Triton beams with light nuclei: searching for halo fingerprints

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Introduction

- Two neutron transfer reactions with light nuclei are well known.
- Cross sections are (relatively) large → mb.
- We can investigate new physics.

A brief history of tritium transfer reactions with light nuclei

(t,p) reactions @ Los Alamos

PHYSICAL REVIEW C VOLUME 17, NUMBER 4 APRIL 1978

(t,p) reactions on ^{4}He, ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, ^{11}B, and ^{12}C†

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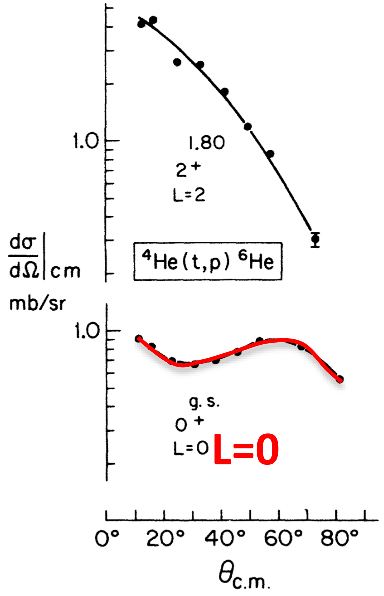
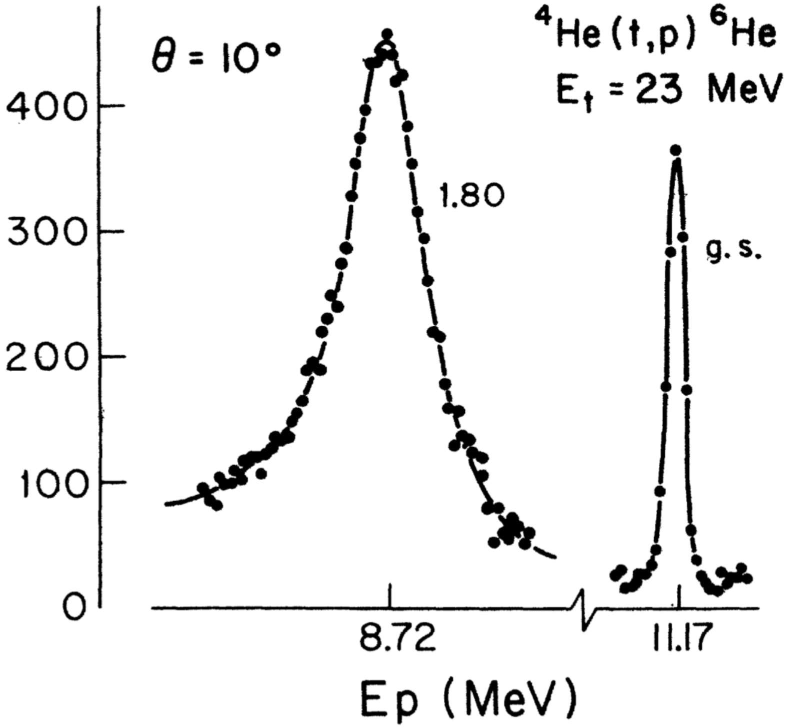
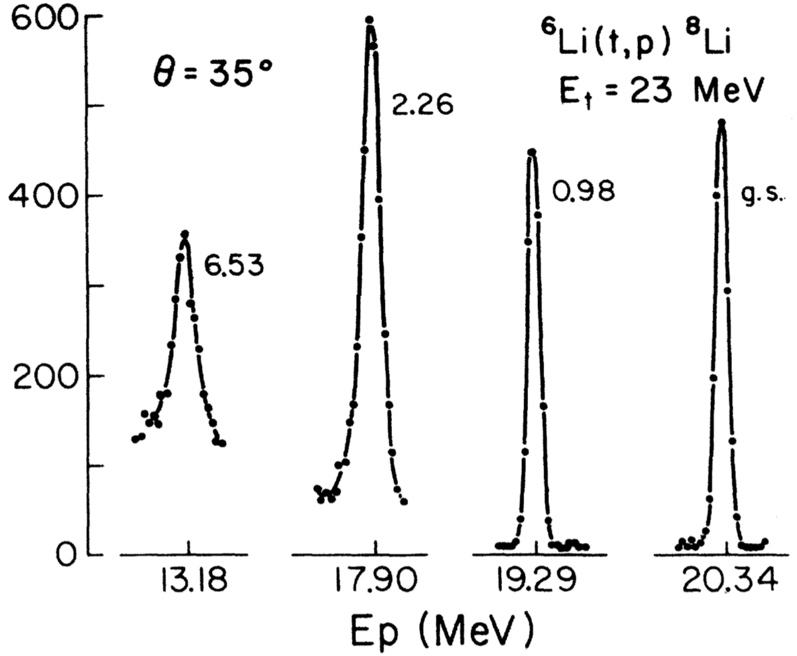
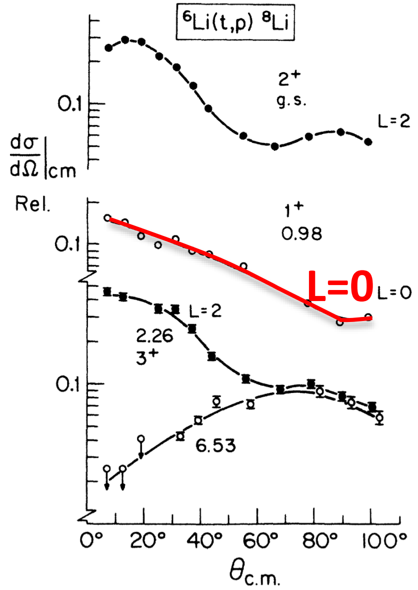
E. R. Flynn and Ole Hansen‡
University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545
(Received 13 December 1977)









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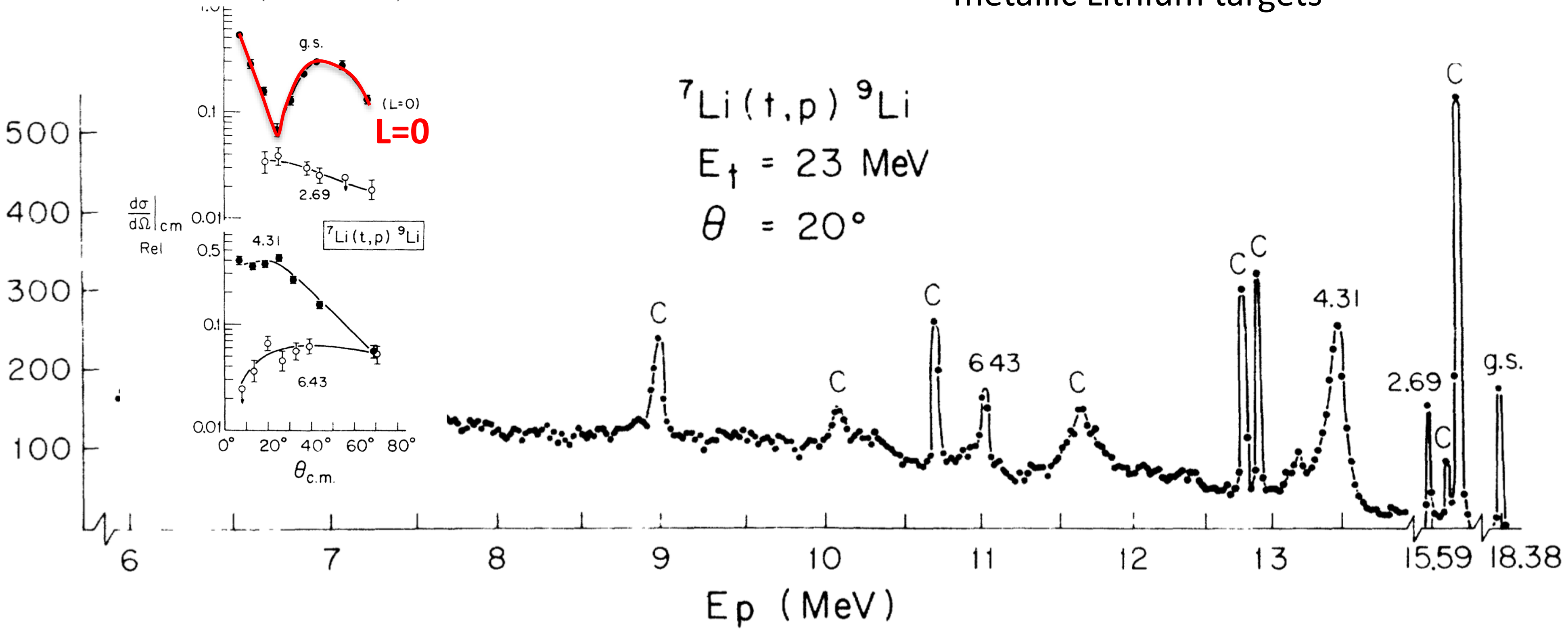
- Strong carbon contamination
- We can now make self-supporting metallic Lithium targets



