Study of the A=9 T=3/2 isobaric quartet through R-Matrix analysis of resonance scattering of analogue states.

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Developing a method of studying the structure of neutron rich nuclei through resonance scattering of their isobaric analogues

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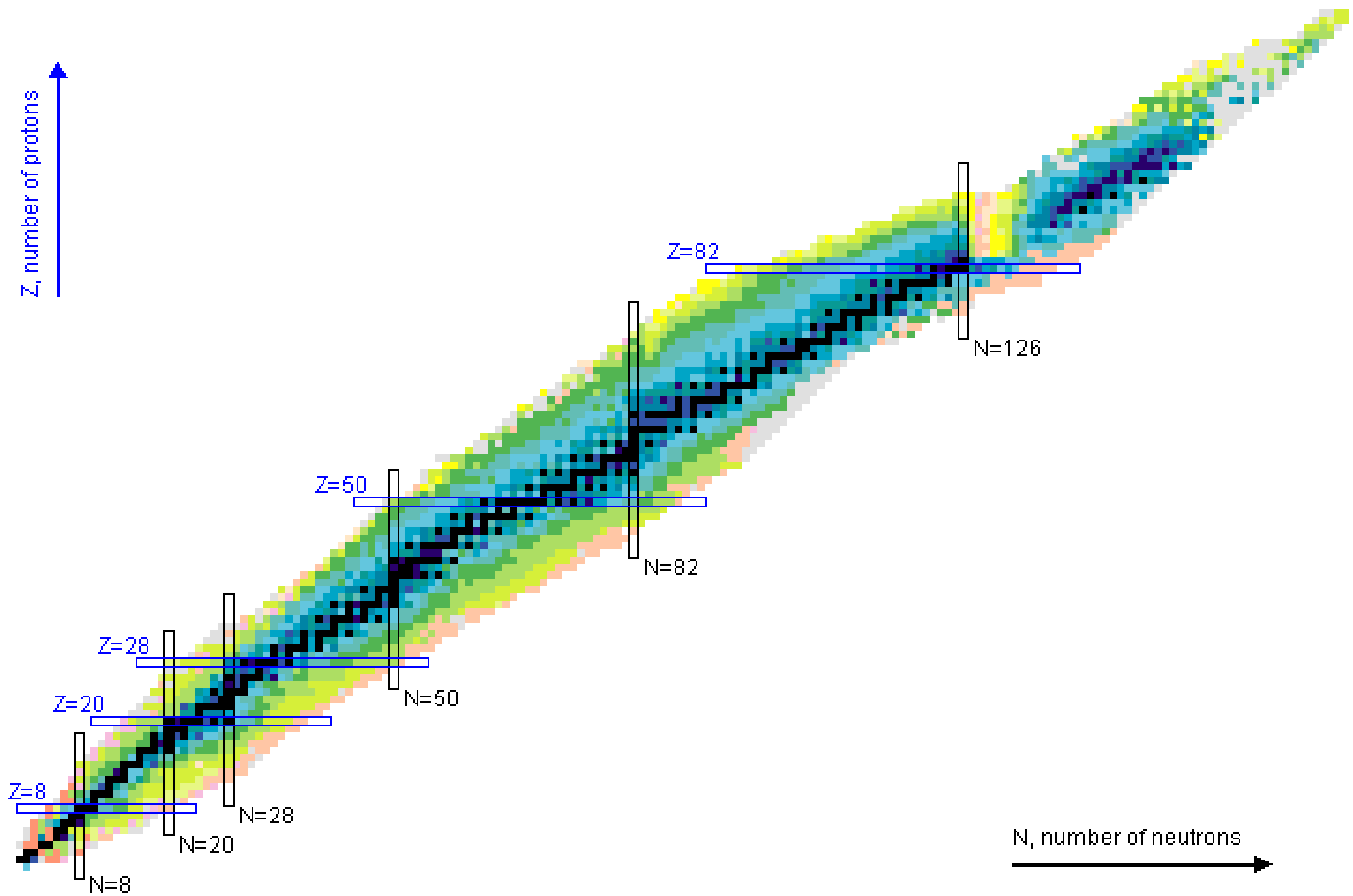
Shell Evolution



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Studies of neutron rich nuclei

- Transfer Reactions
- Charge Exchange
- Knock-out Experiments

Studies of neutron rich nuclei

- Transfer Reactions
- Charge Exchange
- Knock-out Experiments
- Resonance Scattering could be another technique
  - Can do measurements with Thick Target Inverse Kinematics and use R-Matrix for resonances
  - Direct neutron scattering is not possible
  - Mirror nuclei don't always exist
  - Isobaric analogue states may provide an answer!

