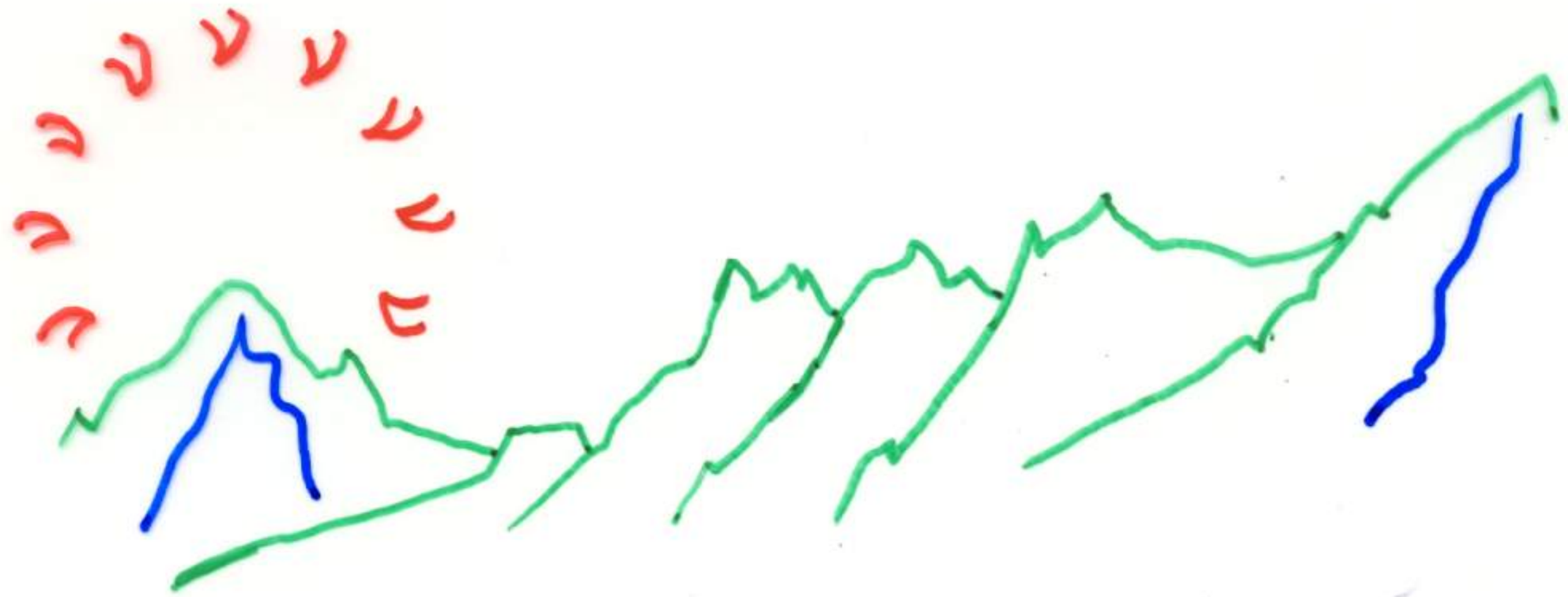


NEUTRINOS & EXTRADIMENSIONS

A SOLUTION TO FIT THE DATA.

N. COSME - ULB PhysTh

~~CONCLUSION.~~

∪ Oscillations with Extra Dim. are dead.

It would be too Easy...

