Laser spectroscopy at TITAN

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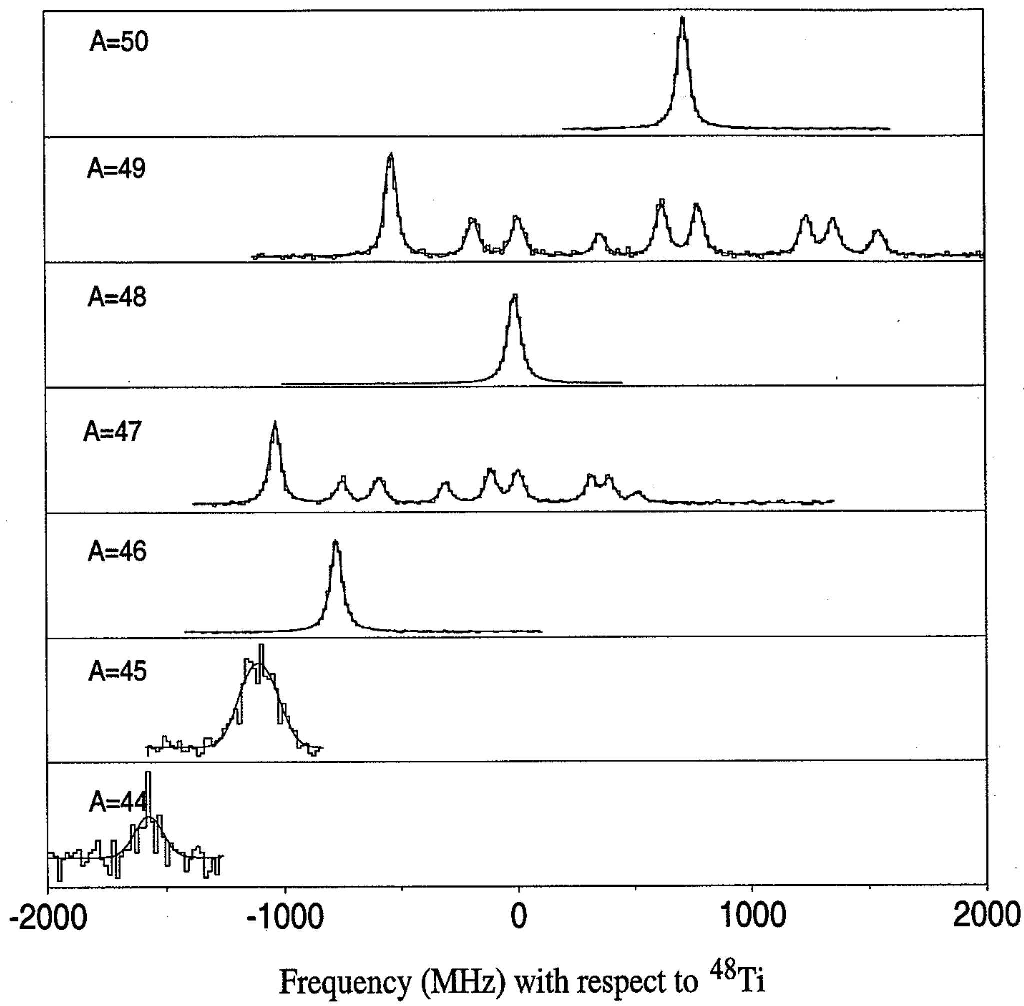
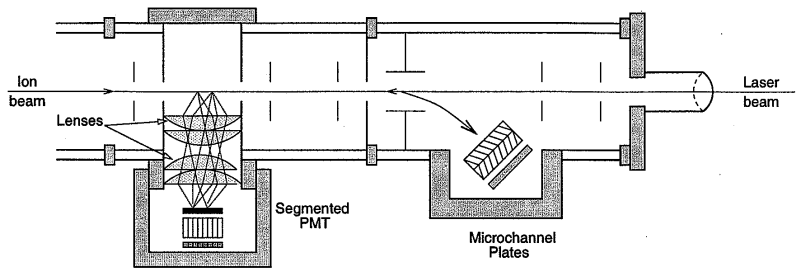
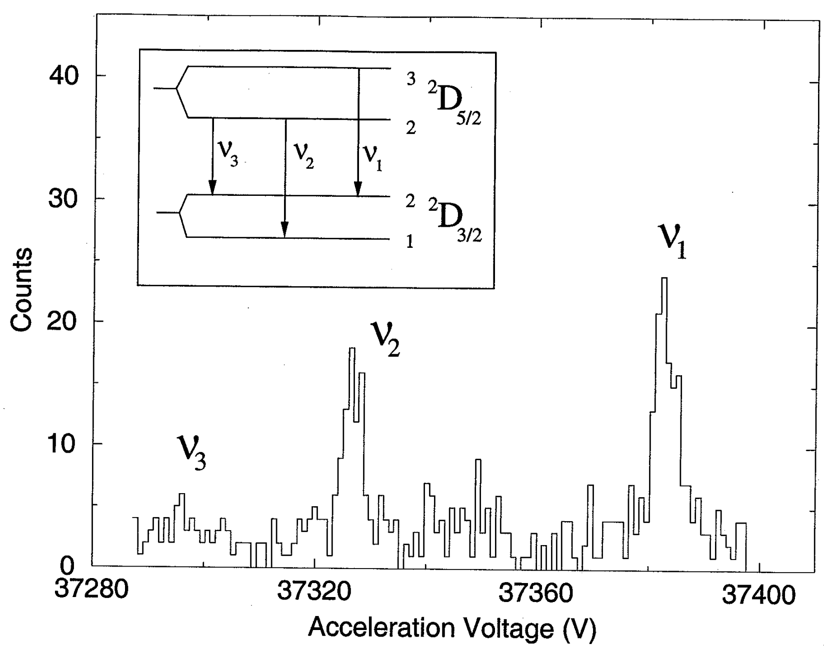
And the data is *moderately* simple to analyse



