JOINT INSTITUTE FOR NUCLEAR RESEARCH

LXXIV INTERNATIONAL CONFERENCE

NUCLEUS-2024

Fundamental problems and applications

Dubna, Russia, 1–5 July 2024

BOOK OF ABSTRACTS

Dubna 2024

The texts of the abstracts are published in author's edition.

ON THE POSSIBILITY OF THE MAJORANA NATURE OF NEUTRINOS

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One of the most popular explanations for the smallness of the neutrino mass is the seesaw mechanism [1], in which the neutrino should be a Majorana fermion. The concepts of C and CPT conjugations play an important role in the theory of Majorana fermions. We have shown that in the literature there are five nonequivalent concepts of charge conjugation ($C1 – C5$) and, accordingly, five possible types of Majorana fermions:

1. A fermion coinciding with its conjugate according to Pauli [2].

2. A fermion coinciding with its charge conjugate according to Majorana [3] and Kramers.

3. A truly neutral fermion coinciding with its antiparticle [3].

4. A fermion coinciding with its conjugate according to Schwinger [4].

5. A fermion coinciding with its charge conjugate with charge conjugation by means of creation and annihilation operators.

Previously, we have proven that Majorana fermions of the second type cannot be physical particles [5]. In this work, we analyze the possibility of a neutrino being a Majorana fermion of the other types.

We have proven that the non-QFT Pauli conjugation operator $C1$, defined in the framework of the theory of "holes" in the Dirac Sea, is equivalent to the QFT conjugation operator $C4$. Charge conjugation $C3$ is equivalent to the CPT inversion with reversal of the sign of the spin projection and chirality. The most commonly used in QFT conjugation $C4$ is antiunitary, reverses the particle chirality, and is not a charge conjugation. Its result coincides with the $C5$ charge conjugation only for chiral symmetric fermions.

We have proven that a comparison of operators in the coordinate representation and the representation of occupation numbers allows us to uniquely determine the phases of the operators P and C, up to sign, and limit the number of variants of charge conjugation and Majorana spinors.

1. R. N. Mohapatra, G. Senjanovic. Phys. Rev. Lett. 1980, 44, 912-915.

2. W. Pauli. Annales de l'Institut Henri Poincare, Physique Theorique 1936, 6, 109-136.

3. E. Majorana. Nuovo Cimento 1937, 14, 171-184.

4. J. Schwinger. Phys. Rev. 1948, 74, 1439-1461.

5. V.Monakhov. Space, time and fundamental interactions 2023, 3, 221-227.