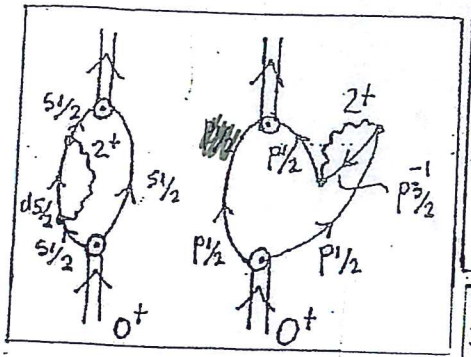
corrected 30/11/17

^{11}Li - halo



MeV
$\varepsilon_{s1/2} = 1.5$
$\varepsilon_{p3/2} = -4.7$
$\varepsilon_{d5/2} = 3.5$
$\varepsilon_{p1/2} = -1.2$
bare sp

WS potential $R_0 = 1.2A^{1/3}$ fm = 2.7 fm

① $U = U_0(+0.4E)$ → (exchange; Pauli)

$R(^{11}Li) = 4.58 \pm 0.13$ fm $\quad \Theta = \left(\frac{R_0}{R}\right)^3 = \left(\frac{2.7}{4.58}\right)^3 \approx 0.2$

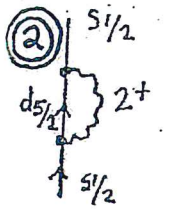
$m_k = \frac{m}{(1+\Theta \times 0.4)} \approx \frac{m}{1.08} \approx 0.93m$

$^9_3Li_6$; $U_0 = (-51+30\frac{N-Z}{A})$ MeV = -43 MeV clothing sp $\langle R_0 \partial U/\partial r\rangle \approx 1.4 U_0 \approx -60$ MeV; $\langle j \| Y_2 \| 1/2\rangle \approx ((2j+1)/4\pi)^{1/2} \approx 0.7$

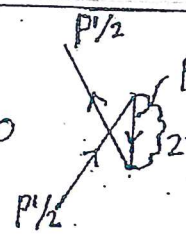
$\hbar\omega_{2^+} = 3.33$ MeV; $\beta_2 = 0.66$

input

$\langle H_c \rangle = \frac{\beta_2}{\sqrt{5}} \langle R_0 \frac{\partial U}{\partial r} \rangle \Theta \langle j \| Y_2 \| 1/2 \rangle \approx \frac{0.7}{\sqrt{5}} \times (-60\text{ MeV}) \times 0.2 \times 0.7 \approx -3$ MeV.

② 

$\begin{pmatrix} (6.8-\lambda) & -3 \\ -3 & (1.5-\lambda) \end{pmatrix} = 0$ MeV

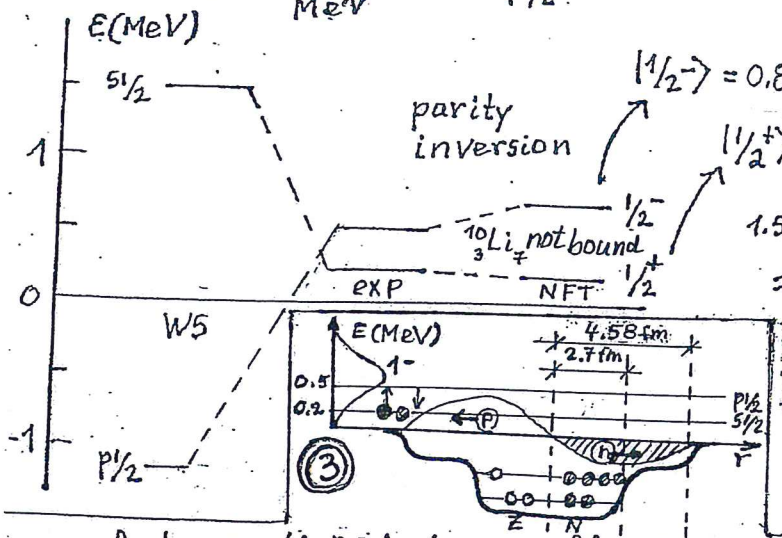


$\begin{pmatrix} (5.6-\lambda) & -3 \\ -3 & (-1.2-\lambda) \end{pmatrix} = 0$ MeV ;

