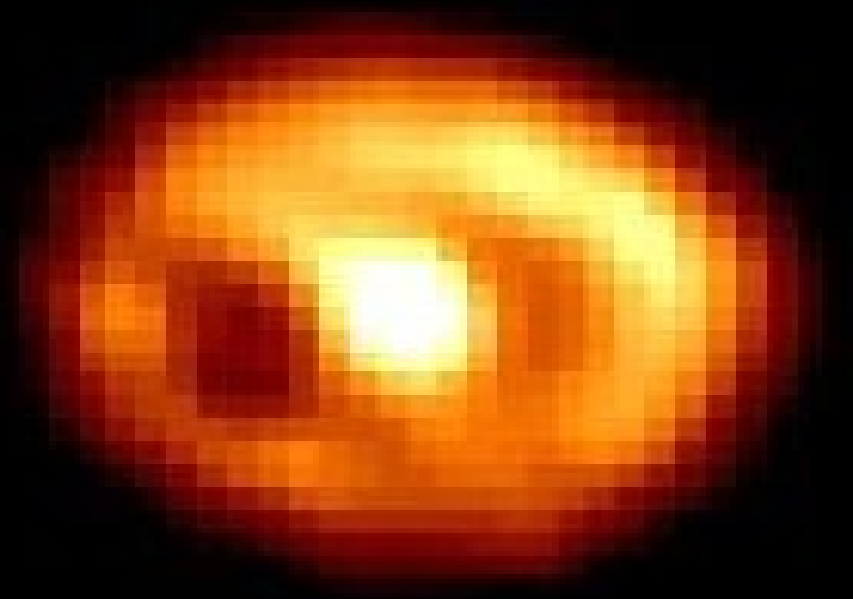
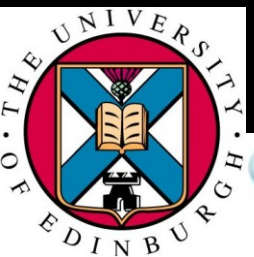
Resonances in ^{19}Ne with relevance to the astrophysically important ^{18}F(p,α)^{15}O reaction



David Mountford
University of Edinburgh



ntents

- 1&F a e
- y try again?
- The Experiment
- Preliminary Results
- Conclusions

T[redacted]rtance of ^{18}F

^{18}F re[redacted]in novae

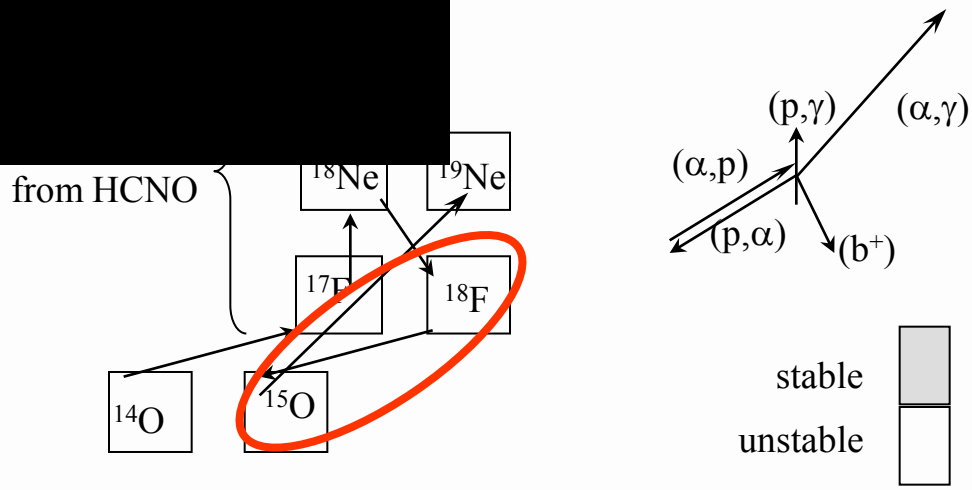
$$^{18}F \rightarrow {}^{18}O + e^{+} + \upsilon$$

- $t_{1/2}$ ~ 110mins
- ^{18}F responsible for majority of gamma rays emitted in novae (~511keV)
- Satellites searching for such gamma rays…


esa
integral
European Space Agency

Prod[redacted]and Destruction

Hot C[redacted]



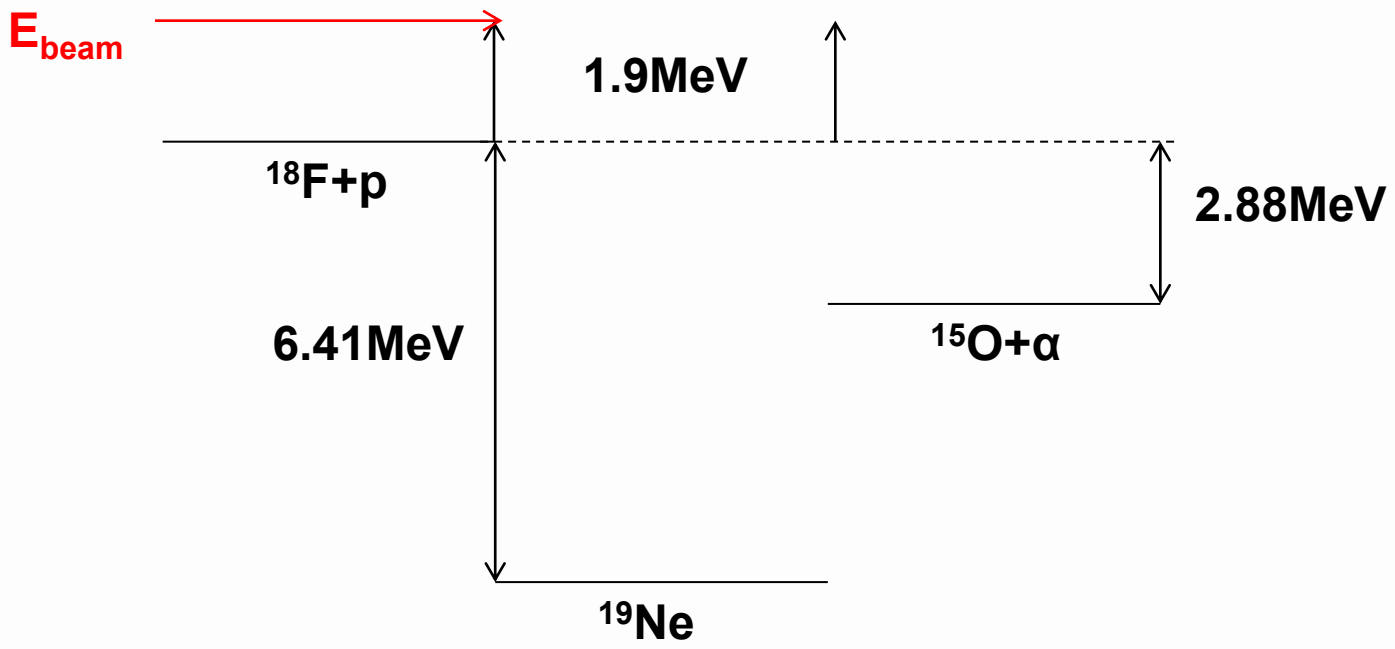
- Destruction by (p,α):

$$^{18}F + p \rightarrow {}^{19}Ne^{*} \rightarrow {}^{15}O + \alpha$$

^{19}Ne

Reacti[illegible] excited states of the compound

[illegible]shold can be explored



^{19}Ne

Ener ins of states will directly
rate of destruction of ^{18}F

Note, for l_p 0:

