Impact of Non-Unitary Mixing on Physics Potential of Long Baseline Experiments

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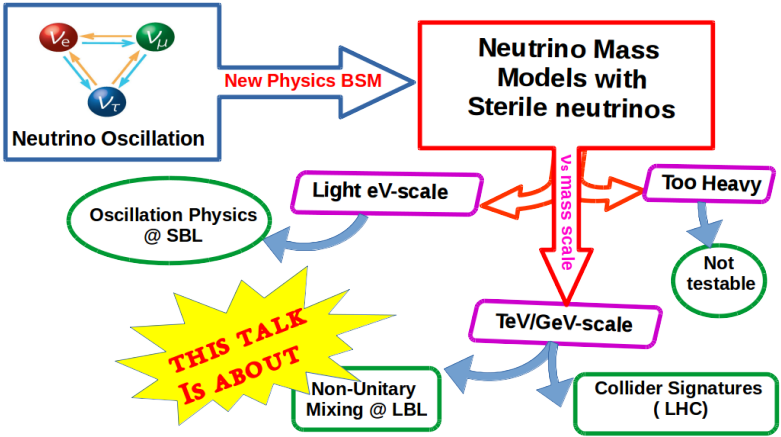
1. Motivation

Why do we look for deviation from unitarity of PMNS matrix?



For more details: see talk by **Filipe R. Joaquim** and flash talk by **Johannes Rosskopp**

2. Non-Unitary Mixing Formalism

Non-unitary neutrino matrix

- The general form of effective unitary neutrino mixing matrix

$$U_{eff} = \begin{pmatrix} N_{3\times3} & \Theta_{3\times n} \\ R_{n\times3} & S_{n\times n} \end{pmatrix}, \tag{1}$$

with active neutrino mixing matrix $N_{3\times3} = (1 - \frac{1}{2}\Theta^\dagger\Theta)U_{\rm PMNS} = (1-\eta)U_{\rm PMNS}$

$$\mathcal{H}_m^N = \frac{1}{2E}\begin{pmatrix} 0 & 0 & 0 \\ 0 & \Delta m^2_{21} & 0 \\ 0 & 0 & \Delta m^2_{31} \end{pmatrix} + N^\dagger \begin{pmatrix} V_{\rm CC}+V_{\rm NC} & 0 & 0 \\ 0 & V_{\rm NC} & 0 \\ 0 & 0 & V_{\rm NC} \end{pmatrix} N. \tag{2}$$

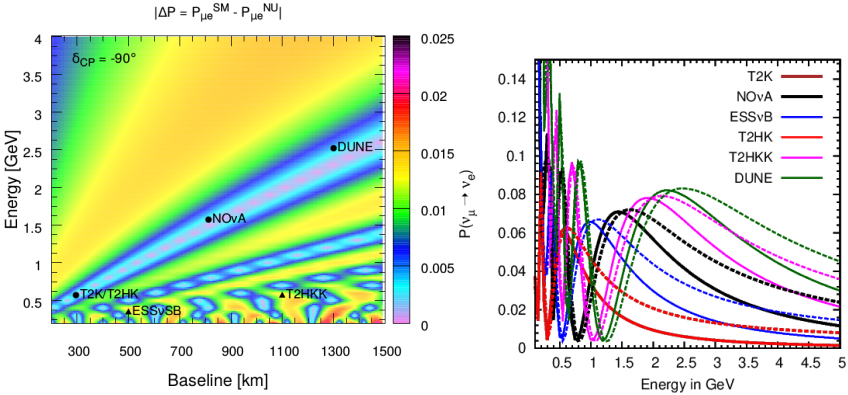
- Oscillation probability,

$$P_{\alpha\beta}(E,L) = |\langle\nu_\beta|\nu_\alpha(L)|^2 = \left|\left(Ne^{-i\mathcal{H}_m^N L}N^\dagger\right)_{\beta\alpha}\right|^2. \tag{3}$$

S.Antusch *et.al.*, Nucl.Phys.**B810**,369(2009)

3. Effect on $\nu_\mu \rightarrow \nu_e$ Oscillation Channel

At probability level

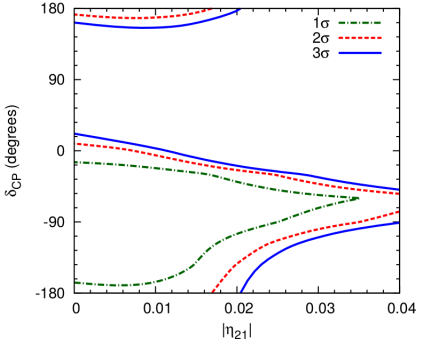


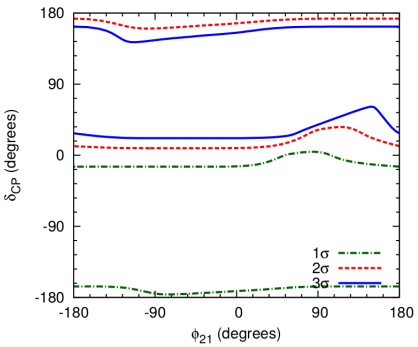
NU parameters in 21 sector significantly affect $\nu_\mu \rightarrow \nu_e$ oscillation channel

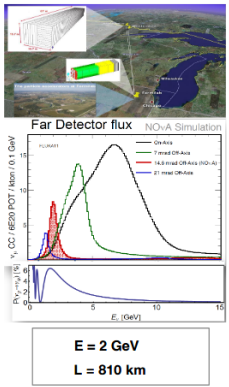
Soumya C., *" Sensitivity limits on NU parameters at LBL experiments"* [in preparation]

MonteCUBE Simulation

4. Sensitivity limit of NOνA to NU parameters







For $\delta_{CP} = -90^o$, sensitive to values of $\eta_{21} < 0.034$ at 1σ C. L.

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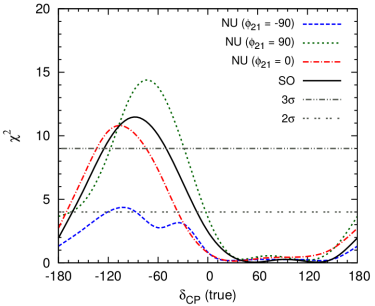
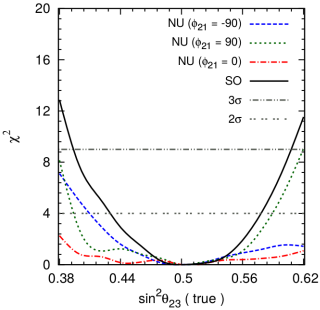
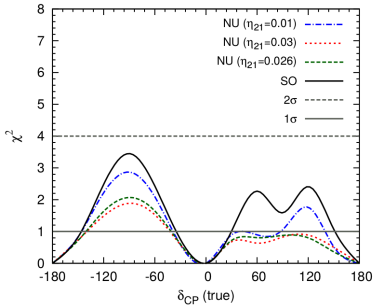
5. Effect of NU mixing on sensitivities of NOνA







Mass Hierarchy | Octant | CP-Violation

NU phase play crucial role in the sensitivity studies.

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MonteCUBE Simulation

6. Conclusions

Analysed the impact of NU mixing on sensitivities of NOνA and found that

- NU parameters in 21 sector play crucial role in $\nu_\mu \to \nu_e$ oscillation channel.
- NU mixing significantly affect the sensitivities of NOνA to determine current unknowns in neutrino sector.
- The sensitivities are crucially depend up on the new CP-violating phase in NU mixing.


THANK
YOU