Outline

- Relativistic Kinematics
  - (4-momentum)2 invariance, invariant mass
  - Hypothesis testing, production thresholds
  - Cross-sections, flux and luminosity, accelerators
  - Particle lifetime, decay length, width
- Classification of particles
  - Fermions and bosons
  - Leptons, hadrons, qu
  - Mesons, baryons
- Quark Model
  - Meson and baryon multiplets
  - Isospin, strangeness, c, b, t quarks
- Particle Interactions
  - Colour charge, QCD, gluons, fragmentation, running couplings
  - Strong and weak decays, conservation rules
  - Virtual particles and range of forces
  - Parity, charge conjugation, CP
  - Weak decays of quarks
  - Ch
- Elect
  -
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- LHC
- Futur

Today

- Lecture 18 (4 slides/page) - Parity violation in weak interaction, helicity
  - Williams, pp. 305-310; see also Lecture 17 textbook references.
  - Halzen and Martin. p. 254
  - C.S. Wu, E. Ambler, R.W. Hayward, D.D. Hoppes, R.P. Hudson, "Experimental Test of Parity Conservation in Beta Decay", Phys. Rev. 105, 1413 (1957).

Previous lecture

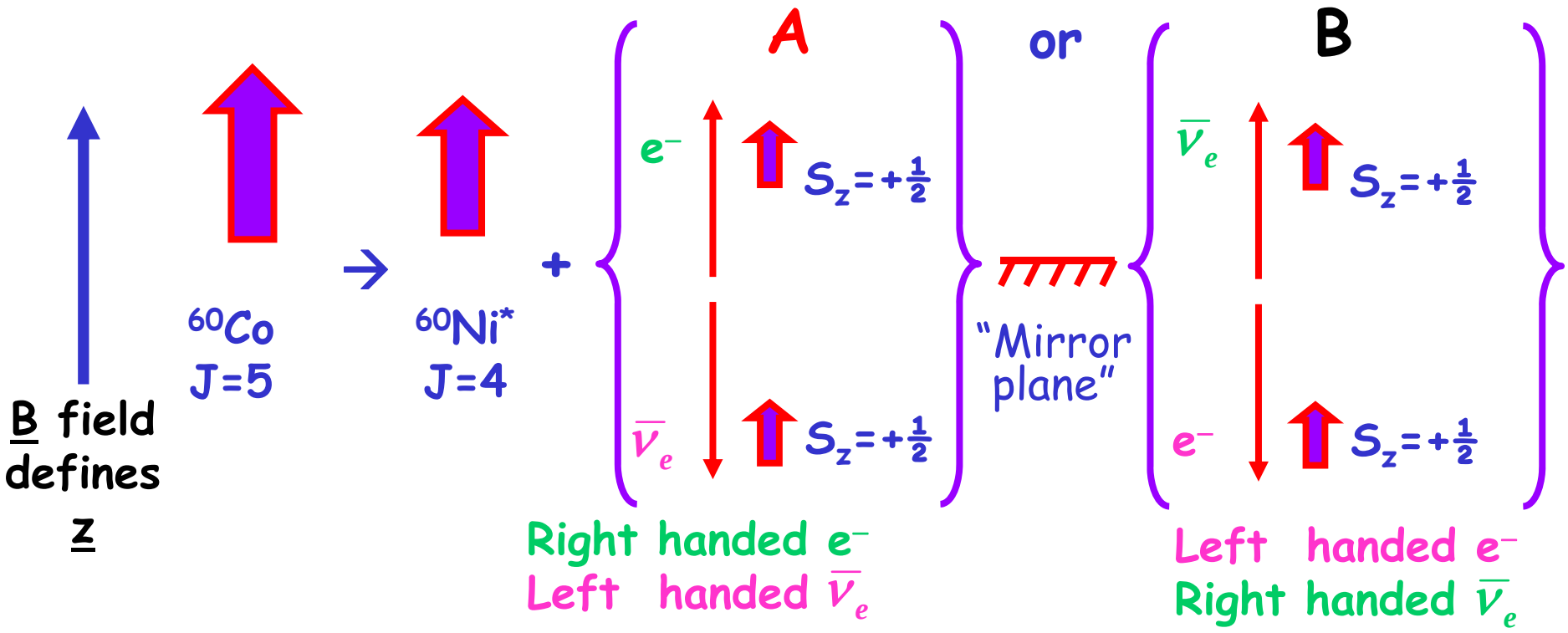
- Lecture 17 (4 slides/page) - Parity, Charge conjugation, Time reversal symmetries
  - Griffiths, pp. 136-144, 149-151, 161.
  - Perkins, pp. 71-76, 83-86,
  - Some experimental studies of T/CPT invariance
    - CERN Press Release, 7 Mar 2012 NEW 1st resonant transitions measured in antihydrogen
    - Phys. Rep. : 374 (2003) , pp.165-270, *Physics at CPLEAR*, A. Angelopoulos et al. (CPLEAR Collaboration), pg ~171.
    - preprint CERN-EP-2001-060, *T-violation and CPT-invariance measurements in the CPLEAR experiment: a detailed description of the analysis of neutral-kaon decays to e pi nu* , Angelopoulos et al.
    - Phys. Rev. D 83, 092001 (2011), *Precise Measurements of Direct CP Violation, CPT Symmetry, and Other Parameters in the Neutral Kaon System*

P and T transformations

Observable	Parity transform	Time, T, transform
Position, **r**	-**r** (vector)	**r**
Momentum, **p**	-p (vector)	-p
Spin, σ	σ (axial vector)	–σ
Longitudinal polarisation, σ.**p**	-σ.p (pseudoscalar)	σ.p
Electric field, **E**	-**E** (vector)	**E**
Magnetic field, **B**	**B** (axial vector)	-**B**
Magnetic dipole moment, σ.**B**	σ.**B** (scalar)	σ.**B**
Electric dipole moment, σ.**E**	-σ.**E** (pseudoscalar)	-σ.**E**

^{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