Origin of the Excess and No Excess of Electron-Neutrinos in MiniBooNE and MicroBooNE, Respectively

Sylwester Kornowski

Abstract: The atom-like structure of baryons, creation of virtual pairs, and different target-detector distances explain why, unlike the MiniBooNE data, the MicroBooNE results show no excess of electron-neutrinos and electron-antineutrinos. Our result, i.e. excess = 414.4 ± 59.0, is consistent with the MiniBooNE data.

1. Introduction

In the MiniBooNE, the muon-neutrinos, ν_μ, muon-antineutrinos, $\nu_{\mu,anti}$, electron-neutrinos, ν_e, and electron-antineutrinos, $\nu_{e,anti}$, are produced by colliding protons to a beryllium target. A neutrino detector (it is a spherical tank filled with mineral oil and its diameter is 12.2 **m**) is placed at distance $L_{Mini} \approx 541 \pm 6.1$ **m** from the target (50 m air, 4 m steel and 487 m earth) [1].

MiniBooNE experiment was designed and built to search for neutrino oscillations ($\nu_\mu \rightarrow \nu_e$ and $\nu_{\mu,anti} \rightarrow \nu_{e,anti}$) and to study interactions of neutrinos [1].

MiniBooNE results showed no evidence for muon-neutrino to electron-neutrino oscillations at low energy so a 2-neutrino oscillation interpretation is incorrect.

In MiniBooNE, a total ν_e plus $\nu_{e,anti}$ event excess of $N_{Excess,Mini} = 460.5 \pm 99.0$ **events** (4.7 σ) is observed, while the total number of events is 2437 [2].

On the other hand, in the MicroBooNE experiment, a neutrino detector (it is the 12.2-m long detector filled with liquid argon) is placed at distance $L_{Micro} \approx 470 \pm 6.1$ **m** from a beryllium target. The MicroBooNE data show no excess of electron-neutrinos and electron-antineutrinos [3]. Unlike the MiniBooNE, the MicroBooNE distinguishes electrons from photons.

A sterile neutrino could explain the MiniBooNE excess but the MicroBooNE experiment shows no hint of sterile neutrino. Notice that the Scale-Symmetric Theory (SST) [4] shows that sterile neutrinos do not exist.

We still need to explain the MiniBooNE excess.

Here we show that the atom-like structure of baryons, creation of virtual pairs, and different target-detector distances explain both the MiniBooNE excess and lack of such an excess in the MicroBooNE data.

We show that the neutrino-baryon interactions are crucial. We incorrectly interpret the single photon events from neutral current (NC) [5]

$$\nu\ (\nu_{anti}) + N \rightarrow \nu\ (\nu_{anti}) + N + \gamma\ , \qquad (1)$$

where N denotes a baryon.

In [5], authors conclude that photon emission processes from single-nucleon currents cannot explain the excess of the signal-like events observed at MiniBooNE. In the MiniBooNE experiment we observe following number of the NC events, N_{NC}, [2]

$$N_{NC}\,[\Delta(1232) \rightarrow N\gamma \text{ radiative decay}] = 172.5 \pm 24.1 + 34.7 \pm 5.4 =$$

$$= 207.2 \pm 29.5\,. \qquad (2)$$

According to SST, the $\Delta(1232)$ resonance consists of nucleon and a charged vector boson $S_{(+-),d=2} \approx 298$ **MeV** or neutral boson $S_{(o),d=2} \approx 297$ **MeV** in the $d = 2$ state (see Section **2.22** and Table 1 in [4]). When the d = 2 boson is charged then it can create on the d = 2 orbit a virtual muon-antimuon $(\mu^+\mu^-)_{virtual,d=2}$ pair. When such a virtual pair interacts with a muon-neutrino then there is created a pion-muon $\pi^+\mu^-$ pair.

Moreover, SST shows that due to the tremendous non-gravitating energy frozen in each neutrino, neutrinos cannot oscillate – neutrinos in interactions with matter, carriers of energy, and the SST absolute spacetime can be exchanged for other neutrinos or they can force appearance of additional neutrinos [4] as it is showed, for example, in Section **2**. Such phenomena lead to an illusion that neutrinos oscillate.

We must add also that the neutrino-antineutrino pairs with opposite weak charges of the components are the virtual photons or they carry energy of real photons [4]. In the composite photons, the neutrino-antineutrino pairs are entangled and each pair can be in different energetic states – it is a quantum/classical superposition but notice that it is not the orthodox quantum superposition which according to SST does not exist [4]. Emphasize also that the entangled neutrino-antineutrino pairs in a photon, due to the SST quantum/classical superluminal entanglement, can exchange their rotational energies so there can be a collapse of wavefunction of composite photon.

2. The neutral-current $\Delta(1232) \rightarrow N\gamma$ radiative decay

In the orthodox physics, the single photon events from neutral current (NC) are defined by expression (1). In SST, we can modify such an event

$$\nu_\mu + \Delta(1232) \rightarrow [(\mu^+\mu^-)_{virtual,d=2} + \nu_\mu] + \Delta(1232) \rightarrow$$

$$\rightarrow \pi^+\mu^- + N + \gamma \rightarrow$$

$$\rightarrow [\nu_e + \nu_{e,anti} + \nu_\mu + \text{virtual photons}] + N + \gamma\,, \qquad (3)$$

where $\pi^+ \rightarrow e^+\,\nu_e\,\nu_{\mu,anti}\,\nu_\mu$ and $\mu^- \rightarrow e^-\,\nu_{e,anti}\,\nu_\mu$.

