Stochastic Neutrino Mixing Mechanism

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Reactor Antineutrino Anomaly

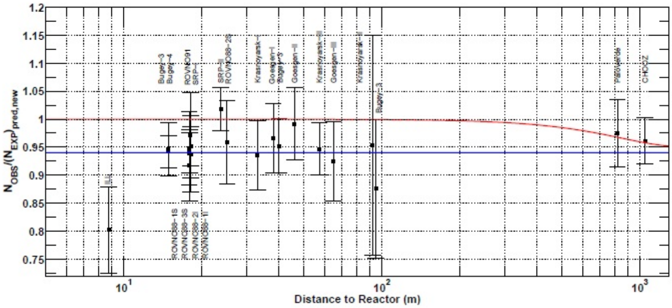


Figure : Reanalysis made by [Mention et al., 2011]

Gallium Anomaly

1. GALLEX e SAGE
2. Sources of ^{51}Cr e ^{37}Ar

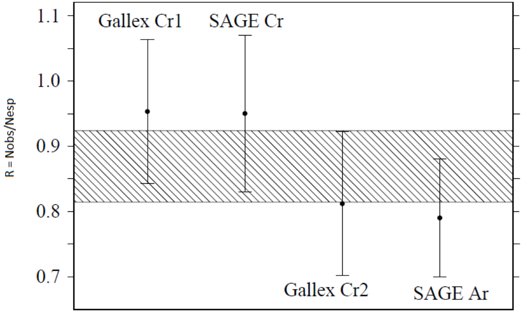


Figure : Extracted from [KUFLIK, 2012]

Pontecorvo Hypothesis

$$i\frac{d}{dt}|\nu_{1,2}\rangle = H_m|\nu_{1,2}\rangle \qquad (1)$$

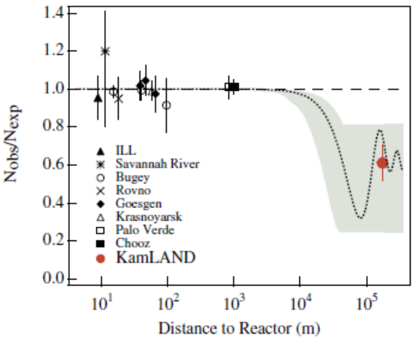
$$H_m = \begin{pmatrix} E_1 & 0 \\ 0 & E_2 \end{pmatrix} \qquad (2)$$

$$|\nu_e\rangle = \cos\theta|\nu_1\rangle + \sin\theta|\nu_2\rangle \qquad (3)$$

$$|\nu_\mu\rangle = -\sin\theta|\nu_1\rangle + \cos\theta|\nu_2\rangle \qquad (4)$$

$$|\nu_{e,\mu}\rangle = U|\nu_{1,2}\rangle \qquad (5)$$

$$|\langle\nu_e|\nu_e(t)\rangle|^2 = 1 - \sin^2 2\theta \sin^2\left(\frac{\Delta m^2 L}{4E}\right) \qquad (6)$$



Stochastic Neutrino Mixing Mechanism

$$|\nu_e^c\rangle = \cos\theta_c|\nu_1\rangle + \sin\theta_c|\nu_2\rangle \tag{7}$$

$$|\nu_e^d\rangle = \cos\theta_d|\nu_1\rangle + \sin\theta_d|\nu_2\rangle \tag{8}$$

$$\left|\langle\nu_e^d|\nu_e^c(t)\rangle\right|^2 = \cos^2(\theta_c - \theta_d) - \sin 2\theta_c \sin 2\theta_d \sin^2\left(\frac{\Delta m^2 L}{4E}\right) \tag{9}$$

Stochastic Neutrino Mixing Mechanism

$$f(\theta_c, \theta_d) = f(\theta_c)f(\theta_d) \tag{10}$$

$$f(\theta_{c,d}) = \exp\left(-\frac{1}{2}\left(\frac{(\theta_{c,d} - \theta_{12})}{\alpha}\right)^2\right) \tag{11}$$

$$P^{real}_{\nu_e \to \nu_e} = \frac{1}{N}\int_0^{\frac{\pi}{2}} \left|\langle \nu_e^d | \nu_e^c(t)\rangle\right|^2 f(\theta_c, \theta_d) d\theta_c d\theta_d \tag{12}$$

$$\int_0^{\frac{\pi}{2}} (P_{\nu_e \to \nu_e} + P_{\nu_e \to \nu_\mu}) \frac{f(\theta_i, \theta_d)}{N} d\theta_c d\theta_d = 1 \tag{13}$$

$$N = \int_0^{\frac{\pi}{2}} f(\theta_c, \theta_d) d\theta_c d\theta_d \tag{14}$$