$$J^{\pi}\left({}^{18}F_{gs}\right) = 1^{+}, J^{\pi}(p) = \frac{1}{2}^{+}$$

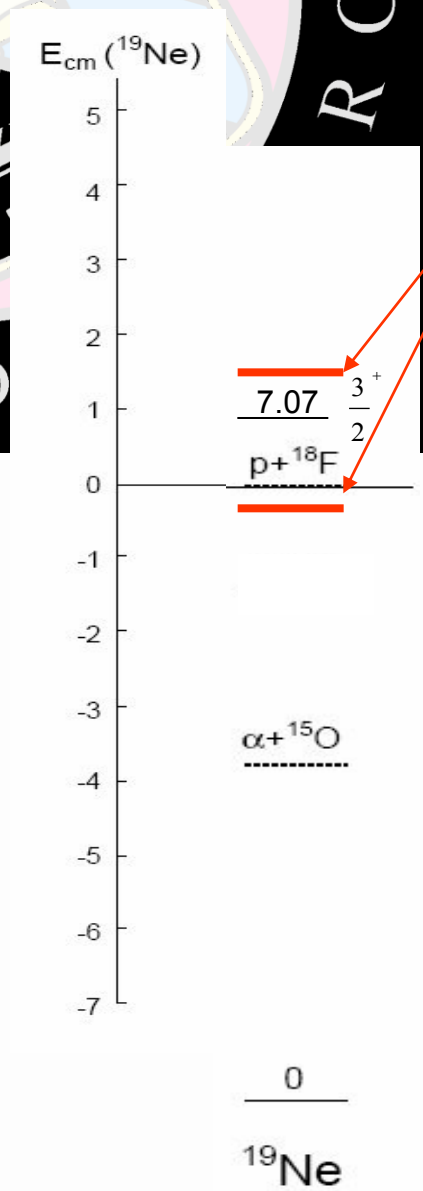
$$\left|J(p) - J\left({}^{18}F_{gs}\right)\right| \leq J\left({}^{19}Ne\right) \leq J(p) + J\left({}^{18}F_{gs}\right)$$

- Hence, ‘easiest’ states to observe have + parity and J = 1/2, 3/2
- May also see l_p=1 or 2

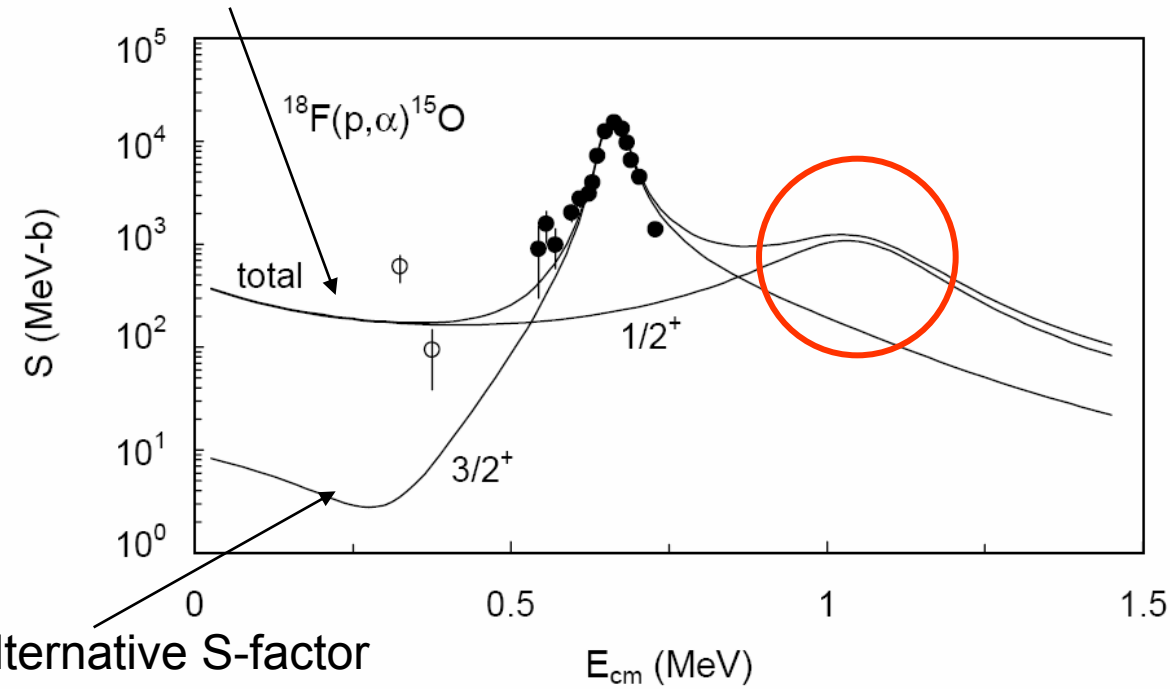
(cont.)

Dufour/Descouvemont[1]

– comparisons to mirror nucleus, ^{19}F



r addition of new states



Alternative S-factor

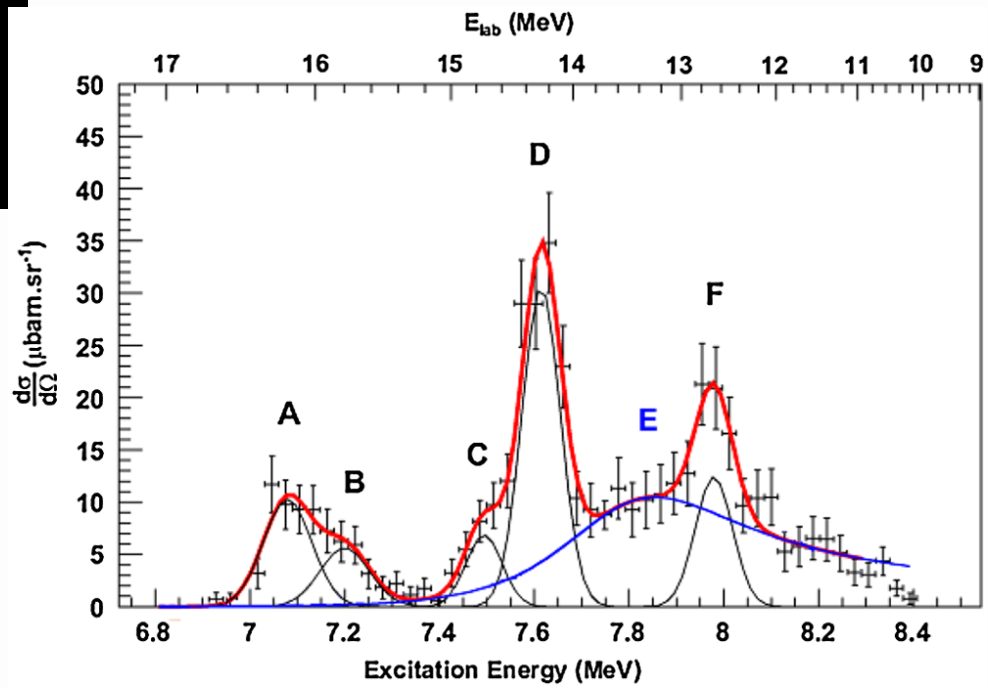
Effect on reaction rate could be 10x/100x or more…

[1] Dufour and Descouvemont, Nucl. Phys. A 785 (2007) 381–394

Previ k: Descouvemont tates

$$^{1}H(^{19}Ne,p)^{19}Ne^{*}(p)^{18}F$$

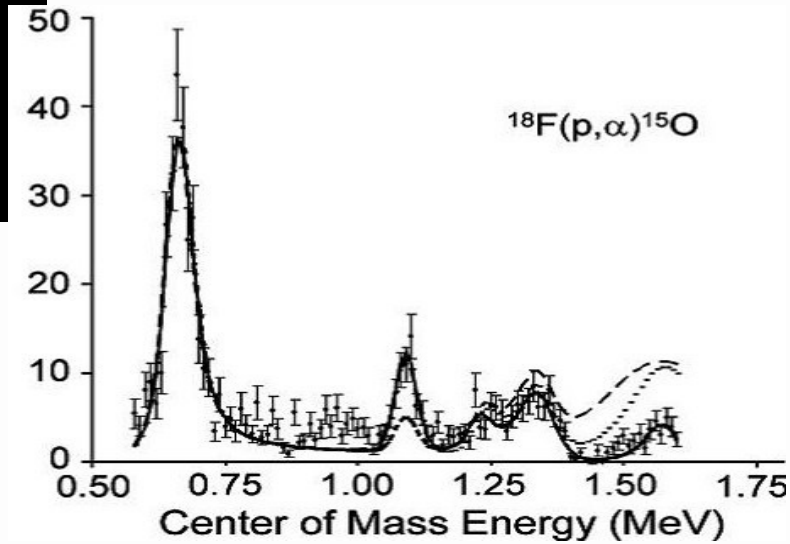
- 1.452MeV above ^{18}F + p threshold



[2] Dalouzy *et al.*, Phys. Rev. Lett. 102, 162503 (2009)

