Physics Reach Summary of WP5

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Physics Reach Talks

5 Pheno talks

3 in joint session

2 in plenary session

A. Joint WP5+WP6 Session: Tuesday before coffee break

- Long Range Force at ESSnuSB FD by Alessio
- Supernova neutrinos at ESSnuSB FD by Myself

B. Joint WP5+WP6 Session: Tuesday after coffee break

- Sterile neutrino with LEMNB by Doris

Mainly discuss A and B

Will youch upon C

C. Plenary Session: Wednesday

- Solar neutrinos at FD by Alessio
- Atmopsheric neutrinos at FD by Sampsa

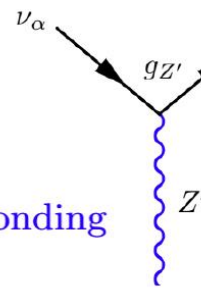# Long Range Force - Alessio

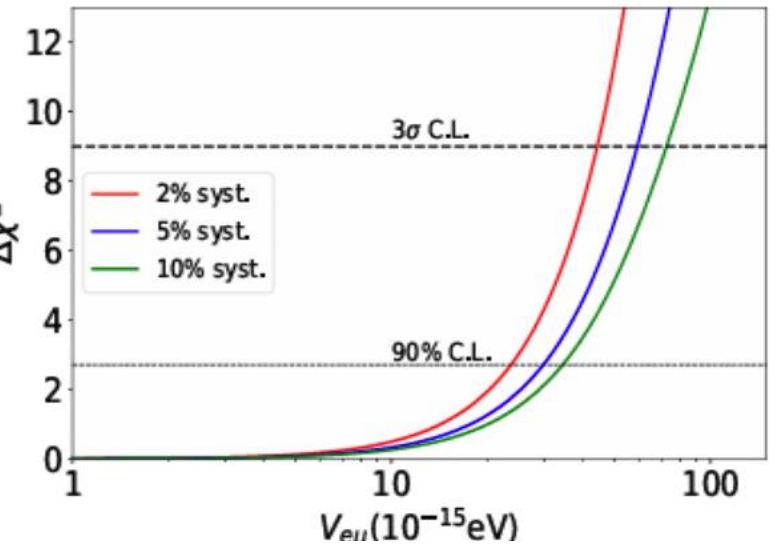Model : $SU(3)_C \times SU(2)_L \times U(1)_Y \times U(1)'$

Xiao-Gang He, Girish C. Joshi, H. Lew, and R. R. Volkas, Simplest Z' model, Phys. Rev. D 44, 2118 2132 (1991).

Z'

$X = L_e - L_\mu$, $L_e - L_\tau$ and $L_\mu - L_\tau$ are the charges of the corresponding symmetries.
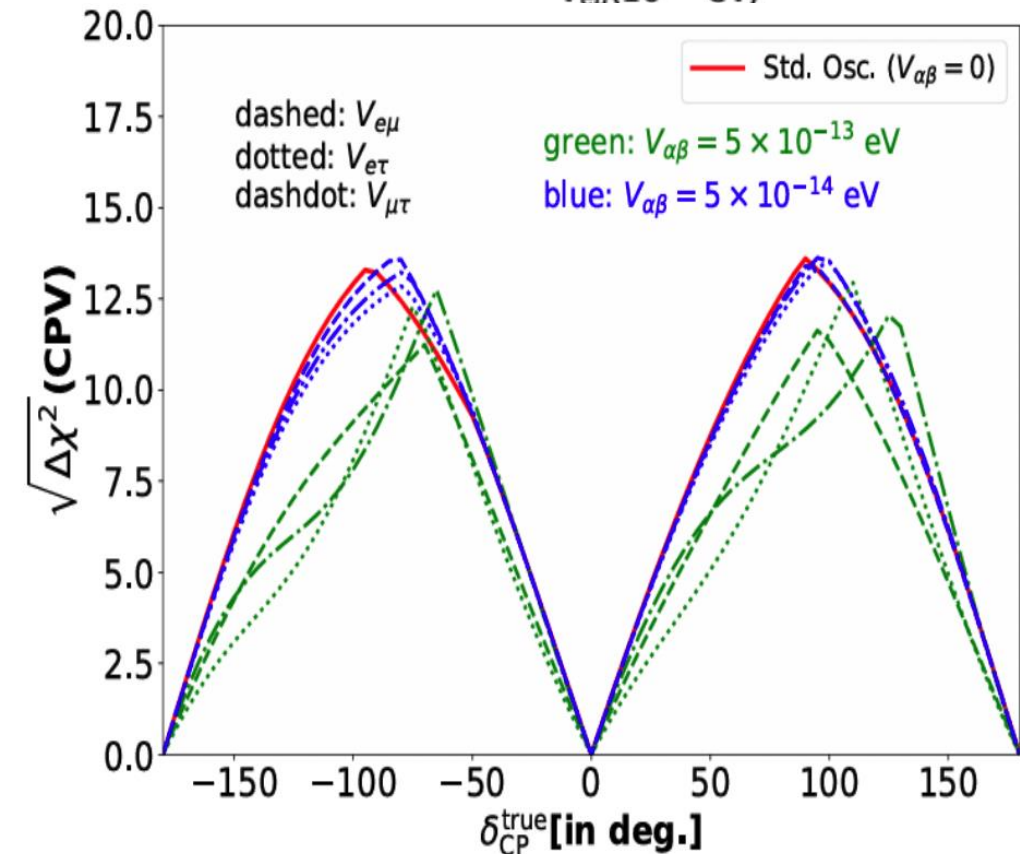
ν_α $\nu_\alpha \nu_\alpha$

