Final Project

TALENT course no. 5 (2017)

Group 1

Introduction

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NushellX - Spectroscopic Factors

- Calculate the spectroscopic factors from the ground state of ^{23}O to all states in ^{22}O in the full $1s0d$ model space. Use the sum rule to obtain the orbital occupations in ^{23}O for $0d_{5/2}$, $1s_{1/2}$ and $0d_{3/2}$. Compare these to those given in the so-called xxx.occ file.

NushellX - Spectroscopic Factors (1)

*.ans file

23O

22O

1 = 1 nucleon transfer

from GS of 23O (1=GS) to 22O (-1=to all)

```
------------------------------------------------
lpe,   0             ! option (lpe or lan), neig (zero=10)
sd                   ! model space (*.sp) name (a8)
n                    ! any restrictions (y/n)
usdb                 ! interaction (*.int) name (a8)
  8                  ! number of protons
 23                  ! number of nucleons
 0.5, 6.5, 1.0,      ! min J, max J, del J
  0                  ! parity (0 for +) (1 for -) (2 for both)
------------------------------------------------
lpe,   0             ! option (lpe or lan), neig (zero=10)
  8                  ! number of protons
 22                  ! number of nucleons
 0.0, 7.0, 1.0,      ! min J, max J, del J
  0                  ! parity (0 for +) (1 for -) (2 for both)
------------------------------------------------
den                  ! option
1                    ! 1, 2 or t
bb0600               ! initial file name (default from lpe above)
  -1                 ! max number (-1 for all)
bb0701               ! final file name (default = from lpe above)
   1                 ! max number (-1 for all)
 0.0, 4.0, 1.0,      ! min, max J, del J for bb0600
 0.5, 0.5, 1.0,      ! min, max J, del J for bb0701
n                    ! restrict coupling for operator
------------------------------------------------
st                   ! option
```

NushellX - Spectroscopic Factors (1)

Sum rules

Look at *.occ

N	NJ	Ex	2J	P	0d3	0d5	1s1	0d3	0d5	1s1
1	1	0.000	1	1	0.00	0.00	0.00	0.17	5.81	1.02

Compare with *.lsf

According to sum rules (particle removal) we should get occupation number (40.13):

$$\sum_{f-} S_{i,f,k} = < n_k >_i$$

NushellX - Spectroscopic Factors (1)

Eg. 1s1/2

Sum rule (1.02)

0.9389+

0.0801=

1.019

```
! model space = sd
! interaction = usdb

( Ai  Tzi)  ( Af  Tzf) (type n,l,2j)    Ji    Jf    ni   nf    C^2S       Ei      Ef    C^2S*(Ef-Ei)  Exi      Exf
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+    1    1   0.7823   -34.498  -37.079    -2.019    0.000    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+    2    1   0.1505   -29.736  -37.079    -1.105    4.762    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+    3    1   0.0038   -24.849  -37.079    -0.046    9.649    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+    4    1   0.0001   -22.361  -37.079    -0.001   12.137    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+    5    1   0.0014   -19.986  -37.079    -0.024   14.512    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+    6    1   0.0000   -16.492  -37.079    -0.000   18.006    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+    7    1   0.0008   -16.341  -37.079    -0.017   18.157    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+    8    1   0.0000   -14.791  -37.079    -0.000   19.707    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+    9    1   0.0000   -13.558  -37.079    -0.000   20.940    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   0.0+  0.5+   10    1   0.0000   -11.207  -37.079    -0.000   23.291    0.000
                                                          sum  0.9389                      -3.213

( Ai  Tzi)  ( Af  Tzf) (type n,l,2j)    Ji    Jf    ni   nf    C^2S       Ei      Ef    C^2S*(Ef-Ei)  Exi      Exf
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+    1    1   0.0030   -24.340  -37.079    -0.038   10.158    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+    2    1   0.0528   -23.900  -37.079    -0.696   10.598    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+    3    1   0.0218   -23.345  -37.079    -0.299   11.153    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+    4    1   0.0010   -21.741  -37.079    -0.015   12.757    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+    5    1   0.0001   -19.890  -37.079    -0.002   14.608    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+    6    1   0.0002   -18.360  -37.079    -0.004   16.138    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+    7    1   0.0000   -17.881  -37.079    -0.000   16.617    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+    8    1   0.0003   -17.261  -37.079    -0.006   17.237    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+    9    1   0.0006   -15.029  -37.079    -0.013   19.469    0.000
( 22  3.0)  ( 23  3.5)  ( n  2 0  1)   1.0+  0.5+   10    1   0.0003   -14.893  -37.079    -0.007   19.605    0.000
                                                          sum  0.0801                      -4.293
```

NushellX - Spectroscopic Factors (1)

Sum over all orbitals = Valence neutrons

```
( 22  3.0)  ( 23  3.5)  ( n  1 2  5)   3.0+  0.5+     9    1   0.0005   -18.384  -37.079   -0.009   16.114    0.000
( 22  3.0)  ( 23  3.5)  ( n  1 2  5)   3.0+  0.5+    10    1   0.0008   -18.102  -37.079   -0.015   16.396    0.000
                                                          sum   3.3424                     -47.421

                                                    total sum   6.9875
```

```
( 22  3.0)  ( 23  3.5)  ( n  1 2  5)   3.0+  0.5+    27    1   0.0000    -5.344  -37.079   -0.000   29.154    0.000
( 22  3.0)  ( 23  3.5)  ( n  1 2  5)   3.0+  0.5+    28    1   0.0000    -2.963  -37.079   -0.000   31.535    0.000
( 22  3.0)  ( 23  3.5)  ( n  1 2  5)   3.0+  0.5+    29    1   0.0000     2.495  -37.079   -0.000   36.993    0.000
                                                          sum   3.3478                     -47.683

                                                    total sum   6.9997
```

NushellX - Spectroscopic Factors (2)

- Calculate the spectroscopic factors from the ground state of ^{23}O to all states in ^{24}O in the full $1s0d$ model space. Use the sum rule to obtain the number of holes in those three orbits in ^{23}O. Compare these to those given in the xxx.occ file.

Similar procedure but different sum rule (particle addition), eq. 40.14:

$$\sum_{f+} \frac{(2J_f+1)}{(2J_i+1)} S_{i,f,k} = (2j+1) - < n_k >_i$$

NushellX - Exploring gamma decay

Example: 59Ni

Thank you