EXPERIMENT ON ANTINEUTRINO SCATTERING BY ELECTRONS AT A REACTOR OF ROVNO NUCLEAR POWER PLANT

**A. V. Derbin, A. V. Cherny, L. A. Popeko,
V. N. Muratova, G. A. Shishkina, S. V. Bakhlanov**

Work continues at the Rovno nuclear power plant to measure the cross section for neutrino scattering by electrons [1]. The neutrino detector is a silicon multidetector, with mass 75 kg, consisting of 600 $Si(Li)$ detectors. The parameters of these detectors and experimental apparatus (neutrino laboratory at the reactor, vacuum chamber, passive and active shielding, electronics and storage of data) are described in detail in [1, 2].

Measurements were made during 16.7 days with the reactor shut down and during 29.6 days with it operating. The spectra of electrons were measured in the region 0.2–2.0 MeV.

To obtain a final result we selected detectors from inner layers (an external layer was used as a supplementary active shielding) reducing the detector mass by a factor nearly 2. For 37.5 kg detector the average counting rate in the interval 0.6–2.0 MeV was 4921 ± 16 day^{-1} with reactor shut down and 4963 ± 12 day^{-1} with the reactor in operation. The final result for the cross section in the interval 0.2–2.0 MeV is $\sigma = (1.26 \pm 0.62) \cdot 10^{-44}$ cm^2/fission.

The result obtained corresponds to $\sigma = (1.28 \pm 0.63)\sigma_{w-s}$, where σ_{w-s} is the cross section expected in the standard theory on the basis of calculations with the well known reactor-neutrino spectrum and $\sin^2 \Theta = 0.22$.

In connection with a possible explanation of the deficiency of solar neutrinos by anomalously large $(10^{-11} - 10^{-10}\mu_B)$ netrino magnetic moment, a limitation on a possible magnetic moment of a neutrino is of interest. Since the weak and magnetic scattering processes do not interfere, we can take the sum of the error and the deviation from the expected value for cross section as a limitation on this magnetic moment. In this case using the above cited result for the cross section in the interval 0.6–2.0 MeV we find $\mu \leq 1.5 \cdot 10^{-10}\mu_B$ (68% c.l.) or $\mu \leq 1.9 \cdot 10^{-10}\mu_B$ (95% c.l.). The limit $\mu \leq 2.4 \cdot 10^{-10}\mu_B$ was recently found from measurements of the cross section for $(\overline{\nu}, e)$ scattering [3].

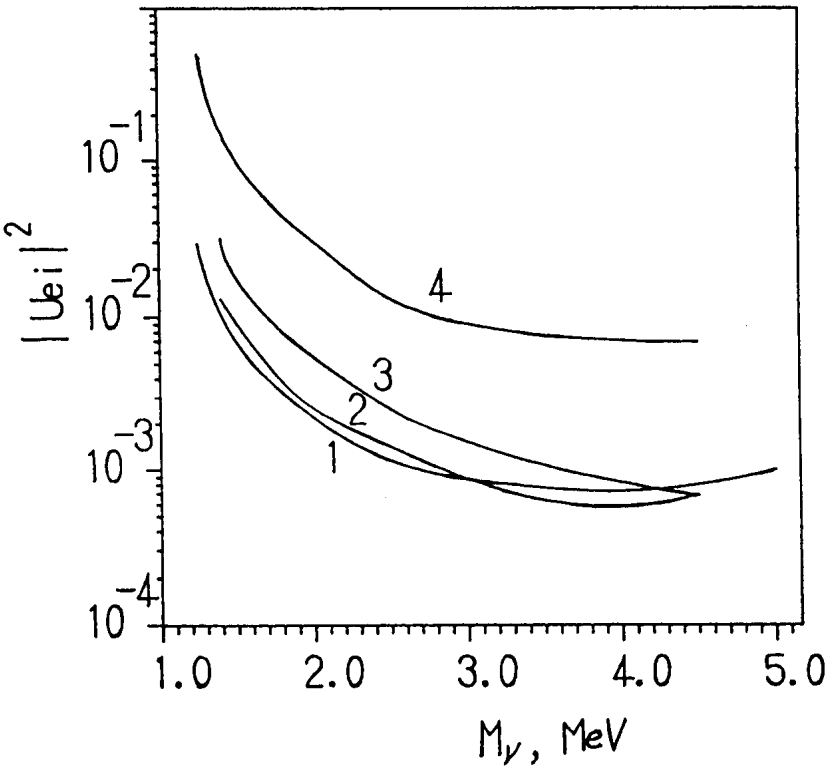

Fig. Curve 1 — limitation on possible admixture of a massive neutrino in the beta decay of fission fragments of the nuclear fuel.
(Curves 2,3,4 — from [5, 4, 6], respectively)

If neutrinos have masses and are mixed, it might be possible to observe decays of more massive neutrino. We consider the radiative decay $(\nu \to \nu + \gamma)$ and the decay $\nu \to \nu + e^+ + e^-$ [4] as the most likely detectable decay modes. In the former case, using assumption that a Dirac neutrino is strongly bound with the electron decays $(U_{ei} \cong 1)$, we find a limitation on the lifetime: $\tau_{c.m.}/m_\nu \geq 200$ s/eV. This is nine times as large as the limitation found in the experiments [5]. A decay into an e^+e^- pair requires neutrino mass greater than $2m_e$, and the decay probability would depend on both the neutrino mass and the mixing angle

($U_{ei} \ll 1$). Accordingly, the limitation on the probability for such a decay, plotted as U_{ei} vs m_ν, would look like the curve in Fig. The curves from the other experiments are shown for comparison.

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