$g_{Z'}$ $\frac{e}{2s_W c_W}$

Z' Z

PRL122,061103(20

Extremely light z'

$$H^{\text{eff}} = \frac{1}{2E}\left[U\begin{pmatrix} 0 & 0 & 0 \\ 0 & \Delta m_{21}^2 & 0 \\ 0 & 0 & \Delta m_{31}^2 \end{pmatrix}U^\dagger\right] + V_{CC}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} + V_{\alpha\beta}.$$

$$V_{\alpha\beta} = \begin{cases} \text{diag}(V_{e\mu}, -V_{e\mu}, 0), & \text{for } L_e - L_\mu \\ \text{diag}(V_{e\tau}, 0, -V_{e\tau}), & \text{for } L_e - L_\tau \\ \text{diag}(0, V_{\mu\tau}, -V_{\mu\tau}), & \text{for } L_\mu - L_\tau \end{cases}$$

Long Range Force - Discussion

Comment from Teppei: The strongest bound on LRF will come from the atmopsheric neutrinos. Sensitivity of LBL is weak.

Supernova neutrinos - Myself

- Number of events depends on the supernova flux models
- Number of events for Standard and 3+1 were calculated for Garching Flux Model.
- Only MSW effect was considered. No collective effect.

Livermore	GKVM	Garching
148,686	88,528.8	51,068.7
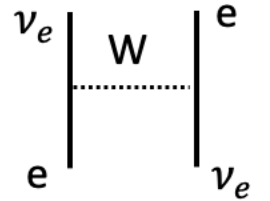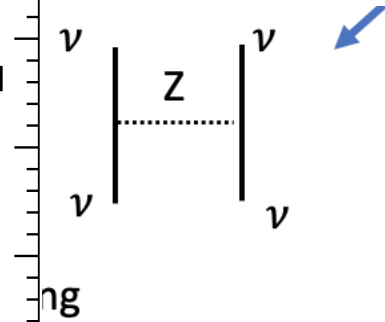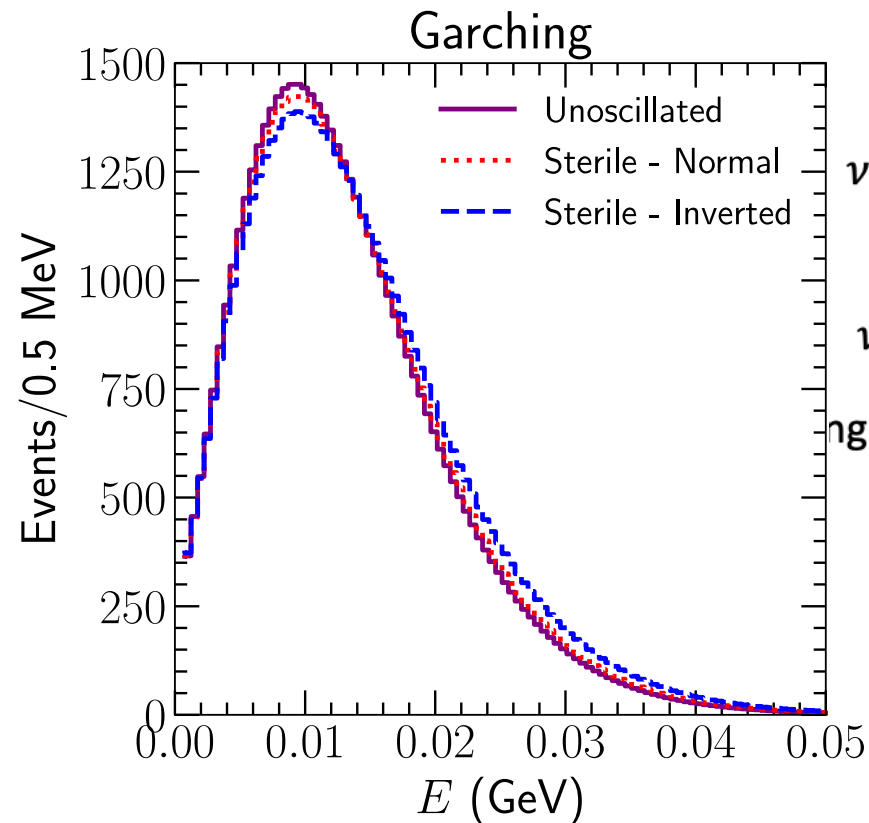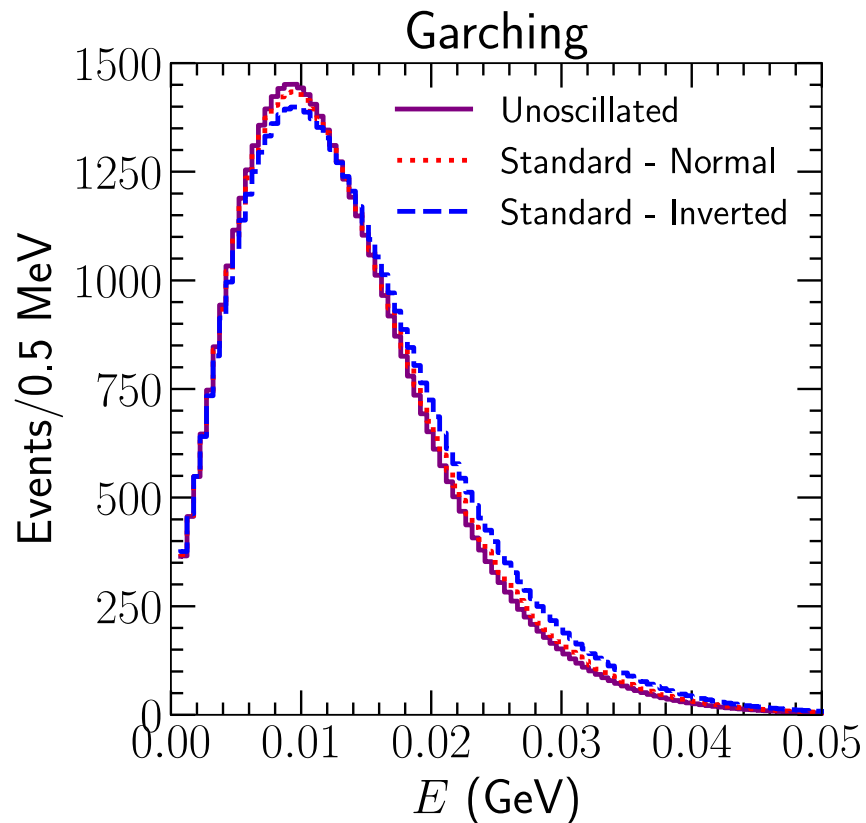
Supernova neutrinos - Discussion

Suggestion from Livia/Tord: To study the capability/requirement of ESSnuSB
to disntinguish the flux models

Suggestion from Teppei: To study the capability/requirement of ESSnuSB
to observe extra galactic supernova

