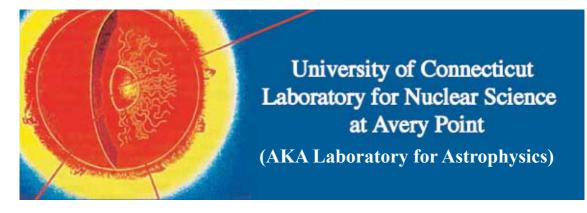
Neutron Interaction With ⁷Be at the SARAF: Evidence for Cluster Shell Model p-h States in ⁸Be and Implication for Big Bang Nucleosynthesis Moshe Gai LNS at Avery Point, University of Connecticut

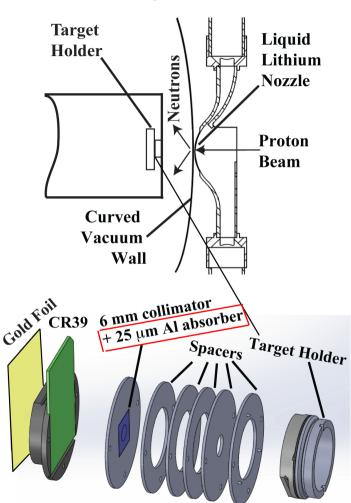
http://astro.uconn.edu moshe.gai@uconn.edu



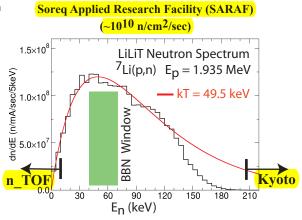
- 1) The SARAF neutron facility
- 2) SARAF measurement with CR39 NTD
- 3) <u>**n** + ⁷Be</u>: **n**_TOF, Kyoto, SARAF
- 4) <u>Particle-Hole States:</u> Cluster Shell Model of ⁸Be

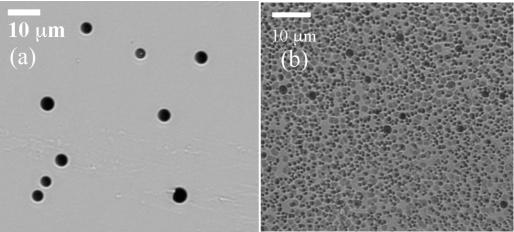
Nuclear Structure and Dynamics, NSD2019 May 13, 2019, Venice, Italy