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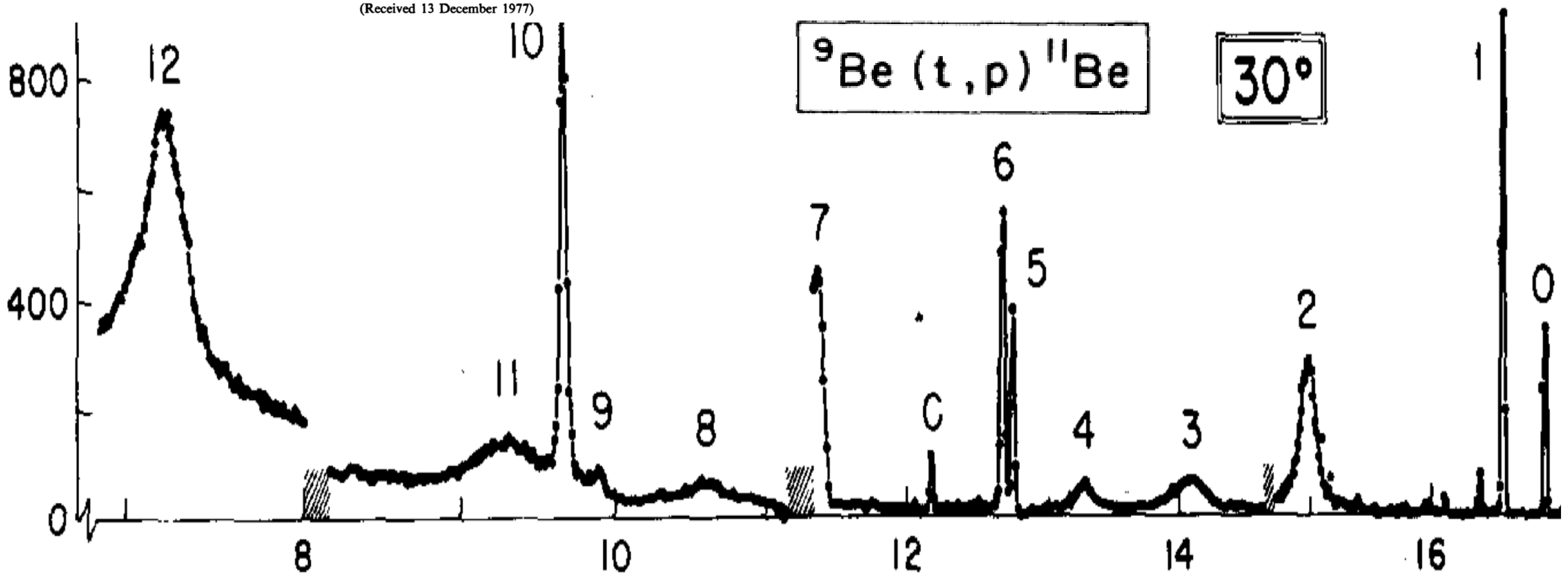

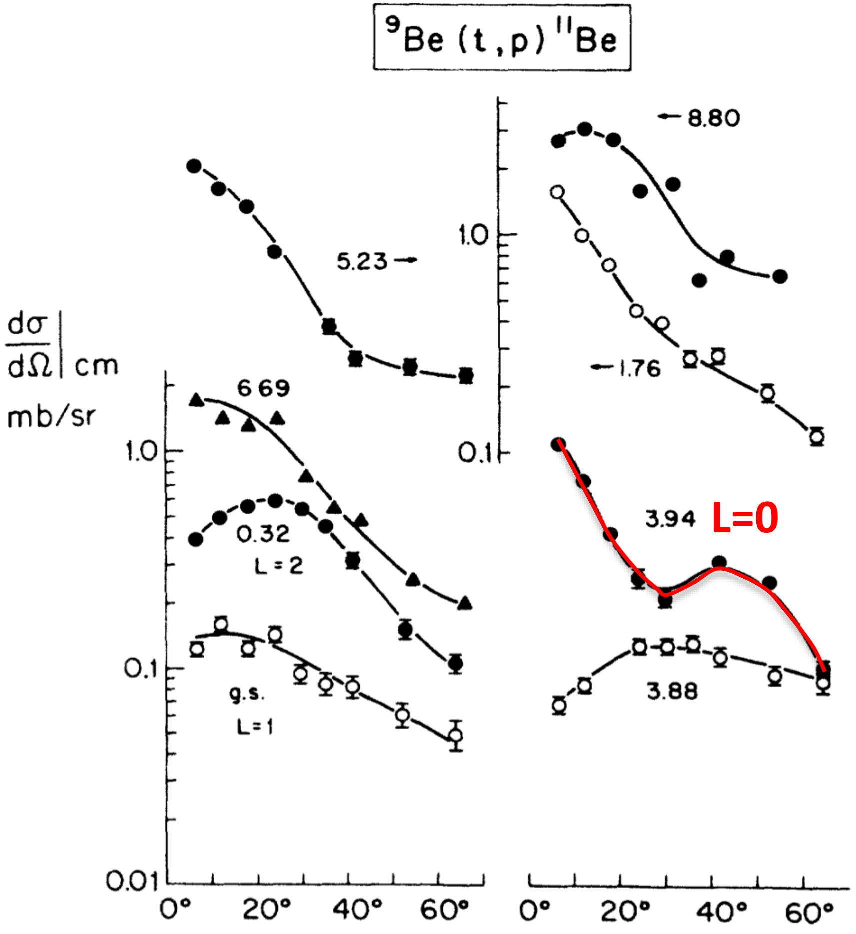

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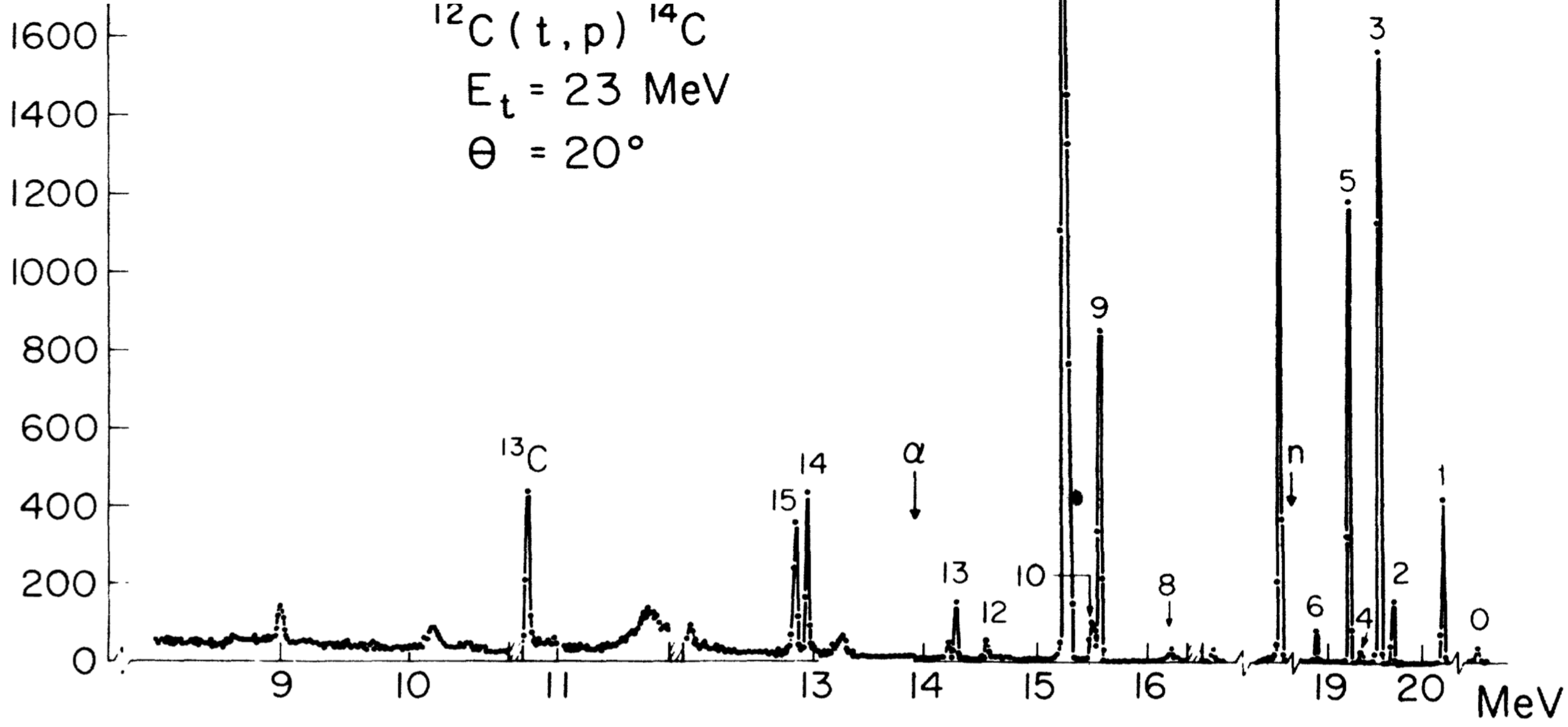