Previ[redacted]k: Descouvemont [redacted]tates

- [redacted]
- None as in Dalouzy
- Must repeat to higher energies

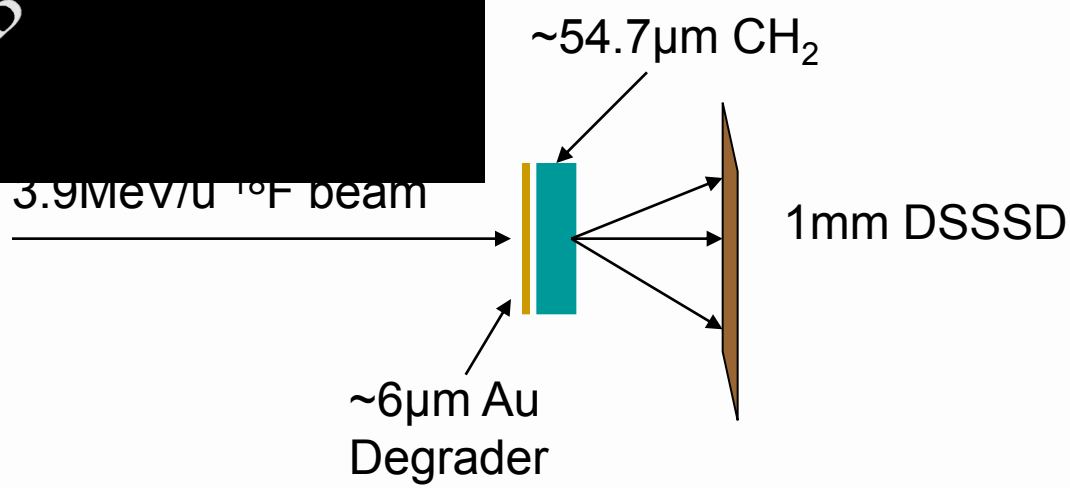


"Its presence provides a clear signature in the cross section, and should be observable in future experiments" Dufour/Descouvemont [1]

[1] Dufour and Descouvemont, Nucl. Phys. A 785 (2007) 381–394
[3] Murphy *et al.*, Phys. Rev. C 79, 058801 (2009)

xperiment

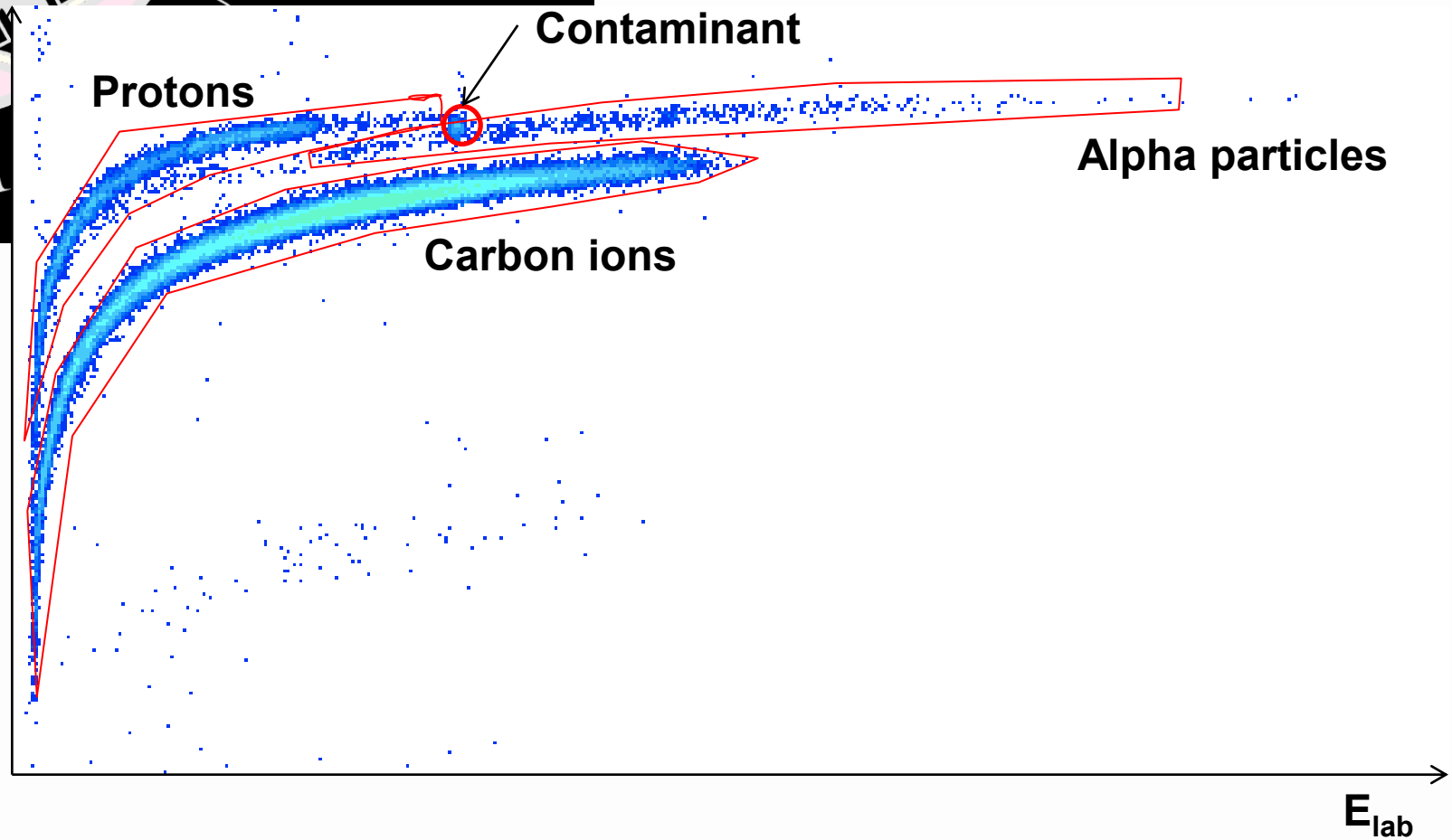
$$Ne^{*} \rightarrow {}^{15}O + \alpha$$