diagonalization

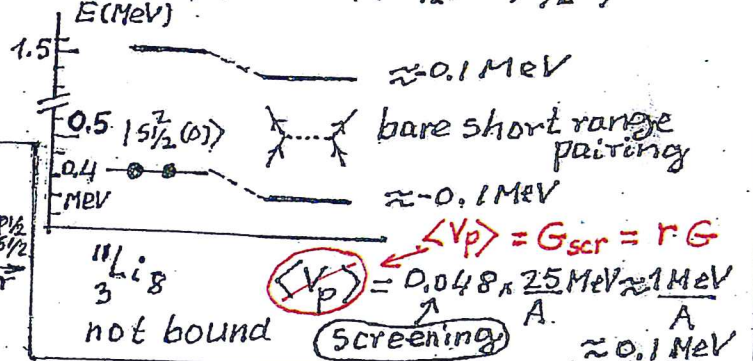
$\tilde{\varepsilon}_{s1/2} = 0.15$ MeV

$\tilde{\varepsilon}_{p1/2} = 0.6$ MeV



$|1/2^-\rangle = 0.86\,|p_{1/2}\rangle + 0.51\,|((p_{1/2}, p^{-1}_{3/2})_{0^+} \otimes 2^+)\, p_{1/2}; 1/2^-\rangle$

$|1/2^+\rangle = 0.91\,|s_{1/2}\rangle + 0.41\,|(d_{5/2} \otimes 2^+)\, 1/2^+\rangle$



$\langle V_p \rangle = G_{scr} = r \cdot G$

$\langle V_p \rangle = 0.048 \times \frac{25\text{ MeV}}{A} \approx \frac{1\text{ MeV}}{A} \approx 0.1$ MeV (screening)

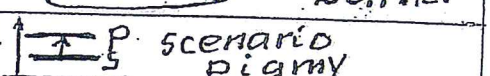
halo-anti pairing effect s,p at threshold

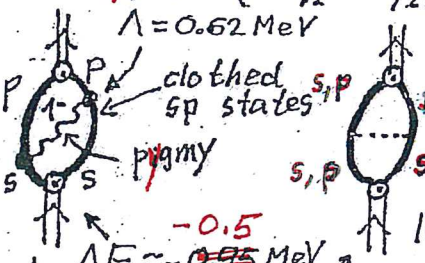
$H_D = K_1 \vec{D}\cdot\vec{D}^+ \quad K_1 = \cancel{5} K_1^0 \; ; \; K_1^0 \sim 5V_1 = \cancel{165}\,125$ MeV (screening)

$K_1 \sim \cancel{12}\,5.6$ MeV ($s \approx \cancel{0.07}\,0.045$) ;

$\hbar\omega_{pigmy} = \left((\varepsilon_{1/2^+} - \varepsilon_{1/2^-})^2 + K_1 \times (2 \times \cancel{0.08}\,0.08\,TRK)^2\right)^{1/2} \approx \cancel{0.8}\,0.9$ MeV

$(B\%)TRK = \frac{9}{4\pi}\frac{\hbar^2}{2M}\frac{NZ}{A}e^2$





$\Lambda^2 \approx \cancel{0.4}\,0.25$ MeV^2

$E_{corr} \approx |2\tilde{E}_{s1/2} + \Delta E_b + \Delta E_{ind}| = |0.4 - 0.1 - \cancel{0.05}\,0.5|$ MeV $\approx \cancel{0.7}\,0.2$ MeV

no absolute value !!

$(E_{corr})_{exp} \approx 0.380$ MeV

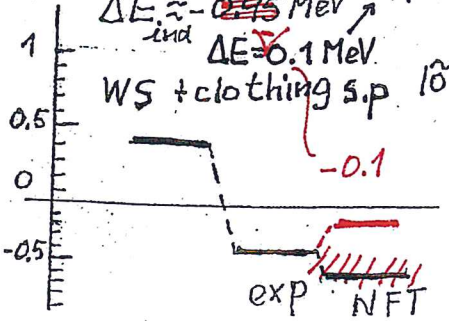
$\Delta E_{ind} \approx -\cancel{0.5}\,-0.5$ MeV