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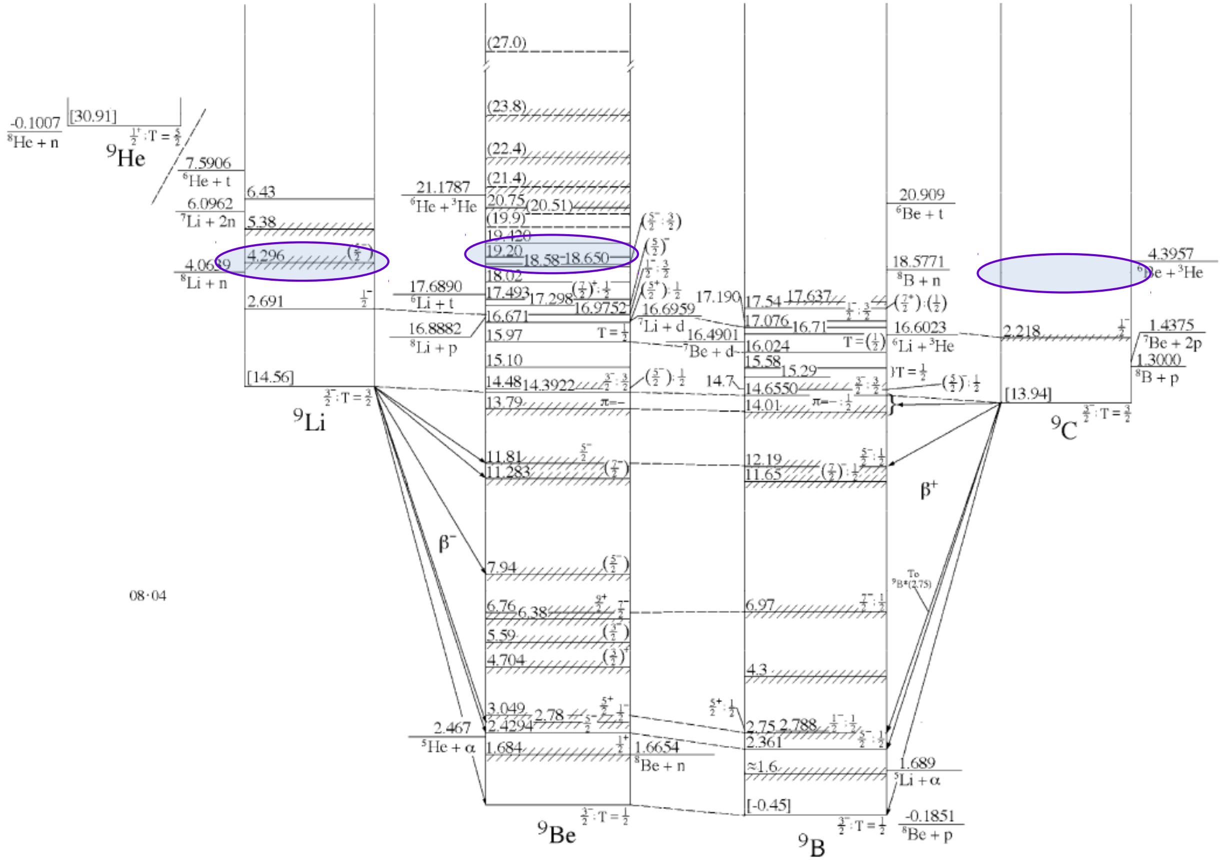
Studying nuclei through isobaric analogue states