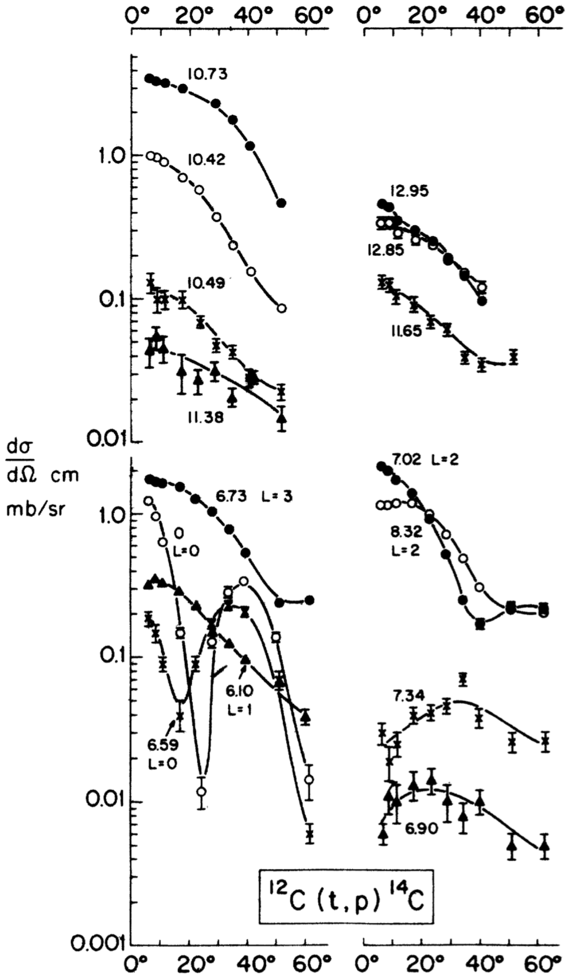

(t,p) reactions @ Penn state

$(sd)^2$ states in ^{12}Be

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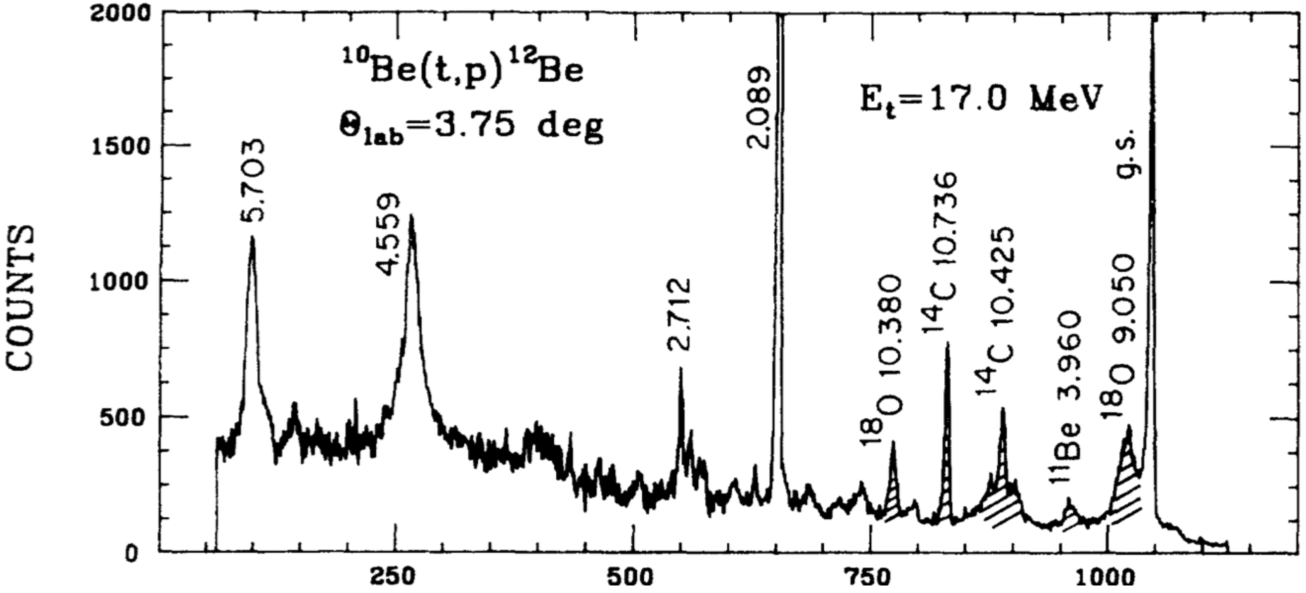
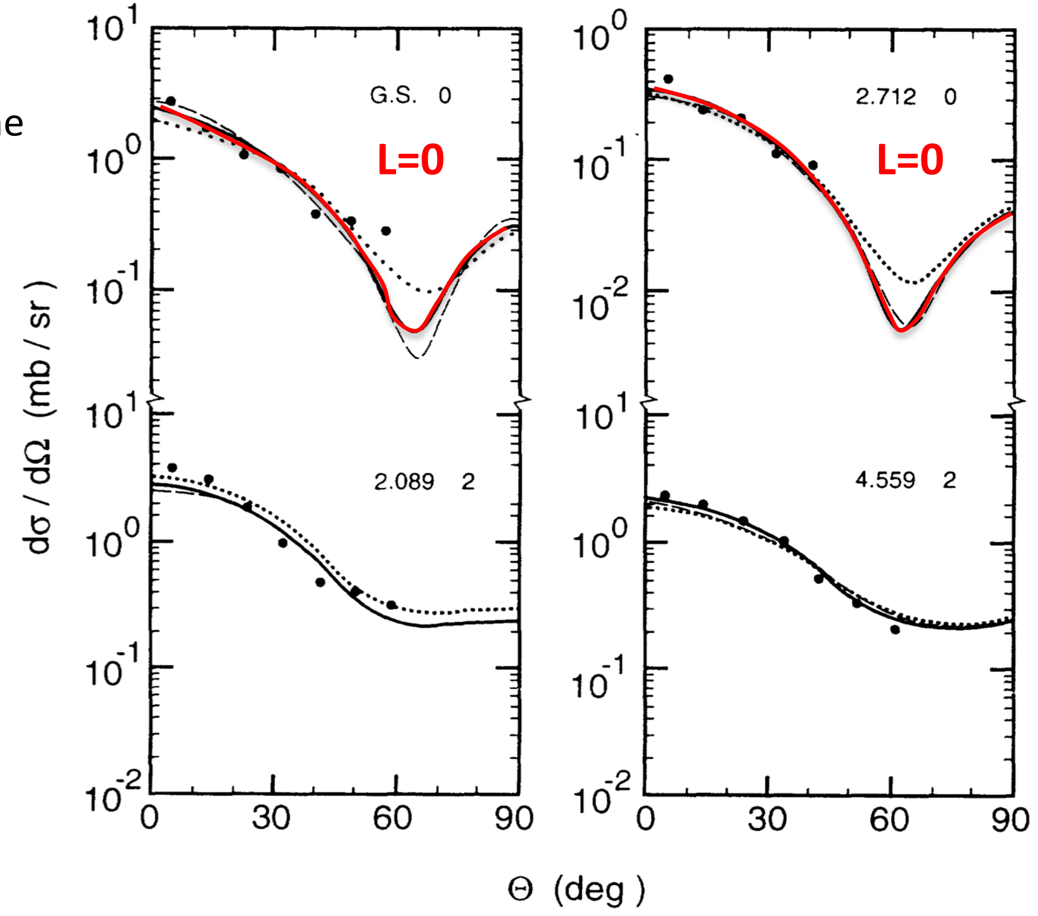
Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19104