In the $\pi^+\mu^-$ pair cannot be two or more the same neutrinos (there are two ν_μ) so there is created a virtual photon

$$\gamma_{virtual} \equiv \nu_{\mu,anti}\,\nu_\mu\,. \qquad (4)$$

Also the virtual e^+e^- pair decays into virtual photons.

We do not detect the virtual photons.

Similar considerations are for the muon-antineutrino

$$\nu_{\mu,anti} + \Delta(1232) \rightarrow [(\mu^+\mu^-)_{virtual,d=2} + \nu_{\mu,anti}] + \Delta(1232) \rightarrow$$

$$\rightarrow \mu^+\pi^- + N + \gamma \rightarrow$$

$$\rightarrow [\nu_e + \nu_{e,anti} + \nu_{\mu,anti} + \text{virtual photons}] + N + \gamma\ , \tag{5}$$

where $\mu^+ \rightarrow e^+ \nu_e \nu_{\mu,anti}$ and $\pi^- \rightarrow e^- \nu_{e,anti} \nu_\mu \nu_{\mu,anti}$.

In the $\mu^+\pi^-$ pair cannot be two or more the same neutrinos (there are two $\nu_{\mu,anti}$) so there is created a virtual photon

$$\gamma_{virtual} \equiv \nu_\mu \nu_{\mu,anti}\ . \tag{6}$$

3. The SST ν_e plus $\nu_{e,anti}$ excess

The difference between expression (1) and (3) or (5) which can be observed in a detector is

$$\text{Difference} \equiv \nu_e + \nu_{e,anti} \tag{7}$$

so from formula (2) we obtain

$$\text{Excess} = 2\ N_{NC} = 414.4 \pm 59.0\ . \tag{8}$$

This SST value is consistent with the MiniBooNE data.

4. Effective range, R_{eff}, for the decay of the virtual muon-antimuon pair, $(\mu^+\mu^-)_{virtual}$, produced in the d = 2 state

Effective range for the decay of the virtual muon-antimuon pair produced in the d = 2 state is defined as follows

$$R_{eff} = v_{d=2}\ \tau_{muon}\ , \tag{9}$$

where $v_{d=2} = 0.6403c$ (c is the speed of light in "vacuum") is the relativistic speed of the π^+ in the $\pi^+\mu^-$ pair in the d = 2 state (see formula (2.5.3) in [4]), and τ_{muon} is the relativistic lifetime of the μ^- in the $\pi^+\mu^-$ pair.

According to SST, the d = 2 state is the ground state above the Schwarzschild surface for the strong interactions of pions with the core of baryons [4].

The lifetime of the charged pion in the rest, $\tau_{o,pion}{}^{\pm} = 2.6033(5)\cdot 10^{-8}$ **s** is much shorter than the lifetime of the muon in the rest, $\tau_{o,muon} = 2.1969811(22)\cdot 10^{-6}$ **s**, [6], so we assume that the $\pi^+\mu^-$ pair decays into the $\mu^+\mu^-$ pair already in the d = 2 state. We assume also that the linear speed of the $(\mu^+\mu^-)_{virtual}$ pair is equal to $v_{d=2}$.

The relativistic lifetime of a particle, τ, is defined as follows

$$\tau = \tau_o\ [1 - (v / c)^2]^{-1/2}\ , \tag{10}$$

where τ_o is the lifetime in the rest. From (9) and (10) we obtain

$$R_{eff} = v_{d=2}\ \tau_{o,muon}\ [1 - (v_{d=2} / c)^2]^{-1/2} = 549.0\ \mathbf{m}\ . \tag{11}$$

5. Why the excess was not observed in MicroBooNE?

The effective range for the decay of the virtual muon-antimuon pair produced in the d = 2 state (549 m) is very close to the target-detector distance in MiniBooNE (~541 ± 6 m) so we observe the excess. But such effective range is about 80 m longer than the target-detector distance in MicroBooNE (~470 ± 6 m) so we do not observe the excess.

6. Summary

According to SST, sterile neutrinos do not exist. Within SST we showed also that the neutrino oscillations are an illusion. It leads to a conclusion that the observed excess of electron neutrinos in MiniBooNE cannot be explained via a sterile neutrino or neutrino oscillations. Here we showed that the excess is a result of incorrectly understood the neutral-current neutrino-baryon interactions – the internal structure of baryons and their dynamics are crucial to understand the excess.

We do not observe the excess in MicroBooNE because the target-detector distance is about 80 meters shorter than the effective range for decays of the virtual muon-antimuon pairs produced in the target.

We can verify our model in collisions of the muon-neutrinos with atomic nuclei for different target-detector distances. A positive result could validate the atom-like structure of baryons described in SST.

References

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Prog. Theor. Exp. Phys. **2020**, 083C01 (2020) and 2021 update