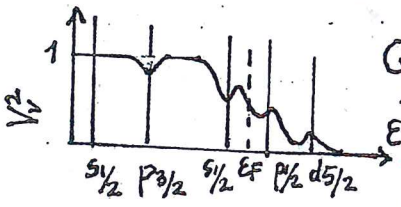
$\Delta E = \cancel{0.6}\,0.1$ MeV

$|\tilde{0}\rangle = |0\rangle_\nu + 0.7\,|(p_{1/2}, p^{-1}_{3/2})_{1^-} \otimes 1^-; 0\rangle + 0.1\,|s_{1/2}, d_{5/2})_{2^+} \otimes 2^+; 0\rangle$

$|\tilde{0}\rangle = |0\rangle_\nu = 0.45\,|s^2_{1/2}(0)\rangle + 0.55\,|p^2_{1/2}(0)\rangle + 0.04\,|d^2_{5/2}(0)\rangle$

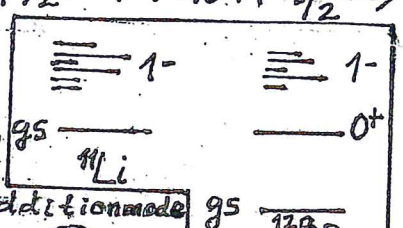
WS + clothing s.p





QRPA symbiotic bootstrap

ε_ν



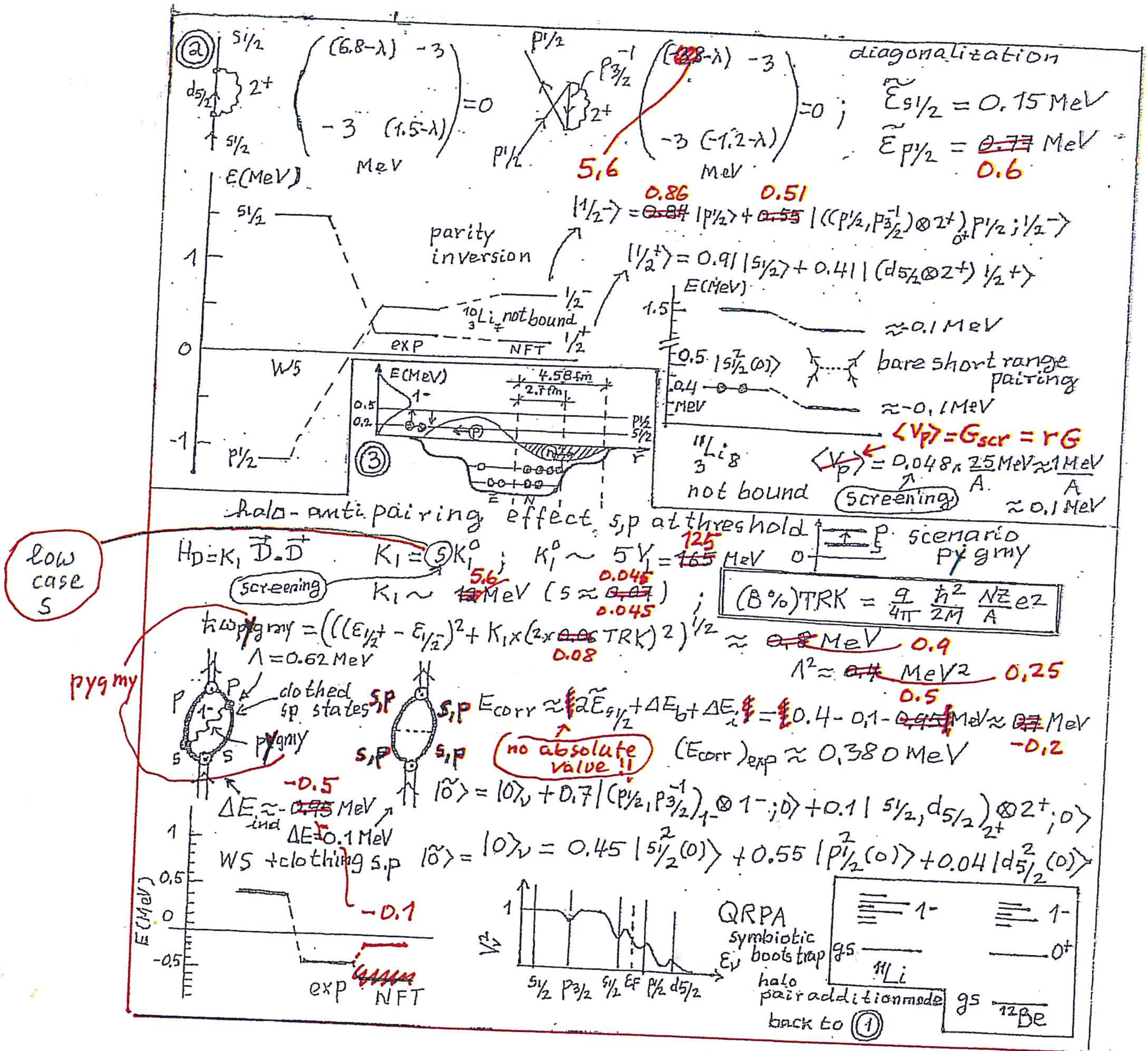

diagonalization
$\tilde{\varepsilon}_{s1/2} = 0.15$ MeV
$\tilde{\varepsilon}_{p1/2} = 0.77$ MeV 0.6
parity inversion
$|1/2^-\rangle = 0.84\,|p_{1/2}\rangle + 0.55\,|((p_{1/2}, p_{3/2}^{-1}) \otimes 2^+)_{0^+} p_{1/2}; 1/2^-\rangle$
$|1/2^+\rangle = 0.91\,|s_{1/2}\rangle + 0.41\,|(d_{5/2} \otimes 2^+)\,1/2^+\rangle$
$^{10}_{3}$Li not bound
exp
NFT
WS
E(MeV)
4.58 fm
2.7 fm
bare short range pairing
≈ 0.1 MeV
≈ -0.1 MeV
$\langle V_p \rangle = G_{scr} = rG$
$\langle V_p \rangle = 0.048 \times \frac{25\,\text{MeV}}{A} \approx \frac{1\,\text{MeV}}{A}$
$^{11}_{3}$Li$_8$ not bound
screening