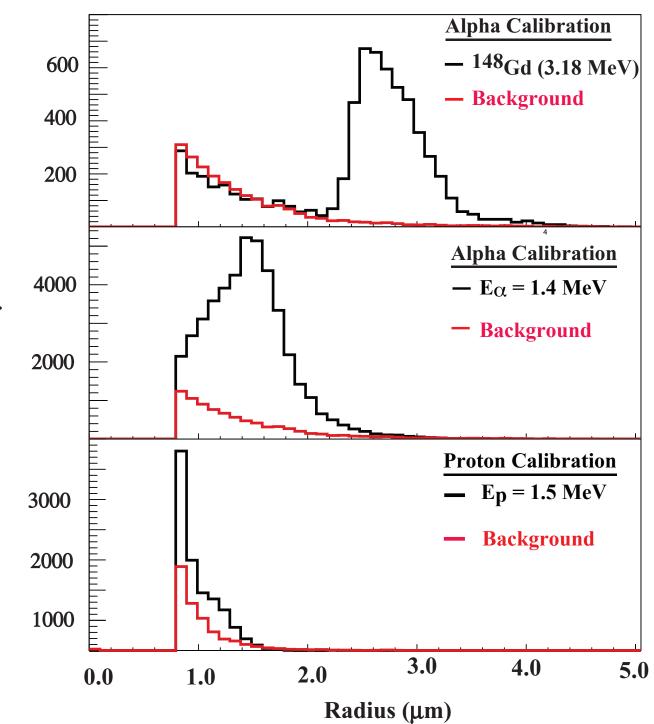
LiLiT @ SARAF



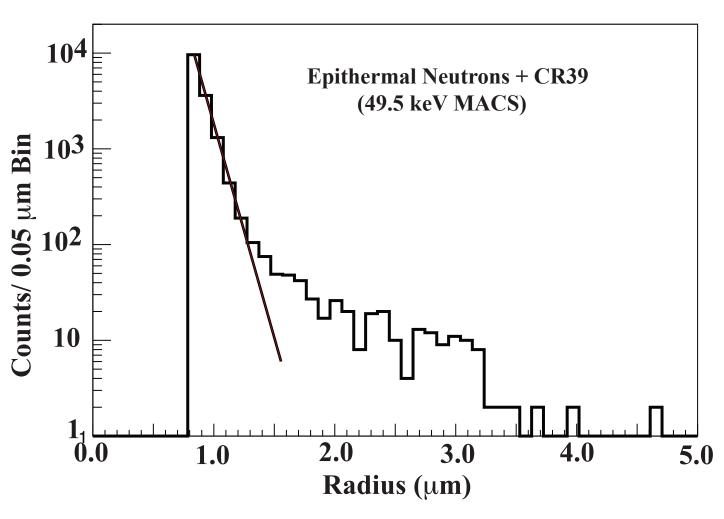


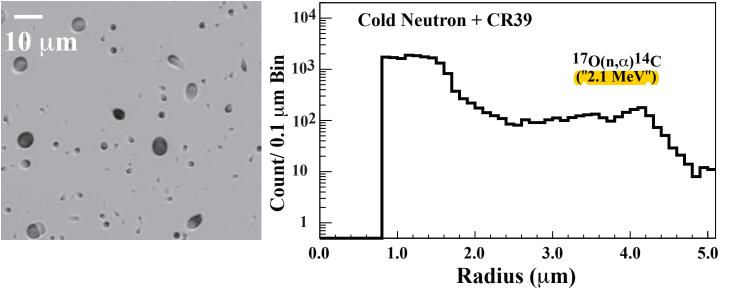


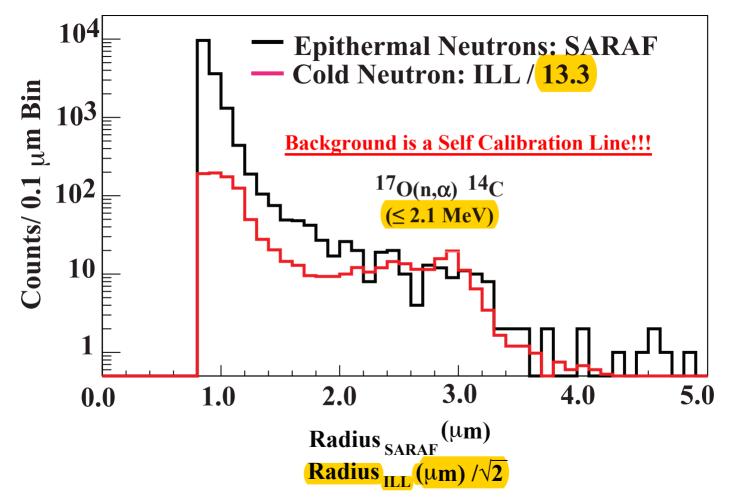


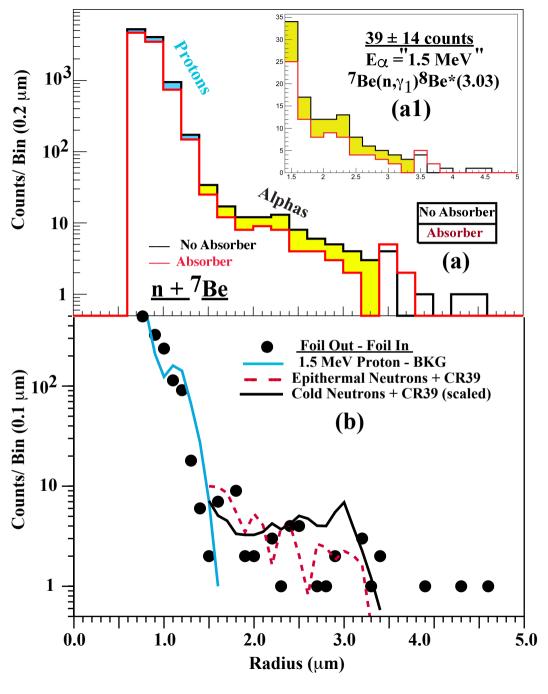


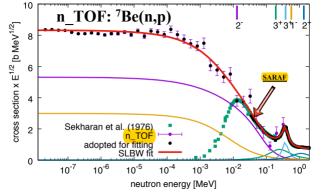