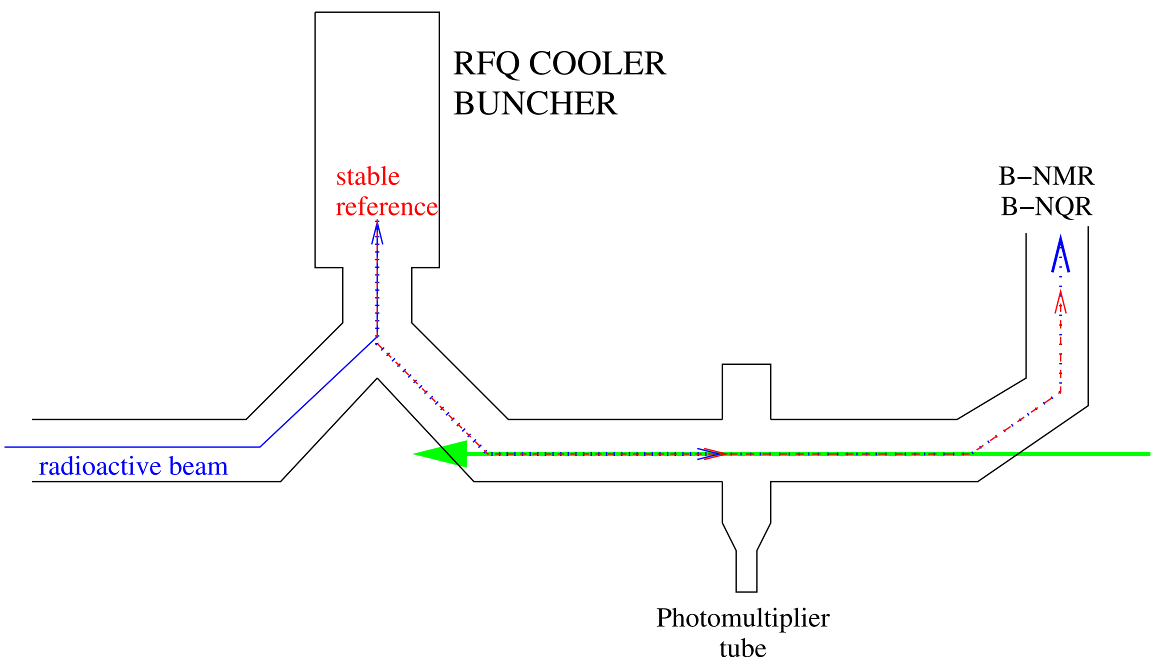
data taken in Jyväskylä by the Manchester group



