- **Input and output files**

$^{6}Li = ^{4}He + 1p + 1n$

## Results

| File name | File size | Download | Display |
|---|---|---|---|
| save_input_ui.txt | 0.08 KB | Download | Display |
| summary_Li6_ckpot.txt | 1.71 KB | Download | Display |
| log_Li6_ckpot_m0p.txt | 10.23 KB | Download | Display |
| log_Li6_ckpot_tr_m0p_m0p.txt | 7.19 KB | Download | Display |
| ckpot.snt | 1.64 KB | Download | Display |

input

input

## • Input

$^{6}Li = ^{4}He + 1p + 1n$

1

```
N
ckpot.snt
1,1

5
0
0
eff_charge = 1.5, 0.5
gl = 1.0, 0.0
gs = 3.910, -2.678

Y
```

2

```
N
ckpot.snt
1,1


0+2,1+1,2+1,3+1
0
0
 eff_charge = 1.5, 0.5
 gl = 1.0, 0.0
gs = 5.586, -3.826

Y
```

**save_input_ui.txt**

**ckpot.snt**

```
model space
 2  2    2  2
 1     0  1  1  -1    !  1 = p 0p_1/2
 2     0  1  3  -1    !  2 = p 0p_3/2
 3     0  1  1   1    !  3 = n 0p_1/2
 4     0  1  3   1    !  4 = n 0p_3/2
! interaction
   4  0
 1  1     2.41900
 2  2     1.12900
 3  3     2.41900
 4  4     1.12900
  34  0
 1  1  1  1   0    0.24400
 1  1  2  2   0   -5.05260
 1  2  1  2   1    0.73440
 1  2  1  2   2   -1.14430
 1  2  2  2   2    1.74230
 2  2  2  2   0   -3.32870
 2  2  2  2   2    0.08780
 3  3  3  3   0    0.24400
 3  3  4  4   0   -5.05260
 3  4  3  4   1    0.73440
 3  4  3  4   2   -1.14430
 3  4  4  4   2    1.74230
 4  4  4  4   0   -3.32870
 4  4  4  4   2    0.08780
 1  3  1  3   0    0.24400
 1  3  1  3   1   -4.29215
 1  3  1  4   1   -0.85185
 1  3  2  3   1    0.85185
 1  3  2  4   0   -5.05260
 1  3  2  4   1    1.76980
 1  4  1  4   1   -2.91415
 2  3  1  4   1    3.64855
 2  3  2  3   1   -2.91415
 1  4  1  4   2   -2.60110
 2  3  1  4   2   -1.45680
 2  3  2  3   2   -2.60110
 1  4  2  4   1   -2.26670
 2  3  2  4   1    2.26670
 1  4  2  4   2    1.23199
 2  3  2  4   2   -1.23199
 2  4  2  4   0   -3.32870
 2  4  2  4   1   -3.43620
 2  4  2  4   2    0.08780
 2  4  2  4   3   -7.26680
```

- **Output**

$^6Li = ^4He + 1p + 1n$

summary_Li6_ckpot.txt

```
Energy levels

    N      J prty N_Jp     T      E(MeV)  Ex(MeV)  log-file

    1       1 +      1     0     -5.433    0.000  log_Li6_ckpot_m0p.txt
    2       3 +      1     0     -5.009    0.424  log_Li6_ckpot_m0p.txt
    3       0 +      1     1     -3.910    1.523  log_Li6_ckpot_m0p.txt
    4       1 +      2     0     -1.273    4.160  log_Li6_ckpot_m0p.txt
    5       2 +      1     0     -0.510    4.923  log_Li6_ckpot_m0p.txt

B(E2)  ( > -0.0 W.u.)  mass = 6    1 W.u. = 0.6 e^2 fm^4
                                            e^2 fm^4 (W.u.)
   J_i     Ex_i      J_f     Ex_f   dE           B(E2)->          B(E2)<-
   3+( 1)  0.424     1+( 1)  0.000  0.424          2.8(  4.3)        6.5( 10.1)
   1+( 2)  4.160     1+( 1)  0.000  4.160          3.1(  4.7)        3.1(  4.7)
   1+( 2)  4.160     3+( 1)  0.424  3.736          0.0(  0.1)        0.0(  0.0)
   2+( 1)  4.923     1+( 1)  0.000  4.923          2.0(  3.1)        3.3(  5.1)
   2+( 1)  4.923     3+( 1)  0.424  4.499          1.9(  2.9)        1.3(  2.1)
   2+( 1)  4.923     0+( 1)  1.523  3.400          0.0(  0.0)        0.0(  0.0)
   2+( 1)  4.923     1+( 2)  4.160  0.763          2.2(  3.4)        3.6(  5.6)


B(M1)  ( > -0.0 W.u.)  mass = 6    1 W.u. = 1.8 mu_N^2
                                            mu_N^2   (W.u.)
   J_i     Ex_i      J_f     Ex_f   dE           B(M1)->          B(M1)<-
   0+( 1)  1.523     1+( 1)  0.000  1.523      7.964( 4.45)     2.655( 1.48)
   1+( 2)  4.160     1+( 1)  0.000  4.160      0.000( 0.00)     0.000( 0.00)
   1+( 2)  4.160     0+( 1)  1.523  2.637      0.130( 0.07)     0.390( 0.22)
   2+( 1)  4.923     1+( 1)  0.000  4.923      0.000( 0.00)     0.000( 0.00)
   2+( 1)  4.923     3+( 1)  0.424  4.499      0.003( 0.00)     0.002( 0.00)
   2+( 1)  4.923     1+( 2)  4.160  0.763      0.003( 0.00)     0.004( 0.00)
```