- The goal is to study neutron rich nuclei through resonant reactions looking at isobaric analogue states
  - Analogous states typically are higher energy excited states found within a sea of lower isospin states.
    - However the higher isospin states are typically much narrower than the lower isospin states due to being locked out of isospin forbidden decays
- Analysis would use a combination of R-Matrix for higher isospin states in the region of interest and the Optical Model for the lower isospin states

A = 9, T = 3/2 Quartet



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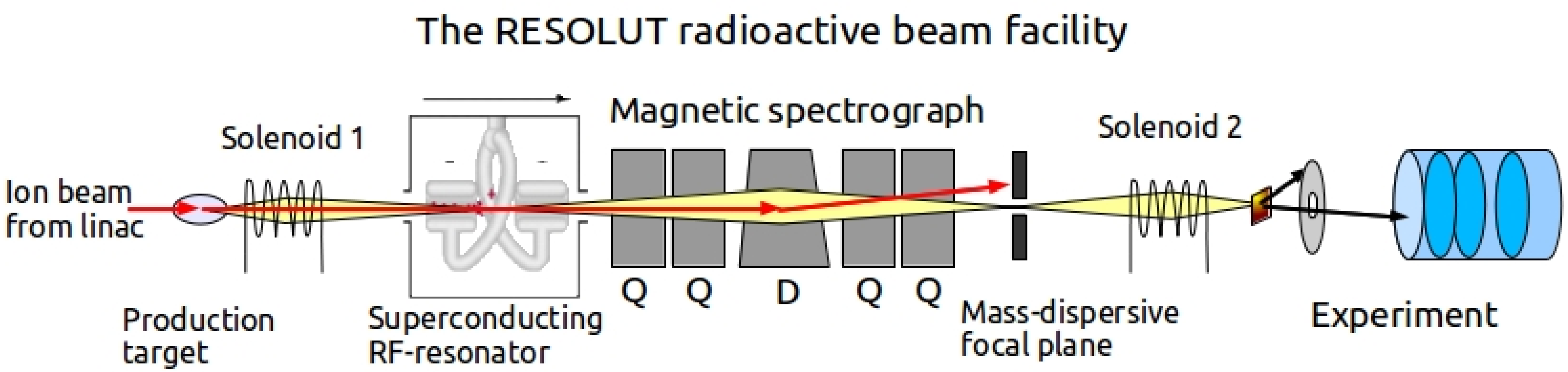
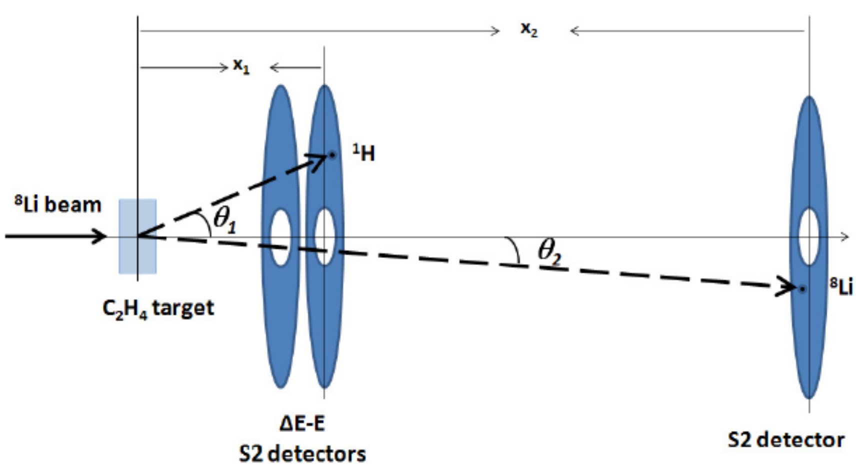
[1] D.R. Tilley et. al. Nuclear Physics A **745**, 155-362 (2004)