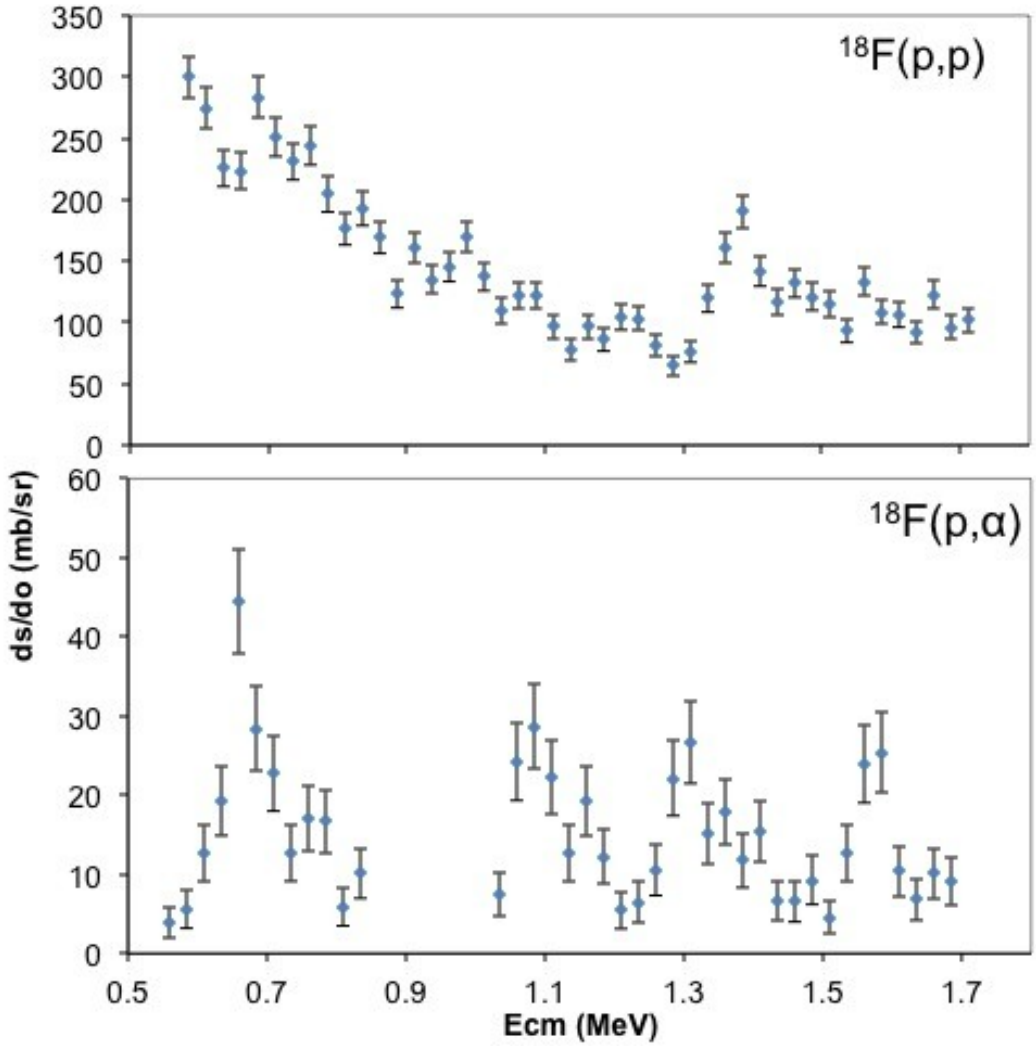
- Energy on CH_2 ~2MeV/u (~1.9MeV CM)
- Higher energy than any previous works
- Beam stops in target
- Carried out at GANIL, Caen from 11th to 16th April 2010:

Exper[redacted]ECLAN Chamber

urements



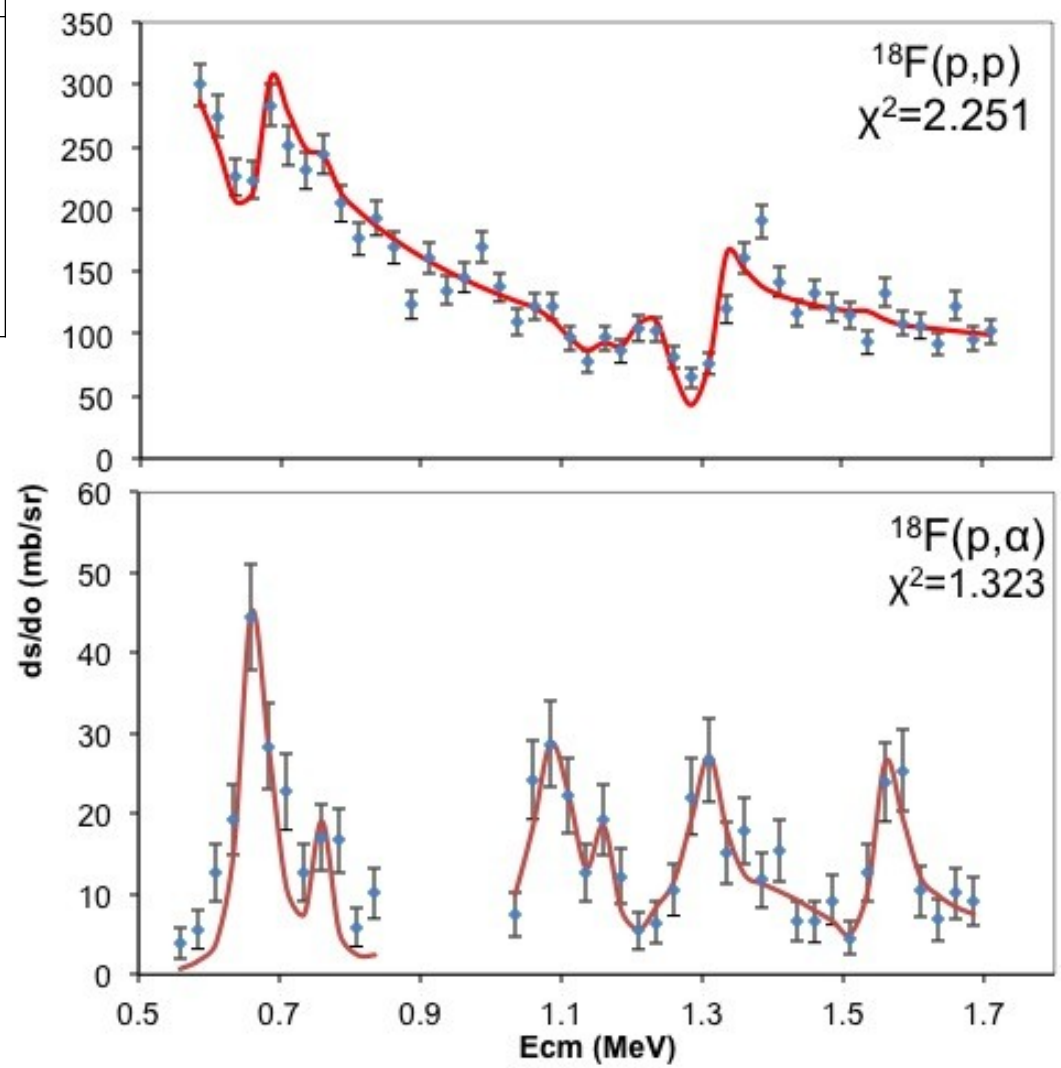
ary Results


^{18}F(p,p)
^{18}F(p,α)
ds/do (mb/sr)
Ecm (MeV)
0
50
100
150
200
250
300
350
0
10
20
30
40
50
60
0.5
0.7
0.9
1.1
1.3
1.5
1.7

ary Results

	m (MeV)	Jπ	Γ	
	0.60	3/2+		
	0.760(18)			
C	1.095(			
G	1.352(17)	1/2+	81(14)	206(58)
H	1.556(17)	5/2+	1.0(3)	27(10)

