Spectroscopy of $^{252}\text{No}$ to Investigate its K-isomer

Edward Parr
Motivation in Superheavies

Next shell gaps predicted for Superheavy spherical nuclei

Cross section to produce these nuclei is too low
Motivation in Superheavies

- Cross section to produce these nuclei is too low
Motivation in Superheavies

• Cross sections of \( \text{nb} \rightarrow \mu \text{b} \), production is experimentally viable

Deformed shell gaps for transfermium nuclei
K-Isomers of nuclei

- Total spin of a nucleus $I$ has rotational component $R$ and single particle contribution $J$. 
K-Isomers of nuclei

- Total spin of a nucleus $I$ has rotational component $R$ and single particle contribution $J$.
- $I$ has projection $k$ onto symmetry axis of nucleus.
K-Isomers of nuclei

A large change in $k$ will inhibit the decay giving a relatively long lived K-isomer state.
K-Isomer particle states

- Theoretical results of energy levels in this region conflict
Theoretical results of energy levels in this region conflict.

- Study K-isomer structures to infer single particle excitations into these levels.
Experiment took place at Jyväskylä in Finland

Beam Energy = 218MeV

Fusion evaporation reaction;

\[ {^{206}\text{Pb}(^{48}\text{Ca}, 2n)^{252}\text{No}} \]
Recoil-Decay Tagging

- Identifying $^{252}$No recoils entering gas detector

![Raw JUROGAM Spectra](image)
Recoil-Decay Tagging

- Identifying $^{252}$No recoils entering gas detector
- Gate on events in region of 2D histogram to identify $^{252}$No
Identifying Decay Events

- Then select gated recoils which decay at focal plane with alpha energies or spontaneous fission.
252\textsuperscript{No Ground State Rotational Band}

*No events were identified and in-beam spectra taken at target position*
No Ground State Rotational Band

Counts

Energy (keV)

Recoil tagged

Recoil-Decay tagged

• Harris model used to fit lower order transitions

<table>
<thead>
<tr>
<th>Transition</th>
<th>Energy (keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20+</td>
<td>20+</td>
</tr>
<tr>
<td>18+</td>
<td>484.6(6)</td>
</tr>
<tr>
<td>16+</td>
<td>453.3(4)</td>
</tr>
<tr>
<td>14+</td>
<td>415.6(3)</td>
</tr>
<tr>
<td>12+</td>
<td>415.6(3)</td>
</tr>
<tr>
<td>10+</td>
<td>373.8(5)</td>
</tr>
<tr>
<td>8+</td>
<td>328.0(2)</td>
</tr>
<tr>
<td>6+</td>
<td>277.6(2)</td>
</tr>
<tr>
<td>4+</td>
<td>223.7(2)</td>
</tr>
<tr>
<td>2+</td>
<td>167.2(2)</td>
</tr>
<tr>
<td>0+</td>
<td>107.7(1)</td>
</tr>
<tr>
<td></td>
<td>46.5(1)</td>
</tr>
</tbody>
</table>
Recoil-Decay Tagged Isomeric Events

- Isomeric recoils decay at focal plane
- Lower transitions are highly converted
- Conversion electrons paired with RDT events to identify isomeric recoils
Half-life of $^{252}\text{No}$ 8$^-$ K-Isomer

- Time between recoil implantation and isomeric decay found
- Half life found consistent with previous: $T_{1/2} = 110(10)\text{ms}$
In-beam spectra of isomer events give prompt gamma at target position
In-beam spectra of isomer events give prompt gamma at target position.
See rotational band built on K-isomer.
Comparisons with $^{250}$Fm

- Comparing rotational band with similarly structured $^{250}$Fm

Energy vs Spin

- $^{250}$Fm
- $^{252}$No

Dynamic MOI vs angular frequency squared

- $^{250}$Fm 8$^-$ band
- $^{252}$No 8$^-$ band

$\gamma^{(2)}$ (h$^2$/MeV) vs $\omega^2$ (MeV$^2$/h$^2$)
Comparisons with $^{250}$Fm

- Comparing rotational band with similarly structured $^{250}$Fm

**Energy vs Spin**

- $^{250}$Fm 8$^-$ bands
- $^{250}$Fm gs bands
- $^{252}$No 2$^-$ bands

**Dynamic MOI vs angular frequency squared**

- $^{250}$Fm 8$^-$ band
- $^{252}$No 8$^-$ band
Use M1/E2 branching ratios to unambiguously assign a configuration to $^{252}$No K-isomer.
Collaborators

Department of Physics, University of Jyväskylä, Finland

R.-D. Herzberg, P.A. Butler, J. Pakarinen, D. Rostron, P. Papadakis, E. Parr
Department of Physics, University of Liverpool

B. Sulignano, Ch. Theisen, A. Drouart, A. Görgen, W. Korten, J. Ljungvall, A. Obertelli and M. Zielińska
DAPNIA/SPhN CEA-Saclay, France

S. Hofmann, D. Ackermann, F.P. Heßberger, S. Heinz and J. Khuyagbataar
GSI, Darmstadt, Germany

M. Venhart, S. Antalic
Department of Nuclear Physics and Biophysics, Comenius University, Bratislava, Slovakia