- **Output**

$^{6}$Li =$^{4}$He + 1p + 1n

1

- log_Li6_ckpot_m0p.txt
- log_Li6_ckpot_tr_m0p_m0p.tx

2

- log_Li6_ckpot_j0p.txt
- log_Li6_ckpot_j2p.txt
- log_Li6_ckpot_j4p.txt
- …

- log_Li6_ckpot_tr_j0p_j0p.txt
- log_Li6_ckpot_tr_j0p_j2p.txt
- log_Li6_ckpot_tr_j0p_j4p.txt
- …

$$\mu = \sqrt{\frac{4\pi}{3}} \sqrt{\frac{J}{(J+1)(2J+1)}} \langle \alpha J || M_1 || \alpha J \rangle$$

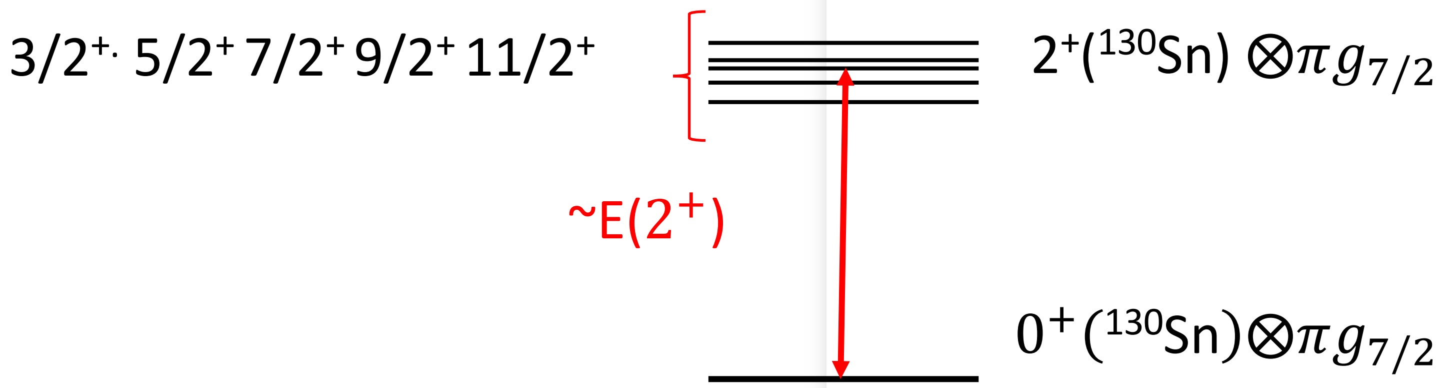
$$Q = \sqrt{\frac{16\pi}{5}} \sqrt{\frac{J(2J-1)}{(J+1)(2J+1)(2J+3)}} \langle \alpha J || Q_2 || \alpha J \rangle$$

## 1. Investigate the development of collectivity in $^{131}$Sb= $^{130}$Sn+1$\pi$

- Calculate E(2) and B(E2;$2^+ \rightarrow 0^+$) in $^{130}$Sn
- Calculate energies and B(E2) in $^{131}$Sb

