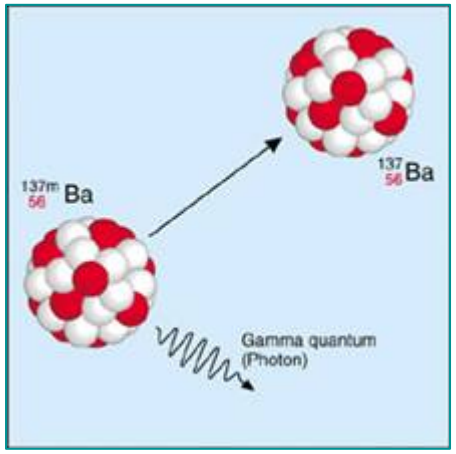
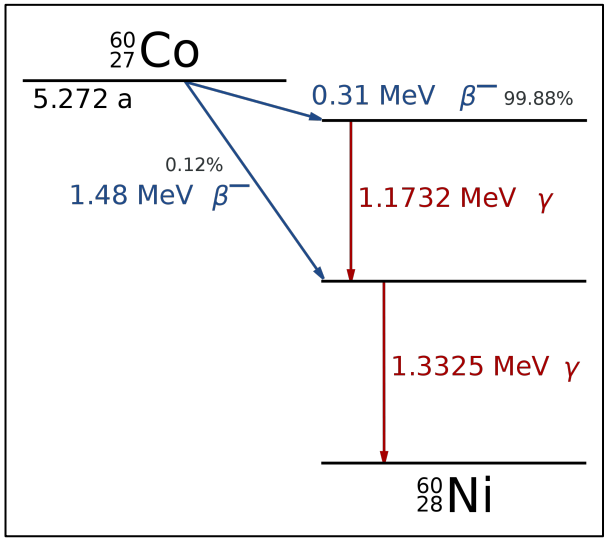
Electromagnetic (gamma) decay

Coupling between nucleons and EM field

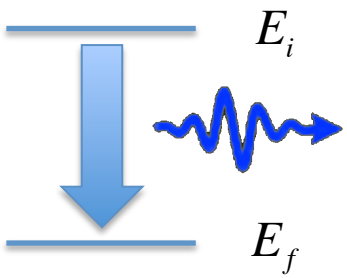




- Electromagnetic and weak interactions can be treated as perturbations
- Emission of a γ-ray is caused by the interaction of the nucleus with an external electromagnetic field
- Besides γ-decay, electromagnetic perturbation can also induce nuclear decay through *internal conversion* whereby one of the atomic electrons is ejected. This is particularly important for the heavy nuclei.
- The decay can also proceed by *creating an electron-positron pair* (internal pair creation)
- Since the nuclear wave function has a definite angular momentum, the external EM field has to be decomposed in spherical multipoles. The quantization and multipole expansion of EM field is straightforward by *tedious*.

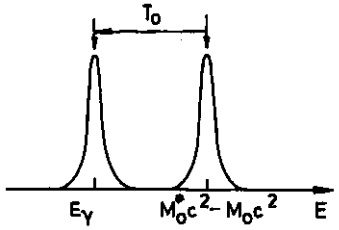
Electromagnetic Decay

Kinematics of photon emission



$$E_i = E_f + E_\gamma + T_0$$

recoil term



$$T_0 \approx \frac{E_\gamma^2}{2M_0c^2}$$

For A=100 and E_γ=1 MeV, the recoil energy is about 5 eV. But the natural linewidth of the radiation is even smaller.

The emission of photons without recoil is possible if one implants the nucleus in a lattice. In such a case, the recoil is taken by the whole lattice and not by a single nucleus. If

$$\hbar\omega_{lattice} >> T_0$$

then, quantum-mechanically, the energy of the emitted gamma radiation takes away the total energy difference (Mössbauer effect – 1958 – or recoilless nuclear resonance fluorescence).