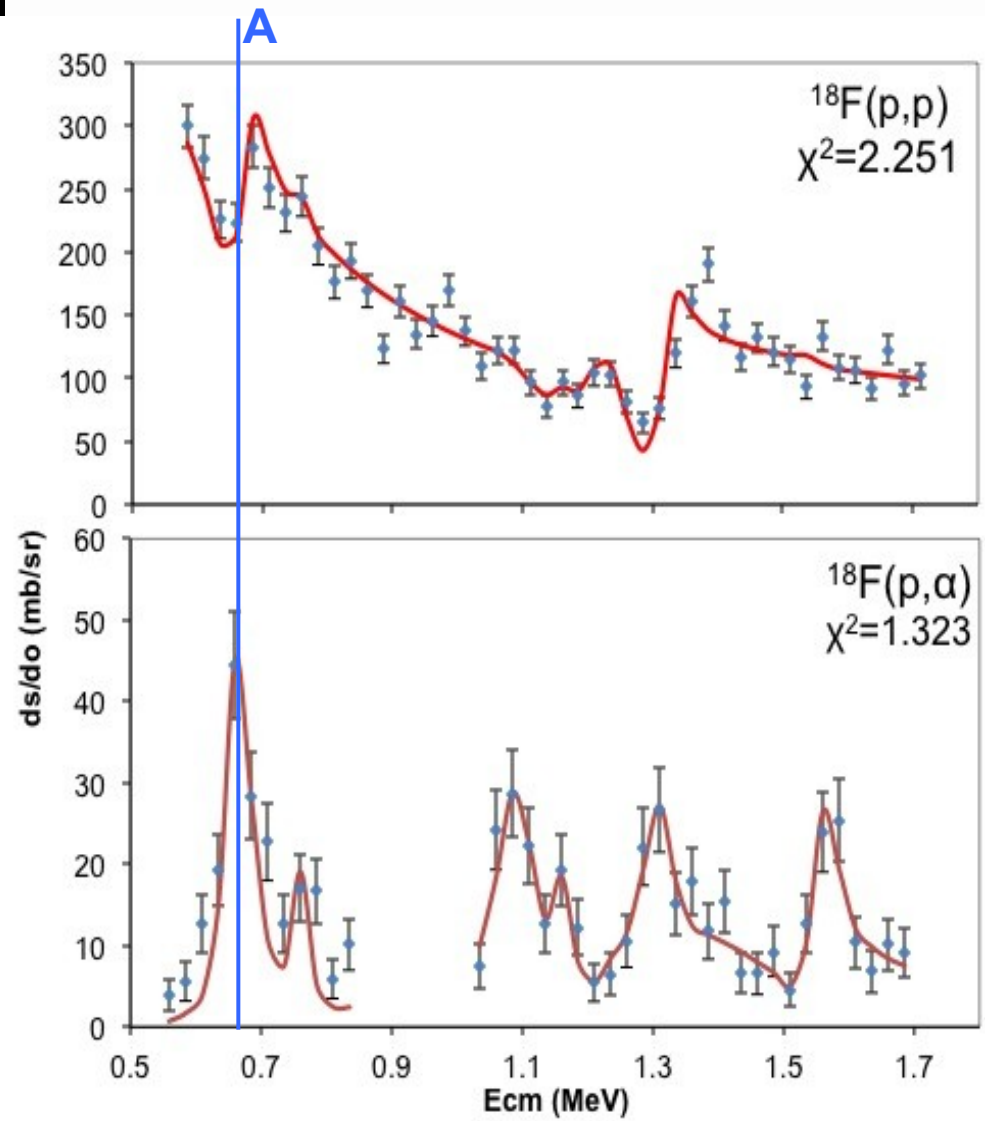
- Results of R Matrix analysis carried out using DREAM code from P. Descouvemont
- Comparison references:
  1. Nesaraja *et al.* PRC 75, 055809 (2007)
  2. Murphy *et al.* PRC 79, 058801 (2009)
  3. Dalouzy *et al.* PRL 102, 162503 (2009)



Pr[redacted]y Results (A)

	Ecm (MeV)	Jπ		
	0.665	3/2		
	0.76[illegible](18)	3[illegible]		
C	1.095(10[illegible])	[illegible]		
D	1.1[illegible]			
H	1.556(17)	5/2+	1.0(3)	27(10)

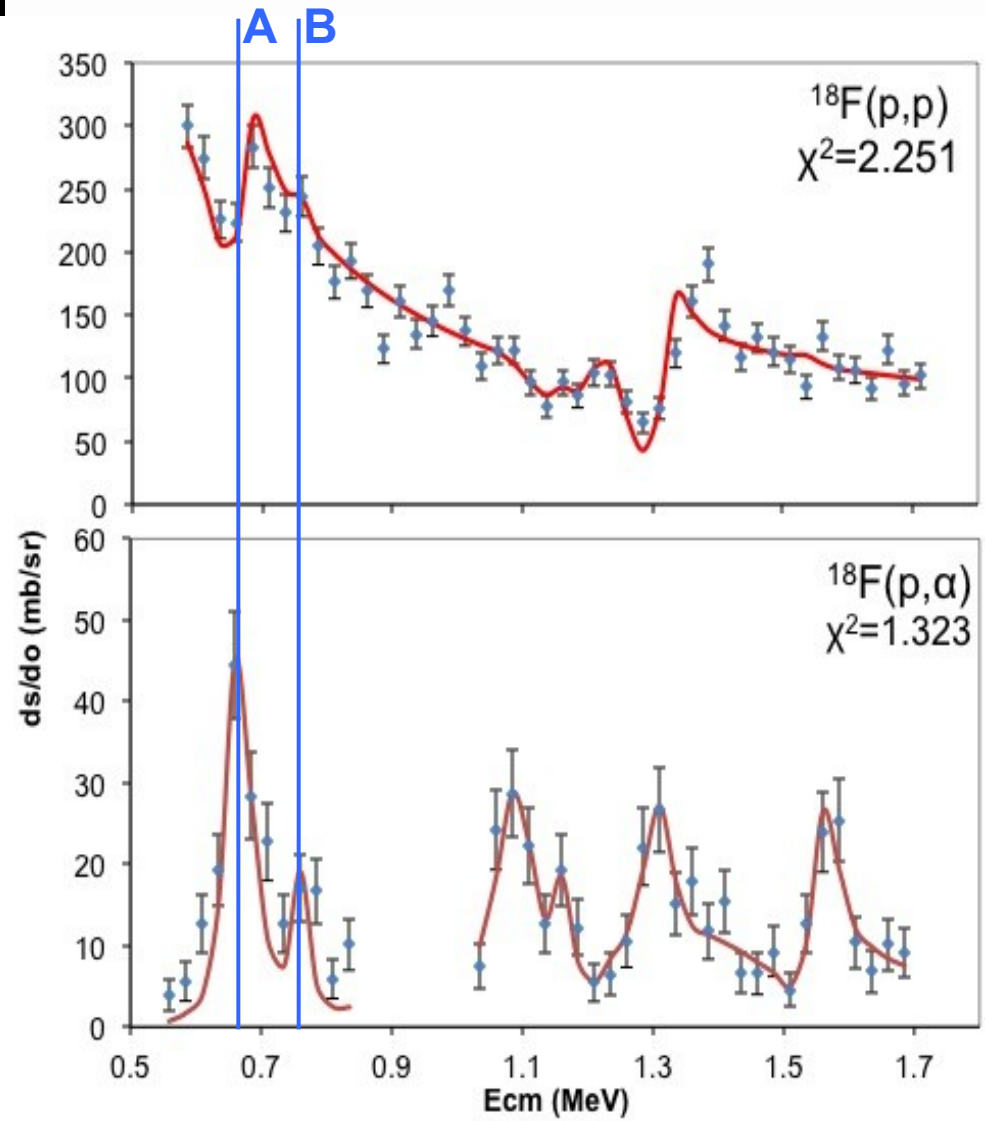
- Well known '665keV' state
- Cross sections scaled to this state



Pr[redacted]y Results (B)

	Ecm	Jπ		
	0.665	3/2-		
	0.7[illegible](18)	3[illegible]		
C	1.095(10)	[illegible]		
D	1.1[illegible]			
H	1.556(17)	5/2+	1.0(3)	27(10)