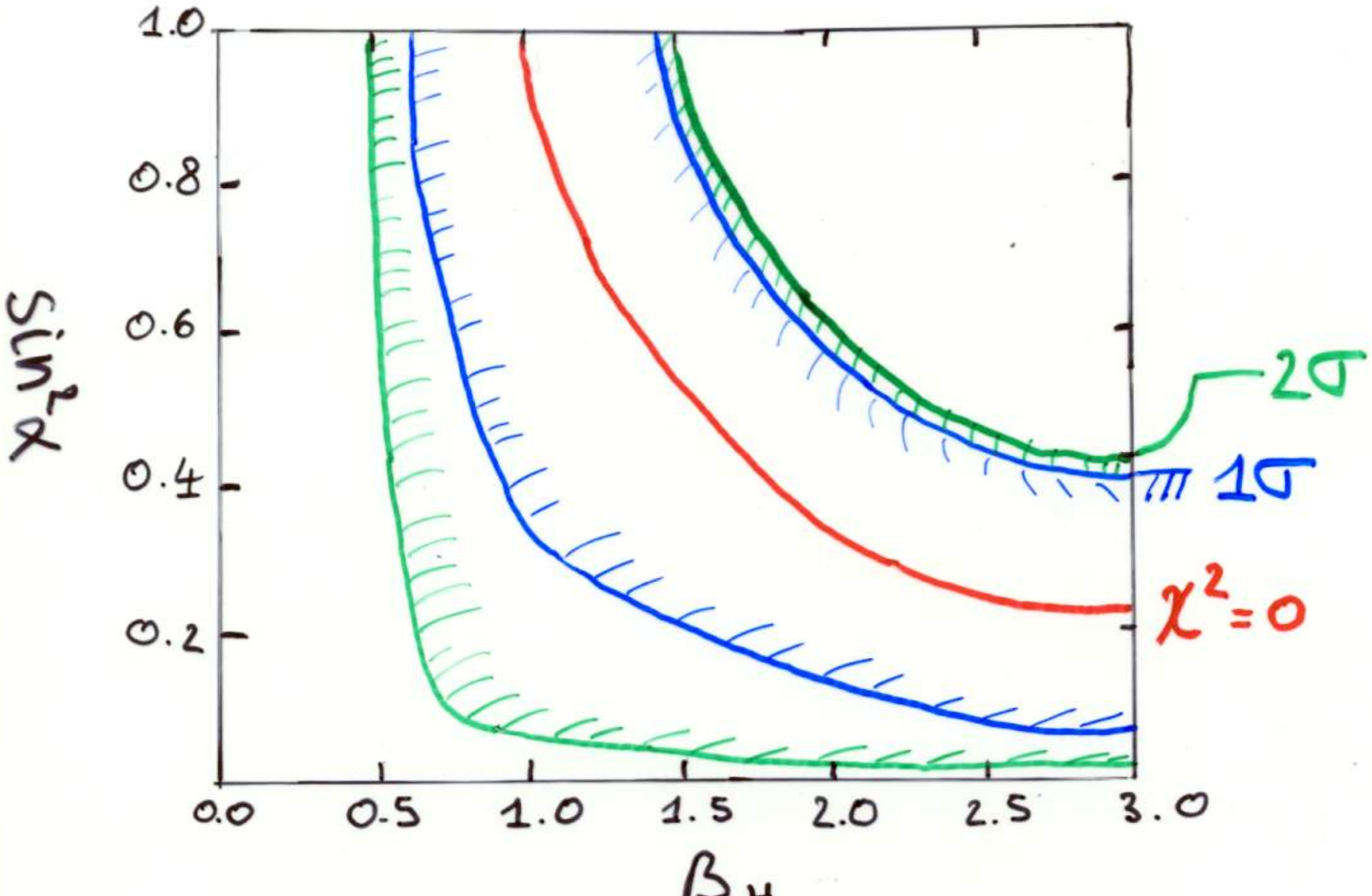
Unknowns after SNO.