$e_p$=1.7e $e_n$=0.7e

### Weak particle-core coupling scheme:




$$\sum B(E2;\uparrow) = B\left(E2;\ 0^+_{gs} \rightarrow 2^+\right)_{core}$$

$$B(E2;J \rightarrow 7/2^+)= B\left(E2; 2^+ \rightarrow 0^+_{gs}\right)_{core}$$

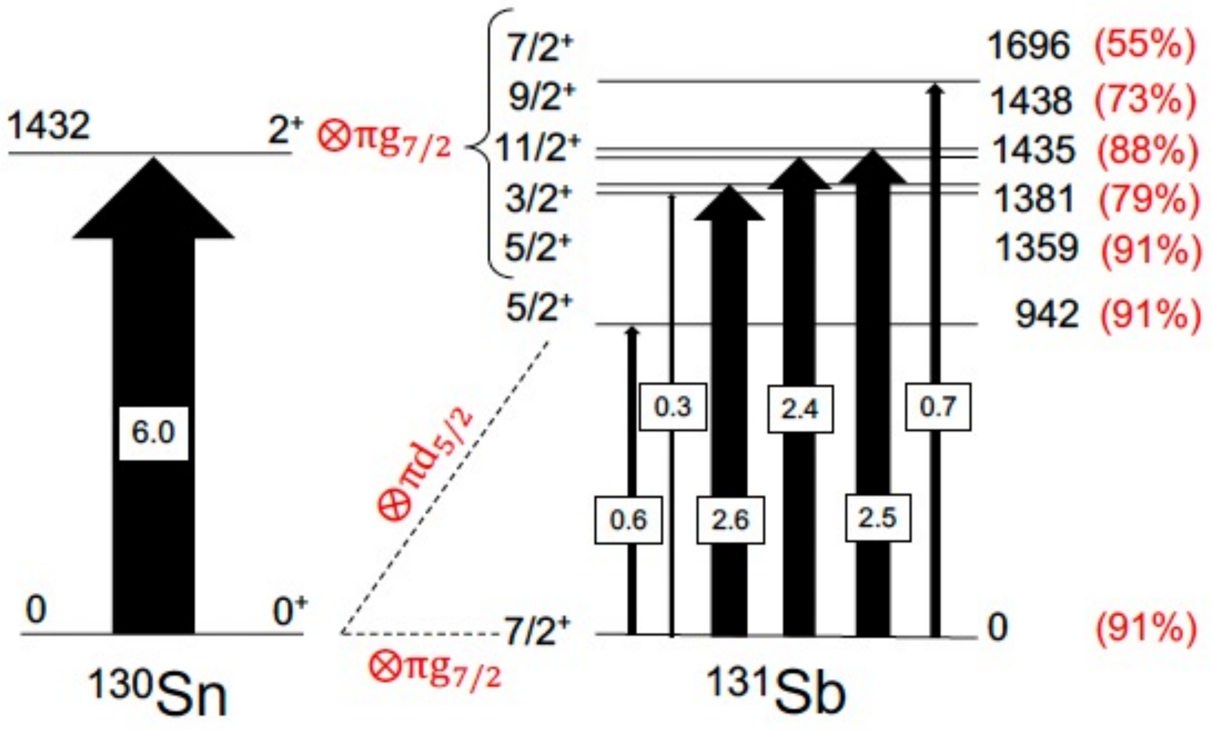
$$B(E2;\uparrow) = \Bigg(\overbrace{e_p \frac{A_p}{\sqrt{2J+1}}}^{\mathbf{p}}\Bigg)^2 + \Bigg(\overbrace{e_n \frac{A_n}{\sqrt{2J+1}}}^{\mathbf{n}}\Bigg)^2 + \overbrace{2e_p\, e_n \frac{A_p\, A_n}{(2J+1)}}^{\mathbf{np}}$$

Deviation from the weak-coupling model

# 1. Investigate the development of collectivity in $^{131}$Sb= $^{130}$Sn+1$\pi$

- Calculate E(2) and B(E2;$2^+ \rightarrow 0^+$) in $^{130}$Sn
- Calculate energies and B(E2) in $^{131}$Sb