D. E. Alburger
Brookhaven National Laboratory, Upton, New York 11973
(Received 17 February 1994)

L=0 differential cross section needs an $(sd)^2$ admixture in the wavefunction



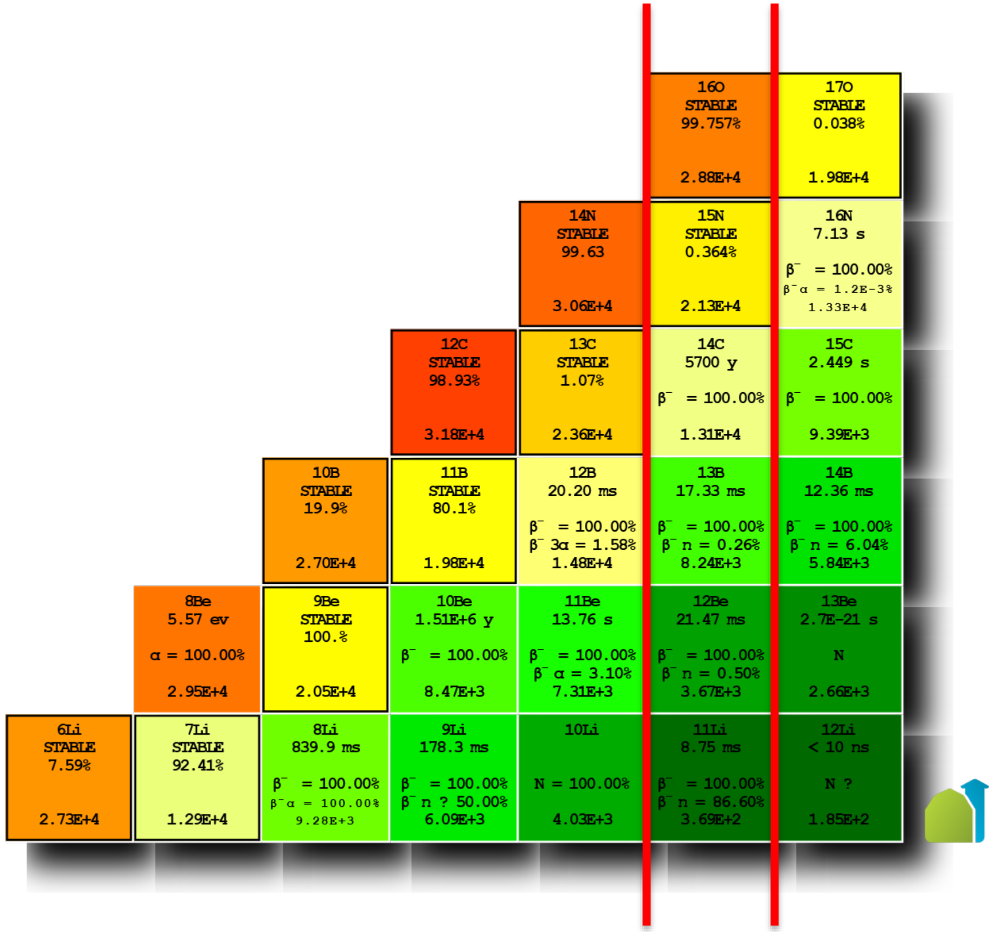


overview

- High quality spectroscopic studies
- Demonstrate two neutron transfer to (sd) orbitals
- Hampered by difficulty of reaction theory of transfer to unbound states.

The N=8 “island of deformation”

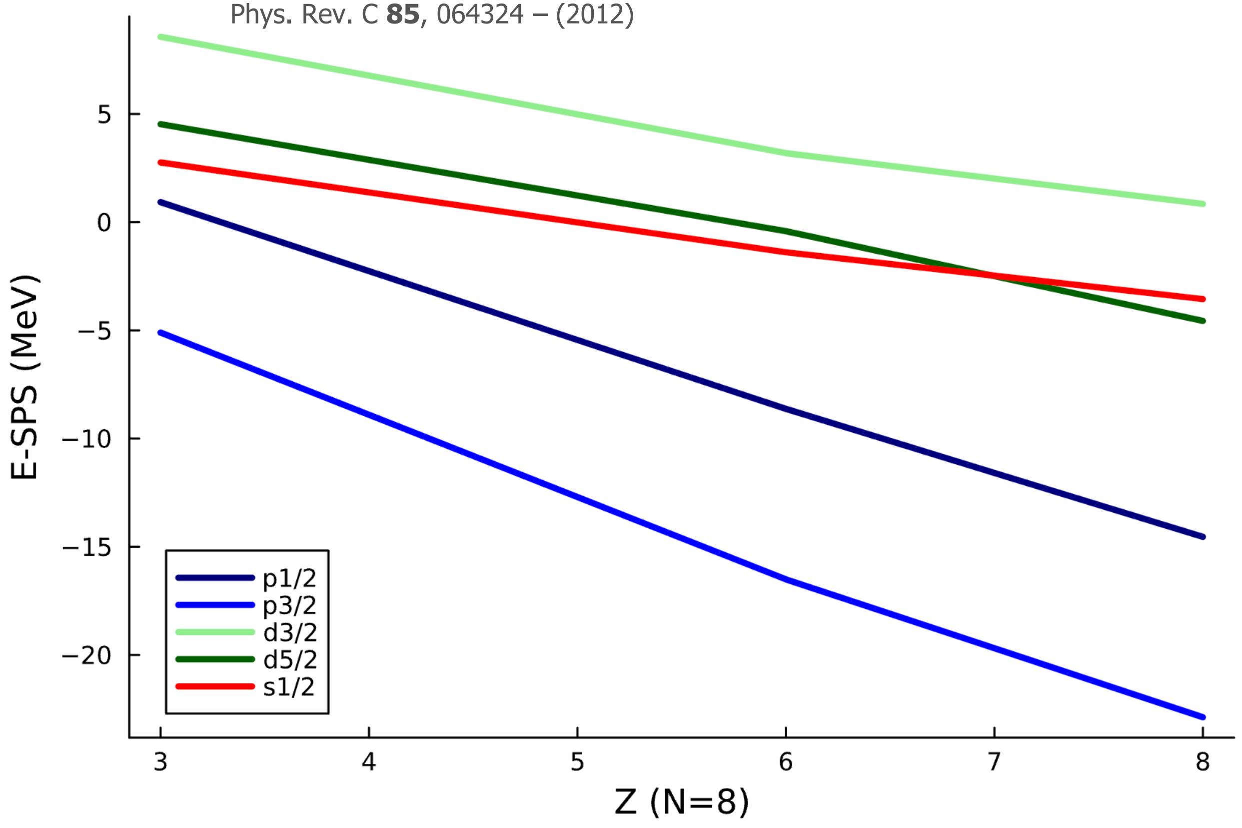
The disappearance of the N=8 shell gap



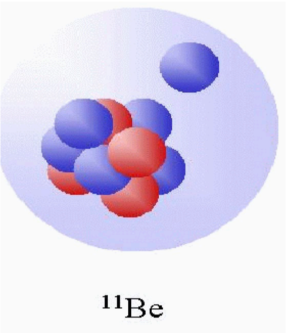
YSOX interaction

V_{MU} monopole universal interaction in the *psd* valence space

Cenxi Yuan, Toshio Suzuki, Takaharu Otsuka, Furong Xu, and Naofumi Tsunoda
Phys. Rev. C **85**, 064324 – (2012)

