

Status Update

Neutrino Oscillation and ROOT

Tran Van Ngoc
Neutrino Group, IFIRSE, ICISE, VN

November 17th, 2017

Status

- Work done
 - Transition probability in matter
 - Successfully installed ROOT in Ubuntu
 - Finished Small Project
 - Successfully executed Prob3++ package
- Next plan

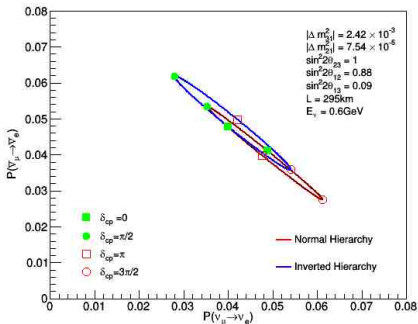
Transition probability $P(\nu_\mu \rightarrow \nu_e)$ in matter

$$\begin{aligned} P(\nu_\mu \rightarrow \nu_e) = & 4s_{13}^2 s_{23}^2 c_{13}^2 \sin^2 \Delta_{31} & (1) \\ & - 8s_{13}^2 s_{23}^2 c_{13}^2 \frac{a}{\Delta m_{31}^2} (2s_{13}^2 - 1) \sin^2 \Delta_{31} \\ & + 8s_{13}^2 s_{23}^2 c_{13}^2 \frac{ax}{4E} (2s_{13}^2 - 1) \sin \Delta_{31} \cos \Delta_{32} \\ & - 8s_{12} s_{13} s_{23} c_{12} c_{13}^2 c_{23} \sin \delta \sin \Delta_{21} \sin \Delta_{31} \sin \Delta_{32} \\ & + 8s_{12} s_{13} s_{23} c_{13}^2 (c_{12} c_{23} \cos \delta - s_{12} s_{13} s_{23}) \sin \Delta_{21} \sin \Delta_{31} \cos \Delta_{32} \\ & + 4s_{12}^2 c_{13}^2 (c_{12}^2 c_{23}^2 + s_{12}^2 s_{13}^2 s_{23}^2 - 2s_{12} s_{13} s_{23} c_{12} c_{23} \cos \delta) \sin^2 \Delta_{21} \end{aligned}$$

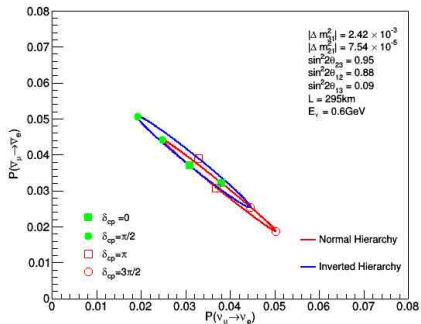
Neutrino oscillation in matter

Mass hierarchy resolution (T2K)

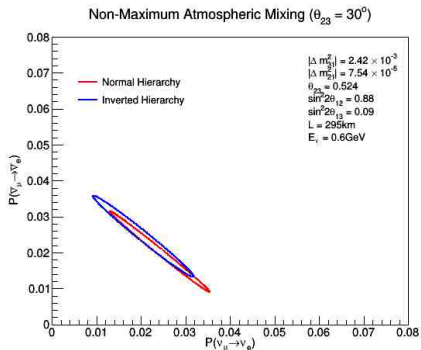
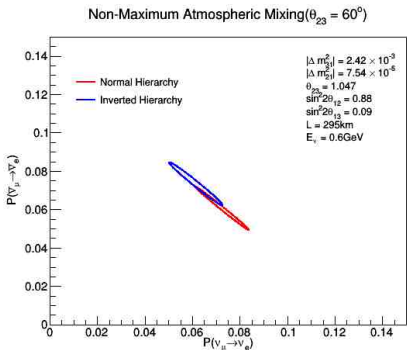
Maximum Atmospheric Mixing



Non-Maximum Atmospheric Mixing



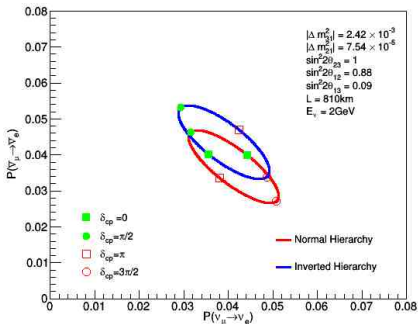
Mass hierarchy resolution (T2K)