Counts / 0.1 µm bin

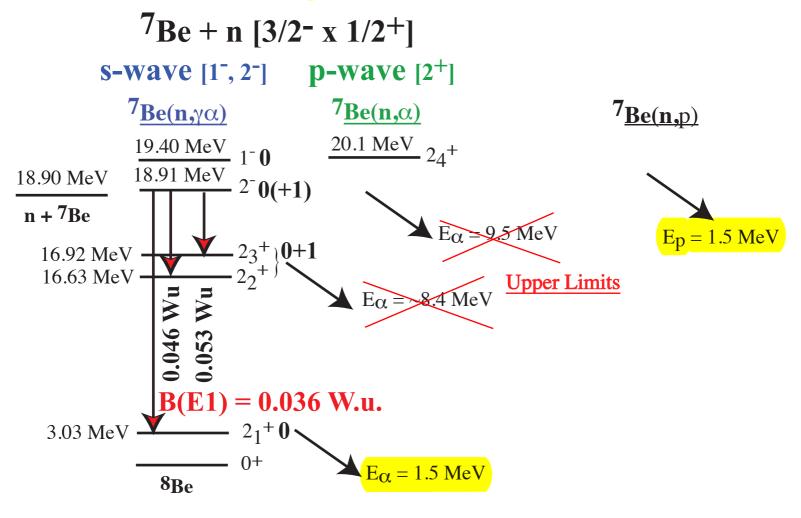


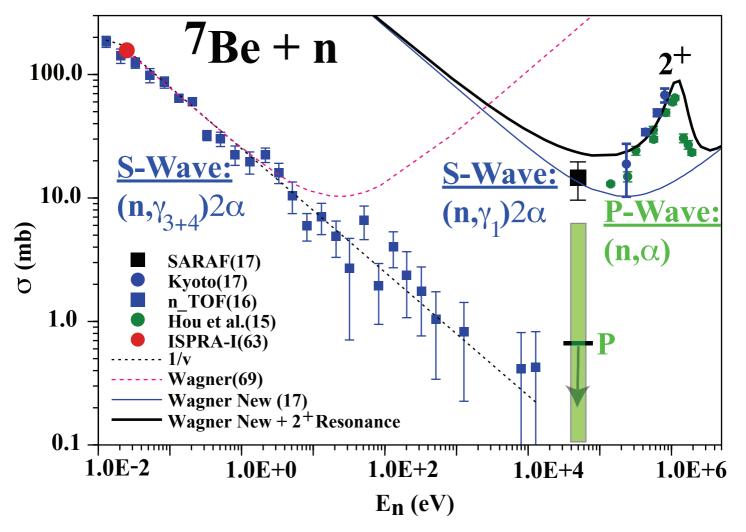


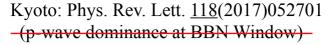


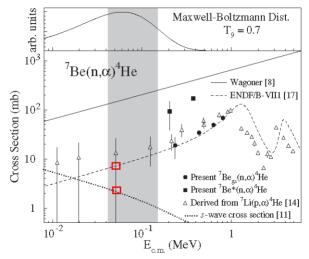












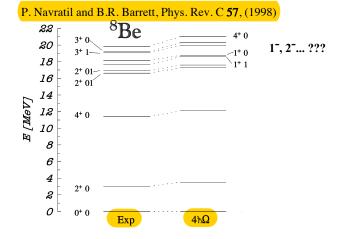
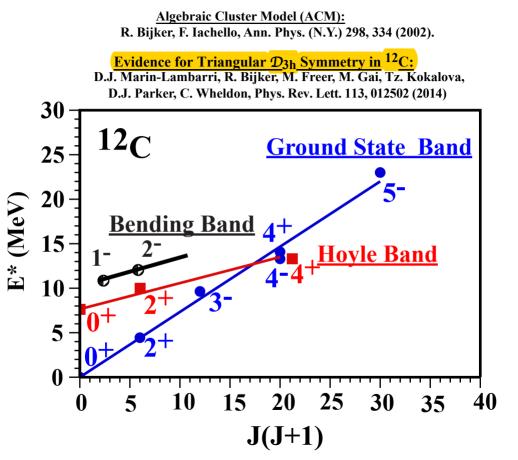