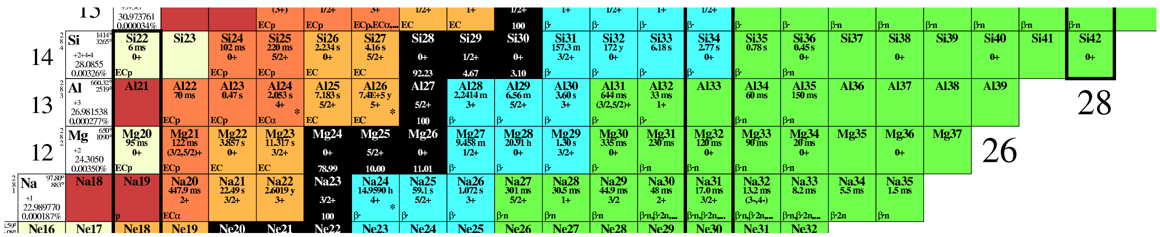
Increase sensitivity by looking for the ion/atom that emitted the photon



cool and bunch using TITAN cooler and buncher



example Aluminium

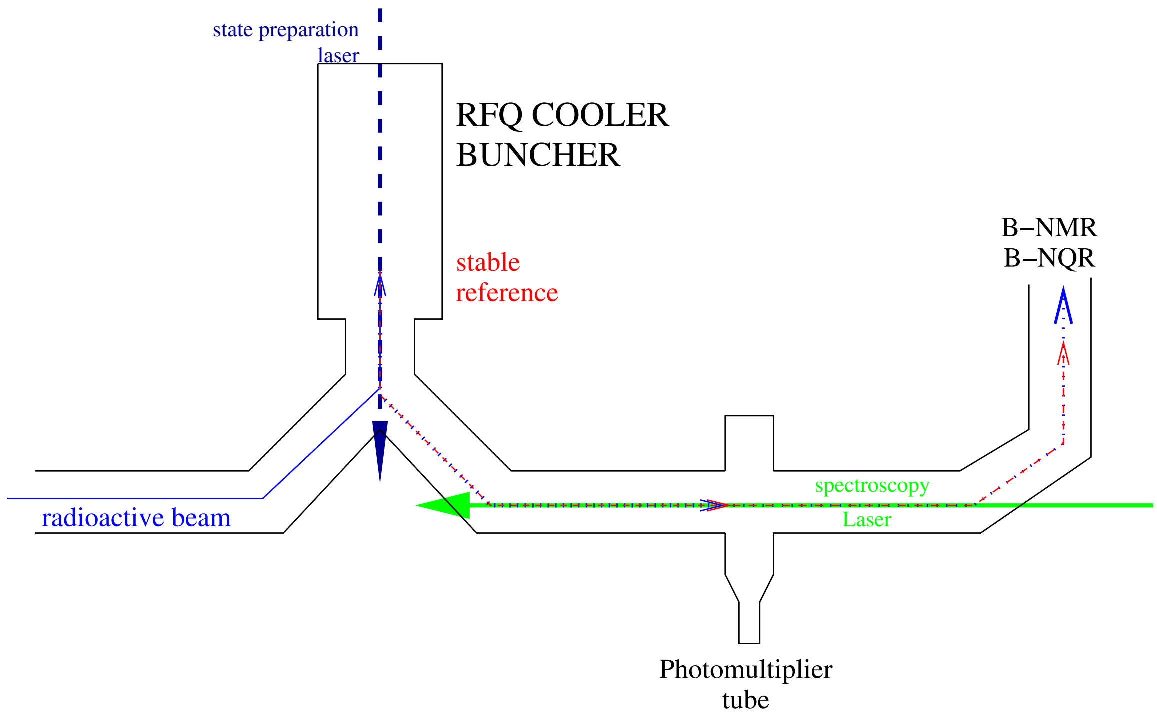


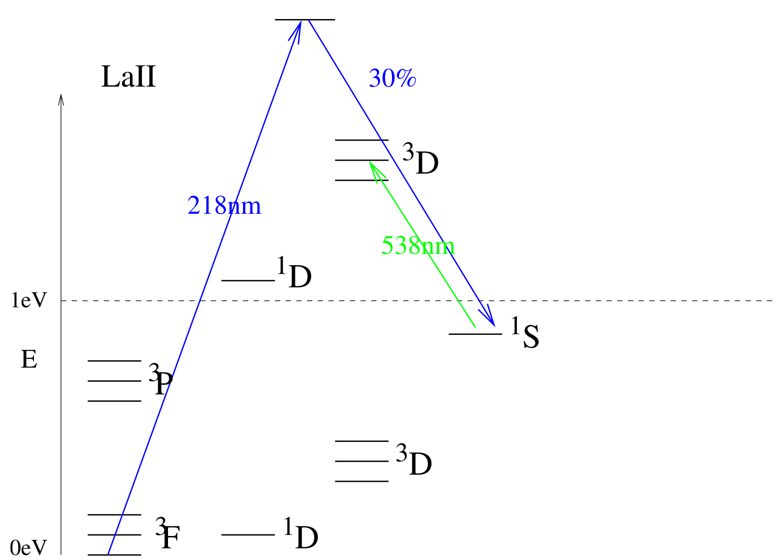
- isotopic chain runs from drip line to drip line

- Na extensively studied at ISOLDE, Mg under investigation

- N=20 neutron magic number known to not be good far from stability

Other possibilities with the RFQ cooler and buncher.





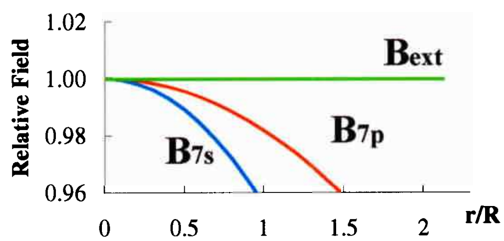
