

Questions following the neutrino oscillation talk (to be answered on October 19)

1. What is the mass hierarchy problem of neutrino? What are the implications of having a normal or an inverted hierarchy? **Bing**
2. Why do neutrinos change flavor? Are they interacting with each other? Is there a known mechanism for this? **Chen**
3. How does one determine the angles θ_{12} , θ_{23} , θ_{13} in the equation for neutrino oscillation? **Dilu**
4. Why do neutrinos have to travel such a long distance before detection? The probability of a ν_μ oscillating to a ν_e is

$$P(\nu_\mu \rightarrow \nu_e) = \sin^2 \theta_{23} \sin^2 \theta_{13} \sin^2 \frac{\Delta m_{23}^2 L}{4 E_\nu}$$

Why does it have a maximum at $E_\nu=0.6$ GeV? What does L/E mean in that equation?
Brian

5. Why is the far detector called a Cherenkov detector? What is the role of water in the detector? **Alina** (also see next question)
6. If we know that neutrinos do not interact with matter, how are they detected? How do they interact with the material in the detector? **Sushil** (also see previous question)
7. Why do you have an on-axis and an off-axis beam? What's the difference, and what's the advantage? **Shamin**
8. Are there background sources other than the off-axis pion decays? How do you separate them? Does the beam timing synchronization completely remove the background? **Linda**
9. What does the CP-violating phase represent? **Youngshin**
10. What is the "invariant mass" that is being plotted along the x-axis in fig. 4? Why did they apply the cut at 105 MeV? **Anthony**
11. How do they ensure the beam of neutrinos is collimated, i.e., wouldn't the beam spread out? **Nowo**
12. Neutrino oscillation occurs because of which reason: mass eigenstate not equal to flavor eigenstate, Hamiltonian is not diagonal in the space spanned by the eigenstate, or the masses are not equal? **Azamat**
13. What is the "flavor" and how does it explain the mass changes of the neutrinos? Have all neutrino flavors been determined to be massless? **Mongi**