V. Barger et al.

Mo. 18/06

~22:00

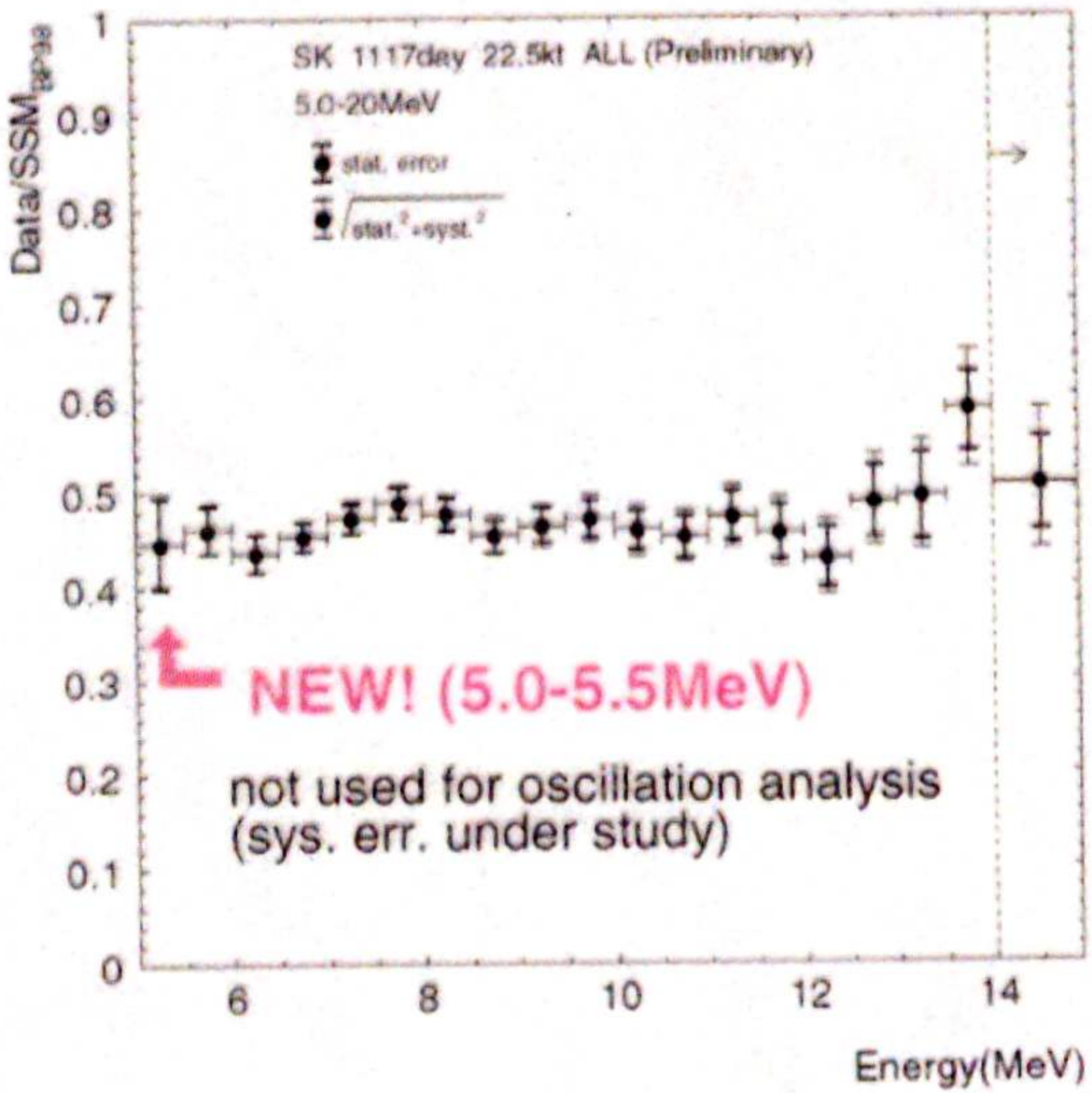
hep-ph/0106207



$\sin^2\alpha$: active ν fraction

β_H: ^8B ν flux normalization

Data/SSM(BP98)



5.5-20MeV:

χ^2 for flat = 13.7/17dof

(including sys. err.)

