**Gamma-transition** (Status: rough draft)

An excited Gd decays by gamma()-transition, which includes three electromagnetic decay processes; -emission/decay, internal conversion (IC) and internal pair production. Gamma-decay sends out an high energy photons, IC kicks out an orbital electron and pair production produces an electron-positron pair. **More on each process in section ??** The propriety of each process is determined by he final and intial QM state of the transition.

~~Quantities such as energy, angular momentum and parity must be consereved during a transition between QM states.~~

Decay by gamma-emission is only allowed between states of different angular momentum. Angular momentum is the sum of intrinsic angular momentum (also known as spin) and orbital angular momentum. The change in spin of the nucleus can be written as:

Initial and final angular momentum is labeled as and , respectively, where is one angular momentum unit. In 1931 it was experimentally proven by C.V Raman and S. Bhagavanta. [[\*](http://dspace.rri.res.in/bitstream/2289/2123/1/1931%20IJP%20V6%20p353.pdf)] a photon possesses an intrinsic spin equal to one unit of angular momentum (. Since angular momentum must be conserved and a photon carries spin only transitions where are allowed for single photon emission.

There are some cases where the first excited state and ground state both have spin 0. Following the gamma-decay selection rules, a transitions between states of spin 0 are prohibited. In these cases the nucleus may de-exite through internal conversion or pair production (if the energy is greater than the collective mass of an electron and a positron, i.e. 1.022MeV). Can IC happen even if delta I not = 0?

Just like angular momentum, the systems energy and parity are conservative quantities. Gamma-decay emits a photon. The photon must have an energy equal to the energy difference between initial and final state:

**If the nucleus transitions between states of different parity, the photon ???**

**Does the photon carry parity? How is it convserved?**

Internal conversion (IC) kicks out an orbital electron, known as an IC electron. ~~If the nucleus decays by internal conversion an orbital electron is kicked out.~~ The electrons kinetic energy equals the difference between final and initial minus its binding energy, i.e. the work needed to free the electron.

Something on pairproduction and conservartion of energy?

**Branching ratio**

**Conversion coefficient**

**Decay of Gadolinium**

**Decay of Gadolinium (draft/brainstorm)**

After neutron capture, Gd-156 and Gd-158 are in an excited state, a neutron capture state. The neutron capture state of Gd-156 and Gd-158 has excitation energy 8.5 MeV and 7.9 MeV, respectively, and identical spin-parity . Both isotopes have ground state with spin-parity , as **all** (?) even-even nucleus do. [MODERN NUCLEAR CHEMISTRY]

The excited Gd-nucleus may transition once or several times before reaching ground state. As long as decay by gamma-emission is allowed.

As the excitation energy decreases, energy available for a gamma decay decreases and the probability of IC increases.

Facts: Gd states, excited and ground.

* First excited state of Gd??
* ∆E from first to ground is less than 1.022MeV? So no (e-e+)-pair?
* Gamma and Ice are of interest and are commonly used as signal generating particles. Deposit energy in detectors like … and … . Different detectors use different particles.

Types of detectors used?

* Their energy spectrum.

How does it decay?

* Q: maximum energy a photon can have
* De-excites in one decay, but usually an avg. of 4 gamma decay (ref.?)
* First-generation: larges energies
* N-generation: lower energy

Parity??

* Type of gamma

Concservation of energy

* Photon
* Electron/resulting particlss

Conservation of spin

* Determine the type of
* (-1)^1+j: magnetic 2j -pole
* (-1)^j: electric 2j -pole

Find

* Fist excited state, spin.
* Neutron capture state, spin and energy
* Photon spin ref. : **OK**
* Read more about IC
  + Decreasing excitation energy