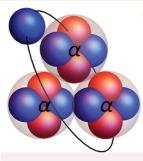
FIG. 7. The experimental and calculated excitation spectra of ⁸Be. The results corresponding to the model-space size of $4\hbar\Omega$ relative to the unperturbed ground-state configuration are presented. A harmonic-oscillator energy of $\hbar\Omega = 17$ MeV was used.



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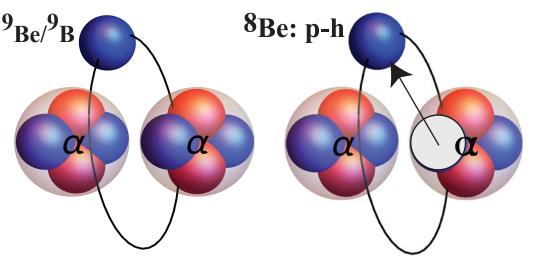
26 April 2019

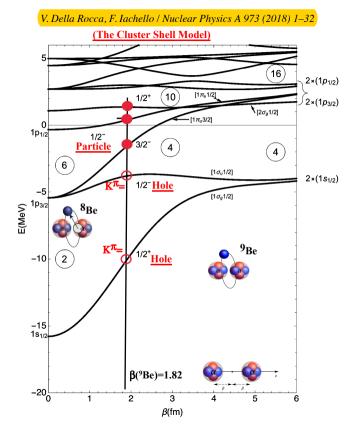


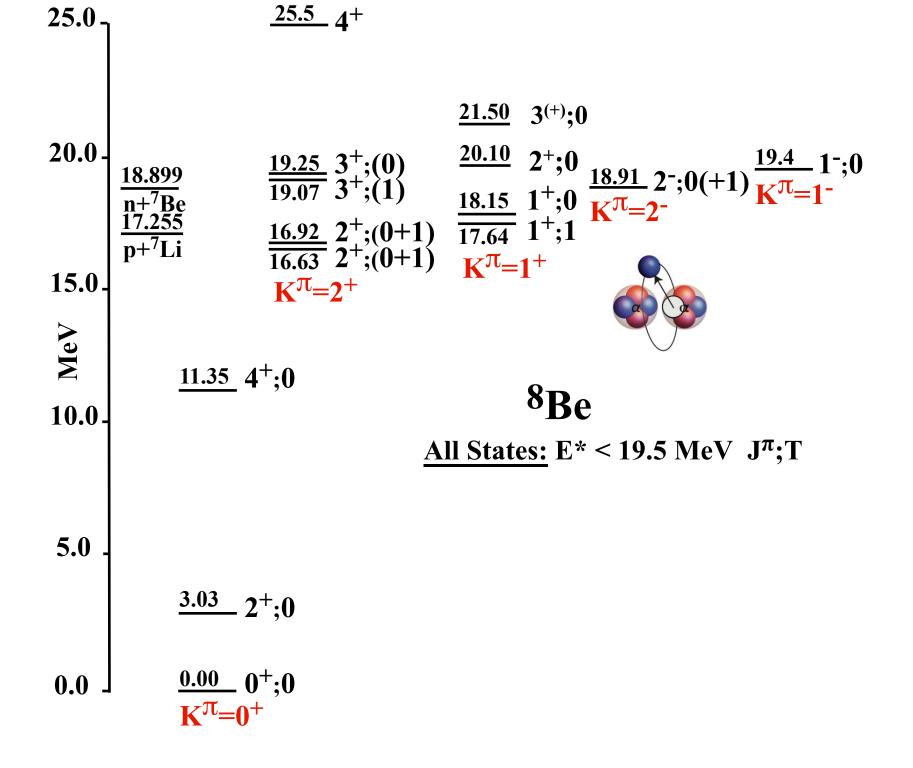
On the Cover

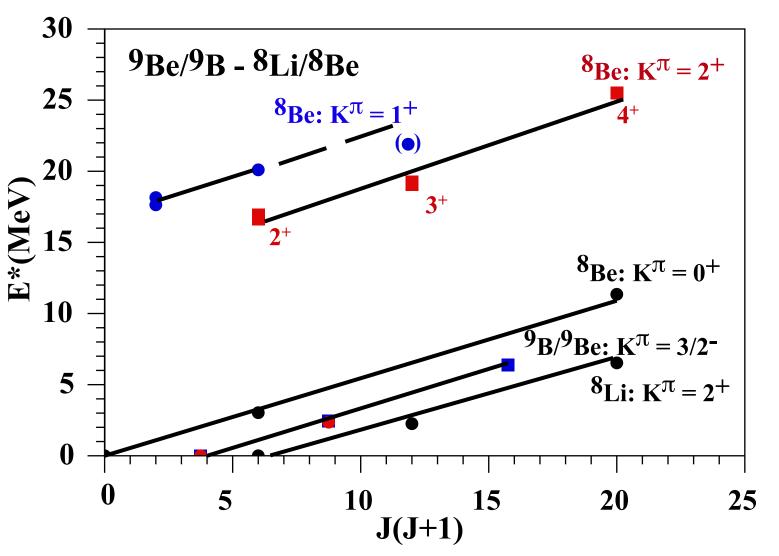
A 13 C nucleus modeled as a triangle of three *a* particles plus an additional neutron.

From the article Evidence for Triangular D_{3h}['] Symmetry in ¹³C R. Bijker and F. Iachello Phys. Rev. Lett. **122**, 162501 (2019)









Rotational Band in ⁸Be/⁸Li similar to ⁹Be

TABLE I: ⁸ Li: B(M1) InBand, Isobaric Analog of ⁸ Be		
$E_i \to E_f \; (\mathrm{MeV})$	$J^{\pi}; T \to J^{\pi}; T$	B(M1) [W.u.]
$2.26 \rightarrow 0.0$	$3^+; 1 \to 2^+; 1$	M1: 0.29 ± 0.12