^{8}Li + p experiment at FSU

- ^{7}Li beam from the Linear Accelerator

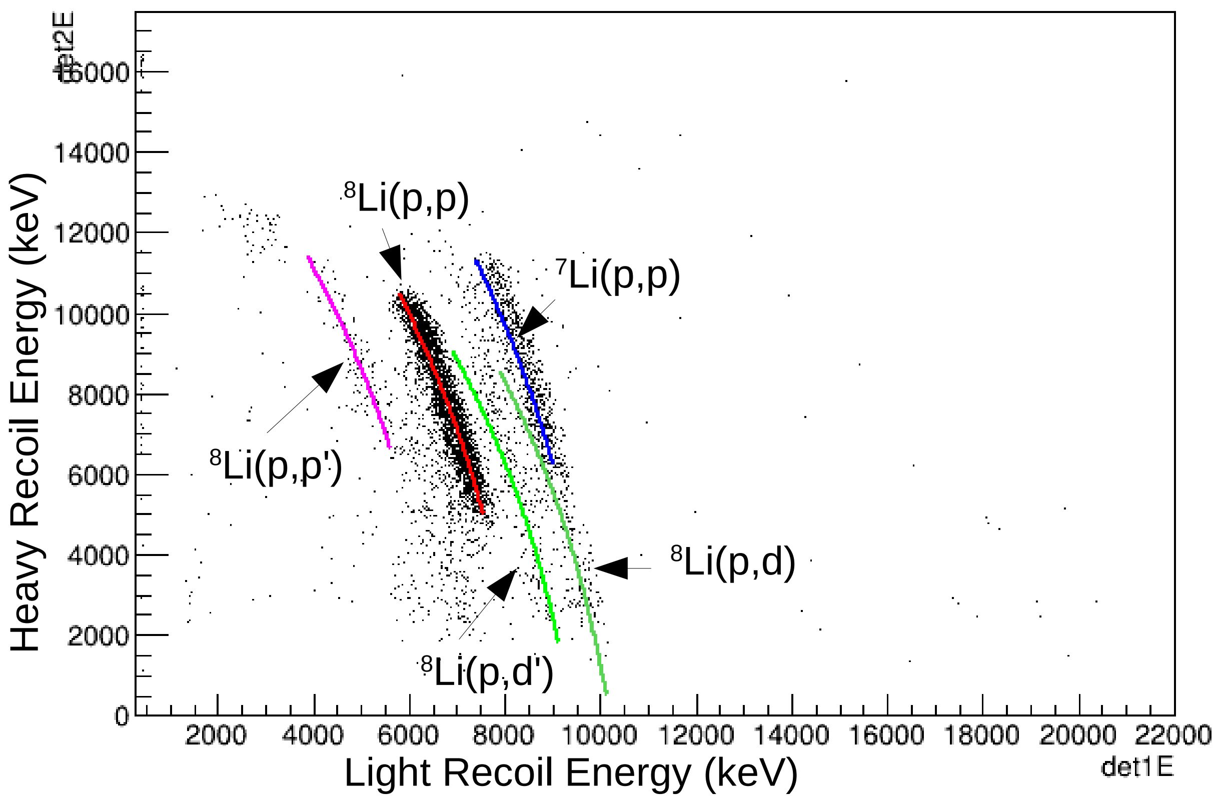


- ^{8}Li beam energies of 25, 22 and 18 MeV
- CH_2 target thickness of 5.5 , 4.13 and 2.75 mg/cm^2



^{8}Li(p,p) Analysis
[Identification of Reactions]

- The light and heavy recoil detectors allowed for easy determination of reactions present in the data