Suggestion from Tord: To study physics at different time slabs of the explosion

Sterile neutrino - Doris

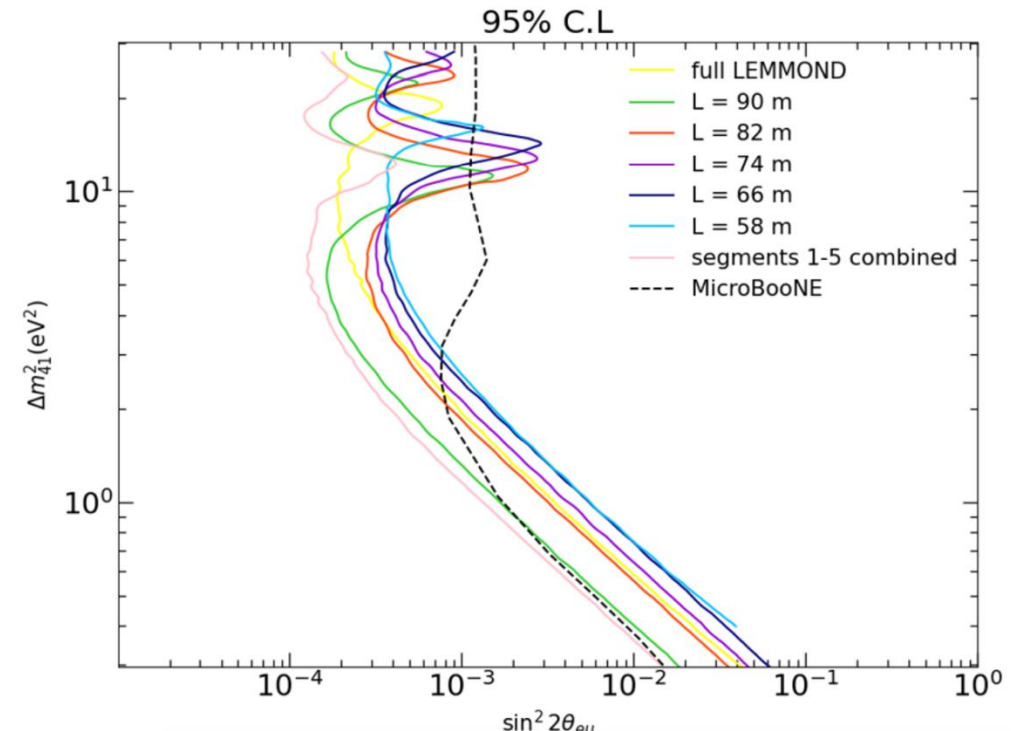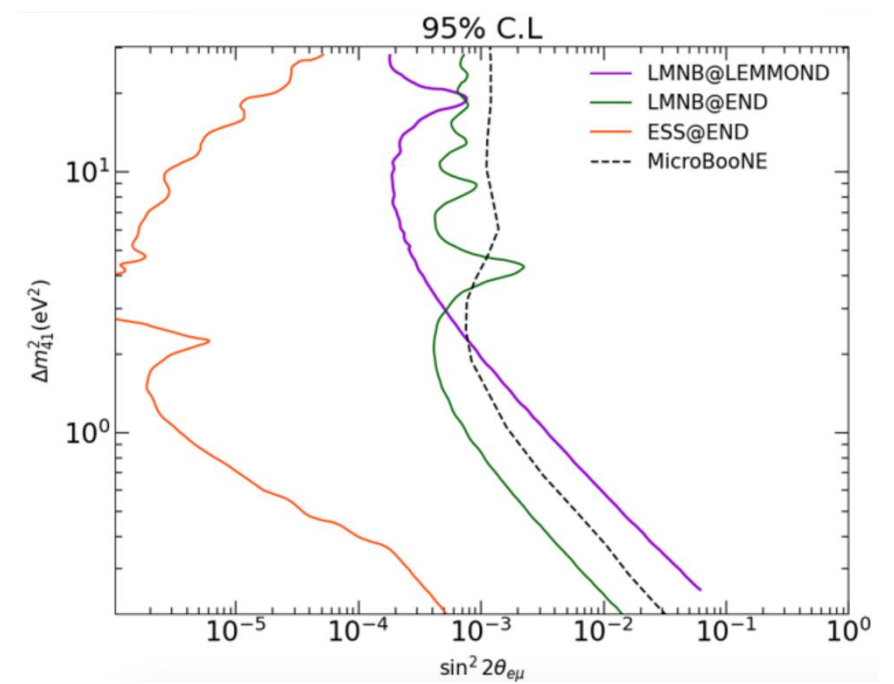$$\sin^2 2\theta_{\mu e} = \sin^2 2\theta_{14}\sin^2\theta_{24}$$

Sensitivity estimated for
- ESS flux – END detector (L = 250 meter)
- LEMNB flux – END detector
- LEMNB flux – LEMMOND detector (L = 50 meter)

For LEMNB - LEMMOND
- Decay pipe (d =50 meter) is divided into 5 equal segments
- Sensitivity estimated for neutrinos coming from each segment
  Effective neutrino travel length L + d

Various values of Δm^2_{41} can be probed

Sterile neutrinos - Discussion

Query from Livia: How systematics error will effect the sensitivity ?

Suggestion from Teppei: Interesting idea. Timing information will be beneficial.

Comment from Francesco: Timing information is difficult for monitored beam.

Plenary Session

Solar (Alessio):

- ESSnuSB is expected to observe 370 events per day

- Possible Physics studies:

 (i) day night assymetry

(ii) Hep neutrios can be observed

(iii) Upturn of 8B spectrum can be observed

(iv) θ_{12} and several new physics can be studied

Atmoshpheric (Sampsa): Sensitivity estimated for:

- Mass ordering, octant and precision of of θ_{23} and Δm^2_{31}

- Paper in JHEP

- Study of NSI is ongoing

- Comment by Livia: Study the effect of resolution, smearing, LBL+atm etc

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