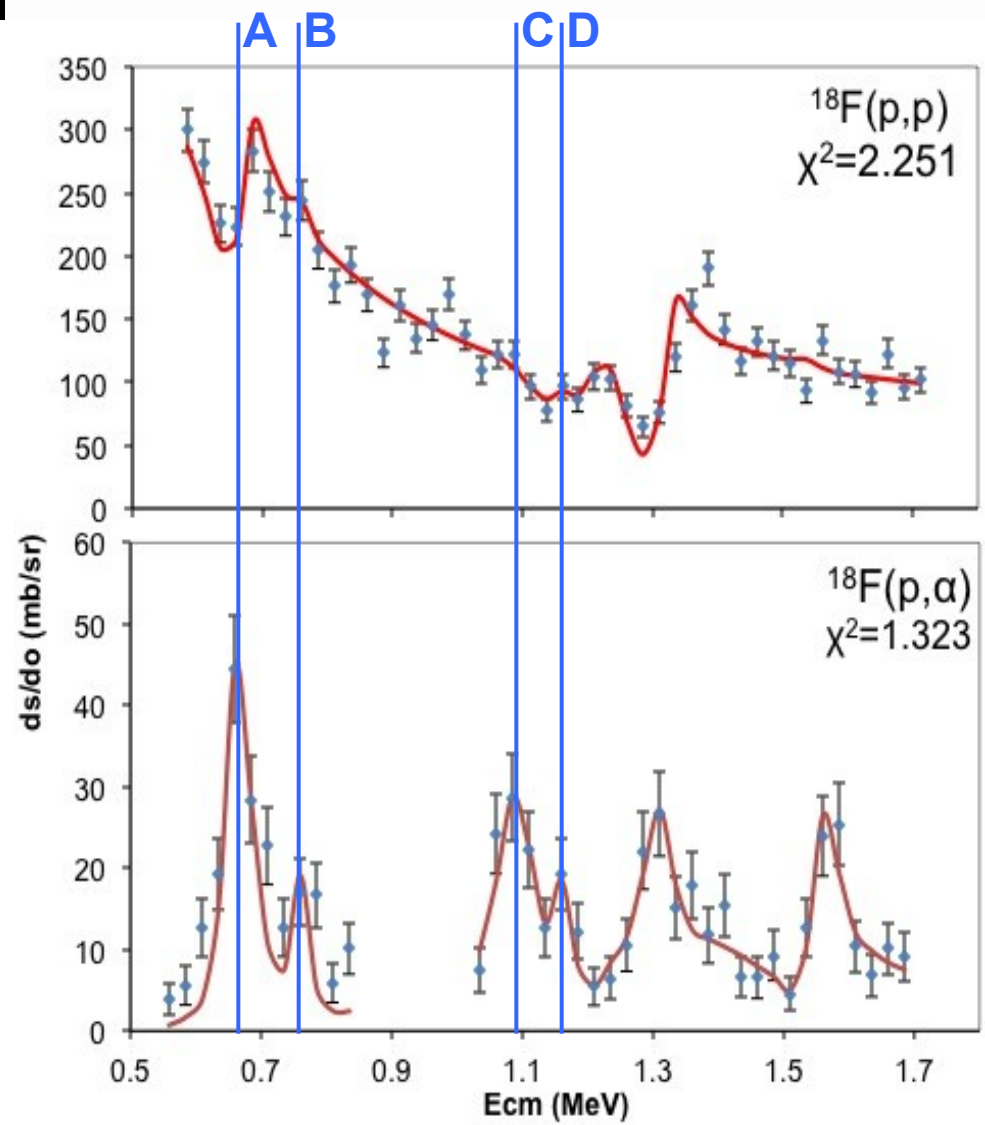
- Reported by Nesaraja/Dalouzy
- Significantly weaker than Dalouzy
- Rough agreement with Nesaraja



Preli[redacted] Results (C & D)

	Ecm [redacted]	Jπ	[redacted]	[redacted]
[redacted]	0.665[redacted]	3/2[redacted]	[redacted]	[redacted]
[redacted]	0.7[redacted](18)	3[redacted]	[redacted]	[redacted]
C	1.095(10[redacted]	[redacted]	[redacted]	[redacted]
D	1.1[redacted]	[redacted]	[redacted]	[redacted]
H	1.556(17)	5/2+	1.0(3)	27(10)

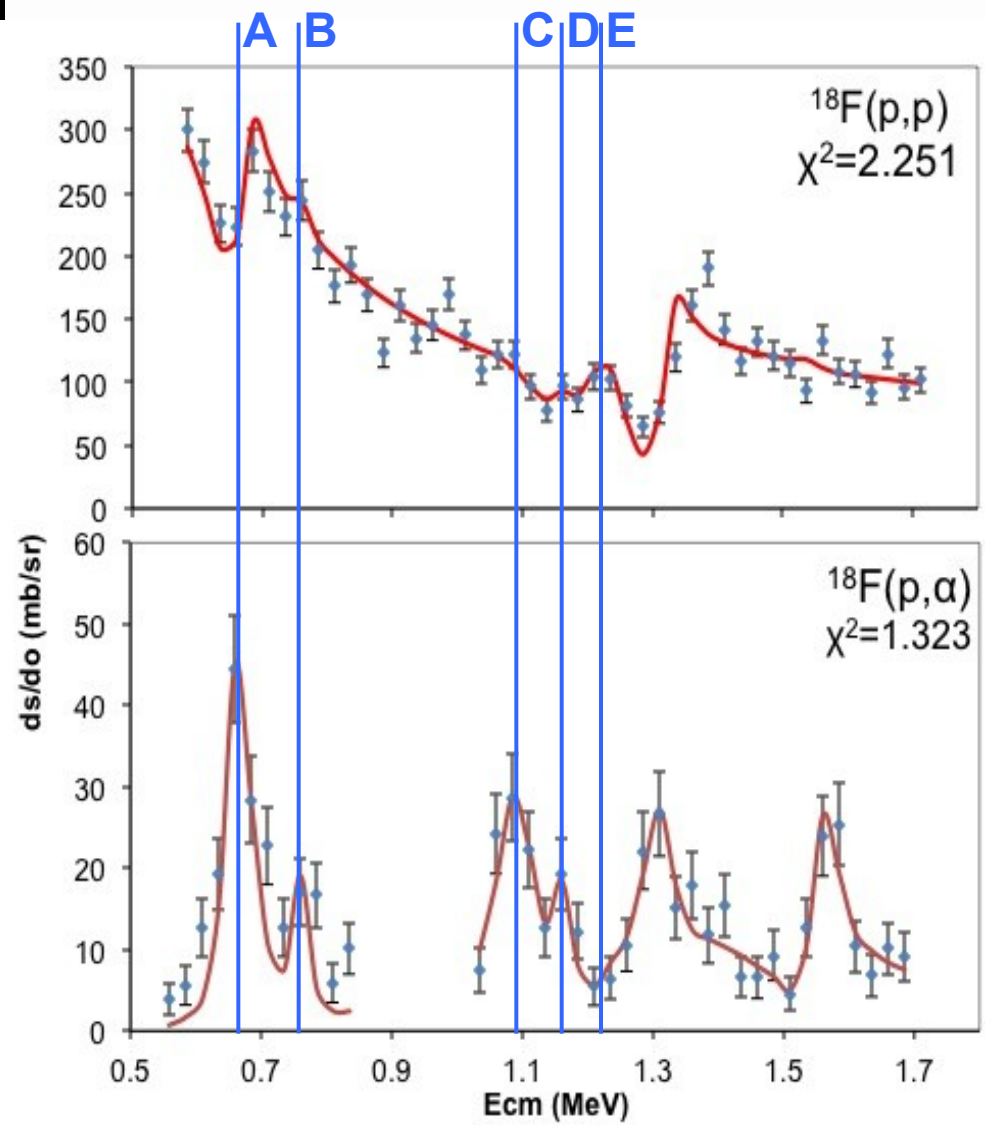
- C reported by Murphy – narrower
- C and D reported by Dalouzy/Nesaraja at different strengths
- Enhanced resolution reveals alternate relative strengths



Pr[redacted]y Results (E)

	Ecm	Jπ		
	0.665	3/2		
	0.7[illegible](18)	3		
C	1.095(10)	[illegible]		
D	1.1[illegible]			
H	1.556(17)	5/2+	1.0(3)	27(10)