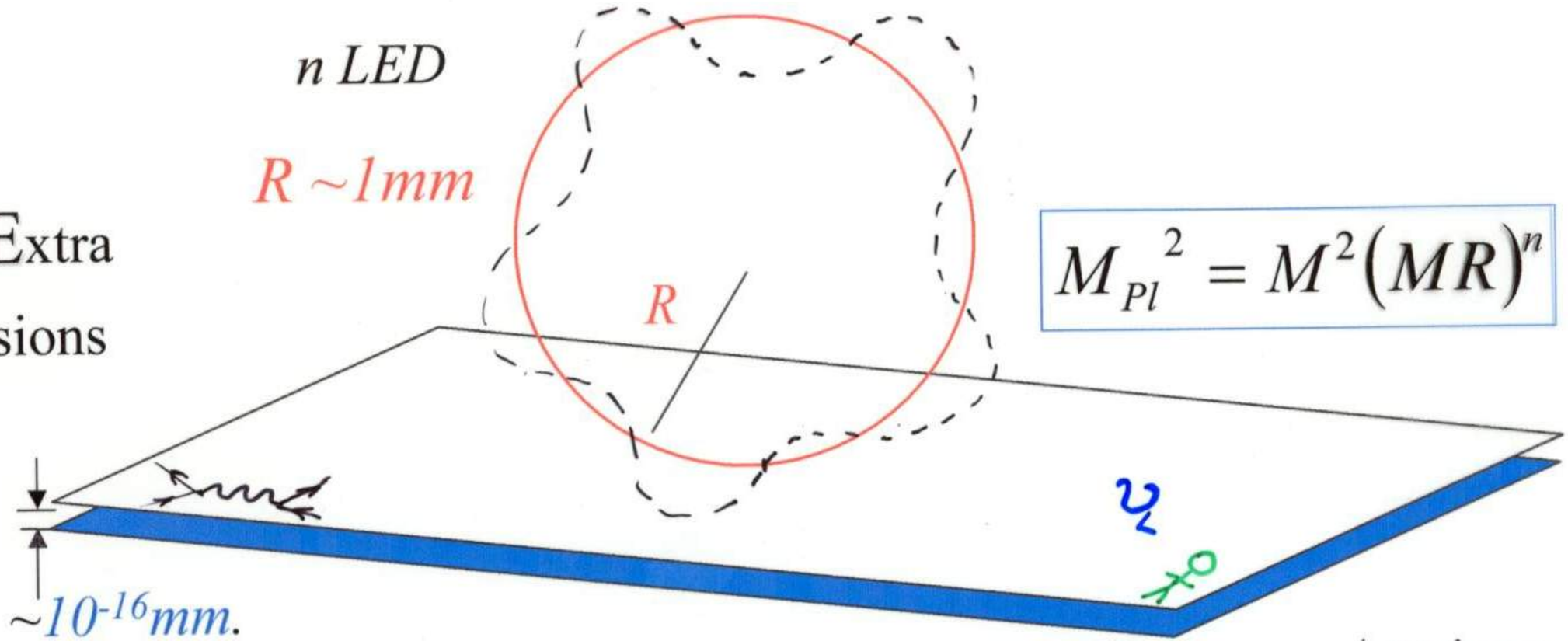
C.L.= 69 %

consistent with flat

LMA

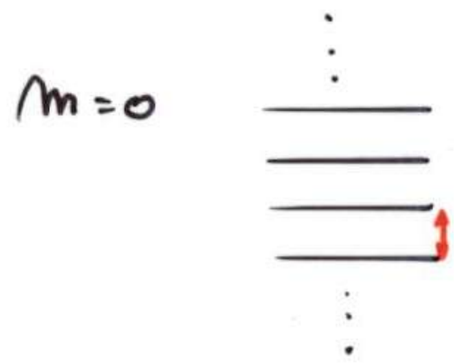
SK
NEUTRINO 2000

Large Extra Dimensions



$$M_{Pl}^{\ 2} = M^2 (MR)^n$$

K-K Tower



$$E^2 = p^2 + p^2 + m^2 = p^2 + (n/R)^2 + m^2$$

$$R \sim 10^{-1} - 10^{-2}\ mm$$

$$1/R^2 \sim 10^{-4} - 10^{-6}\ eV^2$$

ν_R in the LED

Coupling $\nu_1 - \psi$:

$$\mathcal{L}_m = \sum_{n=-\infty}^{+\infty} (m\bar{\nu}_1\psi_n + \frac{n}{R}\bar{\psi}_n\psi n)$$

$$\Downarrow$$

	ν_{R0}	ν_{R1}	$\cdots$	ν_{Rk}	$\cdots$
ν_1	m	$\sqrt{2}m$	$\cdots$	$\sqrt{2}m$	$\cdots$
ν_{L1}	0	$\frac{1}{R}$	0	0	$\cdots$
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
ν_{Lk}	0	0	$\cdots$	$\frac{k}{R}$	$\vdots$
$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\ddots$

