Neutrino Oscillations Hint at a New Fundamental Interaction

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Abstract

It is suggested that neutrino oscillations do not exist and, in the light of the latest results of July 2016 of the Daya Bay Collaboration and the recent discovery of a new fundamental interaction, it is proposed that the neutrino production at the Sun's core in the pp and CNO cycles are much larger than what is predicted by the Standard Solar Model, exactly because of this new interaction. Therefore, the claimed neutrino deficits on Earth are completely misleading.

1. Introduction

Electron neutrinos are copiously produced in the interiors of stars. In stars like the sun they are mainly produced in the pp cycle which dominates the fusion process in cool stars

$$\begin{bmatrix} pp \to de^{+}\nu_e \\ ppe^{-} \to d\nu_e \\ {}^{7}Bee^{-} \to {}^{7}Li\nu_e \\ {}^{8}B \to {}^{7}Be^{*}e^{+}\nu_e \end{bmatrix}$$

This process generates a certain electron neutrino flux Φ_E which would be expected to be detected at the Earth. The Super-Kamiokande data [1,2] show that only about 45% of the predicted flux for ^{8}B electron neutrinos is actually detected. Other experiments with atmospheric electron neutrinos have also reported electron neutrino fluxes with deficits compared to the predicted fluxes by the standard solar model [3-8]. There are also reports of electron neutrino deficits from reactors [9,10]. The neutrino oscillation proposal explains the above problem by supposing that the electron neutrinos are changed into the other neutrino flavors, muon and tau neutrinos, especially to tau neutrinos, through the **Mikheyev–Smirnov–Wolfenstein** mechanism [11-13].

2. A General Critique for the neutrino Oscillation Proposal

The neutrino oscillation proposal has many flaws. I present below only 3 very relevant ones.

2.1 Lack of detection of tau neutrino fluxes

The enhancement in tau neutrino fluxes due to neutrino oscillations has not been measured. Actually only the DONUT collaboration [14,15] from Fermilab detected tau neutrinos from the annihilation of $e^- e^+$ pairs and the OPERA collaboration [16] found one tau neutrino in its quest for neutrino oscillations. **The lack of ν_τ fluxes invalidates the claim for the neutrino oscillations $\nu_e \to \nu_\tau$ and $\nu_\mu \to \nu_\tau$.**

2.2 Lepton Number Violation Decays

According to the neutrino oscillation proposal the three neutrino flavors would be resonant states of the same particle. If this were true we would observe, for example, the weak decays

$$n \to p + e^- + \bar{\nu}_\tau$$

$$n \to p + e^- + \nu_\mu$$

$$\mu^- \to e^- + \bar{\nu}_\tau + \nu_\tau$$

$$\mu^- \to e^- + \bar{\nu}_\mu + \nu_\tau$$

but these decays have not been observed at all.

2.3 Why the strange preference for the tau neutrino?

If the disappearance of electron solar neutrinos were caused by oscillations we would detect a very high flux of muon neutrinos, but what has been reported is exactly the opposite, that is, there is also a muon neutrino deficit [17]. Why would both neutrinos ν_e and ν_μ prefer to change to ν_τ which, according to the neutrino oscillation proposal, would be the most massive neutrino? Why not the opposite, that is, the oscillation of ν_μ and ν_τ to ν_e? In such a case we observe higher fluxes of ν_e.

3. Report of a New fundamental Interaction

On the other hand there have been theoretical proposals for a fifth force of nature [18] and a recent report on the observation of a new fundamental interaction of matter [19,20] mediated by a light boson. The data of reference 19 was carefully analyzed in detail by Feng *et al.* [20]. They reinforce the idea of a new fundamental force of nature mediated by means of a light vector boson X with a mass of about 17 MeV which, although produced through hadronic couplings, only decays to e^-e^+, $\nu\bar{\nu}$ and $\gamma\gamma$. Therefore, it is expected that neutrinos should interact with matter by means of this interaction. It is also expected that there should be an interplay between this new interaction and the weak interaction because both interactions involve leptons. It is important at this point to comment on the Daya Bay results. This collaboration had reported in 2012 [10] a disappearance of about 6% in the electron antineutrino flux along a distance of 1648 m with respect to the produced flux according to the current models of nuclear theory, but in a paper that has just been published [21] the collaboration corrects the previous results because they have now found that the actual production is 6% larger than that one expected from the theoretical nuclear models, and thus, this invalidates their previous disappearance claims.

4. Tentative Solution to the Solar Neutrino Puzzle

Although we do not know much yet on this new interaction above discussed, which will be the subject of many experiments throughout the world in the near future, we can propose that the electron neutrinos interact with matter in the Sun's core and that this is the reason for the disappearance of part of their flux produced in the pp and CNO cycles, and their disappearance in experiments with neutrino fluxes on Earth. Because of the interplay above mentioned between the new interaction and the weak interaction, we should also expect disappearance of a certain neutrino flavor due to the interactions in the medium and appearance of another flavor due to interaction in the same medium, as has been observed by T2K [22] and OPERA collaborations [16]. It is important to emphasize this important conclusion by OPERA: ***"We therefore claim the observation of a first candidate ν_τ CC interaction. Its significance, based on our best conservative knowledge of the background, exceeds two σ. This does not allow yet claiming the observation of $\nu_\mu \to \nu_\tau$ oscillation. Given its sensitivity, the OPERA experiment will require the detection of a few more candidate events in order to firmly establish neutrino oscillations in direct appearance mode through the identification of the final charged lepton."***