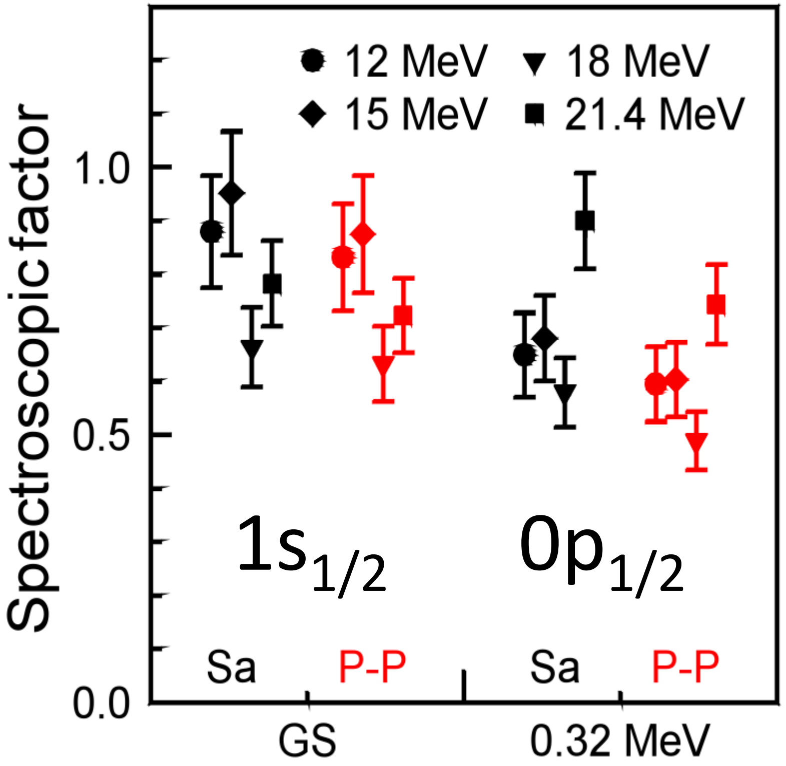


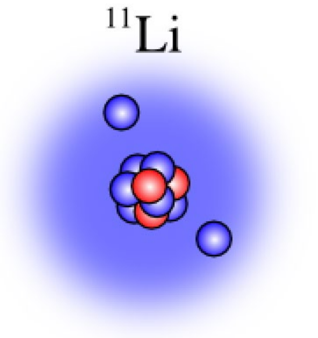
The wavefunctions of nuclear halos



$S_{1/2}$ (YSOX)=50%

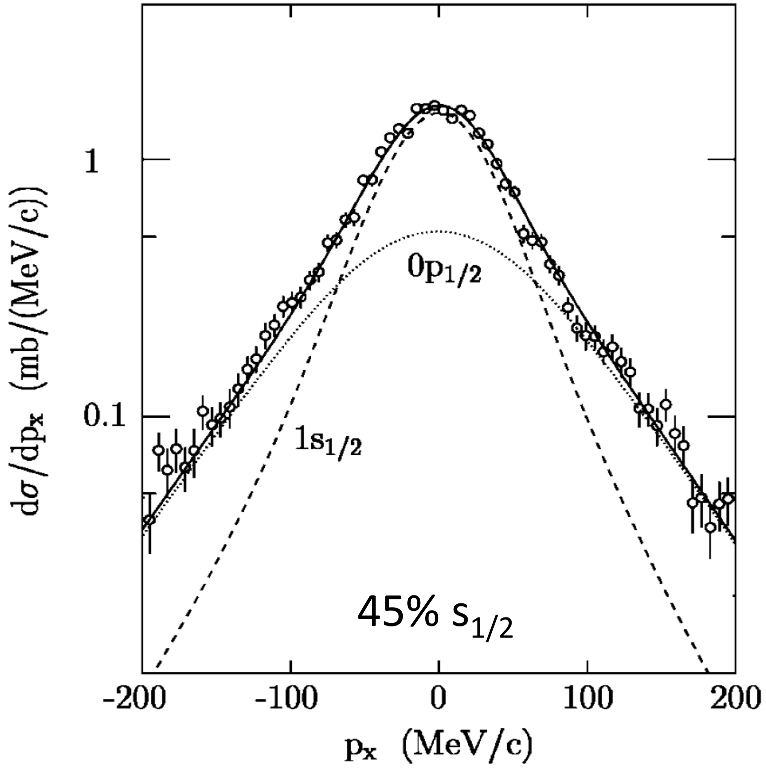
K. T. Schmitt *et al.*
Phys. Rev. Lett. **108**, 192701 (2012)



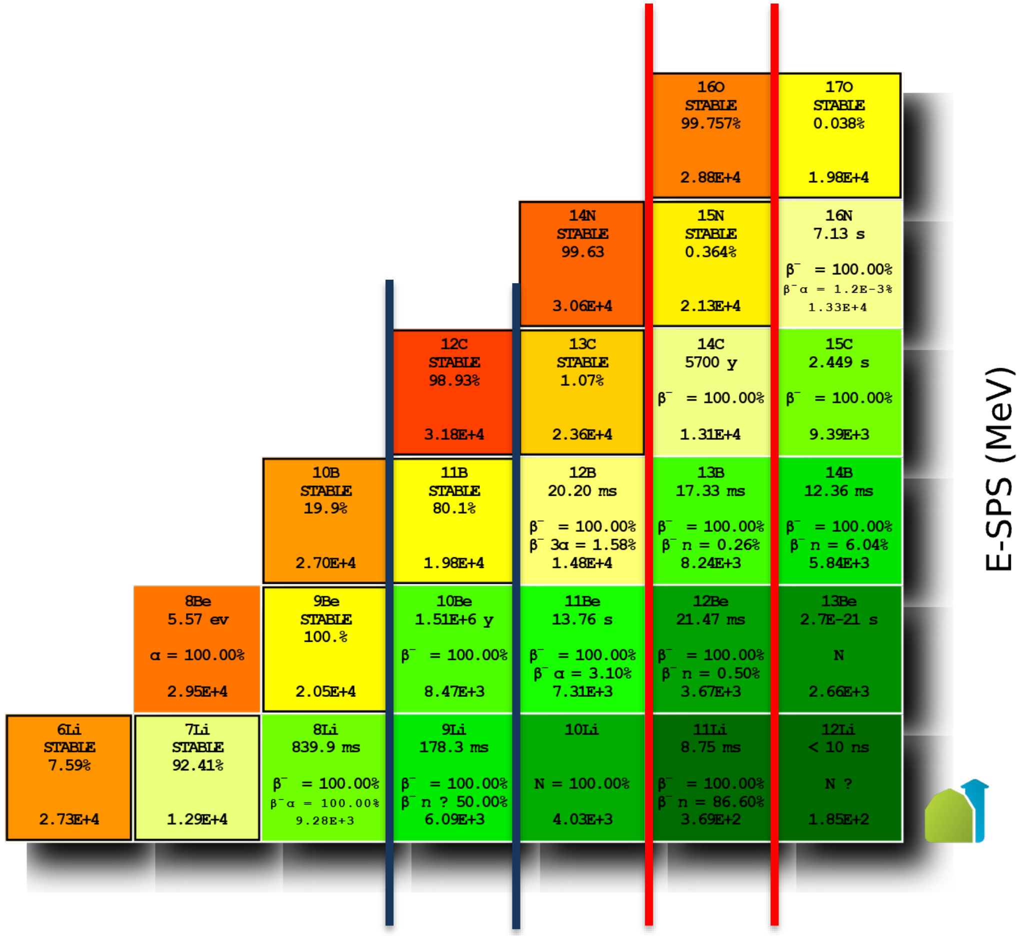


$S_{1/2}$ (YSOX)=30%

H. Simon *et al.*
Phys. Rev. Lett. **83**, 496 (1999)



What happens at N=6?



