S1195: Resonances in $^{19}$Ne with relevance to the astrophysically important $^{18}$F($p,\alpha$)$^{15}$O reaction

Nuclear astrophysics http://www.ph.ed.ac.uk/nuclear/
Dark Matter http://www.ph.ed.ac.uk/nuclear/darkmatter/
Motivation

- Classical Novae
  - accretion of H on CO or ONe WD
- Long standing aim of astronomers...
  - to observe gamma ray emission
  - use that to constrain models
- Largest NP uncertainty: $^{18}\text{F}(p,\alpha)^{15}\text{O}$

- E996*: 665 - 1600 keV
  - May 2007, 22 hrs $4\times10^4$ $^{18}\text{F}^{9+}$ pps
- E996: 665 keV and below
  - May 2008
- S1195: 665 - 2200 keV
  - May 2009 $^{18}\text{F}^{9+}$
E996’ results
Published 14 May 2009
Science goals updated

- In our 2007 work we do NOT see a proposed astrophysically important 1/2+ state at 1.49 MeV

- Recent publication by Dalouzy et al., using $^1\text{H}(^{19}\text{Ne},p)^{19}\text{Ne}^*(p)^{18}\text{F}$ does see some evidence for the state

Can the results be consistent?
Equipment we’re using

TUDA (…and TUDA II)
May 2007 data

Energy Linearised Time of Flight

$^{16}\text{F}(p,\alpha)^{12}\text{C}$

$^{16}\text{F}(p,\beta)^{18}\text{F}$

$^{12}\text{C}(^{18}\text{F},^{12}\text{C})$

$^{3}\text{H}(^{18}\text{F},^{4}\text{He})$

$^{18}\text{F}(\beta)$

$^{12}\text{C}(^{18}\text{F},^{12}\text{C})$

$^{3}\text{H}(^{18}\text{F},^{4}\text{He})$

Fusion-Evaporation

α contamination in the chamber

Energy

Differential Cross Section (mb/sr)
Calibration reactions

- $^{18}\text{O}(p,p)$ & (p,a)
- Pretty much exactly as hoped for/expected:
May 2009 data

LEDA

~5° lab

$^{18}\text{F}^{9+}$ single strip

$S^2$

~14° lab

$^{18}\text{F}^{9+}$ single strip
Intensities delivered

Typically $1.2 \times 10^6$ $^{18}$F at yield station

~5x10$^4$ pps $^{18}$F$^9+$ at TUDA
2-4x10$^3$ pps $^{18}$Ne at TUDA

$^{18}$Ne yield similar to 2008.
$^{18}$F down by factor of >10

$^{18}$Ne unreactive vs $^{18}$F
highly reactive
...and the vacuum is poorer?

- Much larger fraction of $^{18}$Ne.
- Beta end points
  - $^{18}$F: 1.6 MeV
  - $^{18}$Ne: 4.45 MeV
- Betas are contaminating our spectra more than previously.
Beam contamination

E996 May/June 2008
M=18, 4+
Photo diode with thin Al foil
$^{18}\text{Ne}(b^+)^{18}\text{F}^*$

$\rightarrow 1042 \text{ keV gamma}$
Last night...

- Ran on M=18, 10+, to get a $^{18}$Ne data set
- Appear to have seen contaminant, close A/Q (slightly lower) and M~25-30
- $^{27}$P?
  - Produced through $^{28}$Si(p,2n)$^{27}$P
  - ($^{27}$P - $^{27}$Al$)^{3+}$ from molecules source (equivalent to M=18 Q=1+)
  - Dissociated by stripper
- Charge state 15 after second stripper
- A/Q is right for accelerator (equivalent to 18/10)
Comparing to S1195 proposal...

These new data would provide...

- Complete coverage of high energy region for new resonance searches.  
  **Maybe**

- A factor of 10 increased statistics over previous work (assumes 25% transmission and FEBIAD performance as of May 2008).  
  **Approx equivalent to E996’**

- Multiple 'sweeps' over the 665 keV resonance, exploring the effect of energy resolution.  
  **Not attempted**

Analysis is going to be tough, but there is hope
Thank you