It is shown that unobserved processes, which are usually eliminated from the theory by the introduction of muon parity, can be forbidden on the basis of spatial properties.

1. INTRODUCTION

The transformation properties of physical quantities play a fundamental role in present-day physics. In studying any kind of transformation we have to distinguish between its active or passive interpretation. The fundamental difference between these two interpretations is clear from the following.

Let the state of an object with respect to the system \((A)\) be described in this system by the wave function \(\psi_{(A)}(x^{(A)})\).\(^1\) The same object is generally in a different state with respect to system \((B)\) and this state is described in system \((B)\) by the wave function \(\psi_{(B)}(x^{(B)})\). Since \(\psi_{(A)}(x^{(A)})\) and \(\psi_{(B)}(x^{(B)})\) describe the same object they cannot be quite independent and it must hold that

\[
\psi_{(B)}(x^{(B)}) = S \psi_{(A)}(x^{(A)})
\]

where \(S\) is an operator dependent on the relation between \((A)\) and \((B)\). We thus obtain a passive interpretation of the transformation — (1.1) gives the relationship between the description of one and the same object from the point of view of two different coordinate systems.

It is assumed of some other coordinate systems (in accordance with experiments) that they are physically equivalent. In all equivalent systems the physical laws are the same ([1] for greater detail) and thus transformation (1.1) does not change the form of these laws. In this case (1.1) makes it possible to find, on the basis of a knowledge of one possible state of the object with respect to \((A)\), another possible state of this object with respect to the same system \((A)\). Since \(\psi_{(B)}(x^{(B)})\) satisfies all physical laws not only in \((B)\) but also in \((A)\), i.e.

\[
\Phi_{(A)}(y^{(A)}) = \psi_{(B)}(x^{(B)}) = S \psi_{(A)}(x^{(A)})
\]

where \(y^{(A)} \equiv x^{(B)}\), it represents the possible state of the object with respect to \((A)\). We thus obtain an active interpretation of transformation (1.1). However, we also

\(^1\) The coordinates of the world point \(X\) in coordinate system \((A)\) are denoted \(\{x^{(A)}\} = \{x^{(A)}_1, x^{(A)}_2, x^{(A)}_3\}\). The metric used is:

\[g^{\mu\nu} = 0 \text{ for } \mu \neq \nu, \quad g^{00} = -1, \quad g^{11} = -1, \quad g^{22} = -1, \quad g^{33} = 1.\]
know those transformations of wave functions which leave all physical laws invariant but are not connected with a transition to another coordinate system (e.g. gauge transformation). In these cases only active interpretation is possible. On the other hand, at transition to a non-equivalent coordinate system only passive interpretation of relation (1.1) is possible.

The importance of active interpretation of transformations and its connection with the laws of conservation is well known. However, passive interpretation is not usually regarded as a possible new source of physical information (e.g. [2]). That even passive interpretations may have a deeper physical significance is shown by the following example.

Let us consider two non-equivalent coordinate systems \((A), (B)\). It is conceivable that two objects described in the same way in \((A)\) will be described differently in \((B)\). Despite the fact that it is not possible to actively interpret the transformation \((A) \not\equiv (B)\), the difference between these two objects must be clear from the theory.

We shall deal below with the special case when \((A) = (R)\) is a right-handed coordinate system and \((B) = (L)\) the corresponding left-handed coordinate system. Experiments proving the non-conservation of parity show that \((R)\) and \((L)\) are not equivalent. However, there is no reason to assert that \((R)\) is physically more adequate than \((L)\) or vice versa. Since there exists in principle the possibility that two objects described equally in \((R)\) will be described differently in \((L)\), the object must be described simultaneously in \((R)\) and in \((L)\) in order to determine its state. (In this way the equality of \((R)\) and \((L)\) comes in a certain sense back to the theory; however, we do not want to say that all possible states of the object with respect to \((R)\) would also be possible states of this object with respect to \((L)\) but that both \((R)\) and \((L)\) must be used simultaneously in order to obtain a perfect description of the state of the object.)

This is no novelty. For example, in order to determine experimentally whether a quantity is scalar or pseudoscalar it must be measured in both \((R)\) and \((L)\). To perform measurement only in \((R)\) is possible only in the case when the transformation properties of the quantity with respect to spatial inversion are known beforehand from other sources.

As long as \((R)\) and \((L)\) were regarded as equivalent, this postulate (together with the active interpretation of the transformation) was a source of information on the transformation of a wave function at the transition \((R) \not\equiv (L)\). It could thus be stated that

\[
\psi_{(L)}(x^{(L)}) = R_{(R)\rightarrow (L)} \psi_{(R)}(x^{(R)})
\]

\[
R_{(R)\rightarrow (L)} = R_{(L)\rightarrow (R)} = P
\]

and the form of \(P\) was determined from the requirement of invariance of physical laws with respect to (1.3) (e.g. [3]).

Since it is known today that \((R)\) and \((L)\) are not equivalent, (1.4) and the requirement of invariance of physical laws with respect to (1.3) cannot be used to find the form of