

Previous lecture

■ Parity and violation in weak decays

- ▶ Started description of Wu et al. ^{60}Co experiment

This is a list of a few web pages which I have found more or less interesting, with my personal comments on them.

- [Particle Physics glossary](#)
- [Neutrino Oscillation](#) - pretty comprehensive collection of material
- [Particle Data Group \(PDG\)](#) - a reference source includes:
 - ▷ [Summary Tables](#) - it's a concise digest of all major particles
 - ▷ [Review Tables](#) - Most of these reviews are very good and they cover a wide range of topics
 - ▷ [Full Tables](#) - Heavy going, but contains full details of measurements performed
- [Particle Physics Education pages](#) - wide variety of events, some useful background material here
- [The Durham HEP Database](#) - includes reaction rates, allows you to download and study published experimental data yourself
- [Particle Physics "Toolbox"](#) - useful synoptic description of many aspects of HEP
- [Particle Adventure](#) - possibly interesting, but level of text (and humor) is to be desired
- [The Particle Adventure](#) - possibly interesting, but level of text (and humor) is to be desired
- [HEPnet.org](#) (UK network of HEP preprint server). Very latest papers and conference proceedings usually appear before publication, but note that articles are usually not yet peer reviewed so quality (though usually very good) is not guaranteed.
- [HEP2000](#), European Physical Society High Energy Physics Conference, Aachen, Aug. 2000
- [HEP2001](#), Enrico Fermi, Aug. 2001
- [HEP2002](#) - 10 Nov 2002

Lecture Content

■ Approx. lecture content

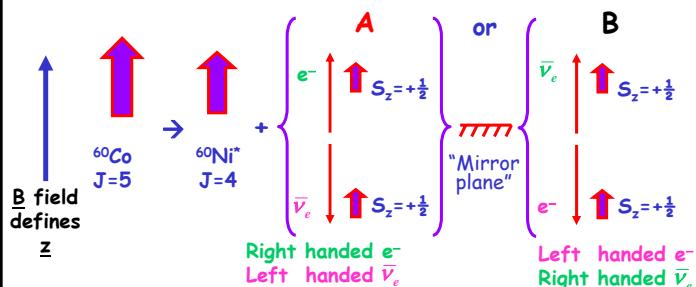
1. PP intro
2. PP intro.
3. v props 1: strong/e.m./weak, no. neutrino generations
4. v props 2: lepton no., v existence
Examples of decay/production
5. Neutrino mass
Fermi-Kurie plot
Phase space kinematics/4-momentum
6. Parity and CP violation... (why so important in lepton sector?)
Wu et al., ^{60}Co experiment
7. Detection & observation
Liquid, solid, bubble chamber
"Direct" methods (DONUT)
8. Solar and atmospheric neutrinos
Puzzle: relative abundances != SSM prediction
Two-flavour neutrino oscillation formalism
9. Neutrino oscillations and mixing
Solutions to solar/atm. v problems
10. Current and future experiments
SK, SNO, KAMLAND, CHOOZ
MINOS, miniBOONE,..
NDBD (NEMO, etc.)
JPARC, VF,
11. Implications for cosmology
Open vs. closed scenarios, various m, regions
v as DM candidate?
Subject outlook (JPARC, MICE, Neutrino Factory, ...)

Today

- Finish Wu et al ^{60}Co parity experiment
- Neutrino detection
 - ▶ inverse β^- decay
 - ▶ Radiochemical detectors (Homestake, Gallex, GNO, SAGE)
- Superkamiokande
- Water Cerenkov detector (Kamiokande, SNO, Super-Kamiokande)
- Next lecture
 - ▶ Super-K data
 - ▶ Oscillations

^{60}Co Parity violation experiment [Wu et al., 1956]

Basic process: $^{60}\text{Co} \rightarrow ^{60}\text{Ni}^+ + e^- + \bar{\nu}_e$
Nuclear spins aligned along z at low temperature ($\sim 0.01\text{K}$)



- When leptons emitted parallel to +/- z, lepton spins constrained along +z
- Scenario B is mirror reflection of A (in plane $\perp z$), i.e. B is equivalent to parity transformed version of A.
- As scenario A is not observed, the weak interaction does change its behaviour during a parity transformation, i.e. parity is violated in the weak interaction

Super-Kamiokande

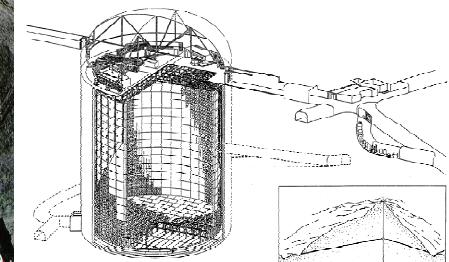


- 1000m below surface
- 41.4m (h) x 39.3 (d)
- mass: 50 000 tonnes
pure H₂O (32k/18k
inner/outer)
- 11 200 x 50cm PMT
- Cerenkov detector

Kamioka Observatory, ICRR (Institute for Cosmic Ray Research),
The University of Tokyo

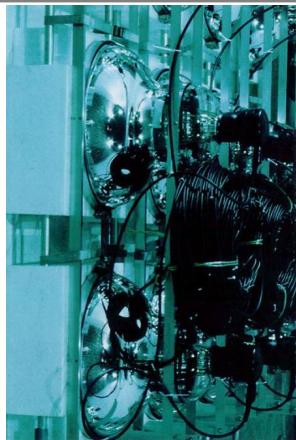
SUPERKAMIKANDE INSTITUTE FOR COSMIC RAY RESEARCH, UNIVERSITY OF TOKYO

Cavern before installation



Situated under mountain, 1km below surface

Photo Multiplier Tubes (PMT)



- 50cm diameter
- world's largest

Instrumenting (top dome)