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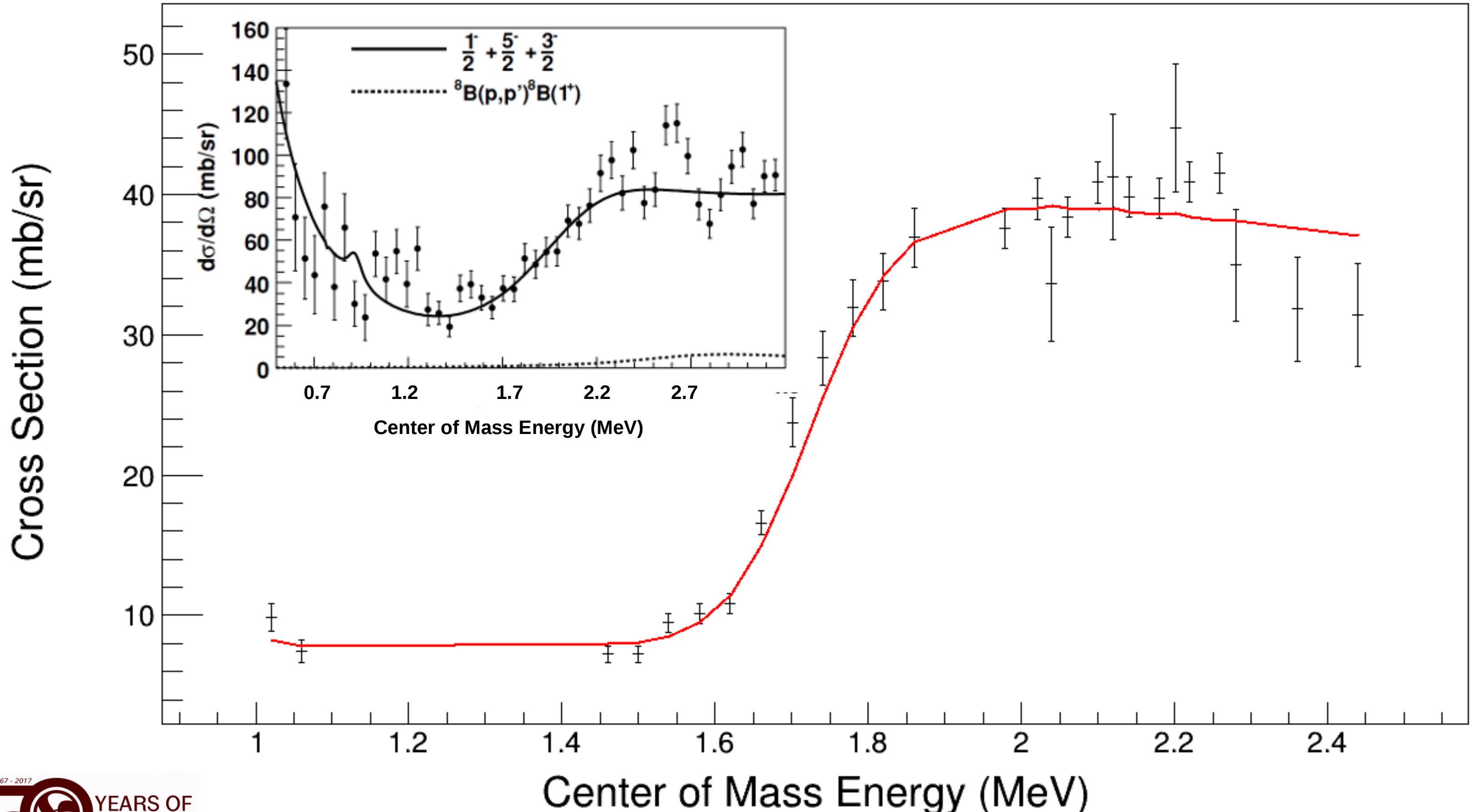
^{8}Li(p,p) Analysis

[^{8}Li(p,p) Excitation Function]



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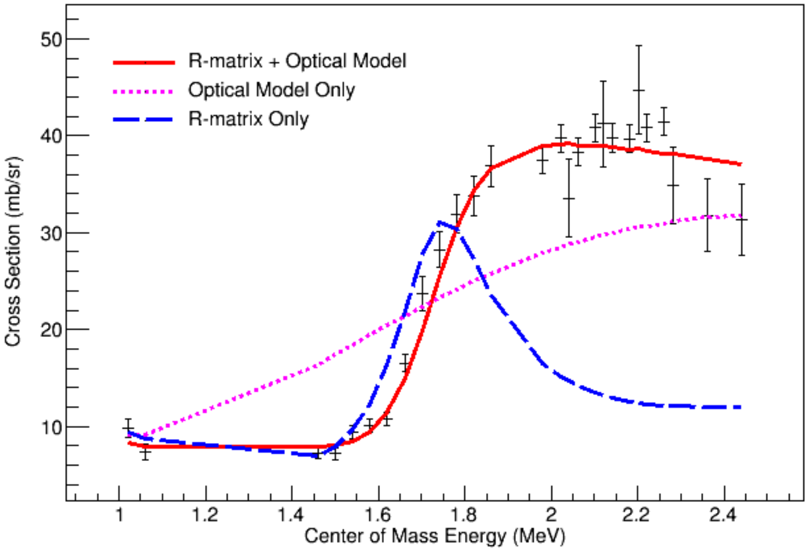
[2] G.V. Rogachev et al. Phys. Rev. C **75**, 014603 (2007)