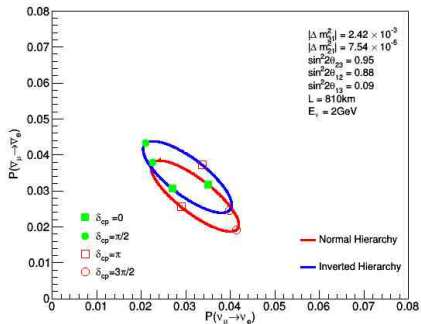
Neutrino oscillation in matter

Mass hierarchy resolution (NOvA)

Maximum Atmospheric Mixing



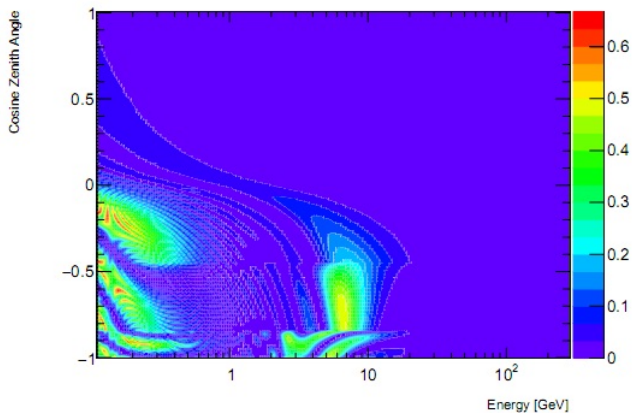
Non-Maximum Atmospheric Mixing



Neutrino oscillation in matter

Prob3++ package

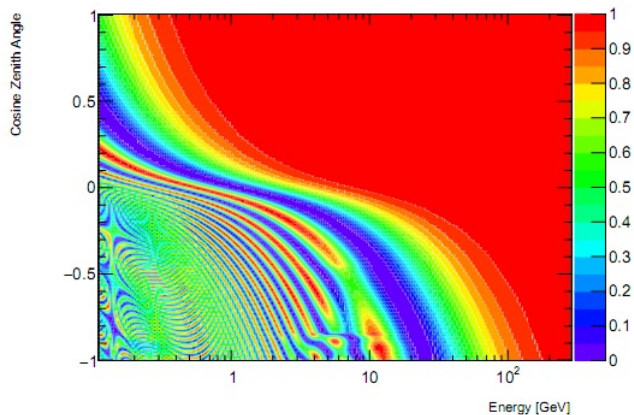
3 Flavor $P_{\nu_\mu \rightarrow \nu_e}$



Neutrino oscillation in matter

Prob3++ package

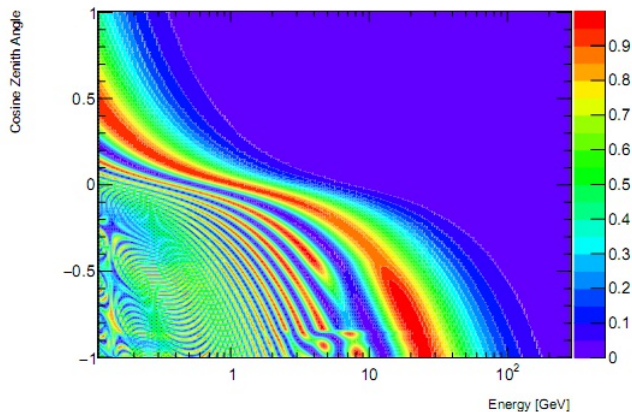
3 Flavor $P_{\nu_\mu \rightarrow \nu_\mu}$



Neutrino oscillation in matter

Prob3++ package

3 Flavor $P_{\nu_\mu \rightarrow \nu_\tau}$



Next to do

- Book reading (W. R. Leo's book)
- Learn Statistics
- Learn about T2K experiment

References

- Carlo Giunti, Chung W. Kim (2007), *Fundamentals of Neutrino Physics and Astrophysics*, Oxford University.
- E. Kh. Akhmedov (2000), [arXiv: hep-ex/0001.1264v2].
- Fumihiko Suekane (2015), *Neutrino Oscillations*, Springer.
- J. Arafune, M. Koike, J. Sato (1999), [arXiv: hep-ph/9703351v5].
- Mark Thomson (2013), *Modern Particle Physics*, Cambridge University.