The Hyperfine Anomaly in $^{208\text{-}212}$Fr

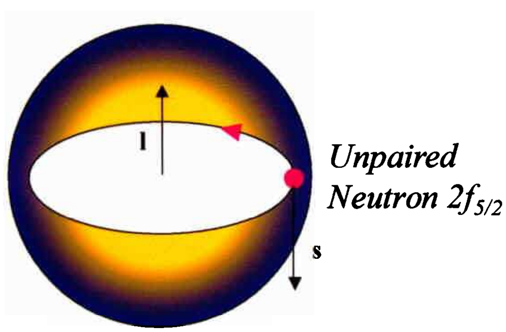
The magnetic hyperfine structure arises from the interaction of nuclear magnetic moment and the magnetic field of electrons at the nucleus.

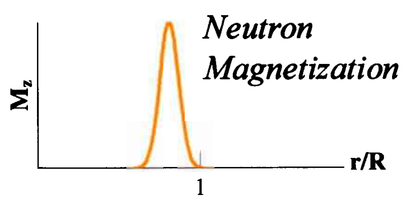
-- A depends upon $\mathbf{B}(r)\cdot\mu_I$.

-- 7s and 7p states have different radial wavefunctions, and thus sample the nuclear magnetic distribution differently. (hyperfine anomaly)

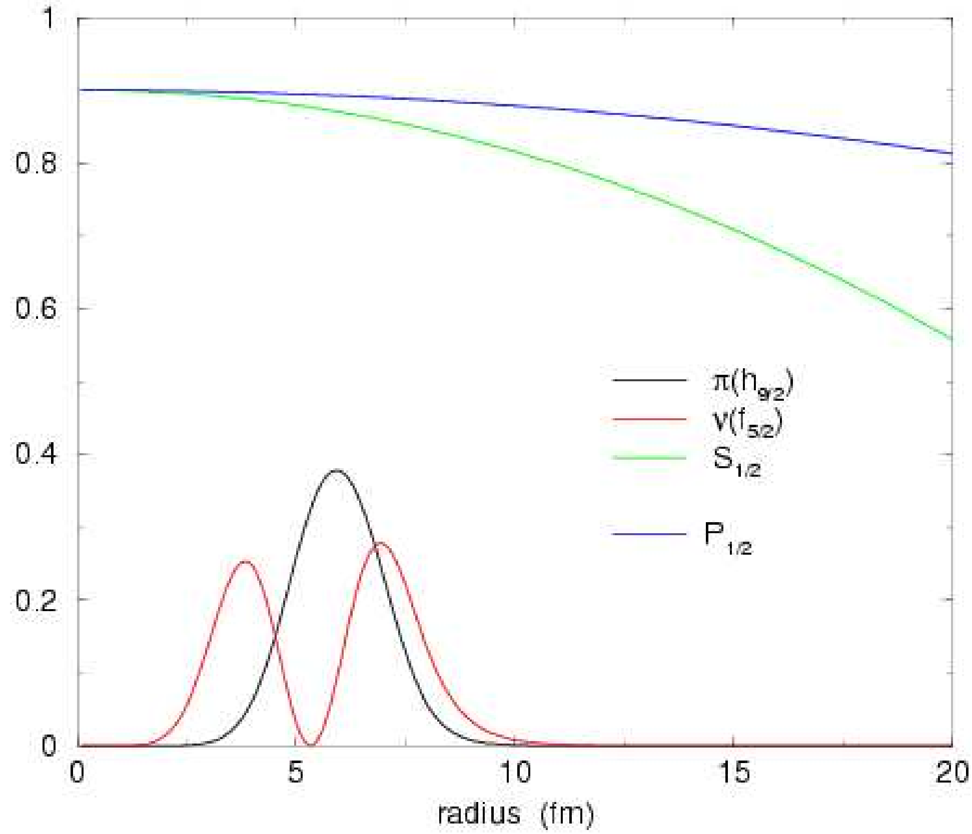
-- Is A_{7s} / A_{7p} isotope dependent?



