

The DONuT Experiment

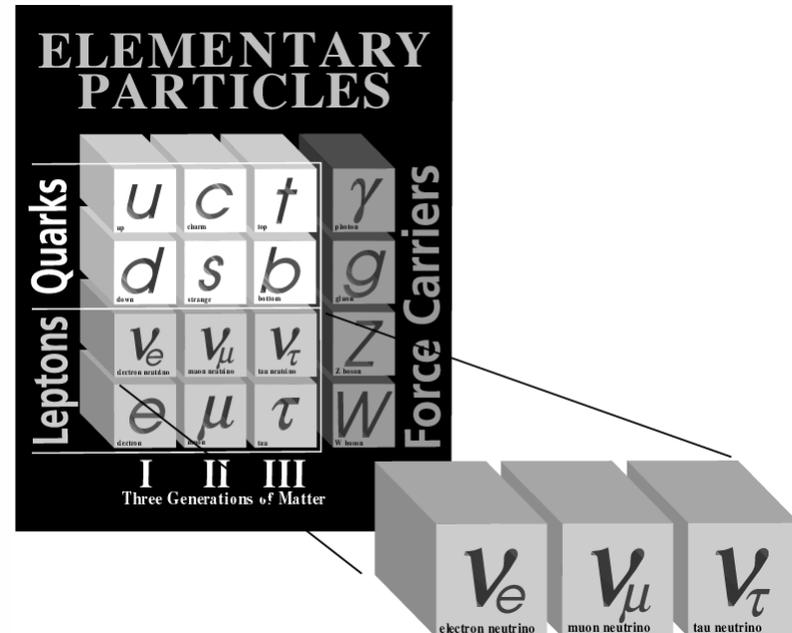
Observations of the Tau Neutrino
Presentation by Suzanne Nichols

Overview

- * Introduction and motivation for the Tau neutrino
- * The DONut Experiment
- * Analysis
- * Results

The Tau Neutrino

- * Member of the third generation of matter
- * Once Tau lepton discovered implied Tau neutrino existence



Properties of Tau Neutrino

- * Chargeless lepton, associated with the negatively charged Tau lepton.
- * Created in weak decays.
 - In this experiment they created specifically Tau neutrinos, but because they have some mass there is a small probability they could oscillate.
- * No magnetic dipole moment predicted by the Standard model.

Motivating the DONuT Experiment

- * There was no direct evidence for the Tau, but there was indirect evidence.
 - Tau lepton
 - Constraints on the total number of neutrinos
 - Nucleosynthesis (from the big bang)
 - Measurement of the Z boson properties
 - No observation of the Tau lepton coupling to the other two neutrinos

The Width of the Z

QuickTime and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Properties of the DONuT

- * The neutrino source was the tungsten beam dump behind the Tevatron.
- * Only 36 feet from source to target.
 - This did not allow enough time for flavor oscillations.
- * The target was made of emulsion sheets, which was used as an electromagnetic calorimeter in some cases.

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TIFF (LZW) decompressor
are needed to see this picture.

Electronics at the DONuT

* Spectrometer

- Tracking
 - Used to assign charge and momentum to observed particles
 - Drift chambers
- Calorimetry and Muon ID.
 - Used to measure energy of incoming neutrinos.
 - To distinguish them from charmed background.

* Working with the Target

- These two worked in tandem to distinguish background (mostly from Muon events.)
- Used to find vertices to track secondary interactions
- Used to identify the leptons.

Analysis- equipment

- * Nuclear Emulsion (taking energy pictures)
- * Emulsion Scanning
 - Completely electronic
 - Stack the sheets and retrace back to the vertex.
- * Measuring the Momenta
 - Use the inversion of the scattering angle as found from the scanning.
- * Since all the data was in digital form they could store lots of data.

Data

* Finding Neutrinos

– Excluding background

- Mostly Muons and Electron interactions
- Misidentification of tracks
- Secondary interactions

– Seeing a Tau

- Momentum $> 1\text{GeV}/c$ for daughter track
- Transverse momentum fits
- Nothing from primary vertex identified as Muon or Electron.

Results and conclusions

- * We have observed the Tau Neutrino!
 - 4 observed Interactions
 - Last Standard Model fermion to find.
 - Still looking for the mass and the magnetic moment.

QuickTime and a
TIFF (LZW) decompressor
are needed to see this picture.

Credits

- * Observations of the Tau Neutrino. Lundberg, Niwa, Paolone. Ann. Rev. Nucl. Part. Sci. 2003, 53:199-218
- * Standard Model picture from <http://www-numi.fnal.gov/public/images/standardmodel.gif>

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