition to the three then known elementary particles, the photon, the electron and the proton. The discovery of the neutron opened a way out of the unsatisfactory and problematic concept of a nucleus being composed of protons and electrons. Fermi proposed a theory of beta decay explained as the decay of a neutron into a proton and an electron-neutrino pair laying the fundament for the future studies of weak interactions. Heisenberg got inspired to view the proton and the neutron as equivalent partners of what we call today the nucleon. This marks the beginning of the new field of strong interactions. The discovery of the positron was a triumph of Dirac's theory and indicated a way out of his hole theory.

Majorana started his career in this extremely exciting atmosphere as part of a community of brilliant young physicists, such as Fermi, Dirac, Heisenberg and many others, all about the same age. He left only a handful of papers, but what a legacy! Zichichi's article pays homage to Majorana. He highlights aspects in the oeuvre and includes notes on the enigmatic disappearance. The reports on recollections of Oppenheimer, Segrè, Wick, Pontecorvo elucidate the personality of Majorana.

A lecture about *Dirac and Majorana Neutrinos* was delivered by John Bell in the 1st course of the 1963 Subnuclear Physics School at Erice.

Each of Majorana's papers contains fundamental and original ideas. The two papers of 1933 and 1937 show his outstanding contribution to the newly developing fields of strong and weak interactions.

The discovery of the neutron was the breakthrough to understand the structure of nuclei. Majorana immediately recognized the importance and developed his ideas about the forces acting between the nucleons. He passed several months at the Theoretical Institute of Physics at Leipzig, where Heisenberg was working. They had intensive discussions. Heisenberg liked Majorana's approach.

In studying the Dirac equation of electrons and positrons Majorana discovered an elegant choice of the gamma-matrices, today called *the Majorana representation*, where all coefficients are real. Majorana noticed then that an intriguing situation occurs when he applied his formalism to a neutral massive fermion, since there is, in his own words, *now no need to assume the existence of antineutrons or antineutrinos*. This observation inspired many theoretical analyses, in particular after the discovery of parity violation. Once the neutrino was discovered the crucial question became whether it is of Dirac or Majorana nature. This issue is still open. The article by Bettini describes in detail an experiment dedicated to the search for neutrinoless double beta decay with the strong hope to get a *yes or no answer*.

Majorana fermions entered the huge field of condensed matter physics. The article by Benedek gives an overview of the status and prospects.

Majorana leaves us a rich legacy. The reader will find in this book deep insights and stimulation.

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