Contribution ID: **40** Type: **Oral report**

C, P, T symmetries and Lorentz transformations in the theory of superalgebraic spinors

Tuesday 13 October 2020 15:30 (25 minutes)

The study of continuous (Lorentz transformations) and discrete symmetries of P, T, C, CP, and CPT and their disturbances is one of the important directions in modern quantum field physics. However, the derivation of formulas defining these transformations for spinors still relies heavily on physical considerations, rather than on the algebraic properties of spinors. Initially, in quantum field theory, spinors were considered using the Dirac matrix formalism. The modern theory of spinors is formulated in the framework of the formalism of Clifford algebras, such spinors are called algebraic [1]. However, algebraic spinors are rarely used in quantum field theory, since difficulties arise in constructing the vacuum state vector, second quantization theory, and spinor bundles. The theory of superalgebraic spinors [2-4], which is an extension of the theory of algebraic spinors, solves these problems. In it, spinors, basis Clifford vectors (analogues of Dirac gamma-matrices) and the state vector of vacuum are constructed from Grassmann variables and derivatives with respect to them. In this case, the expansion of the second quantization for the operator of the spinor field is obtained from purely algebraic relations, and the spinor momentum, electromagnetic and other gauge fields are of the same nature - they arise as affine connections in a superalgebra bundle. In the case of four independent Grassmann variables and derivatives with respect to them, not five Dirac matrices arise, but seven gamma operators - superalgebraic analogues of such matrices. Of these, one corresponds to the fifth Dirac matrix, multiplied by an imaginary unit, and is a pseudovector.
We have shown that in a matrix formalism there are two outwardly indistinguishable, but fundamentally different types of matrix operators acting on spinors. Operators of the first type are associated with spinor transformations. The operators of the second type are associated with the replacement of the spinor basis, and in the superalgebraic formalism, the spinor itself does not change from such a replacement.
We have constructed in an explicit form the state vector of the vacuum and its change during symmetry transformations. It is invariant with respect to Lorentz transformations and spatial reflections. There are two unitary transformations of the reflection of the time axis, which act equally on Clifford vectors, but act differently on spinors. For one of them, the vacuum is not T-invariant. When the time axis is reflected, it passes into an alternative vacuum, for which the spinor creation operators turn into annihilation operators, and the annihilation operators turn into birth operators. For the second operator, the vacuum is T-invariant, and the corresponding CPT transformation is an anti-unitary symmetry transformation.

1. Lounesto, P. Clifford algebras and spinors. 2001. Cambridge University Press.
2. Monakhov, V. Vacuum and Spacetime Signature in the Theory of Superalgebraic Spinors. Universe, 2019, 5(7), 162.
3. Monakhov, V. V. Superalgebraic structure of Lorentz transformations. Journal of Physics: Conference Series, 1051(1), 012023.
4. Monakhov, V. V. Generalization of Dirac Conjugation in the Superalgebraic Theory of Spinors. Theoretical and Mathematical Physics, 200(1), p. 1026-1042.

Author: Prof. MONAKHOV, Vadim (Saint Petersburg State University)

Presenter: Prof. MONAKHOV, Vadim (Saint Petersburg State University)

Session Classification: Section 4. Relativistic nuclear physics, elementary particle physics and high-energy physics

Track Classification: Section 4. Relativistic nuclear physics, elementary particle physics and high-energy physics.