^{8}Li(p,p) Analysis
[^{8}Li(p,p) Excitation Function]

R-Matrix Parameters			
	E (MeV)	J^{π}	Γ (keV)
Best Fit	18.675	5/2-	300

Optical Model Parameters							
	V (MeV)	r (fm)	a (fm)	W_s (MeV)	r_s (fm)	a_s (fm)	r_c (fm)
Best Fit	74	1.10	0.8	30	0.45	0.6	1.5

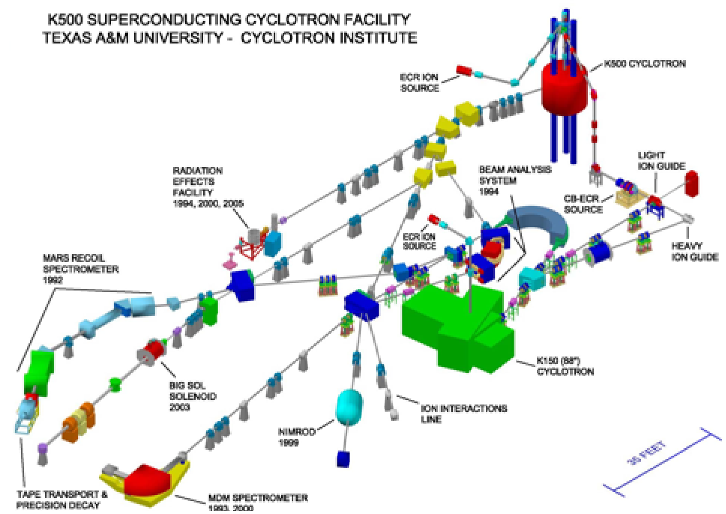


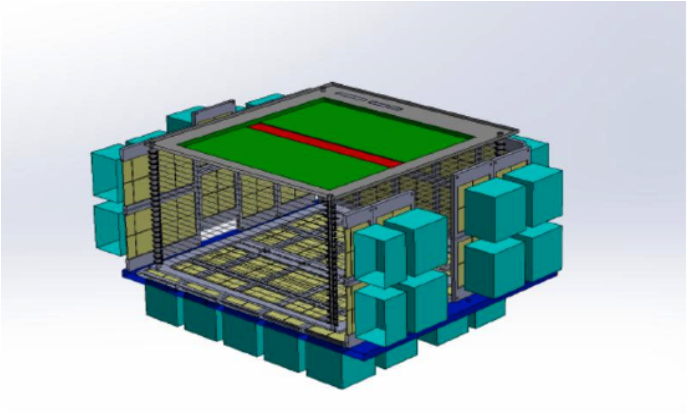
- R-Matrix required only the known T=3/2, 5/2- state and width from literature [3] with no modification
- Optical Model required much more work to determine parameters for

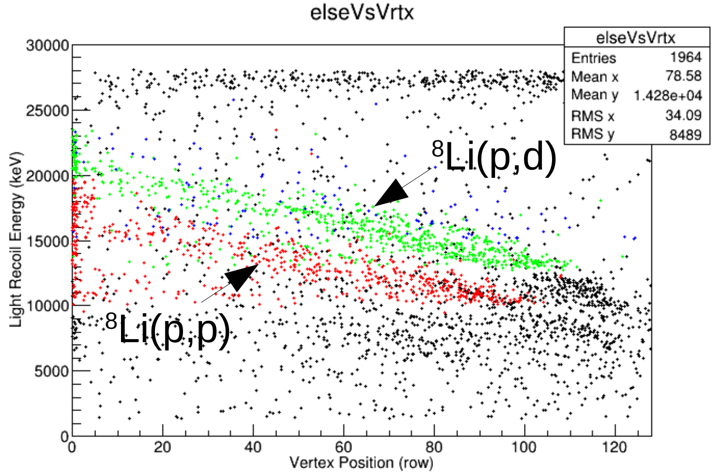
[3] A.H. Wuosmaa, et al., Phys. Rev. Lett. 94 082502 (2005)