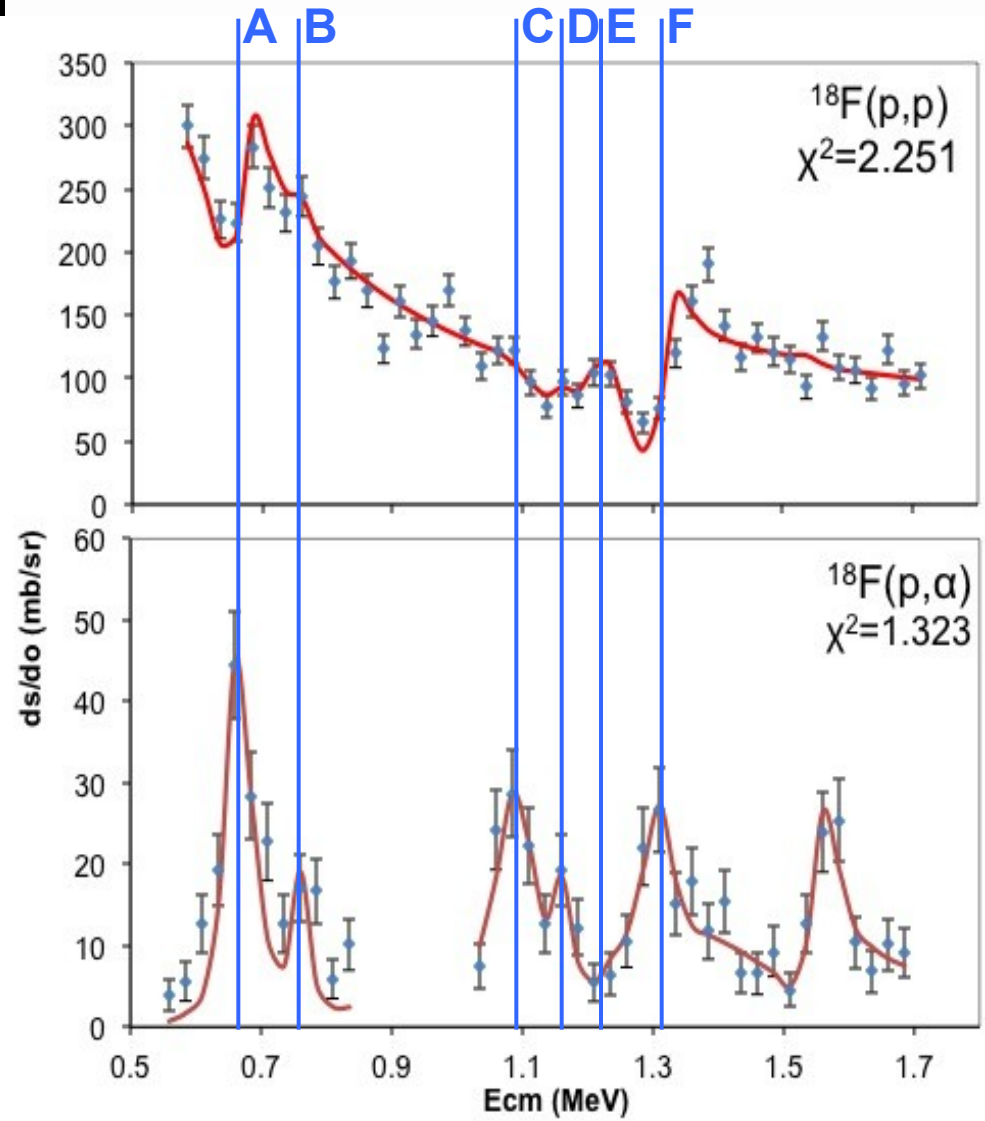
- Previously reported by Nesaraja and Murphy
- Agreement in spin with Murphy
- No agreement in strength
- Required to fit bottom of state F



Pr[redacted]y Results (F)

	Ecm	Jπ		
	0.665	3/2		
	0.7[illegible](18)	3		
C	1.095(10)	[illegible]		
D	1.1[illegible]			
H	1.556(17)	5/2+	1.0(3)	27(10)

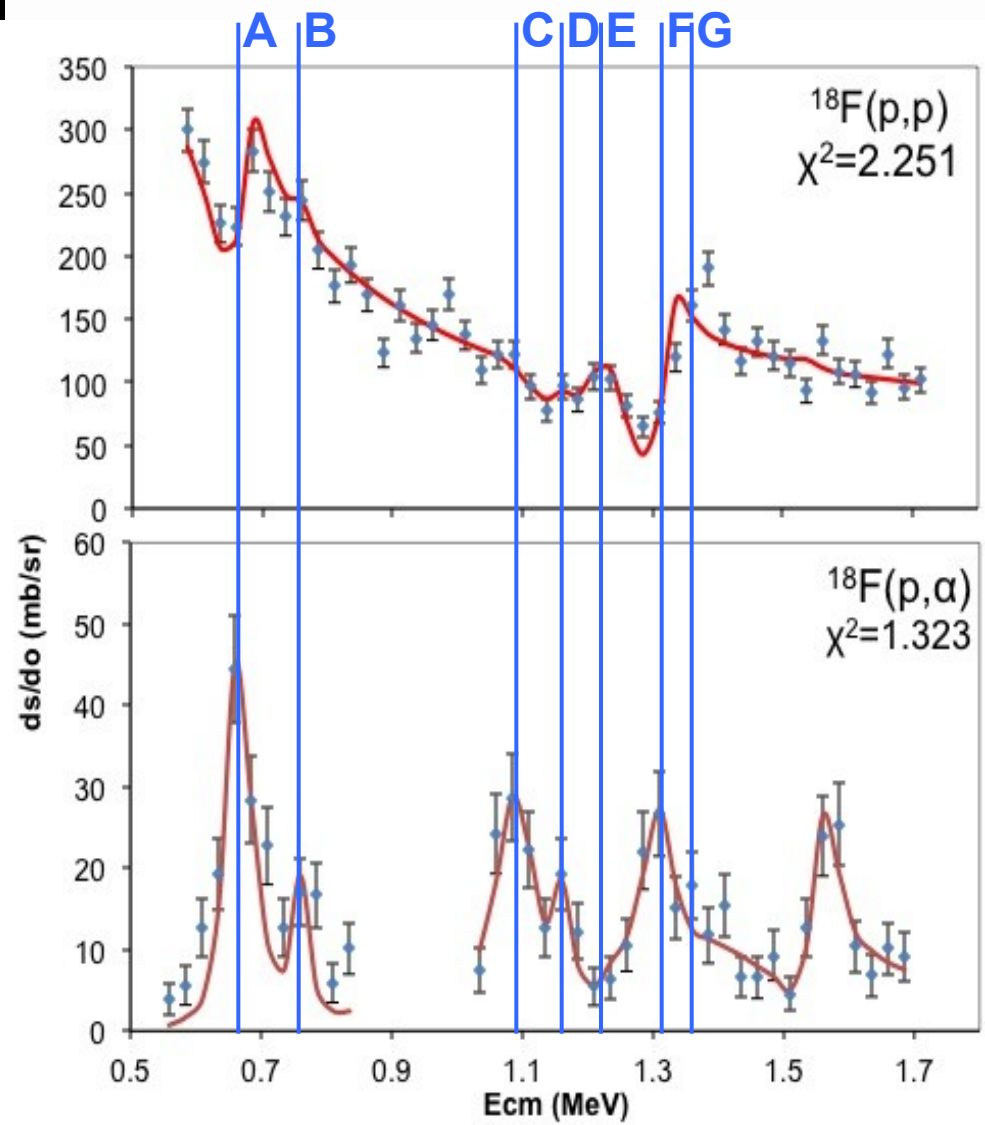
- Observed by Murphy, much broader in proton channel
- New strength accounts for addition of new broad state (G)



Pr[redacted]y Results (G)

	Ecm	Jπ		
	0.665	3/2		
	0.7[illegible](18)	3		
C	1.095(10)	[illegible]		
D	1.1[illegible]			
H	1.556(17)	5/2+	1.0(3)	27(10)