halo-anti pairing effect s,p at threshold
scenario pygmy
low case s
$H_D = K_1\,\vec{D}\cdot\vec{D}$
$K_1 = s K_1^0$; $K_1^0 \sim 5V_1 = 165$ MeV 125
$K_1 \sim 12$ MeV 5.6 ($s \approx 0.07$) 0.045
$(B\%)\,TRK = \frac{9}{4\pi}\frac{\hbar^2}{2M}\frac{NZ}{A}e^2$
$\hbar\omega_{pygmy} = ((\varepsilon_{1/2^+} - \varepsilon_{1/2^-})^2 + K_1 \times (2 \times 0.06\,TRK)\,2)^{1/2} \approx 0.8$ MeV 0.9
$\Lambda = 0.62$ MeV
$\Lambda^2 \approx 0.4$ MeV^2 0.25
pygmy
clothed sp states
$E_{corr} \approx 2\tilde{\varepsilon}_{s1/2} + \Delta E_b + \Delta E_{ind} = 0.4 - 0.1 - 0.95$ MeV ≈ 0.7 MeV -0.2
no absolute value!!
$(E_{corr})_{exp} \approx 0.380$ MeV
$\Delta E_{ind} \approx -0.95$ MeV -0.5
$\Delta E = 0.1$ MeV
WS + clothing s.p
$|\tilde{0}\rangle = |0\rangle_\nu + 0.7\,|(p_{1/2}, p_{3/2}^{-1})_{1^-} \otimes 1^-; 0\rangle + 0.1\,|(s_{1/2}, d_{5/2})_{2^+} \otimes 2^+; 0\rangle$
$|\tilde{0}\rangle = |0\rangle_\nu = 0.45\,|s_{1/2}^2(0)\rangle + 0.55\,|p_{1/2}^2(0)\rangle + 0.04\,|d_{5/2}^2(0)\rangle$
-0.1
QRPA
symbiotic boots trap
halo pair addition mode
back to (1)
^{11}Li
^{12}Be
gs

Figure 1.9.1