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Kh.M.Beshtoev

# A MODEL-INDEPENDENT APPROACH TO THE SEARCH FOR THE SUN NEUTRINO OSCILLATIONS FROM SNO DATA

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# 1 Introduction

Model-independent approach to analyse the existence of the Sun neutrino oscillations from SNO data is proposed. The used approximations [1] for the calculations are offered as will as a scheme to determine the existence of the neutrino oscillations.

# 2 Reactions and Approximations

The following reactions [1] are used:

$$1)\nu_e + d \longrightarrow p + p + e^-, E_{thre} = 1.45 Mev,$$

$$2)\nu_x + d \longrightarrow p + n + \nu_x, E_{thre} = 2.23 Mev,$$

where $x = e, \mu, \tau$.

Then the probability of reactions 1) ($W_1$), 2)($W_2$) is computed. For this purpose the following approximations have been taken:
1. Reactions 1), 2) have high threshold and therefore in this case only neutrinos of $B^8$ are mainly accessible.
2. The temperature in the Sun is about 1 keV, therefore the Sun neutrino spectrum is not distorted in the energy region of reactions 1), 2). Therefore for our purpose it is important to know a relative flow of the Sun neutrinos. The temperature in the Sun must not influence our results.
3. The calculations have shown that the deposit of reaction 1) in the probability of the energy regions $1.45 \leq E_\nu \leq 2.23 MeV$ is $\simeq 1\%$ since its cross sections very small.

The details of the calculations are: a) The used spectrum of the Sun neutrinos in work [2] has a good accuracy.

b) The cross sections of reactions 1), 2) have been taken from work [3] (precision is 5%).

The calculated values of probabilities to register reactions 1), 2) are defined from the product of the neutrino flow of [2], normalized to the unit and the cross sections of the reactions 1) and 2) ($E_\nu \leq 15 MeV$). Then the following values are obtained:
for reaction 1) $W_1 = 1.2610^{-42}$,
for reaction 2) $W_2 = 0.4910^{-42}$.

To use these values for the SNO data analysis, it is necessary to recalculate these values (or SNO data) taking into account the characteristics of the SNO detector.

## 3 The scheme to search for neutrino oscillations

The scheme to search for neutrino oscillations from the SNO data is the following:
From reaction 1) it is determined the probability of the electron neutrino flow- $P_{\nu_e}$ ( $E_{thre}$ = 1.45 MeV) and then this flow is recalculated for threshold $E_{thre}$ = 2.23 MeV and then $P_{\nu_e}$ ($E_{thre}$ = 2.23 MeV) is obtained. If neutrino oscillations take place, then the flow $P_{\nu_e}$ (E= 2.23 MeV) will decrease on the value characterizing the neutrino oscillations:

$$P_{\nu_e}(E_\nu \geq 2.23) = P^{pr}_{\nu_e}(E_\nu \geq 2.23)(1 - \sum_i^{\mu,\tau} \sin^2 2\theta_i), \qquad (1)$$

where $P^{pr}_{\nu_e}(E_{\nu_e} \geq 2.23)$ is a primary probability of the Sun neutrino flow -$\nu_e$.
From reaction 2) it is determined the full flow of the Sun neutrinos- $P^{pr}_{\nu_e}(E \geq 2.23)$.

The calculated relative value of the neutrino flow probability is:

$$W = \frac{P_{\nu_e}(E_\nu \geq 2.23)}{P^{pr}_{\nu_e}(E_\nu \geq 2.23)} = 1 - \sum_i^{\nu,\tau} \sin^2 2\theta_i. \qquad (2)$$



If neutrino oscillations do not take place, then

$$W = 1.$$

If you take the calculated values $W_1$ and $W_2$, then

$$\omega_{theor} = \frac{W_1}{W_2}. \qquad (3)$$

If the neutrino oscillations are absent, then

$$\omega_{theor} = \frac{W_1}{W_2} = 2.59. \qquad (4)$$

Value (3) is the same value to be compared with the SNO data - $\omega_{exp}$

$$\omega_{exp} = \frac{W(1))}{W(2))}.(1 - \sum_i^{\mu,\tau} \sin^2 2\theta_i). \qquad (5)$$

When the equation (5) is obtained, it is supposed that neutrino ocsillations take place.
From (3) and (5) obtain

$$\frac{\omega_{exp}}{\omega_{theor}} = [\left(\frac{W_2}{W_1}\right)\left(\frac{W(1)}{W(2)}\right)](1 - \sum_i^{\mu,\tau} \sin^2 2\theta_i). \qquad (6)$$

The term in square brackets in equation (6) is equal to one by determination and then

$$\frac{\omega_{exp}}{\omega theor} = (1 - \sum_i^{\mu,\tau} \sin^2 2\theta_i). \qquad (7)$$

is obtained.

This equation can be rewriten in the form:

$$\sum_i^{\mu,\tau} \sin^2 2\theta_i = 1 - \frac{\omega_{exp}}{\omega_{theor}}. \qquad (8)$$

If $\frac{\omega exp}{\omega theor} = 1$, then the Sun neutrinos oscillations do not take place.

## 4 Conclusion

A model-independent approach to analyse the existence of the Sun neutrino oscillations from SNO data is proposed. The used approximations are offered for the calculations as well as the scheme to determine the existence of the neutrino oscillation. Value 1- $\frac{\omega_{exp}}{\omega_{theor}}$ will characterize oscillations of the Sun neutrinos.

## References


[1] Aardsma G. et al., Phys. Lett.B, 1977, v.194, p.321.

[2] Bahcall J.N., 1989, Neutrino Astrophysics (Cambridge, Cambridge Univ. Press.)

[3] Nozawa s. et al., J. Phys. Soc. Japan, 1986, v.55, p.2636.
Kohyama Y., Kubodera K., USC(NT)Report-92-11, 1992.
Kubodera K., Nozawa S., Journ. of Modern Phys.E, 1994, v.3, p.101.



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Безмодельный подход к поиску осцилляций солнечных нейтрино из SNO-данных


Предлагается безмодельный подход для анализа существования осцилляций солнечных нейтрино. Даются используемые при вычислении приближения и схемы для определения наличия осцилляций нейтрино.



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A Model-Independent Approach to the Search for the Sun Neutrino Oscillations from SNO Data


A model-independent approach to analyse the existence of the Sun neutrino oscillations from SNO data is proposed. The used approximations for the calculations are offered as well as a scheme to determine the existence of the neutrino oscillations.



The investigation has been performed at the Laboratory of Particle Physics, JINR.

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