^{8}Li(p,p) with TexAT

- 75.5 MeV ^{8}Li beam from MARS spectrometer
- 470 Torr Isobutane gas as target







Conclusion

- Resonance scattering populating isobaric analogue states can provide insight into the structure of neutron rich nuclei
- R-Matrix Analysis can be used on narrow resonances while the Optical Model handles wider, typically lower isospin states and produce a good fit
- This method offers high efficiency (thick target) and excellent c.m. energy resolution (~20 keV)
- Developing a robust method for obtaining Optical Model parameters for the wide, low isospin states will require more work

Thanks to Texas A&M and FSU

G.V. Rogachev , S Almaraz-Calderon , A. Aprahamian , B. Bucher , W. Tan , E.D. Johnson , J. P. Mitchell , M. Avila , A. Kuchera , L. T. Baby

Yevgen Koshchiy, Josh Hooker, Teja Upadhyayula, Heshani Jayatissa, Tony Ahn, Marina Barbui, Eric Aboud and Vladilen Goldberg

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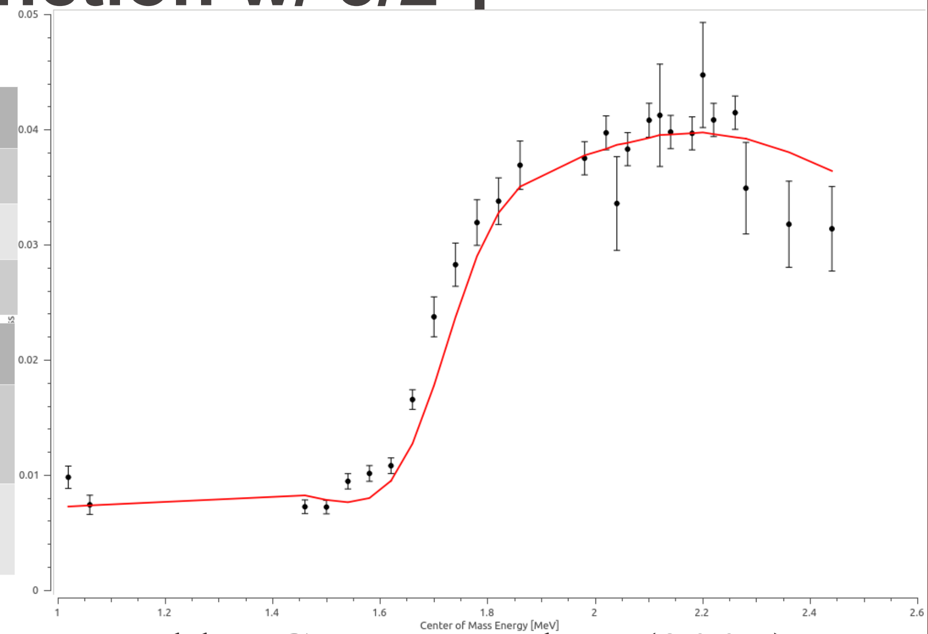
^{8}Li(p,p) Analysis

[^{8}Li(p,p) Excitation Function w/ 3/2-]

R-Matrix Parameters			
	E (MeV)	J^{π}	Γ (keV)
Best Fit	18.675	5/2-	300
	19.0	3/2-	640

Optical Model Parameters							
	V (MeV)	r (fm)	a (fm)	W_s (MeV)	r_s (fm)	a_s (fm)	r_c (fm)
Best Fit	40	1.55	0.8	23	0.45	0.6	1.7



- The addition of a 3/2- state as suggested by G.V. Rogachev (2007) can also fit the data
- Most importantly the 5/2- still dominates and the Optical Model cannot simply make any fit we want