Three families case

$$U^c = \begin{pmatrix} \cos x_1 \cos x_2 & -\sin x_1 \cos x_2 & \sin x_2 \\ \sin x_1 \cos x_3 + \cos x_1 \sin x_3 \sin x_2 & \cos x_1 \cos x_3 - \sin x_1 \sin x_3 \sin x_2 & -\sin x_3 \cos x_2 \\ \sin x_1 \sin x_3 - \cos x_1 \cos x_3 \sin x_2 & \cos x_1 \sin x_3 + \sin x_1 \cos x_3 \sin x_2 & \cos x_3 \cos x_2 \end{pmatrix} \quad (15)$$

$$U^d = \begin{pmatrix} \cos y_1 \cos y_2 & -\sin y_1 \cos y_2 & \sin y_2 \\ \sin y_1 \cos y_3 + \cos y_1 \sin y_3 \sin y_2 & \cos y_1 \cos y_3 - \sin y_1 \sin y_3 \sin y_2 & -\sin y_3 \cos y_2 \\ \sin y_1 \sin y_3 - \cos y_1 \cos y_3 \sin y_2 & \cos y_1 \sin y_3 + \sin y_1 \cos y_3 \sin y_2 & \cos y_3 \cos y_2 \end{pmatrix} \quad (16)$$

$$P_{\nu_l \to \nu_l'} = \left(\sum_\gamma U^c_{l\gamma} U^d_{l\gamma} \right)^2 - 4 \sum_{\gamma > \beta} U^c_{l\gamma} U^d_{l'\gamma} U^c_{l\beta} U^d_{l'\beta} \sin \left(\frac{\Delta m^2_{\gamma\beta} L}{4E} \right) \quad (17)$$

$$\frac{1}{N} \int_0^{\frac{\pi}{2}} P_{\nu_e \to \nu_e}(x_1, x_2, x_3, y_1, y_2, y_3) f(x_1, x_2, x_3, y_1, y_2, y_3) dx_1 dx_2 dx_3 dy_1 dy_2 dy_3 \quad (18)$$

$$\frac{1}{N} \int_0^{\frac{\pi}{2}} P_{\nu_e \to \nu_e}(x_1, y_1) f(x_1, y_1) dx_1 dy_1 \quad (19)$$

$$f(x_1, y_1) = \exp \left(-\frac{1}{2} \left(\frac{x1 - \theta_{12}}{\alpha_{x1}} \right)^2 \right) \exp \left(-\frac{1}{2} \left(\frac{y1 - \theta_{12}}{\alpha_{x1}} \right)^2 \right) \quad (20)$$

Reactors + Gallium

$$\chi^2 = \sum_{i,j=1}^{4} (\vec{R}^t - \vec{R}^e)_i^T W_{ij}^{-1} (\vec{R}^t - \vec{R}^e)_j$$

$$\alpha_{x1} = 0.174 \quad [0.067, 0.249]$$

$$\chi^2_{SNMM} = 39.08/(31-1)$$

$$\chi^2_{SOM} = 48.24/31$$

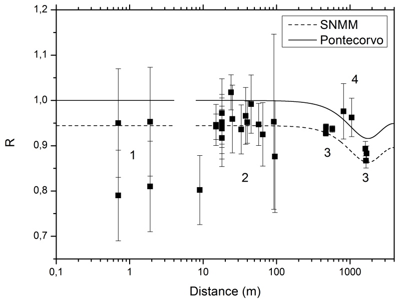


Figure : [Guzzo et al., 2013] [a]

[a] Stochastic Neutrino Mixing Mechanism: M. M. Guzzo, P. C. de Holanda, O.L.G. Peres and E.M. Zavanin