We make use below of the concept of particle transparency in a medium and use it for the electron neutrinos in the Sun's core. Extending the concept of transparency developed by Shapiro and Teukolsky [23] in their analysis of neutrino transparency in stars with core temperatures smaller than $10^9 K$, we can say that the effective mean free path of a neutrino in the Sun's core is given by

$$\lambda_{eff} \sim \left(\lambda_n \lambda_e \lambda_X\right)^{1/3}$$

in which λ_n and λ_e are the neutrino mean free paths due to elastic scattering off neutrons and the $\nu_e - e^-$ weak inelastic scattering, respectively, and λ_X is the neutrino mean free path due to the new interaction.

Let us try to find an estimate for the new interaction cross section by making the following considerations. In order to diminish the electron neutrino flux to half in the Sun's core we should have $\lambda_{eff} \sim R_c / -\ln 0.45 \approx 0.25 R_\odot / -\ln 0.45 \approx 2.13 \times 10^8 m$ where R_c is the core radius of the Sun and $R_\odot$ is the Sun's radius, assuming that the neutrino flux diminishes exponentially along the travelled distance. The product $\lambda_e \lambda_n$ is given by the following relation [23]

$$\left(\lambda_e \lambda_n\right)^{1/2} = 2 \times 10^5 km \left(\frac{\rho_{nucl}}{\rho}\right)^{7/6} \left(\frac{10^5}{E_\nu}\right)^{5/2}$$

where E_ν is the neutrino energy in electron-volt, $\rho_{nucl} = 2.8\times10^{14}$ g/cm^3 is the nuclear density and $\rho \approx 100\, g/cm^3$ is the Sun's core density. For ^{8}B neutrinos the energy spectrum [24] goes from zero up to 14 MeV, and the neutrino flux peaks around 7 MeV [25]. Thus, making $E_\upsilon \approx 7$ MeV we obtain $\lambda_e\lambda_n \approx 2.6\times10^{36}\, m^2$, and from the relation $\lambda_{eff} \sim (\lambda_n\lambda_e\lambda_X)^{1/3} = 2.13\times10^8\, m$ we have then $\lambda_X \approx 2.6\times10^{-12}$ m. The mean free path λ_X is related to the inelastic cross section σ_X due to the new interaction by the equation

$$\lambda_X = \frac{1}{\sigma_X n_N}$$

where n_N is the number of nucleons per unit volume. For the Sun's core the density of 100 *g/cm^3* means 6×10^{25} *nucleons/cm^3* and, hence, we obtain $\sigma_X \approx 6.4\times10^{-19}$ *cm^2*.

As $\lambda_e = 1/(\sigma_e n_e)$ and $\lambda_n = 1/(\sigma_n n_n)$ depend on the electron and neutron densities, we should take the above calculation with caution because the electron and neutron densities depend strongly on the distance from the core center [26], and thus, λ_X is an average number. A very important fact raised by Lopes and Turck-Chièze [26] is that different electron neutrinos are generated in different shells in the Sun's core, and thus, we cannot compare the different values for λ_X and σ_X from the neutrino data of different collaborations when they refer to different neutrinos, but because of the conclusion below we do not need to make such comparisons.

The problem with the above calculation is that $\sigma_X \approx 6.4\times10^{-19}$ cm^2 is too large to be true. And as we saw above, although the new interaction is produced through hadronic couplings, its boson only decays to e^-e^+, $\nu\bar{\nu}$ and $\gamma\gamma$. This means that not only the neutrino, but also the electron would interact strongly by means of this new interaction, but this has not been seen for the electron. All this means that σ_X has to be much smaller than the above number. Reinforcing this reasoning it is worth recalling that the strong interaction between two protons has a cross section of about 40 mbarn, and thus, σ_X would be about 10000 times larger than the strong interaction cross section. Therefore, the solar neutrino problem may have only the other solution presented below.

4. A Possible Line of Solution to the Solar Neutrino Puzzle

In the light of the recent results of the Daya Bay Collaboration (21) and of the discovery of the new interaction above mentioned, we can propose that the actual production of electron neutrinos in the Sun's core is much larger than what has been predicted by the Standard Solar Model, exactly because of this new interaction. For example, if the production of ^{8}B electron neutrinos in the pp cycle were 55% larger than what is predicted by the Standard Solar Model, the solar neutrino puzzle would be solved. Therefore, it is urgent to investigate further this new interaction and find out the order of magnitude of its cross section for the different leptons. And this new interaction may also have an important role in the beginning of the Universe.

5. Conclusion

Taking into account the discovery of a new fundamental interaction of matter which involves neutrinos and the latest results of the Daya Bay Collaboration [21], I propose a completely different solution to the solar neutrino deficits which is more logical than the neutrino oscillation solution. My proposal is that more neutrinos are generated in the pp and CNO cycles in the Sun's core in such proportions that there are cancellations with the claimed neutrino deficits. We should investigate further the existence of this new fundamental interaction and the role that it plays in the pp and CNO cycles in the Sun's core for modifying the Solar Model accordingly. The above simple calculations provide a rationale for the definitive solution to the solar neutrino puzzle.

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