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On a New Approach to Sterile Neutrino Searching

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Abstract: *The paper deals with a discussion of a new approach to sterile neutrino searching as well as the perspectives for searching of the reactor neutrino oscillations at short distances. To find out the phenomenon of existence of sterile neutrino an experimental laboratory with a 100 MW reactor SM-3 was founded. A neutrino detector can be located at short distances between six and eleven meters from the reactor core center. During performed experiments it was specified that the cosmic radiation background may course certain problems in measurements of the sterile neutrino searching. A number of tests have been performed to illustrate the correlation between the stream of the reactor antineutrino and the distance from a reactor core center. The outlooks of explorations of the reactor antineutrino oscillations at short distances were examined as well.*

Keywords: *Neutrino oscillation, Sterile neutrino searching.*

1. INTRODUCTION

It is assumed that the Universe possesses a non-zero special curvature. Most likely the Universe is infinite both in time and in space. Now we are interested in creation of a new neutrino laboratory to provide reactor neutrino oscillations experiments at a 100 MW reactor SM-3 [1]. Sterile neutrinos are currently being regarded as candidates for dark matter in the Universe. The effect of oscillation can be checked by a direct measurement of antineutrino spectrum at short distances from the reactor. In our previous work [2] it was discussed the necessity of a direct measurement of neutrino at short distances. The 100-MW reactor SM-3 was originally developed for realization of the beam and loop tests. It was created five particle-beam rooms partitioned off the concrete walls with a thickness of one meter. It has made a possibility to perform experiments on neutron beams without varying of background conditions at adjoining experimental rooms. During a couple of decades it was accumulated quite high fluence at the core tank materials which leads to necessity to replace it. Recently the renovation of the sliding valve of the former neutron beam has been performed with the aim to prepare the reactor SM-3 for searching the transitions of reactor antineutrino to a sterile state. As a result of such renovation it was observed the decreasing of the fast neuron up to the level of the neuron streams on the ground surface. Such conditions are preferable to realize a neutrino experiment.

2. MAIN RESULTS

There has been designed an experimental project Neutrino-4 for searching the reactor antineutrino transitions into a sterile state. The main problem of this experiment consists in a presence of a hum noise of space radiation. Some trial measurements have been performed to specify the dependency of reactor antineutrino stream on the distances from the reactor fissile region. The perspectives of study of the antineutrino reactor oscillation at short distances are now under discussion [2]. To prepare an experiment in framework of Neutrino-4 at the reactor SM-3, experimental investigations have been carried out by means of the reactor WWR-M. The main task of such tests was to record the background of cosmic rays on the Earth surface. This experiment had to show the possibility to perform an experiment at the reactor SM-3 using the comparison of the background conditions. The experiment has illustrated that the main experimental problem is connected with cosmic radiation background yielding the correlated events. These events are hardly distinguished from the events of the reactor antineutrino registration.

At present time the question about the possibility of existence of a sterile neutrino is under active discussion. Because of a transition of the reactor antineutrino to a sterile state it is assumed that the oscillation effect at short distances from the reactor can be observed as well as the deficit of the antineutrino stream at long distances. The position sensitive detector records a positron whose energy is defined through the energy of an antineutrino. The detector of reactor antineutrino is based on using the reaction

$$\bar{\nu}_e + p \rightarrow e^- + n. \quad (1)$$

The detector registers two subsequent signals from positron and neutron. The detector holds records of two subsequent signals from positron a neutron which are referred to as correlated events.

Thus, as a result of our experiments the following conclusions were made.

Firstly, an attempt has been performed to measure the stream of the reactor antineutrino at short distances varying between six and eleven meters from the reactor core center. Note that the obtained accuracy is not enough to make some definitive conclusions about the statement of the problem for the sterile neutrino searching. The problem had only the aim of possibility to carry out such experiment under the background conditions on the surface of the Earth and the exploitation background of the reactor. A small volume detector has been implemented at this experiment.

Secondly, the cosmic radiation has made a sufficient impact to the experimental problems of the performed tests. The cosmic background depends on the distance from the active reactor core due to the distribution of the concrete frames of the building where experiments have to be realized. Besides, the cosmic background changes over time due to the variation of the atmospheric pressure and the temperature at the lower atmosphere. But to fight against those problems the following methods can be proposed. From one side the monitoring of the cosmic rays intensity can be performed regarding the high energy part of the spectrum of detector starting with 10 MeV. From the other side, the distance measurements should be performed by the method of distance scanning.

Thirdly, the usage of the active protective covering gives the possibility to reduce correlated background of cosmic radiation only by 66%. That seemed to suggest that it is a part of background associated with muons. It can be controlled by an active shielding. Neutron component cannot be entirely controlled by an active shielding therefore it is required the implementation of the method of signal separation from protons and positrons with respect to the impulse shape.

The proposed results enhance the information needed to develop a full-scale detector. At the present time a new project of a full-scale detector has been developed. We expect that the realization of the project and the method of the signal separation bring the relation effect-background closer to 1 and sufficiently improve the statistical accuracy of the experiment. It allows proceeding to the next step of research associated with a searching of oscillations at short distances.

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Dr. Vladimir Efrosinin, since 1972 a Senior Scientist at the Institute for Nuclear Research Russian Academy of Sciences, priority scientific interest is the Elementary-Particle Physics. At the present time he deals with a problem of neutrino including evaluation of the role of neutrinos in the modern Universe.