LSND/MINIBOONE

$$P_{\nu_\mu \to \nu_e} = (0.264 \pm 0.067 \pm 0.045).10^{-2} \quad (21)$$

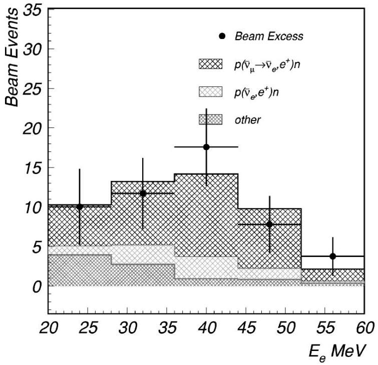


Figure : Extracted of [Aguilar et al., 2001]

$$P_{\nu_\mu \to \nu_e} = (0.21).10^{-2} \quad (22)$$

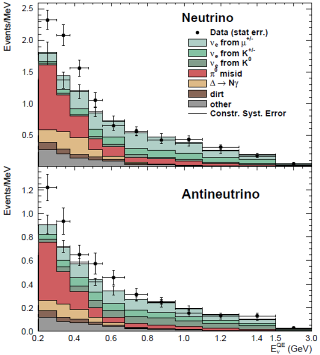


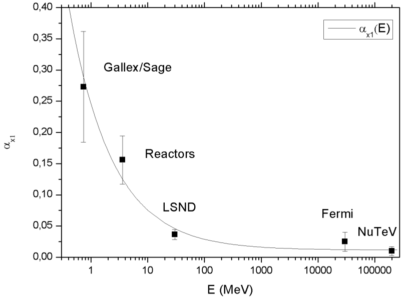
Figure : Extracted of [Aguilar-Arevalo et al., 2012]

Fit polinomial

$$\alpha_{x1}(E) = A + (B/E)^n \quad (23)$$

$$\chi^2 = \sum_i^5 \left(\frac{\alpha_{x1}(E) - \alpha^i_{x1}(E)}{\Delta\alpha^i_{x1}(E)} \right)^2 \quad (24)$$

1. $A_{b.f.} = 0{,}009$
2. $B_{b.f.} = 0{,}076$
3. $n_{b.f.} = 0{,}565$



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[a] Stochastic Neutrino Mixing Mechanism: M. M. Guzzo, P. C. de Holanda, O.L.G. Peres e E.M. Zavanin

Conclusion

1. The model provides a possible explanation to the Gallium and Reactor Antineutrino Anomalies
2. With the energetic dependence $\alpha(E)$ we also propose a possible solution to solve the appearance effect in LSND and MINIBOONE
3. A more complete analisys is in development

Aguilar, A. et al. (2001).
Evidence for neutrino oscillations from the observation of $\overline{\nu}_e$ in a $\overline{\nu}_\mu$ beam.
Phys. Rev. D, 64:112007.

Aguilar-Arevalo, A. A. et al. (2012).
A combined $\nu_\mu \to \nu_e$ and $\overline{\nu}_\mu \to \overline{\nu}_e$ oscillation analysis of the miniboone excesses.

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Extended Pontecovo Mechanism.
, :.

KUFLIK, E. (2012).
Neutrino anomalies and sterile neutrino phenomenology.
Palestra no Cern.

Mention, G., Fechner, M., Lasserre, T., Mueller, T. A., Lhuillier, D., Cribier, M., and Letourneau, A. (2011).
Reactor antineutrino anomaly.
Phys. Rev. D, 83:073006.

NuTeV

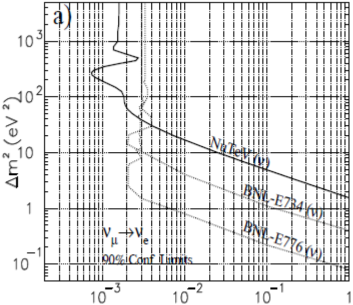

Figure : NuTeV - Neutrino Channel

Fermi

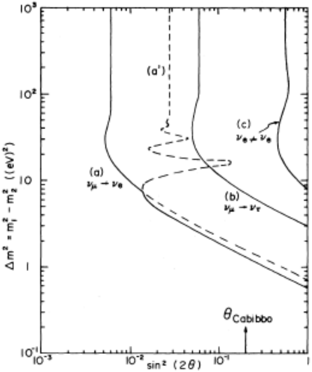

Figure : Fermi