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ИЗВЕСТИЯ АКАДЕМИИ НАУК ЭСТОНСКОЙ ССР. ТОМ 24
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IS ABSOLUTE DISTINCTION BETWEEN PARTICLES AND ANTIPARTICLES RIGOROUSLY ESTABLISHED?

L. PALGI. KAS OSAKESTE JA ANTIOSAKESTE ABSOLUUTNE ERISTATAVUS ON RANGELT KINDLAKS TEHTUD?

Л. ПАЛЬГИ. УСТАНОВЛЕНО ЛИ СТРОГО АБСОЛЮТНОЕ РАЗЛИЧИЕ МЕЖДУ ЧАСТИЦАМИ И АНТИЧАСТИЦАМИ?

It is well known that the *CP*-violation enables to absolutely distinguish particles and antiparticles. For example, it would be possible, at least in principle, to communicate to intelligent beings in outer space that our atom is made up of a positively charged nucleus and negatively charged electrons. That can be done, for instance, in case these intelligent beings in outer space are able to carry out one of the following experiments now known to us: the study of charge asymmetry in K_L semi-leptonic decays [1] or the comparison of the time distributions of the decays $K^\circ \to \pi^+\pi^-$ and $\bar{K}^\circ \to \pi^+\pi^-$ in the same apparatus [2]. In general opinion, the observation of the difference in the $\pi\pi$ decay distributions of K° and $\bar{K}^\circ$ mesons serves as a direct proof of *CP*-violation, independent of any theoretical conventions.

After all, in this note we wish to propose a *CP*-invariant model, still consistent with present data of neutral kaon decays which are usually considered as evidence of *CP*-violation. Therefore an additional experimental proof of *CP*-violation is needed. Until this time, an absolute distinction between particles and antiparticles has not been rigorously established. Thus, trying to incorporate observed data with *CP*-conservation, we propose a new interpretation based on the following assumptions:

(i) All interactions are *CP*-invariant.

(ii) There are partner particles $\varkappa^\circ$ (strangeness $S=+1$) and $\bar{\varkappa}^\circ$ (strangeness $S=-1$) of K° and $\bar{K}^\circ$.

(iii) The strong interactions and masses of K° and $\varkappa^\circ$ are equal.

(iv) In every ordinary reaction (target is made up of nucleons), K° and $\varkappa^\circ$ are produced coherently as a superposition $K^\circ + \alpha\varkappa^\circ$; $\bar{K}^\circ$ and $\bar{\varkappa}^\circ$ are produced coherently as a superposition $\bar{K}^\circ + \bar{\alpha}\bar{\varkappa}^\circ$.

(v) In every extraordinary reaction which is charge-conjugated to ordinary reactions, (target is made up of antinucleons) K° and $\varkappa^\circ$ are produced coherently as a superposition $K^\circ + \bar{\alpha}\varkappa^\circ$; $\bar{K}^\circ$ and $\bar{\varkappa}^\circ$ are produced coherently as a superposition $\bar{K}^\circ + \alpha\bar{\varkappa}^\circ$.

(vi) The coefficients α and $\bar{\alpha}$ are universal in all the creation reactions and $|\alpha| = |\bar{\alpha}| = 1$.

(vii) The mixing through weak interactions between the *CP*-even states $K_1 \leftrightarrow \varkappa_1$ might be as effective as the self-transitions $K_1 \leftrightarrow K_1$ and $\varkappa_1 \leftrightarrow \varkappa_1$. The mixing through weak interactions between the *CP*-odd states $K_2 \leftrightarrow \varkappa_2$ might be as effective as self-transitions $K_2 \leftrightarrow K_2$ and $\varkappa_2 \leftrightarrow \varkappa_2$.

LOCATION OF THE LABORATORY	OUR WORLD				ANTIWORLD *			
KAON CREATION REACTION	ORDINARY		EXTRAORD.		ORDINARY		EXTRAORD.	
STRANGENESS OF INITIAL KAON BEAM	+1	−1	+1	−1	+1	−1	+1	−1
a CP-VIOLATION	+1	−1	+1	−1	+1	−1	+1	−1
a OUR MODEL	+1	−1	−1	+1	−1	+1	+1	−1
a EXPERIMENT.	+1	−1						
sgn δ CP-VIOLATION	+1	+1	+1	+1	−1	−1	−1	−1
sgn δ OUR MODEL	+1	−1	+1	−1	−1	+1	−1	+1
sgn δ EXPERIMENT **	+1							

* An ordinary reaction in our world turns into an extraordinary reaction in the antiworld and vice versa. The definition of charge asymmetry in an antiworld of the same meaning as (2) is $\delta = (N(l^-) - N(l^+))/(N(l^-) + N(l^+))$.