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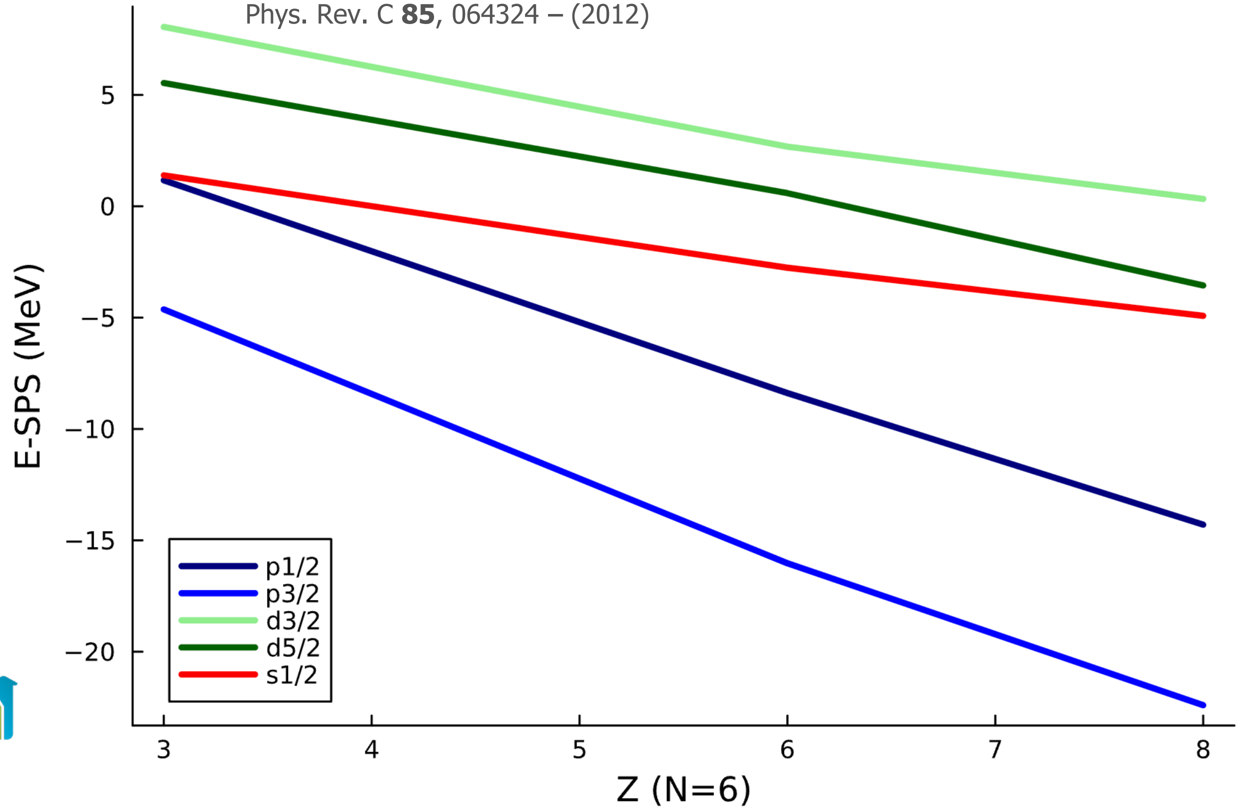
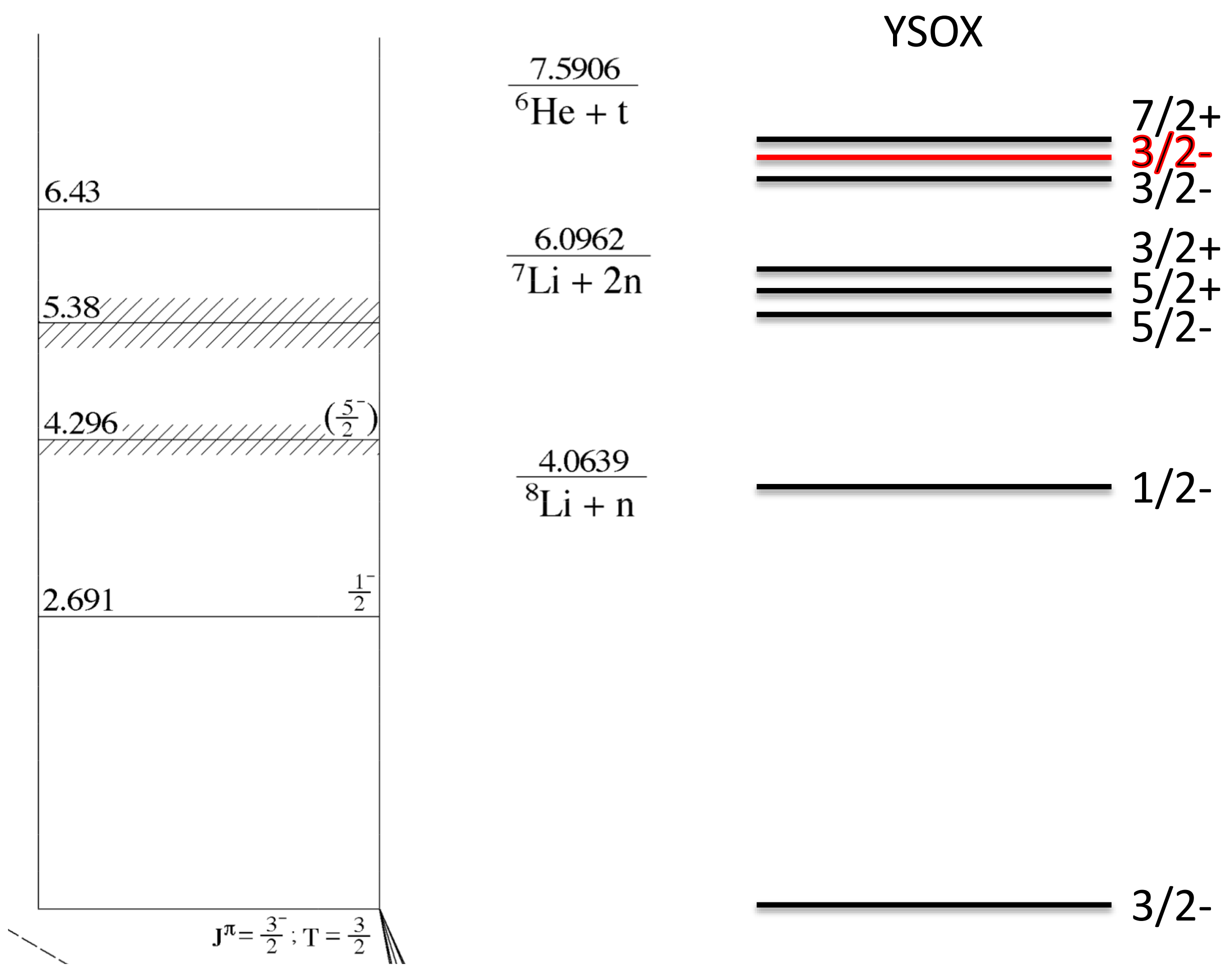
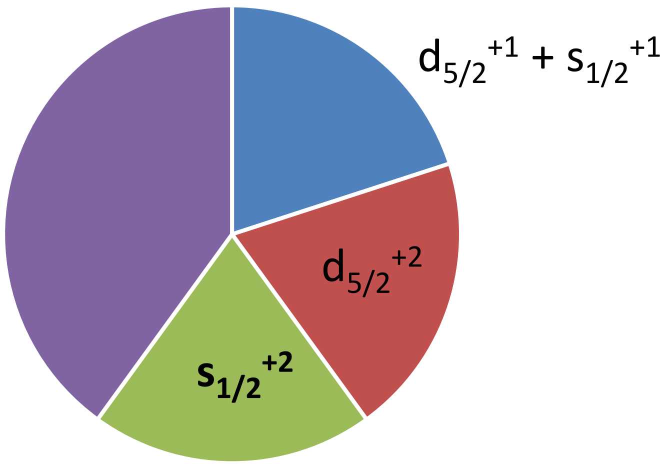


$(sd)^2$ states in Lithium-9

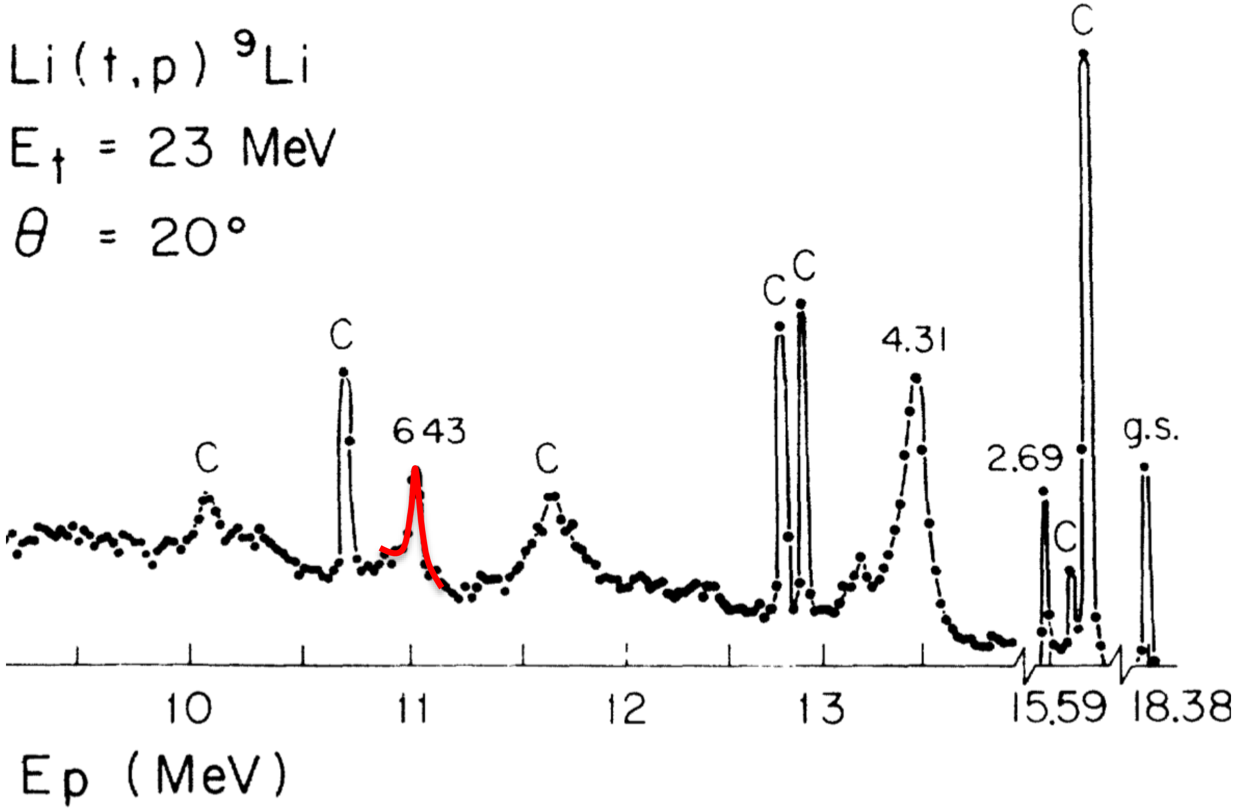


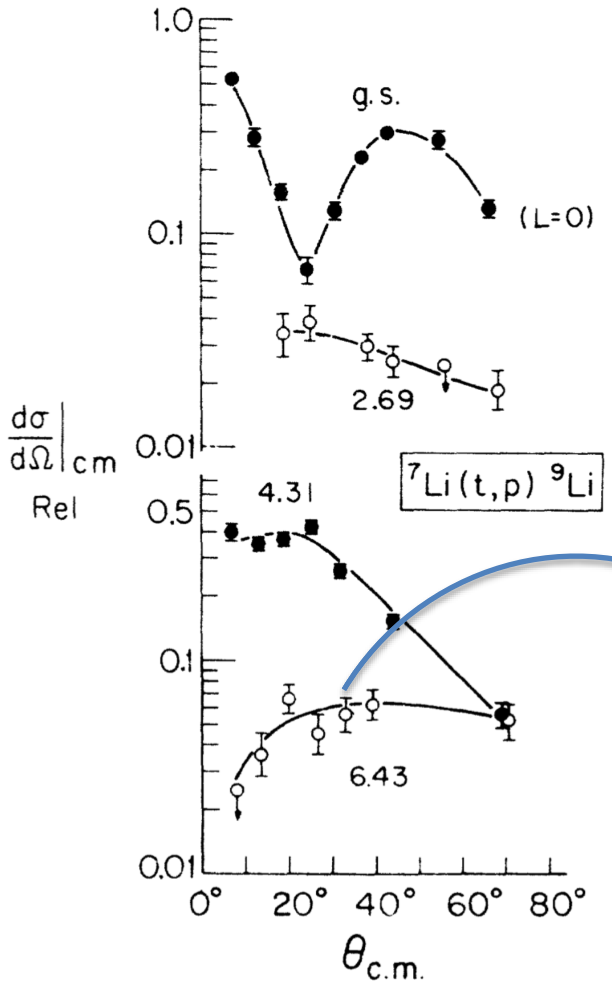
- one state present around 2-neutron separation energy
- 6.8 MeV state 90% $2\hbar\omega$
  - 20% $^7Li_{gs} \otimes d_{5/2}^{+1} + s_{1/2}^{+1}$
  - 20% $^7Li_{gs} \otimes d_{5/2}^{+2}$
  - **20%** $^7Li_{gs} \otimes \mathbf{s_{1/2}^{+2}}$



