Measurement of the Giant Monopole and Quadrupole Resonances in $^{68}\text{Ni}$ using Maya Active Target

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1. Giant Resonances

2. Motivations in exotic nuclei

3. Experiment
   - the active target MAYA
   - the experiment at GANIL

4. Data Analysis
Giant Resonances

<table>
<thead>
<tr>
<th>$T = 0$</th>
<th>$T = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>isoscalar</td>
<td>isovectorial</td>
</tr>
</tbody>
</table>

- Compression modulus of the nucleus can be related to nuclear matter incompressibility $K_\infty$
- $K_\infty$ has been well determined for symmetric matter
- Concerning asymmetric matter, data is missing

$$\delta = \frac{(N-Z)}{A}$$

- ISGMR
- ISGQR

Determination of the compression modulus of the nucleus
Status of GR in Exotic Nuclei

- Understand these excitation modes from stable to exotic nuclei: the IVGDR has been measured in $^{68}$Ni, neutron rich Oxygen and Tin isotopes at GSI, in $^{26}$Ne at Riken

- 1st measurement of the ISGMR and ISGQR in unstable nuclei $^{56}$Ni: $^{56}$Ni + d $\rightarrow$ d' + $^{56}$Ni*

Soft GMR in neutron rich Ni isotopes

• Prediction of Monopole strength in Ni neutron rich isotope

The Active Target MAYA

68Ni is an exotic nucleus, we have to consider:
- Inverse kinematic with a low recoiling energy
- Low production rate

Use of an Active Target:
- low detection threshold
- thick target

<table>
<thead>
<tr>
<th>Beam @ Energy (A.MeV)</th>
<th>Facility</th>
<th>Reaction</th>
<th>Gas</th>
<th>Pressure (mbar)</th>
<th>Aim</th>
</tr>
</thead>
<tbody>
<tr>
<td>8He @ 3.9</td>
<td>SPIRAL*</td>
<td>p(8He, 8He)p</td>
<td>C4H10</td>
<td>1.10^3</td>
<td>NIM 583, 341 (2007)</td>
</tr>
<tr>
<td>8He @ 15.4</td>
<td>SPIRAL*</td>
<td>12C(8He, 7H) 13N</td>
<td>C4H10</td>
<td>30</td>
<td>7H PRL 99, 062502 (2007)</td>
</tr>
<tr>
<td>25,26F @ 50</td>
<td>SISSI*</td>
<td>d(25,26F,X) 3He</td>
<td>D2</td>
<td>2.2 10^3</td>
<td></td>
</tr>
<tr>
<td>56Ni @ 50</td>
<td>SISSI*</td>
<td>d(56Ni, 56Ni)d</td>
<td>D2</td>
<td>1.10^3</td>
<td>GMR PRL 100, 042501 (2008)</td>
</tr>
<tr>
<td>11Li @ 3.6</td>
<td>ISAC2†</td>
<td>p(11Li, 9Li)t</td>
<td>C4H10</td>
<td>100-600</td>
<td>PRL 100, 192502 (2008)</td>
</tr>
<tr>
<td>9Li @ 3.6</td>
<td></td>
<td>p(11Li, 10Li)d</td>
<td></td>
<td></td>
<td>PRC 79, 031603 (2009)</td>
</tr>
<tr>
<td>9Li @ 3.6</td>
<td></td>
<td>p(11Li, 11Be)n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36Ar @ 3.0</td>
<td>CIME*</td>
<td>α(36Ar, 36Ar)α</td>
<td>He/CF4</td>
<td>? 10^3</td>
<td>TEST</td>
</tr>
<tr>
<td>68Ni @ 50</td>
<td>LISE*</td>
<td>d(68Ni, 68Ni)d</td>
<td>D2</td>
<td>1.10^3</td>
<td>GMR</td>
</tr>
<tr>
<td>68Ni @ 50</td>
<td></td>
<td>α(68Ni, 68Ni)α</td>
<td>He/CF4</td>
<td>0.5 10^3</td>
<td>GMR</td>
</tr>
<tr>
<td>56Ni @ 50</td>
<td>LISE*</td>
<td>α(56Ni, 56Ni)α</td>
<td>He/CF4</td>
<td>500</td>
<td>ISGDR</td>
</tr>
<tr>
<td>8He @ 15.4</td>
<td>SPIRAL*</td>
<td>19F(8He,4n+ 3H) 20Ne</td>
<td>CF4</td>
<td>20</td>
<td>7H</td>
</tr>
<tr>
<td>12C @ max</td>
<td>ORSAY</td>
<td>12C(α,3α)α</td>
<td>He/CF4</td>
<td>10^3</td>
<td>3α TEST</td>
</tr>
<tr>
<td>12Be @ 3.</td>
<td>REX†</td>
<td>p(12Be, 12B)n</td>
<td>C4H10</td>
<td>100</td>
<td>13Be</td>
</tr>
</tbody>
</table>

*GANIL †TRIUMF ‡ISOLDE
$^{68}\text{Ni}$ is an exotic nucleus, we have to consider:
- Reverse kinematic with a low recoiling energy
- Low production rate

Use of an Active Target:
- low detection threshold
- thick target

- Gaseous detector
- Time Projection Chamber:
  - the scattered deuton or $\alpha$ ionizes the gas
  - the electrons move towards the wires
  - amplification on the wires
- The amount of electrons and the drift time are collected

$^{68}\text{Ni} 50\text{MeV/A}$
Intensity : $10^4$ pps
Purity : 75%

Gas : $\text{D}_2$
Pressure : 1 bar
$^{68}\text{Ni} + d \rightarrow d' + ^{68}\text{Ni}^*$

Gas : Helium 98% + CF4 2%
Pressure : 0.5 bar
$^{68}\text{Ni} + \alpha \rightarrow \alpha' + ^{68}\text{Ni}^*$
The Experiment at GANIL

The experiment was performed in September 2010 on LISE beam line.
1. Reconstruction of the 2D trajectory
   - Beam fit
   - Subtraction of the average beam
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   - Beam fit
   - Subtraction of the average beam
   - Scattered particle fit

2. Projection of the charges along the 2D trajectory: they are projected according 1 of the 3 MAYA axis
Data analysis

1. Reconstruction of the 2D trajectory
   - Beam fit
   - Subtraction of the average beam
   - Scattered particle fit

2. Projection of the charges along the 2D trajectory: they are projected according 1 of the 3 MAYA axis

3. Reconstruction of the third dimension using time on the wires

Range et θ
E_{deuton}
Energy excitation $^{68}\text{Ni}$
Geometric efficiency using ActarSim code:
- 1000 events generated per MeV
- $0 \, \text{deg} < \theta_{\text{CM}} < 8 \, \text{deg}$
- $-180 \, \text{deg} < \varphi < 180 \, \text{deg}$
- $0 \, \text{mm} < X_{\text{vertex}} < 300 \, \text{mm}$
• Elastic peak
• First excited states included in the elastic peak
• Need angular distribution to study 15-20MeV region
Angular Distribution

- Angular distribution not corrected for efficiency
- Geometric efficiency will play a major role for small $\theta_{CM}$

Very preliminary results
Future work

- Status of the analysis in deuteron gas
  - Improve the simulation of the geometric efficiency
  - Work on the angular distribution
  - Evaluate the deuteron break up background
  - Microscopic calculations with multipole decomposition analysis and comparison to theory

- Analyse the experiment in Helium gas
Collaboration

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