$$\Rightarrow \xi = \frac{m}{1/R} = mR$$

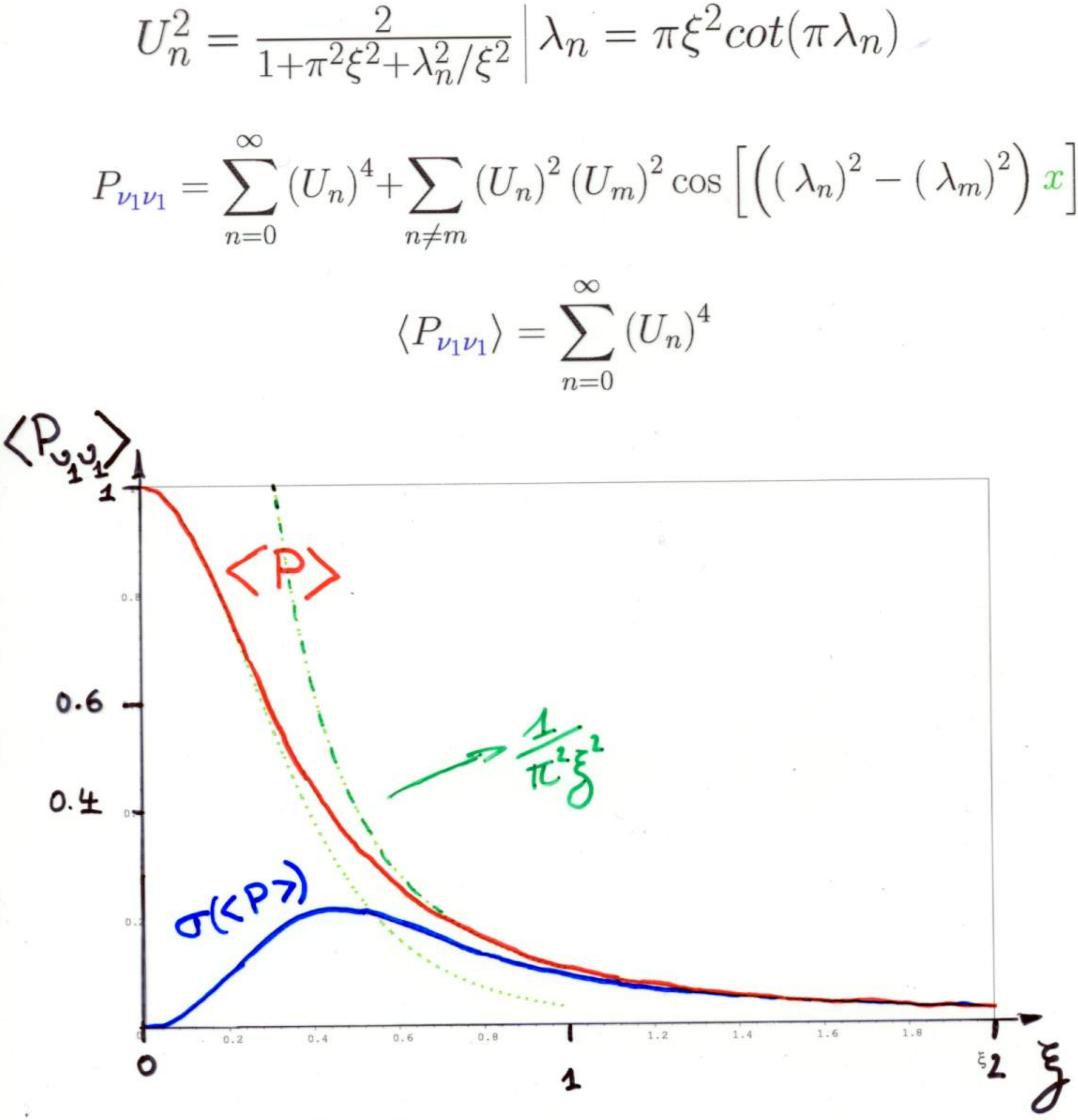
- $\xi \leq 1$, weak coupling: $\nu_{Lk} \leftrightarrow \nu_{Rk}$.
- $\xi \geq 1$, strong coupling: $\nu_1 \leftrightarrow \nu_{Rk}$.

$$\nu_1(L) = \sum_{n=0}^{+\infty} U_n(\xi, R)\mathcal{N}_n exp(i\frac{\lambda_n^2 L}{2ER^2})$$

$$U_n^2 = \frac{2}{1+\pi^2\xi^2+\lambda_n^2/\xi^2} \Big| \lambda_n = \pi\xi^2 cot(\pi\lambda_n)$$

$$P_{\nu_1\nu_1} = \sum_{n=0}^{\infty} (U_n)^4 + \sum_{n\neq m} (U_n)^2 (U_m)^2 \cos\left[\left((\lambda_n)^2 - (\lambda_m)^2\right) x\right]$$