TABLE II: ⁹Be: B(M1) CSM InBand

$E_i \to E_f \ (MeV)$	$J^{\pi}; T \to J^{\pi}; T$	B(M1) [W.u.]
$2.4294 \rightarrow 0.0$	$\frac{5}{2}^{-}; \frac{1}{2} \to \frac{3}{2}^{-}; \frac{1}{2}$	M1: 0.3 ± 0.03

TABLE III: ⁸Be: B(E2) Cluster Band

$E_i \to E_f \ (MeV)$	$J^{\pi}; T \to J^{\pi}; T$	B(E2) [W.u.]
$11.35 \rightarrow 3.03$	$4^+; 0 \to 2^+; 0$	E2: 25.8 ± 8.4

TABLE IV: ⁹Be: B(E2) CSM InBand

$E_i \to E_f \ (MeV)$	$J^{\pi}; T \to J^{\pi}; T$	B(E2) [W.u.]
$2.4294 \rightarrow 0.0$	$\frac{5}{2}^{-}; \frac{1}{2} \to \frac{3}{2}^{-}; \frac{1}{2}$	E2: 24.4 ± 1.8
6.38 ightarrow 0.0	$\frac{7}{2}^{-}; \frac{1}{2} \to \frac{3}{2}^{-}; \frac{1}{2}$	E2: 8.5 ± 3.7

$E_i \to E_f \ (MeV)$	$J^{\pi}; T ightarrow J^{\pi}; T$	B(M1) [W.u.]
$17.64 \rightarrow 16.626$	$1^+; 1 \to 2^+; 0 + 1$	M1: 0.9 ± 0.1
$17.64 \rightarrow 16.92$	$1^+; 1 \to 2^+; 0 + 1$	M1: 0.10 \pm 0.03
$18.15 \rightarrow 16.626$	$1^+; 0 \to 2^+; 0 + 1$	M1: 0.6 ± 0.2
$18.15 \rightarrow 16.92$	$1^+; 0 \to 2^+; 0 + 1$	M1: 0.96 \pm 0.1