^{7}Li(t,p)^{9}Li (23 MeV) @ Los Alamos

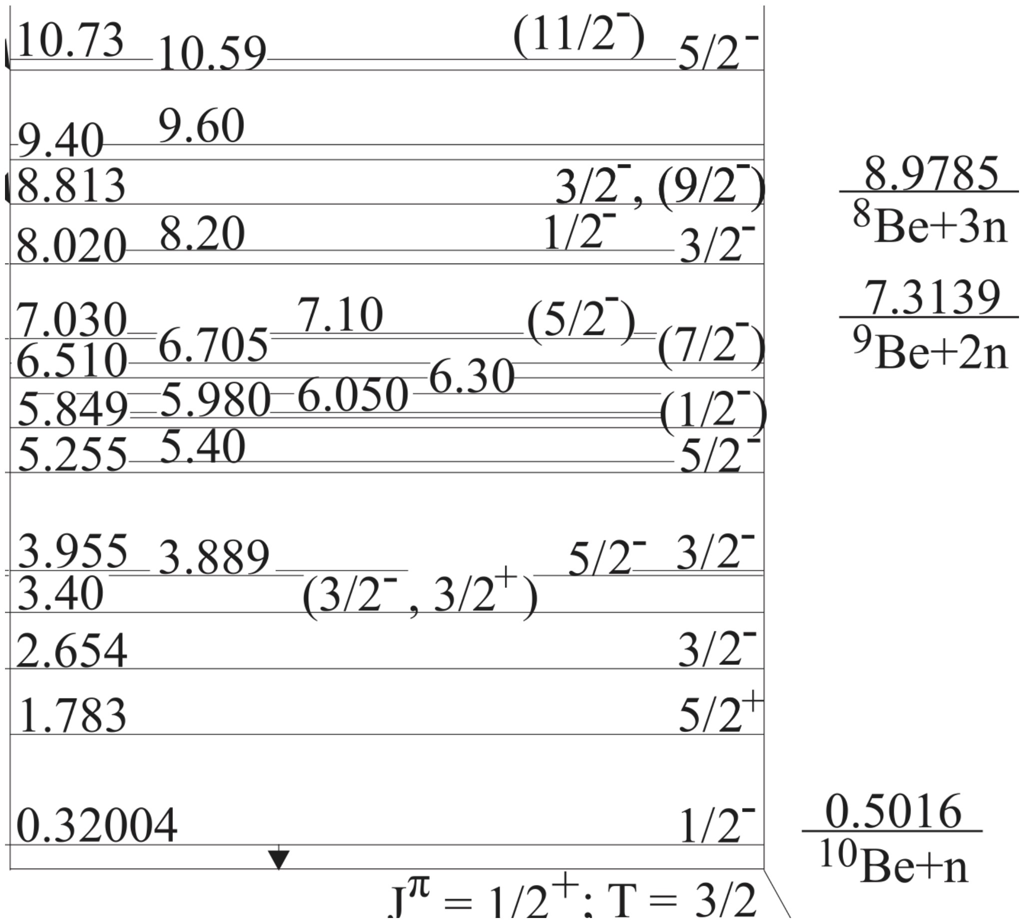
F. Ajzenberg-Selove, E. R. Flynn, and Ole Hansen
Phys. Rev. C **17**, 1283 (1978)