$$\langle P_{\nu_1\nu_1}\rangle = \sum_{n=0}^{\infty} (U_n)^4$$



$0.29 \lesssim \xi \lesssim 0.42$

$P_{\nu_1\nu_1}$

1

0.6

0.4

0

10^{-2} 10^{-1} 1 10

x

$\xi = 1/10$

$\xi = 1/3$

$\xi = 1$

$\xi = 3$

$$x = \frac{L}{2ER^2}$$

$P_{\nu_1\nu_1}$

1

CHOOZ

10^{-3} 10^{-2} 10^{-1} 1 10 10^2

x

$L = 1\,km$

$E \sim$ MeV

$$x = \frac{L}{2ER^2}$$

- Average Suppression between 40-60%

- No MSW Effect → $1/R^2$

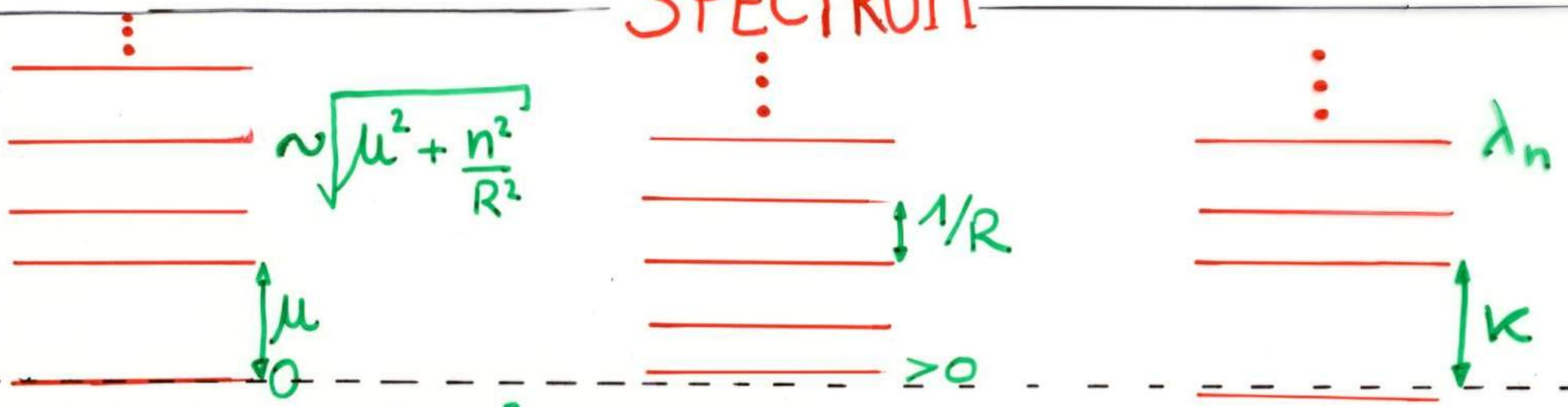
→ Cannot Agree with CHOOZ
(≤ 5% DISAPPERANCE E ~ MeV L ~ km)

- All the Oscillating $\nu_e \rightarrow \nu_s$

→ Alternatives?

BULK DIRAC μ | NO BULK MASS | BULK MAJO. K

SPECTRUM



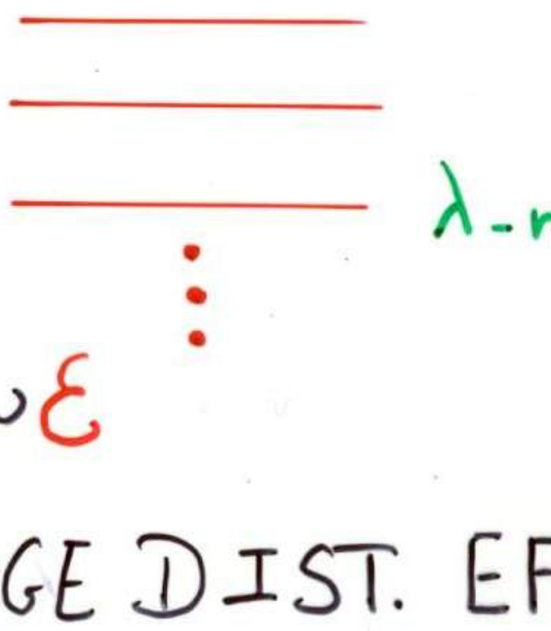
$\mu^2 > 4 \cdot 10^{-4}\ eV^2$

→ NO MSW

BUT:

$\langle P \rangle \sim 50\% \Longleftrightarrow \xi^2 \propto \mu$

~~CHOOZ~~



$(\lambda_n^2 - \lambda_{-n}^2) \sim \varepsilon$

→ LARGE DIST. EFFECTS

STILL IN PROGRESS...

The 2-1 Model:) ⟶ MIRACLE

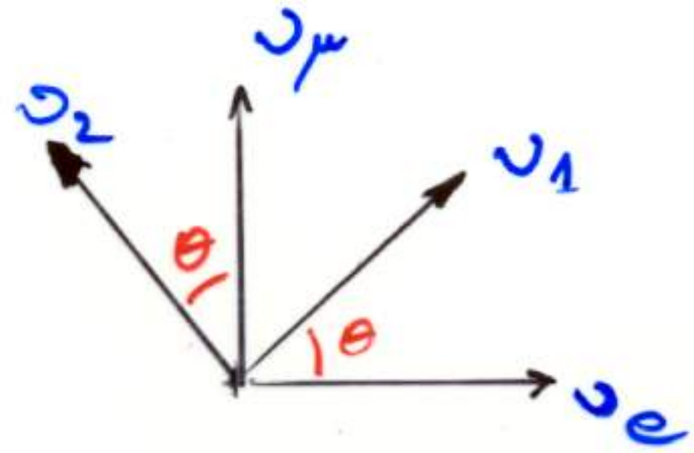
$$\mathcal{L}_y = m_e \bar{\nu}_e \Psi_B(y=0) + m_\mu \bar{\nu}_\mu \Psi_B(y=0) + h.c.$$

