Investigating the Nuclear Shell Closure at N=32 in Neutron Rich 52Ca

Robin Coleman – University of Guelph
CAP Congress, SFU
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MOTIVATION

• Shell model Calculations
• Magic Numbers
  • Elevated first 2+ level
• Small Charge Radius
• High Separation Energy
MOTIVATION

• Calcium 52
  • Traditionally Magic Protons

Protons = 20  Neutrons = 32
MOTIVATION

- Shell model Evolution
- 3N interaction required to reproduce 28 Shell closure

MOTIVATION

- Calcium 52
  - Traditionally Magic Protons
  - Evolution to Magic Neutrons

Neutrons = 32
Motivation

- Different Interactions
  - NN+3N
  - GXPF1A- G Matrix
  - KB3G- Kuo-Brown Interaction

J.D. Holt, et al. PHYSICAL REVIEW C 90, 024312 (2014)
Motivation

• Previous Level Scheme
  • 5 Gamma-ray Transitions
  • 4 Observed Excited Levels
  • Other levels are deduced from the beta-delayed neutron energy spectra


Sn=6005 keV
Experiment

- TRIUMF – Vancouver, BC
  - ISAC 1
- GRIFFIN – High precision gamma energy
- ZDS & SCEPTAR – Beta tagging Scintillators
Experiment

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Experiment

• TRIUMF – Vancouver, BC
  • ISAC 1
• GRIFFIN – High precision gamma energy
  • ZDS & SCEPTAR – Beta tagging Scintillators
Experiment

• 52 Ca Compton-suppressed Gamma spectrum
• Following 48 hrs of ~300 pps

Compton Suppressed Addback Singles threshold 200

<table>
<thead>
<tr>
<th>aE_{supp}</th>
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</thead>
<tbody>
<tr>
<td>Entries</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Std Dev</td>
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</tbody>
</table>
Preliminary Results

- Preliminary Level Scheme
  - 14 Levels
  - 10 New
  - 21 Transitions
  - 16 New
- States 2MeV above the Neutron Separation energy has been observed previously in Ni70 [1]

Preliminary Results

52K

Allowed Beta
PRELIMINARY RESULTS

- Measurement of gamma branching ratio
- Gamma- Efficiency
- N-Counts
- I-Intensity

\[
\frac{\Gamma_\gamma}{\Gamma_\beta} \frac{N_\gamma}{N_\beta} = I_\gamma
\]
PRELIMINARY RESULTS

- Comparison to previous work
- Previously deduced from emitted neutron energies
- Currently measured through gamma cascades

<table>
<thead>
<tr>
<th>Neutron Excitation Energy (keV)</th>
<th>Neutron Intensity (%)</th>
<th>Preliminary Gamma Excitation Energy (keV)</th>
<th>Preliminary Gamma Intensity %</th>
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</thead>
<tbody>
<tr>
<td>6062</td>
<td></td>
<td>6062</td>
<td>0.66 +/- 0.02</td>
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<tr>
<td>6495 +/- 20</td>
<td>4.3</td>
<td>6502</td>
<td>1.71 +/- 0.3</td>
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<td>6658</td>
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<td>6658</td>
<td>33.0 +/- 0.9</td>
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<td>6683</td>
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<td>6683</td>
<td>1.68 +/- 0.01</td>
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<td>6855 +/- 30</td>
<td>6.6</td>
<td>6857</td>
<td>2.77 +/- 0.2</td>
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<td>7065 +/- 40</td>
<td>21.5</td>
<td>7012</td>
<td>10.5 +/- 0.2</td>
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<tr>
<td>7255 +/- 40</td>
<td>3.1</td>
<td>7265</td>
<td>6.65 +/- 0.05</td>
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<td>8245 +/- 80</td>
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<tr>
<td>8465 +/- 20</td>
<td>0.7</td>
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</tbody>
</table>
FUTURE WORK

• Finalize level Scheme
• Investigate Shell Model Calculations
• Further Data taken in August
  • Explore Ca 52, 53, 54
Collaborators

C.E. Svensson  
F.A. Ali  
V. Bildstein  
C. Burbadge  
R. Dunlop  
P.E. Garret  
F. Ghazi Moradi  
A.T. Laffoley  
A.D. MacLean  
A. Radich  
T. Zidar  

G.C. Ball  
S.S. Bhattacharjee  
M. Bowry  
R. Caballero-Folch  
A.B. Garnsworthy  
G. Hackman  
R. Lafleur  
B. Olaizola  
C.J. Pearson  
E. Timakova

N. Bernier  
Y. Saito  
D. Yates  

C. Andreoiu  
F.H. Garcia  
K. Whitmore

G.F. Grinyer  
M.P. Hladun  
J.L. Mitchell

I. Dillmann  

C.R. Natzke  

L. Sexton

THANK YOU!

Robin Coleman  
CAP Congress
Motivation

- Separation Energy
  - Measured at TITAN 2012
- Excitation Energy
  - Measured at RIKEN 2013


PRELIMINARY RESULTS

• Comparison to Shell model calculations
Experiment

• GRIFFIN
  • Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei

https://www.triumf.ca/research-program/research-facilities/isac-facilities
Motivation

- R-Process
- Rapid capture of Neutrons
- Synthesis depends on Stability
- Magic Nuclei

FUTURE WORK

• Charge Radius

![Graph showing the variation of charge radius with mass number A](chart.png)

BGO SUPPRESSION

- Hit Pattern Shows Real and False coincidences
- Threshold Set for event vetoes

Bgo Griffin Hit Pattern

<table>
<thead>
<tr>
<th>Hp</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>Mean x</td>
</tr>
<tr>
<td>Mean y</td>
</tr>
<tr>
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</tr>
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<td>Std Dev y</td>
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</table>
BGO SUPPRESSION

- 15 of 16 Clovers had BGO shields installed
- Shields pulled back in configuration

Credit: C. Andreoiu