TABLE I: <u>*Be:</u> B(M1) p-h States

TABLE I: ⁸Li: B(M1) InBand, Isobaric Analog of ⁸Be

$E_i \rightarrow E_f (MeV)$	$J^{\pi}; T \rightarrow J^{\pi}; T$	B(M1) [W.u.]
$2.26 \rightarrow 0.0$	$3^+; 1 \rightarrow 2^+; 1$	M1: 0.29 ± 0.12

TABLE II: ⁹Be: B(M1) CSM InBand

$E_i \to E_f \ ({\rm MeV})$	$J^{\pi}; T \rightarrow J^{\pi}; T$	B(M1) [W.u.]
$2.4294 \rightarrow 0.0$	$\frac{5}{2}^{-}; \frac{1}{2} \rightarrow \frac{3}{2}^{-}; \frac{1}{2}$	M1: 0.3 ± 0.03

TABL	E II <mark>I: <u>⁹Be:</u> B(E2) CS</mark> I	M InBand
$E_i \to E_f \ ({ m MeV})$	$J^{\pi}; T \rightarrow J^{\pi}; T$	B(E2) [W.u.]
$2.4294 \rightarrow 0.0$	$\frac{5}{2}^{-}; \frac{1}{2} \rightarrow \frac{3}{2}^{-}; \frac{1}{2}$	E2: 24.4 ± 1.8
$6.38 \rightarrow 0.0$	$\frac{7}{2}^{-}; \frac{1}{2} \rightarrow \frac{3}{2}^{-}; \frac{1}{2}$	E2: 8.5 ± 3.7

TABLE IV: $\frac{9}{\text{Be:}}$ B(E1)		
$E_i \to E_f \; ({\rm MeV})$	$J^{\pi}; T \rightarrow J^{\pi}; T$	B(E1) [W.u.]
$1.684 \rightarrow 0.0$	$\frac{1}{2}^+; \frac{1}{2} \to \frac{3}{2}^-; \frac{1}{2}$	E1: 0.11 \pm 0.04
$3.049 \rightarrow 0.0$	$\frac{5}{2}^+; \frac{1}{2} \to \frac{3}{2}^-; \frac{1}{2}$	E1: 0.036 ± 0.03

TABL	E <mark>II: <u>*Be:</u> B(E2) Clus</mark>	ster Band
$E_i \to E_f \ ({\rm MeV})$	$J^{\pi}; T \rightarrow J^{\pi}; T$	B(E2) [W.u.]
$11.35 \rightarrow 3.03$	$4^+; 0 \to 2^+; 0$	E2: 25.8 ± 8.4

TABLE II<mark>I: <u>*Be:</u> B(E1): $2^- \rightarrow 2^+$ states</mark>

$E_i \to E_f \; ({\rm MeV})$	$J^{\pi}; T \rightarrow J^{\pi}; T$	B(E1) [W.u.]
$18.91 \rightarrow 3.03$	$2^{-};0(+1) \rightarrow 2^{+};0$	E1: 0.036 ± 0.013
$18.91 \rightarrow 16.626$	$2^{-};0(+1) \rightarrow 2^{+};0+1$	E1: 0.053 ± 0.02
$18.91 \rightarrow 16.92$	$2^{-};0(+1) \rightarrow 2^{+};0+1$	E1: 0.046 ± 0.02

University of Connecticut Laboratory for Nuclear Science at Avery Point (AKA Laboratory for Astrophysics)

Conclusions:

- 1. Measured ⁷Be(n,α) ⁷Be($n,\gamma\alpha$) in BBN Window.
- 2. First Measurement of ${}^{7}Be(n,\gamma){}^{8}Be^{*}(3.03 \text{ MeV})$ (Reasonable B(E1: $2^{-}\rightarrow 2^{+}_{1}$) = 0.036 W.u.)
- 3. Measured ⁷Be(n,p) MACS @ 49.5 keV = 10.1 b. (Perfect Agreement With n_TOF Measurement)
- 4. No hitherto unknown Resonance in BBN Window (that would lead to large cross section).
- 5. S wave dominance at BBN Window (Corrected previous s and p waves extrapolations).

Lack of Standard Nuclear Solution To the Primordial ⁷Li Problem

6. New p-h CSM Structure in ⁸Be revealed. (A Major Challenge to ab-initio)