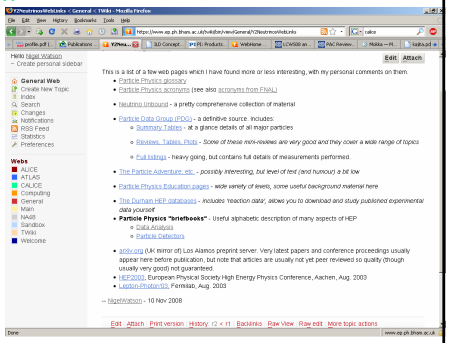
Previous lecture

- Parity and violation in weak decays
  - Started description of Wu et al. ^{60}Co experiment

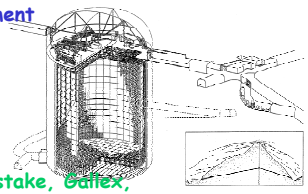


Lecture Content

- Approx. lecture content
  1. PP intro
  2. PP intro.
  3. ν props 1: strong/e.m./weak, no. neutrino generations
  4. ν props 2: lepton no., ν 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. ν problems
  10. Current and future experiments
      SK, SNO, KAMLAND, CHOOZ
      MINOS, miniBOONE,..
      NDBD (NEMO, etc.)
      JPARC, νF,
  11. Implications for cosmology
      Open vs. closed scenarios. various m_ν regions
      ν as DM candidate?
      Subject outlook (JPARC, MICE, Neutrino Factory, …)

Today

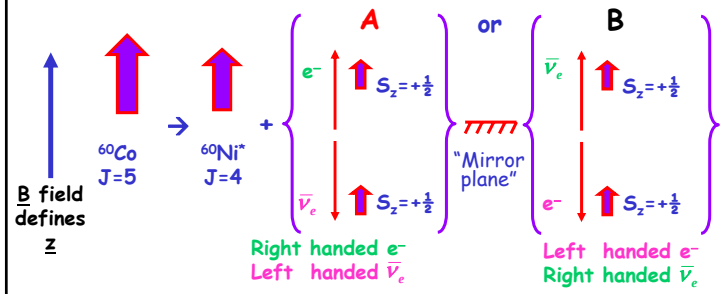
- Finish Wu et al ^{60}Co parity experiment



- 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

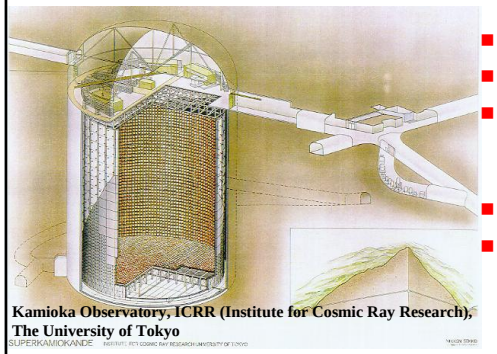
^{60}Co Parity violation experiment [Wu *et al* ,1956]

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



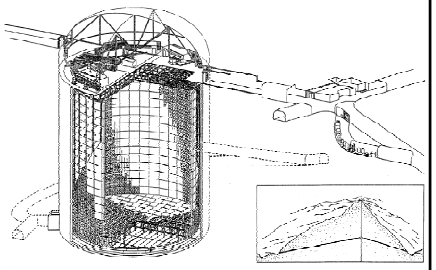
- When leptons emitted parallel to +/- z, lepton spins constrained along +z
- Scenario B is mirror reflection of A (in plane ⊥ z), i.e. B is equivalent to parity transformed version of A.
- As scenario A is not observed, the weak interaction does change its behaviour during a parity transformation, i.e.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

Super-Kamiokande



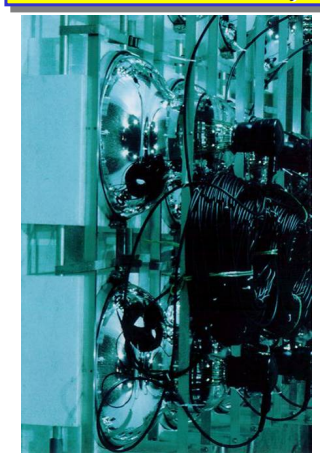
- 1000m below surface
- 41.4m (h) x 39.3 (d)
- mass: 50 000 tonnes
  pure H_2O (32k/18k inner/outer)
- 11 200 x 50cm PMT
- Cerenkov detector

Cavern before installation



Situated under mountain, 1km below surface

Photo Multiplier Tubes (PMT)



- 50cm diameter
- world's largest

Instrumenting (top dome)