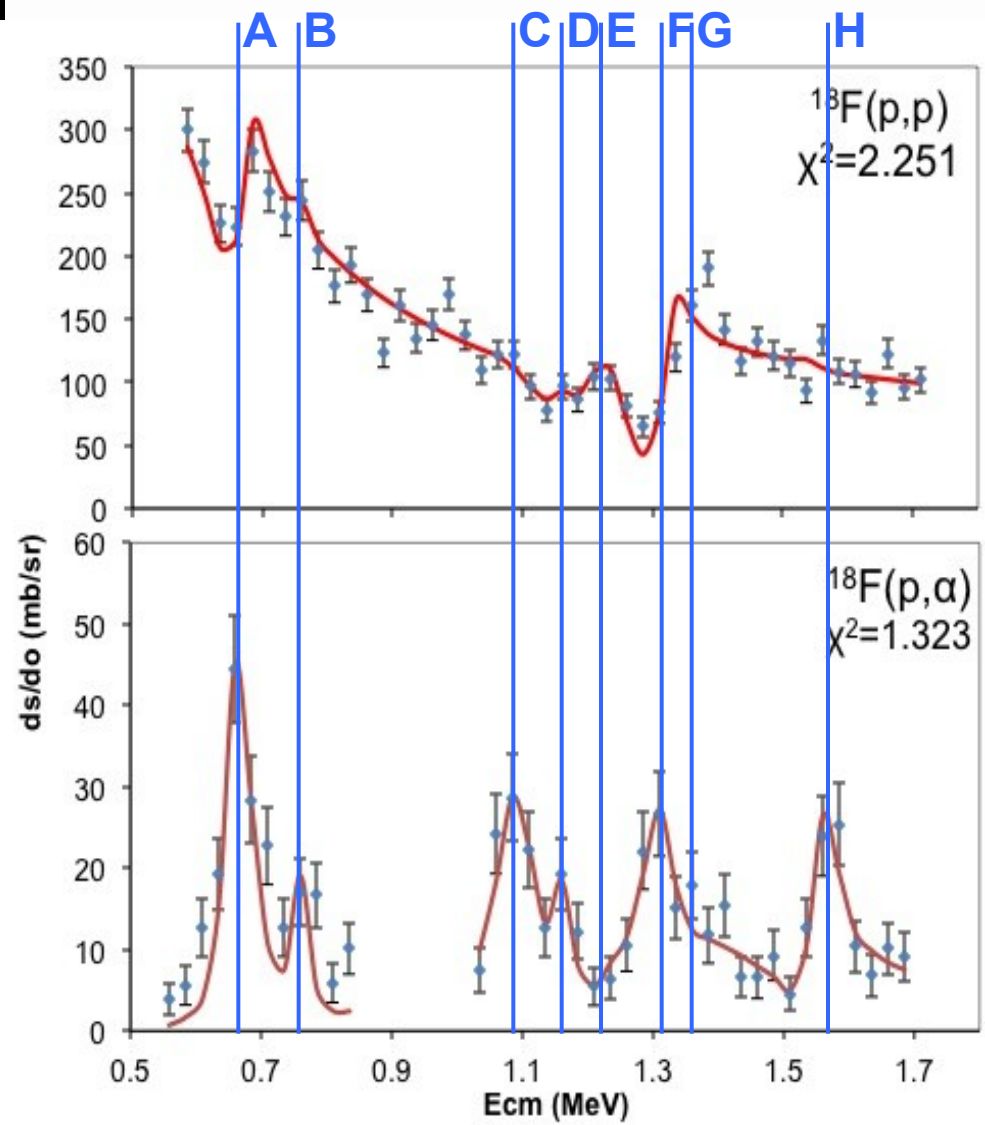
- Descouvemont state?



Pr[redacted]y Results (H)

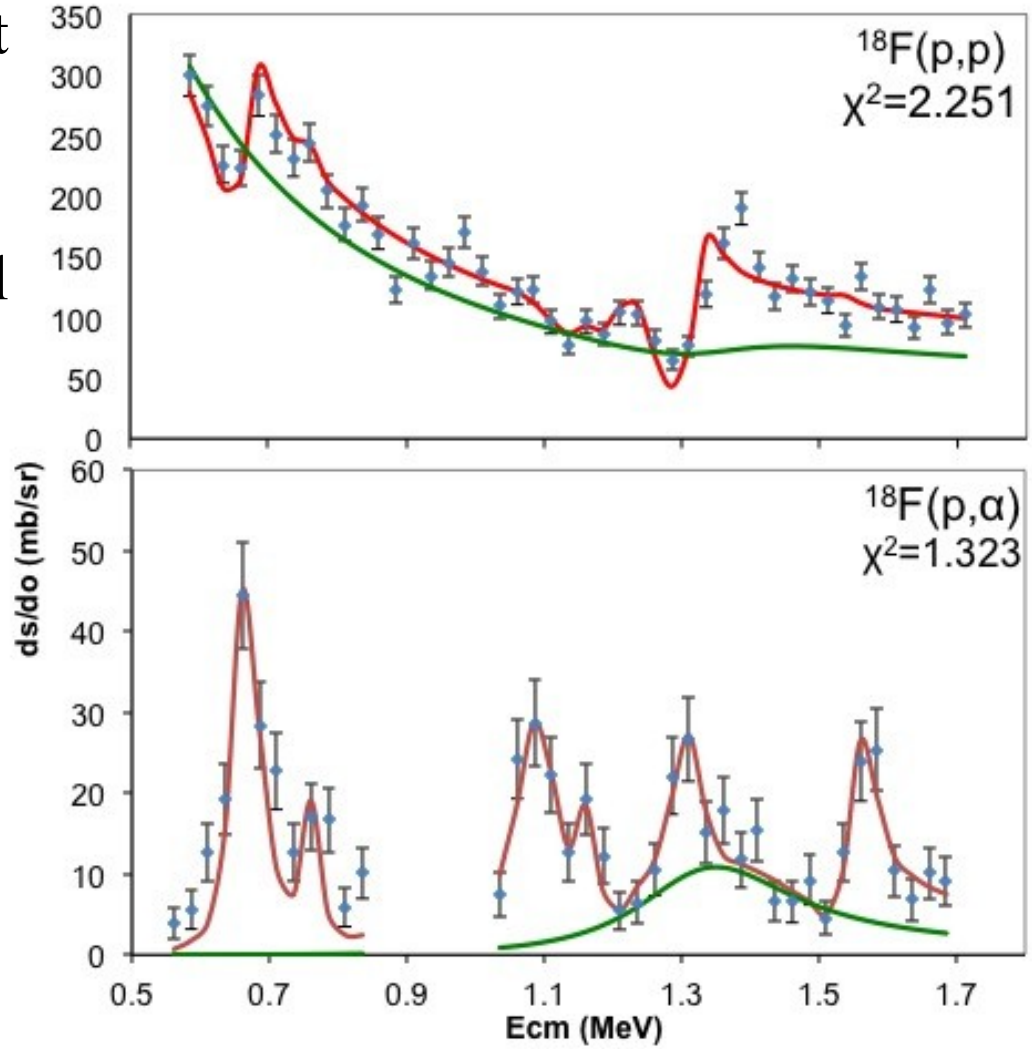
	Ecm	Jπ		
	0.665	3/2		
	0.7[illegible](18)	3		
C	1.095(10)	[illegible]		
D	1.1[illegible]			
H	1.556(17)	5/2+	1.0(3)	27(10)

- Observed by Dalouzy and Murphy
- Different spin
- Analysis significantly hampered by statistics at this energy



Dulou[redacted]uvemont State??

- Candida[redacted] at E[redacted]
  [redacted]n predicted in proton channel
- Factor of 2 *broader* than predicted in alpha channel
- Rough agreement in total width (287keV) with Dalouzy (292keV) and prediction (296keV)
- Broad state **<u>is required</u>** to fit to data



clusions

- New udy of astrophysically ion

- New work finds candidate for a crucial, newly predicted, ½+ state in limited agreement with previous measurement

- Precision of extracted parameters is constrained by limited statistics

borators

- University o
  - A. S. M
  - T. D
  - A. M. Laird
  - J. R. Brown
- Orsay:
  - N. de Sereville
- Tractebel:
  - C. Angulo
- LPC Caen
  - N. L. Achouri
- GANIL
  - F. de Oliveira
  - P. Ujic
  - O. Kamalou
- ORNL:
  - S. Pittman
- ULB:
  - Pierre Descouvemont

References

[1] Dufour and Descouvemont, Nucl. Phys. A 785 (2007) 381–394
[2] Dalouzy *et al.*, Phys. Rev. Lett. 102, 162503 (2009)
[3] Murphy *et al.*, Phys. Rev. C 79, 058801 (2009)
[4] Nesaraja *et al.* Phys. Rev. C 75, 055809 (2007)