1 Coupled state
1 Massless state

$$\begin{pmatrix} \nu_1 \\ \nu_2 \end{pmatrix} = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} \nu_e \\ \nu_\mu \end{pmatrix}$$

$$tg\,\theta = \left(\frac{m_e}{m_\mu}\right)^{-1}$$

$$m = \sqrt{m_e^2 + m_\mu^2}$$



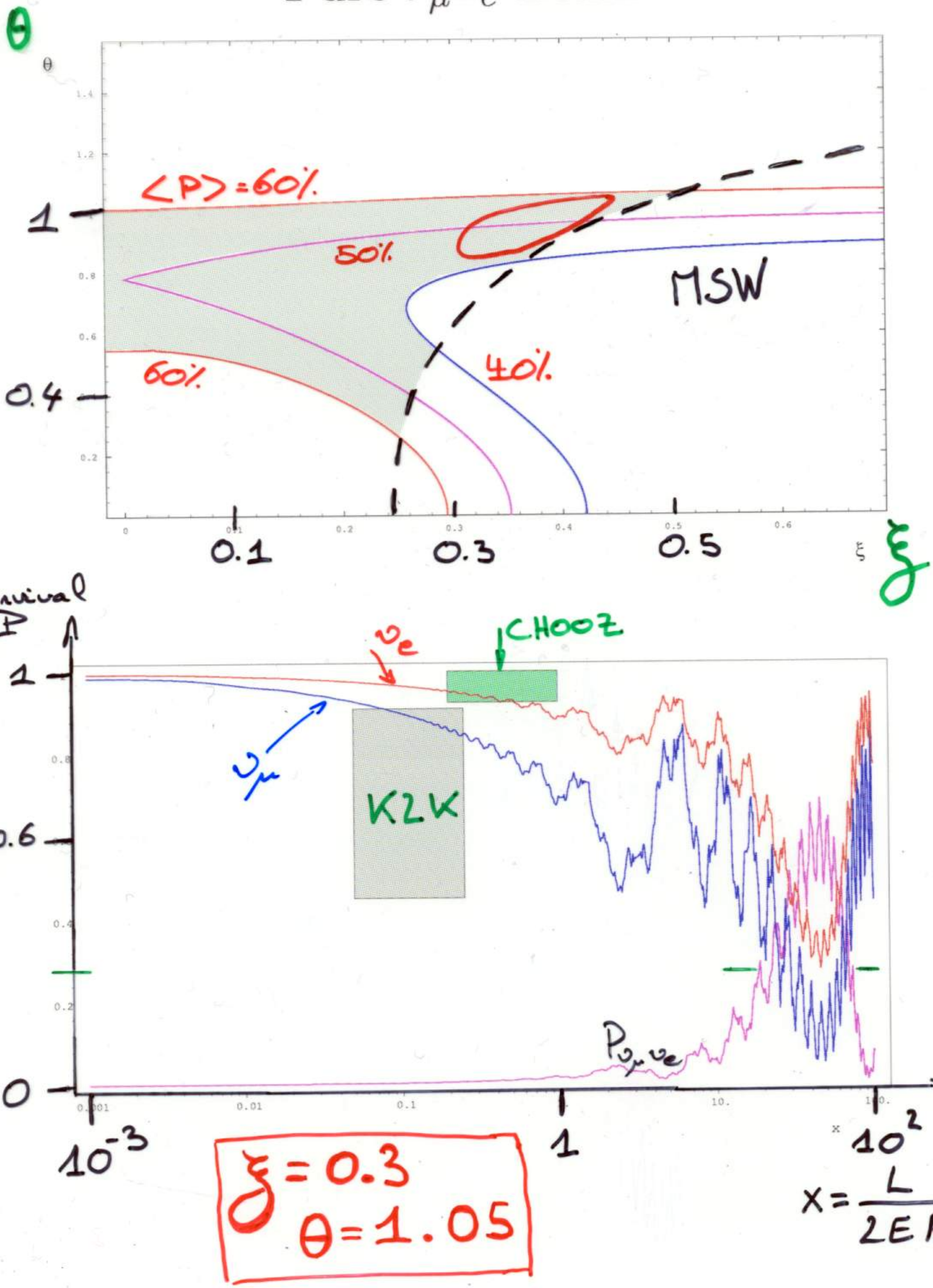
$$\mathcal{L}_y = m \bar{\nu}_1 \Psi_B + h.c.$$

- $\langle \nu_e | \nu_e(L) \rangle = \cos^2\theta\, A_{\nu_1\nu_1}(L, \xi, R) + \sin^2\theta$

- $\langle \nu_e | \nu_\mu(L) \rangle = \sin\theta \cos\theta \left[A_{\nu_1\nu_1}(L, \xi, R) - 1 \right]$

! ! (!)