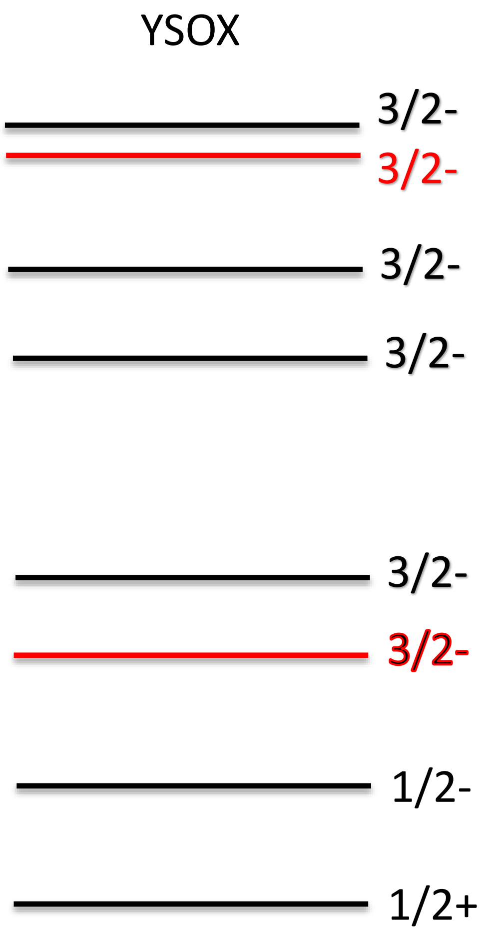


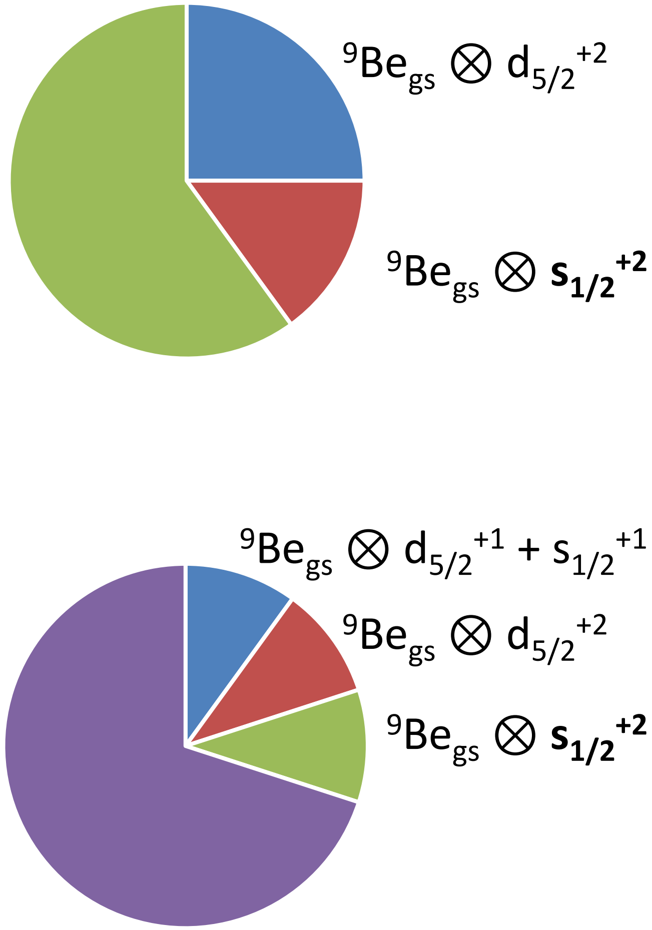


- Angular distribution compatible with L≥ 4

N=7 beryllium-11

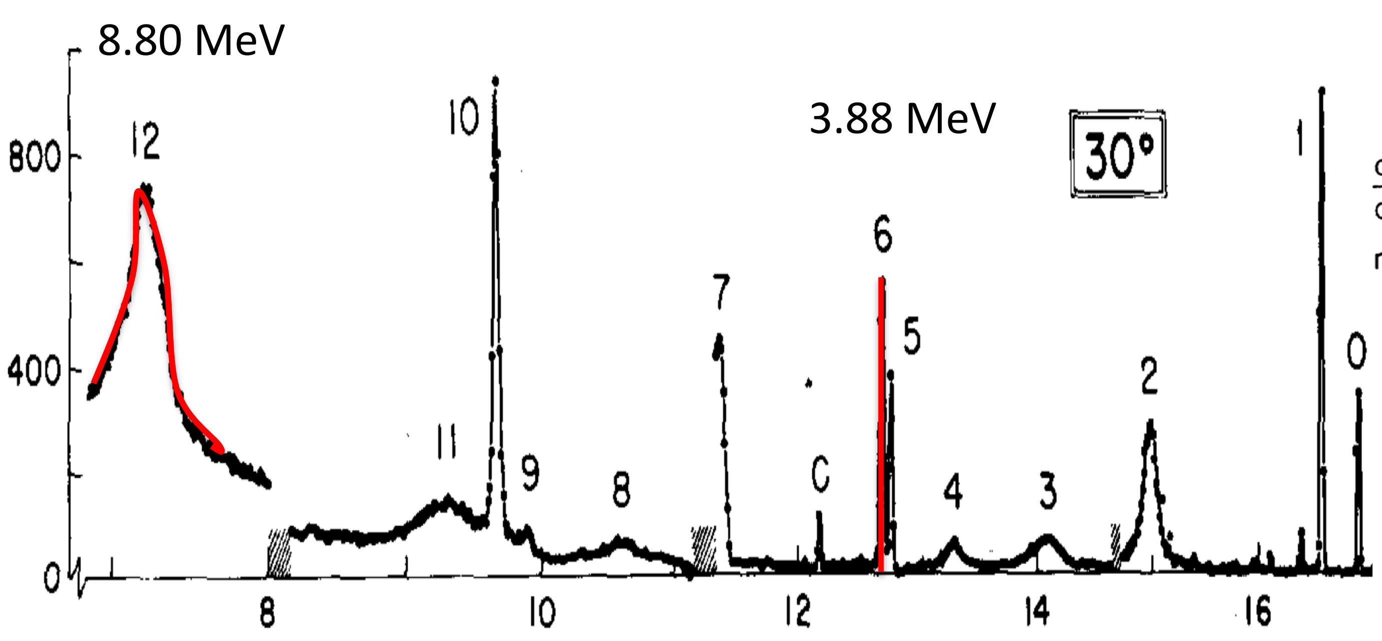


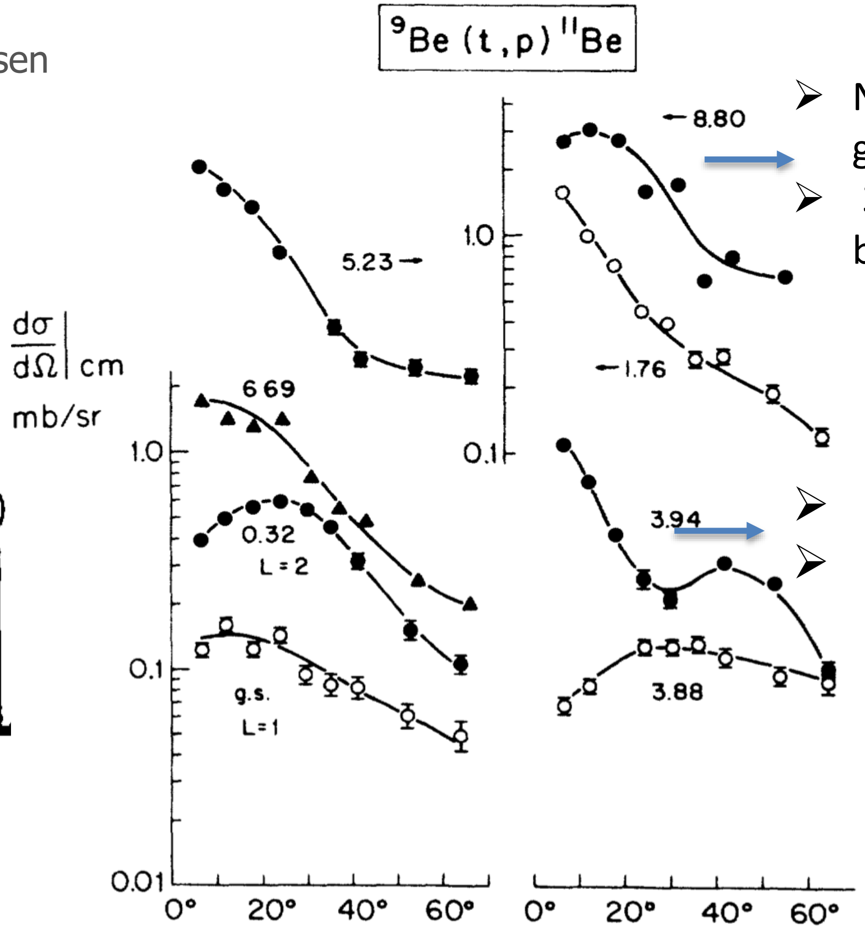




$^{9}Be(t,p)^{11}Be$ (23 MeV) @ Los Alamos

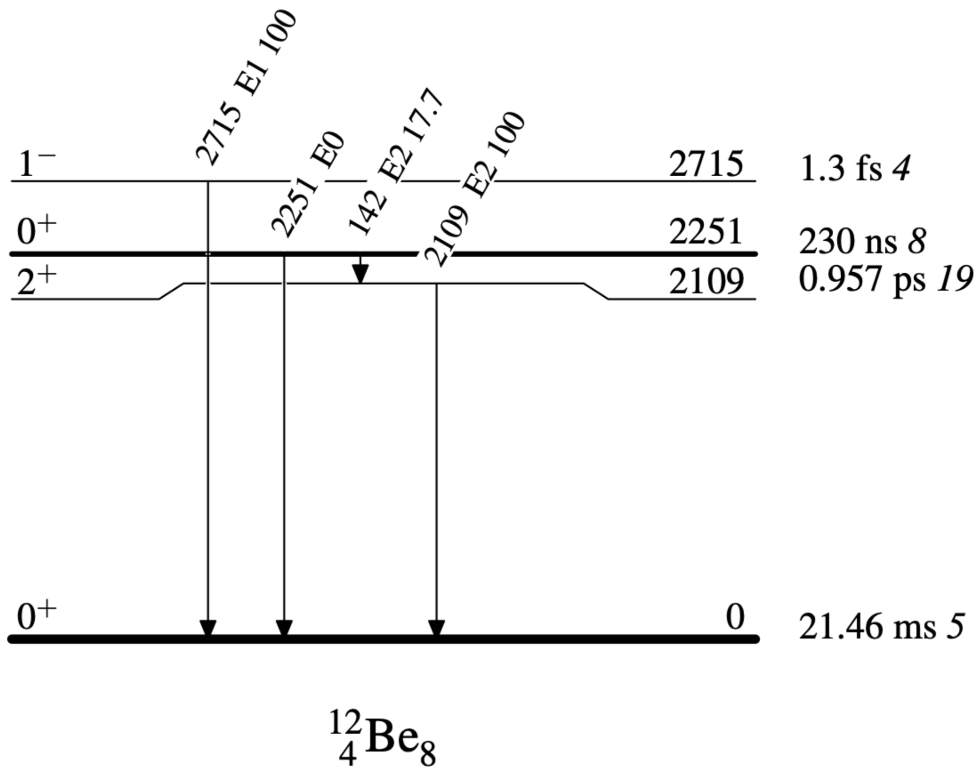
F. Ajzenberg-Selove, E. R. Flynn, and Ole Hansen
Phys. Rev. C **17**, 1283 (1978)





- No interpretation given
- 3/2- known from beta decay
- L=0
- proposed $d_{5/2}^2$

Stretch goal: $^{10}Be(t,p)^{12}Be$



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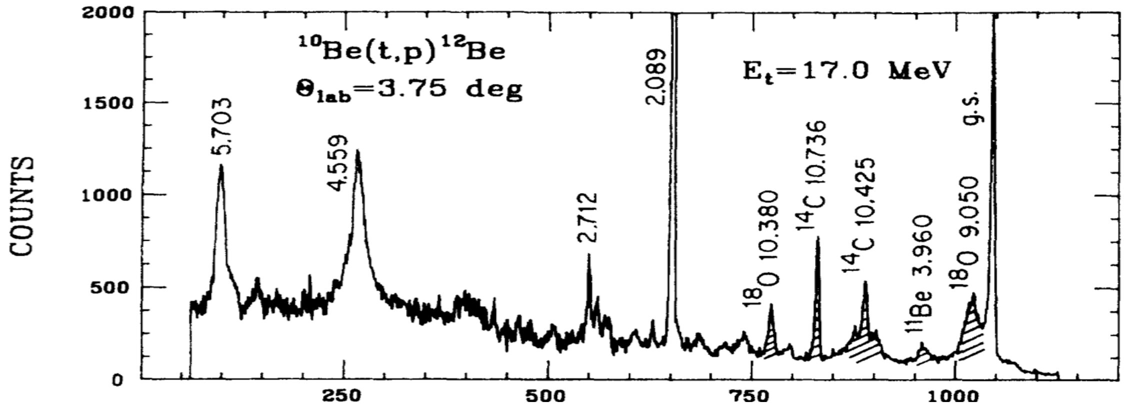

- 0^+_2 two neutron halo → ^{11}Li analogue
- 1^- dipole excitation of the halo state
  - Is there a E1 branch to 0^+_2?
  - CeBrA can help

Thanks to G. Potel

conclusions

- Revisiting (t,p) for neutron rich
  Li and Be can provide information on the evolution of the (sd) shell close to the dripline
  - Search for $s_{1/2}$ spectroscopic factors $\geq$ 50%
  - Fingerprint of an excited state halo?
- States of interest will be 1n and even 2n unbound → reaction theory input.
- Part of the tritium source commissioning run.