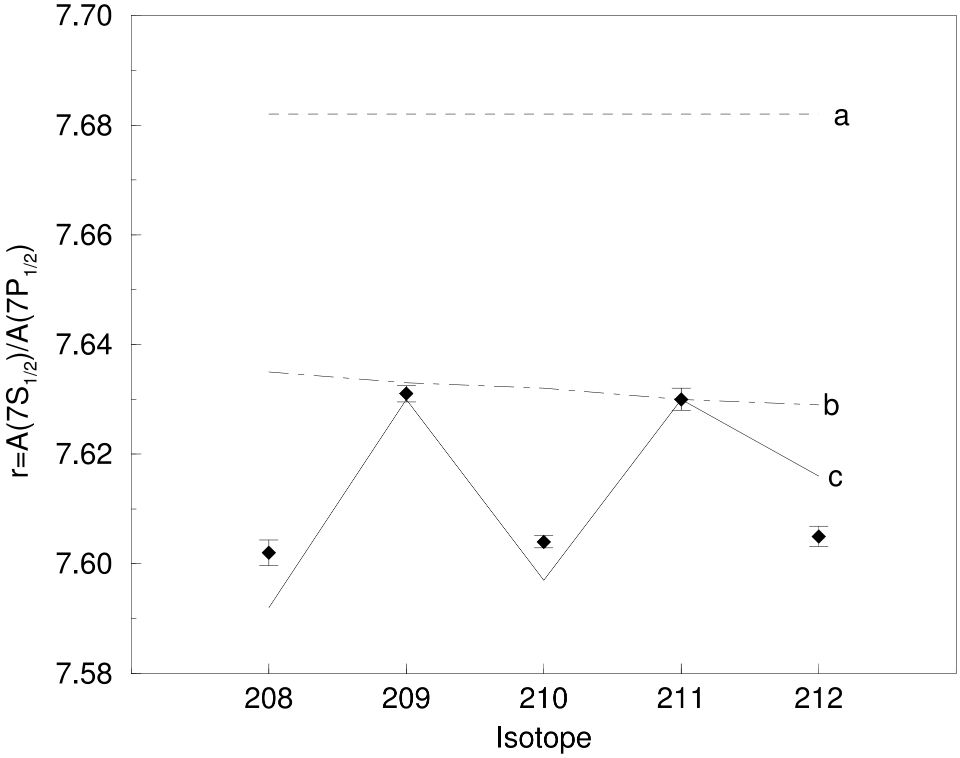




Change in electron wave-functions across the nucleus



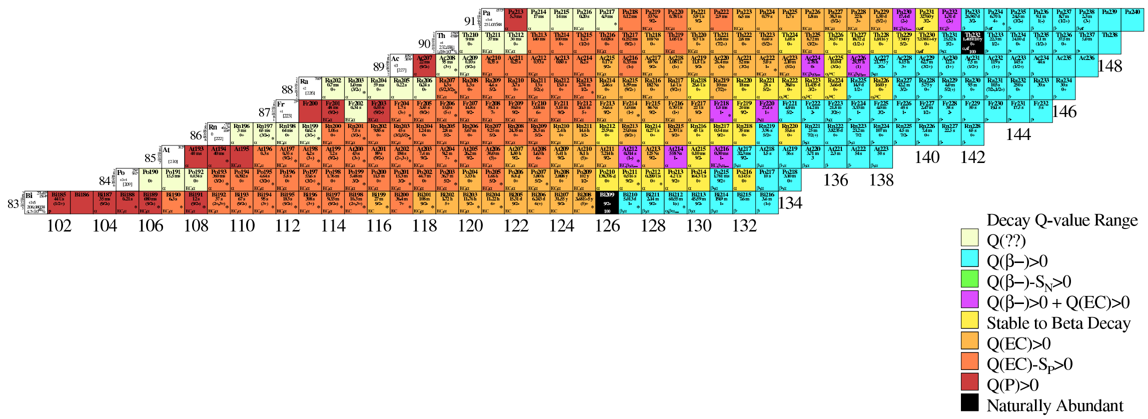
Results



Approved experiment E1010 to extend these measurements well into the next neutron shell

Using the ebit any element can be made to have an alkali like atomic structure

- H-like $1s$
- Li-like $1s^2 2s$
- Na-like $1s^2 2s^2 2p^6 3s$
- K-like $1s^2 2s^2 2p^6 3s^2 3p^6 4s$
- Cu-like $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s$
- Pm-like $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s$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146
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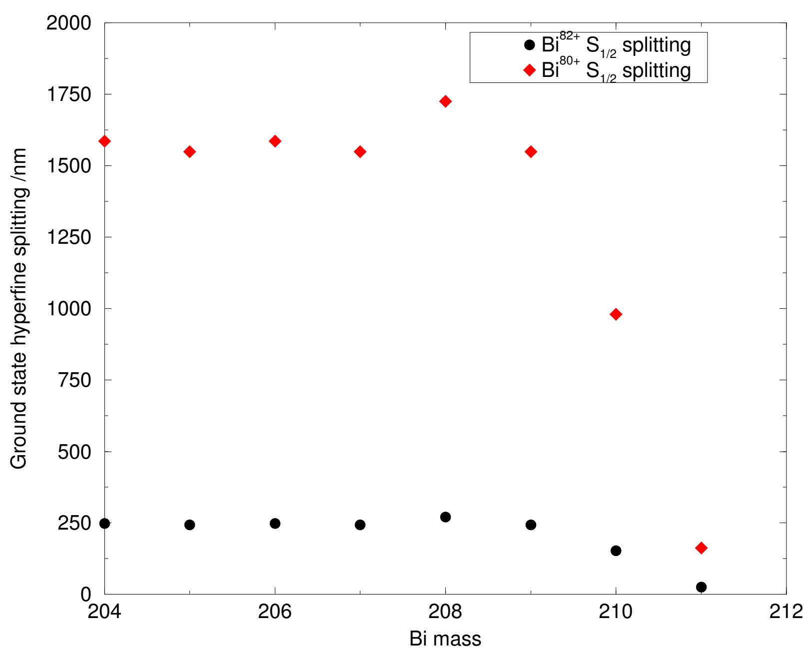
Decay Q-value Range
Q(??)
Q(β–)>0
Q(β–)-S$_N$>0
Q(β–)>0 + Q(EC)>0
Stable to Beta Decay
