Hyperfine splitting in ESR spectroscopy

Interaction between electron spin and nuclear spin is known as hyperfine interaction, due to this interaction ~~ESR~~ splitting of ESR signals take place and this splitting is known as hyperfine splitting.

When the electron spin interacts with nuclear spin then each electron spin state split into $(2I+1)$ levels this splitting is known as hyperfine splitting.

Nuclei are also known to have spin, but the nucleus contain protons and neutrons, each having spin $1/2$.

Following are some rules to determine nuclear spin.

(1) A nucleus with an even number of Proton and even number of neutron has Zero spin $I=0$,

e.g ^{12}C, ^{16}O, ^{4}He, ^{32}S $I=0$

(2) A nucleus with an odd number of proton and odd number of neutron has an Integral spin.

e.g ^{2}H, ^{14}N $I=1$, ^{10}B $I=3$.

(3) A nucleus with an odd mass has half integral spin

^{1}H, ^{13}C, ^{19}F $I=1/2$

Nuclear spin quantum number I may have several nuclear spin ~~quantum~~ angular quantum numbe ~~ray~~ ranging from $+I$ to $-I$

Thus if $I = 1$, m_I may $= +1, 0, -1$

$I = 1/2$ $\quad m_I = +\frac{1}{2}, -1/2$

$I = 7/2$ $\quad m_I = +7/2, +5/2, +3/2, +1/2, -1/2, -3/2, -5/2,$

ie total $(2I+1)$ values

Simply hyperfine splitting is nothing but $(2I+1)$ values

ESR Selection rules

~~ES~~ $\Delta m_s = \pm 1$

$\Delta m_I = 0$

] transition between states of same multiplicity.

e.g ~~four~~ for hydrogen (^1H)

* one unpaired electron ($m_s = \frac{1}{2}$) of hydrogen interacts with nuclear spin.
* I value of hydrogen is $1/2$, therefore $m_I = +1/2$ and $-1/$
* Each m_I state will interact with m_s value and split into $2I+1$