Investigation of low-lying resonances in $^{11}\text{Li}$ and $^{10}\text{Li}$ via $^{11}\text{Li}(p,p')$ and $^{11}\text{Li}(p,d)$ reactions

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for the S1147 collaboration

TUDA II
Two-neutron halo nucleus $^{11}\text{Li}$

- $^{9}\text{Li}$ and $n$ are loosely bound
- $^{10}\text{Li}$ and $2n$ are unbound

Very diffuse neutron surfaces caused by
- loosely bound neutrons
- states of low angular momentum

Borromean nucleus
- $^{11}\text{Li}$ is bound
- $^{10}\text{Li}$ and $2n$ are unbound

$^{10}\text{Li}$ : input for 3-body models
New mode of excitation: Soft dipole resonance

Giant dipole resonance

Neutrons oscillate against protons

High frequency oscillation

High excitation energy

Giant dipole resonance

Halo neutrons oscillate against the core

Soft dipole resonance

Halo neutrons oscillate against the core

TUDA
(TRIUMF UK Detector Array)
Experiment: $^{11}\text{Li}(p,p')^{11}\text{Li}^* \ & ^{11}\text{Li}(p,d)^{10}\text{Li}$

- Silicon detectors: $dE - E$ (YY1) LEDA + S2
- Scintillator + PMT to count the beam

- $^{11}\text{Li}$ $\ @ \ 4 \ A \ MeV$
- $260 \ \mu g/cm^2$ CH2 target

$dE-E$ : detect light particles $\rightarrow$ identify reaction channel
S2 : detect heavy residues $\rightarrow$ reduce background
11Li Beam

- 203.4 hrs over 348 hours of scheduled beamtime (~58% of beamtime)

- Beam energy variations over > 1 day (~ 414.7 keV lower) (observed in the S2 detector)

- Beam intensity ~ 2200 pps (proposal beamtime requested for 5000 pps)

- 4 days of beamtime taken from S1203 experiment (might run in Fall or Winter 2010)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Approved</th>
<th>Scheduled</th>
<th>Received</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1147</td>
<td>32 shifts 384h</td>
<td>May3 – May12 240h</td>
<td>May3-May17 203h</td>
<td>Cyclotron off for ~ 6 days</td>
</tr>
<tr>
<td>S1203</td>
<td>10 shifts 120h</td>
<td>May14- may17 96h</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>
Saint Mary's University dE-E telescope (2 arrays)

1 array : 8 sectors, 16x8 rings

dE : 45 μm, E : 1000 μm

→ clear identification of reaction channels
→ better angular resolution from dE-E angular constraints
$^{11}$Li(p,p) reaction channel – Kinematics

$\rightarrow$ excitation energy of $^{11}$Li
$^{11}\text{Li}(p,d)\,$ reaction channel – Kinematics

$M_{^{10}\text{Li}} = M_{^{9}\text{Li}} + M_n$

$\rightarrow$ excitation energy of $^{10}\text{Li}$
Reaction Channels – Kinematics

→ optical potentials parameters for $^{11}\text{Li}(p,p)^{11}\text{Li}$
→ reduce backgrounds
Conclusions

• Experimental setup is ok

• Need more beamtime for S1147?

• Need beamtime to run S1203
S1203 - Spectroscopy of $^{12}$Li via $^{11}$Li(d,p)$^{12}$Li

TUDA II

$^{11}$Li beam @ 8 A MeV

Ask for beam in next beamtime schedule 2010
3 days of 9Li beam @ 5 A MeV into 490 μg/cm² CH2 target

Observed 3 excited states in 9Li → determine spin of states

better angular resolution using dE-E → better resolution in E*