Q(EC)>0
Q(EC)-S$_P$>0
Q(P)>0
Naturally Abundant


Bi^{82+} S$_{1/2}$ splitting
Bi^{80+} S$_{1/2}$ splitting
Ground state hyperfine splitting /nm
Bi mass
2000
1750
1500
1250
1000
750
500
250
0
204
206
208
210
212

Hyperfine structure of highly charged ions

for hydrogen like ions

$$\Delta E_{s_{1/2}} = \frac{4\alpha^4 Z^3}{3}\frac{\mu_I}{\mu_N}\frac{m_e}{m_p}\frac{2I+1}{2I}\frac{mc^2}{(1+\frac{m_e}{M})^3}$$

$$\times \quad [A\alpha Z(1-\delta)(1-\epsilon)+\kappa_{rad}]$$

for Li like ions

$$\Delta E_{s_{1/2}} = \frac{1}{6}\alpha\,(\alpha Z)^3\,\frac{m_e}{m_p}\frac{\mu_I}{\mu_N}\frac{2I+1}{2I}\frac{mc^2}{(1+\frac{m_e}{M})^3}$$

$$\times \quad \left[A\alpha Z+\frac{1}{Z}B\alpha Z+\frac{1}{Z^2}R(z,\alpha Z)\right]$$

$$\times \quad [(1-\delta)(1-\epsilon)(1+\kappa_{rad})]$$