

Hey Bob, what's with the flowers? It's Friday knew what happens in Friday 14 happens EVERY Friday A, Æ interact Neekly. Neutrinos

Nefarious Neutrinos

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Introduction

 My research is conducted through the Neutrino Group at Pitt



 Neutrino physics is a sub-branch of particle physics (particle → lepton → neutrino)

Why do we care about neutrinos?

- As particle physicists, our job is to study particles – neutrinos are one of the least-understood particles that exists.
- There's a lot of them about 10 million just in the space your body takes up

 Currently, all physics described by Standard Model. Neutrinos offer a window to change the standard model



So what's the problem?

• Neutrinos are:

- chargeless (can't use EM force)
- colorless (can't use strong force)
- nearly massless (can't use Gravitational force)
- Weak force is the only thing that's left. But doesn't interact very often!
 Median decay time is "light year of lead."



What to do?

- The interaction rate is very low, so to compensate we have to use a lot of neutrinos. That's not a problem – neutrinos are abundant!
- Experimental setup:

 make a neutrino beam (~10²⁰/s) and fire it into a neutrino detector.
 a few (~3/day) will decay weakly, and we can analyze the decay



Above: the setup for the K2K experiment

Status?

<u>Know</u>

- Mass and Flavor Eigenstates incompatible
- Oscillations between different flavors
- Mass eigenstates very small < 1 eV/c²
- Sources:
 - $_{\odot}$ Left over from big bang
 - Supernovae
 - Nuclear Reactors

<u>Want to Know</u>

- Oscillation Parameters
- Cross-Section
- Absolute Mass



<u>Summary</u>



1.Neutrinos have exotic properties

 Oscillations
 Indistinct mass/favor eigenstates
 Few interactions

 2.Difficult & Expensive Experiments

 Low statistics → Indistinct Conclusions
 Very expensive

The Pitt Group

MINERvA at Fermilab

Measure neutrino cross-sections

T2K in Japan

Measure θ₁₃ (υ_u → υ_e oscillations)





The Detector

• Neutrino Event is of form:



 $n + u_e \rightarrow p^+ + e^-$

• The charged particles give off Cerenkov Light, which can be detected in the







Light Injection

 In both experiments, we're working on the Light Injection System, used for calibration



LED Fiber-Optic Cable PMT

Specific Tasks

- Choose LEDs
- Build a box to set the LED frequency, amplitude, on/off, etc., and the codes to run the box
- Build and test the optical fibers
- Use MonteCarlo methods
 to analyze the PMT gain

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<u>Outlook</u>

As neutrino physics develops, the oscillation parameters can be refined.

Hopefully, it will be possible to come up with a theoretical basis for these parameters.

The biggest frontier is money: we have to find a cheaper way to get good results.