Pure $\nu_{\mu-e}$ Beam



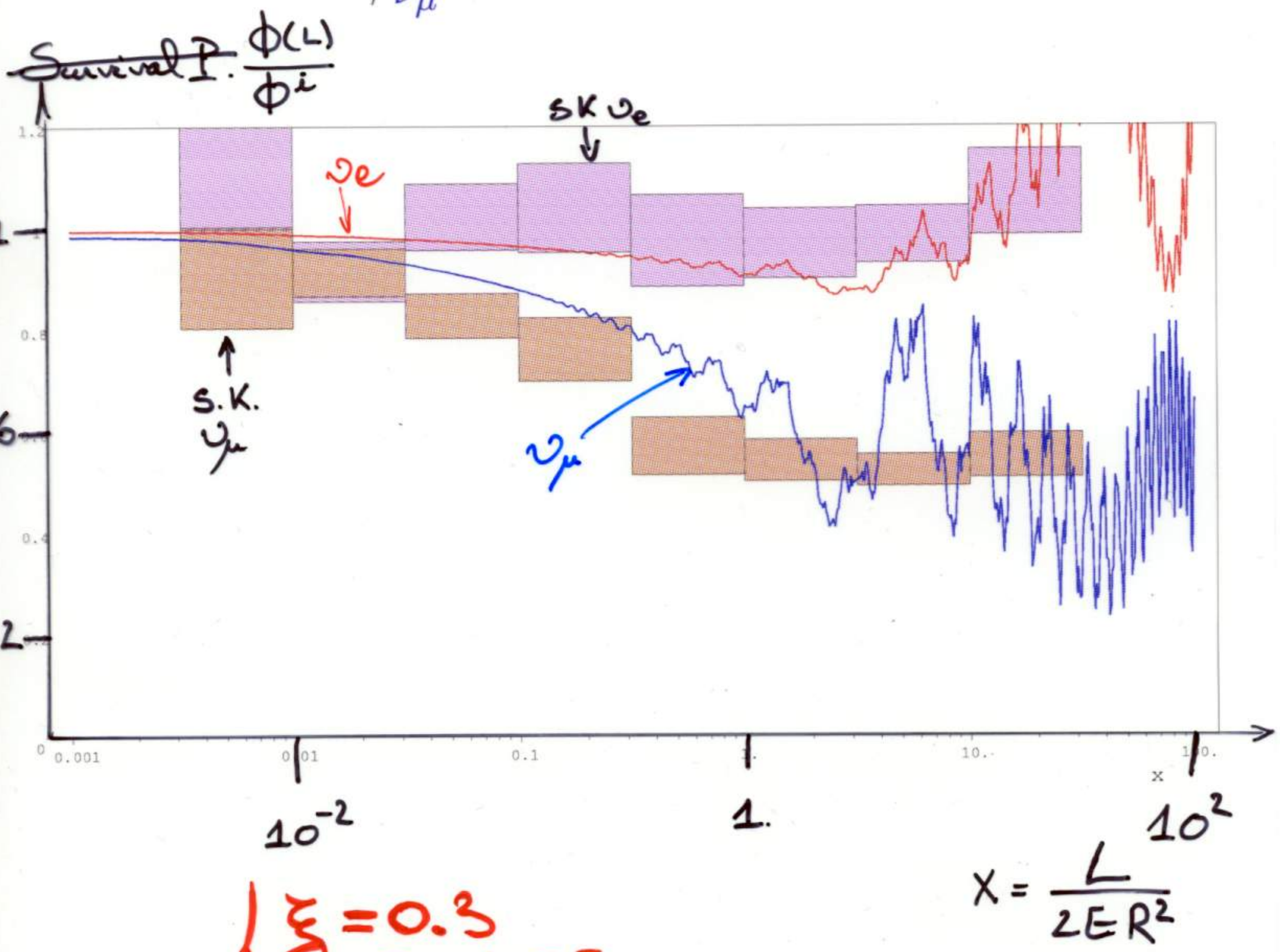
ATMOSPHERIC ν

$$\nu_e \rightleftharpoons \nu_\mu$$

$$\phi^{(i)}_{\nu_\mu} / \phi^{(i)}_{\nu_e} \simeq 2$$

$$\frac{\phi_{\nu_e}}{\phi^{(i)}_{\nu_e}} = P_{\nu_e\nu_e} + 2\,P_{\nu_\mu\nu_e}$$

$$\frac{\phi_{\nu_\mu}}{\phi^{(i)}_{\nu_\mu}} = P_{\nu_\mu\nu_\mu} + \frac{1}{2} P_{\nu_e\nu_\mu}$$



CONCLUSION.

- Still alive!! even after SNO
- Only Extra Dim. Oscill. (NO MSW, NO FLAVOR MIXING)
- 3 Variables: θ, ξ, R

FURTHER STUDIES:

BULK MASSES.