$e_p$=1.7e $e_n$=0.7e

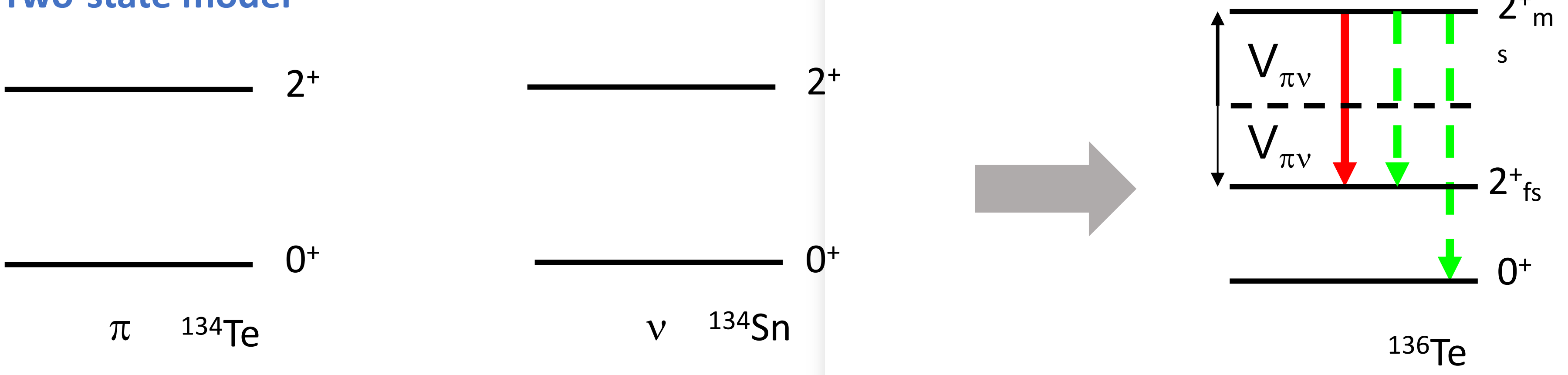



The sum of the fragmented B(E2) strength is a factor 1.6 larger than the B(E2;0+ → 2+ ) in 130Sn, in contrast with the expectation of a pure weak coupling scheme

# 2. Investigate the $2^+$ MS states in $^{136}\mathrm{Te} = {}^{134}\mathrm{Sn} \otimes {}^{134}\mathrm{Te}$

1. Calculate the yrast $2^+$ state of $^{134}$Sn
2. Calculate the yrast $2^+$ of $^{134}$Te
3. Calculate energies, B(E2), B(M1) for the first two $2^+$ states of $^{136}$Te

**Two-state model**




$$|2^+_{FSS}\rangle = \alpha|0^+(\pi)\rangle|2^+(\nu)\rangle + \beta|0^+(\nu)\rangle|2^+(\pi)\rangle \qquad |2^+_{MS}\rangle = \alpha|0^+(\pi)\rangle|2^+(\nu)\rangle - \beta|0^+(\nu)\rangle|2^+(\pi)\rangle$$

$|2^+_{MS}\rangle$ characterized by
- strong M1 to $2^+_{FSS}$ due its isovector nature
- weak E2 to $0^+$ due to the partial cancellation of the neutron and proton contributions

# Seniority

**Seniority quantum number corresponds to the number of alike nucleons in every single j orbital that are not in J = 0 pairs**

Related to the strong short attractivess of the nuclear interaction → two particles in a $j^2$ configuration are strongly bound when coupled to J=0 → a simple schematic interaction as the paring force is introduced which acts only in J=0 two particle states & whose eigenstates can be classiffied by seniority quantum number

For $j \leq \frac{7}{2}$ seniority is automatically conserved

For $j \geq \frac{9}{2}$ seniority breaking effects may be observed being the eigenstates admixtures of states with different seniorities

However, for $j = \frac{9}{2}$ it was shown that there is a partial conservation among the J=4 and 6 states. There is a state with (v=4 J=4) and a state with v=4 J=6) independently from the used interaction [Van Isacker PRL 100, 052501 (2008)]

## 3. Seniority in Ni isotopes with N from 42 to 48

1. Calculate the excitation energy of the $2^+$ states and the B(E2; $2^+ \rightarrow 0^+$)

$^{56}$NI Core , valence neutron in the f5/2 p3/2 p1/2 g9/2 model space

$^{70}$Ni – $^{76}$Ni: $(g_{9/2})^2 - (g_{9/2})^{-2}$: J=0+(v=0), 2+,4+,6+, 8+ (v=2)

$^{72}$Ni - $^{74}$Ni $(g_{9/2})^4 - (g_{9/2})^{-4}$ : J=0+ (1 v=0, 1 v=4); J=2+ (1 v=2, v=4); J=4+ (1 v=2, 2 v=4);
J=6+ (1 v=2, 2 v=4); J=8+(1 v=2, 1 v=4)

$$\langle j^n v\, J || B(E2) || \, j^n v\, J' \rangle = \frac{2j+1-2n}{2j+1-2v} \, \langle j^v v\, J || B(E2) || \, j^v v\, J' \rangle$$

$$\langle j^n v\, J || B(E2) || \, j^n v-2\, J' \rangle = \sqrt{\frac{(n-v+2)(2j+3-n-v)}{2(2j+3-2v)}} \, \langle j^v v\, J || B(E2) || \, j^v v-2\, J' \rangle$$