** Up to now there are no experiments with initially pure K^0 and $\bar{K}^0$ beams made. In known experiments [8] the K^0 part in initial beams is obviously dominated.

Assumptions (i), (ii) and (iv) are similar to those in the Nikolaev and Ryndin [3] model. Detailed description of the model, based on assumptions (i)—(vii), is presented elsewhere [4].

It turns out [4] that, in accordance with the experiments [5,6], the interference term in kaon two-pion decays behind the regenerator does not depend on the strangeness of the initial kaon beam, and there is no dependence of η_{+-} on the thickness of the regenerator.

The behaviour of the $\pi\pi$ decay distributions of the neutral kaons in an initially pure strangeness eigenstate as a function of time is given by [7]:

$$R(t) = R_0\left\{ e^{-\gamma_S t} + |\eta|^2 e^{-\gamma_L t} + 2a|\eta| \exp\left[-(\gamma_S+\gamma_L)\frac{t}{2}\right]\cos(\Delta m t - \Phi)\right\}. \quad (1)$$

The charge asymmetry in K_L semileptonic decays is defined as usual

$$\delta = \frac{N(l^+) - N(l^-)}{N(l^+) + N(l^-)}. \quad (2)$$

The coefficient a and sgn δ in dependence on the strangeness of the initial kaon beam and on the creation reaction of kaons according to theory of CP-violation and our model [4] compared with the available experimental data, are presented in the Table.

It is seen from the Table that the measurement of the coefficient a and sgn δ, according to the theory of CP-violation enables us to distinguish particles and antiparticles absolutely. In our model the absolute distinction between particles and antiparticles is impossible, as it must be if CP-invariance is valid.

Both alternatives — CP-violation and CP-conservation — are up to now in accordance with experimental data. The measurement of the charge asymmetry in K_L semileptonic decays using pure K^0 and $\bar{K}^0$ initial beams enables us ot take a choice between these alternatives and we believe that it is a necessary step in the experimental research of the CP-problem.

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П. КАРД

К ОБОСНОВАНИЮ СПЕЦИАЛЬНОЙ ТЕОРИИ ОТНОСИТЕЛЬНОСТИ

P. KARD. ERIRELATIIVSUSTEOORIA PÕHJENDAMISEST

P. KARD. ON THE FOUNDATION OF SPECIAL RELATIVITY THEORY

В предыдущем сообщении [1] был развит простой метод обоснования специальной теории относительности (включая релятивистскую динамику), в котором преобразования Лоренца не играют фундаментальной роли, но являются одним из частных результатов теории. За исходные положения в этом методе берутся, как обычно, оба традиционных постулата Эйнштейна — принцип относительности и принцип постоянства скорости света — и вдобавок еще законы сохранения массы и импульса. Как и в обычном методе, основанном на преобразованиях Лоренца, эти законы нужны для вывода зависимости массы от скорости.

С другой стороны, уже давно известно [2–5], что при выводе преобразований Лоренца второй постулат Эйнштейна может быть заменен требованием, чтобы преобразования Лоренца образовывали группу. Точнее, принцип относительности вместе с требованием групповости приводит к формулам преобразования координат и времени, содержащим неопределенную постоянную с размерностью скорости. Отождествляя эту постоянную со скоростью света, получаем преобразования Лоренца, а устремляя ее к бесконечности — преобразования Галилея.

Естественно возникает вопрос: возможно ли, приняв в основу принцип относительности вместе с требованием, чтобы преобразования из одной инерциальной системы в другую образовывали группу, построить специальную теорию относительности помимо преобразований Лоренца? Иначе говоря, возможно ли предложенный в [1] метод видоизменить так, чтобы место второго постулата Эйнштейна в нем занял принцип групповости преобразований?