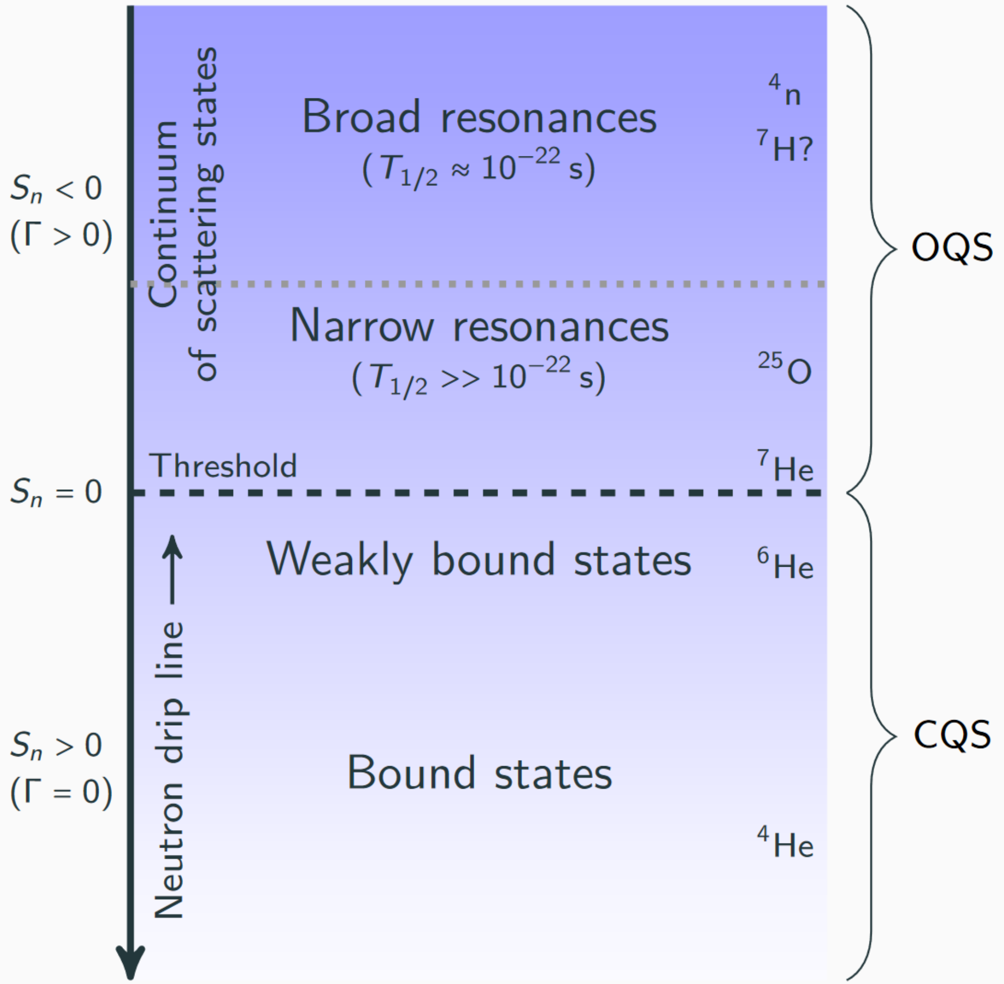
Instituto Galego de Física de Altas Enerxías

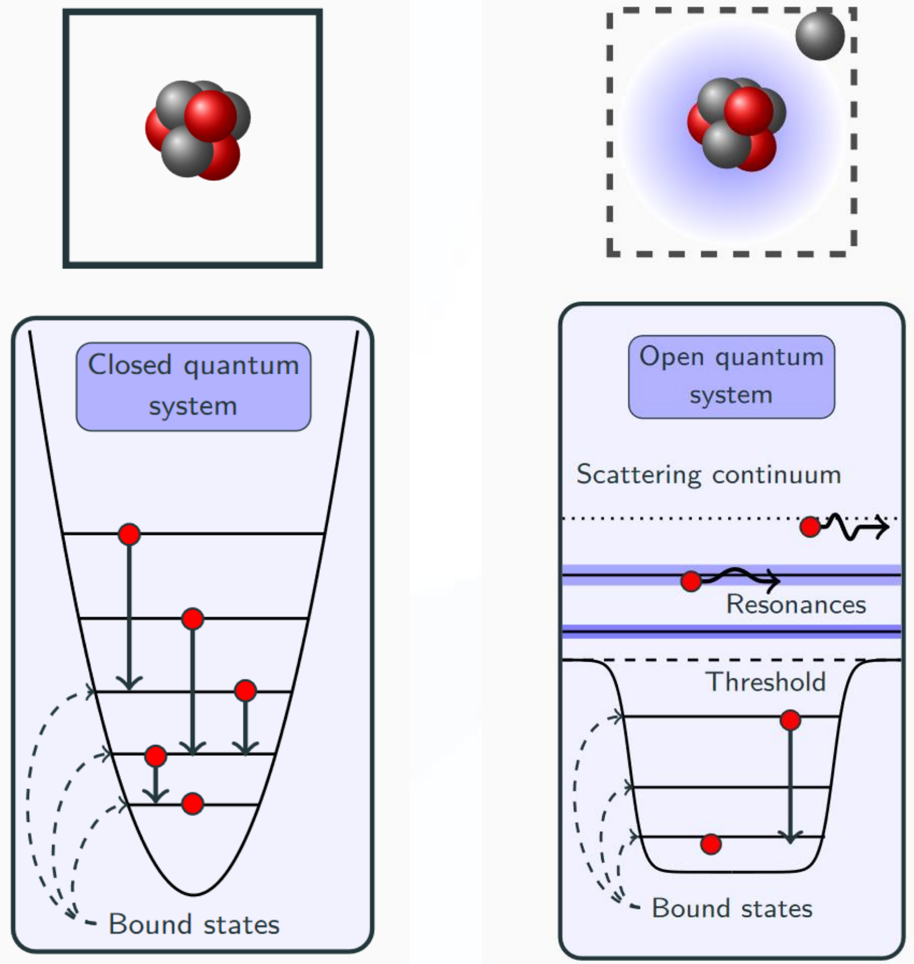
Observation of a proton-emitting near-threshold resonance in ^{11}B via ^{10}Be+p

Yassid Ayyad (IGFAE, Universidad de Santiago de Compostela)

- Beta-decay proton emission in ^{11}Be.
- ^{10}Be+p resonant scattering.
- Outlook and conclusions.

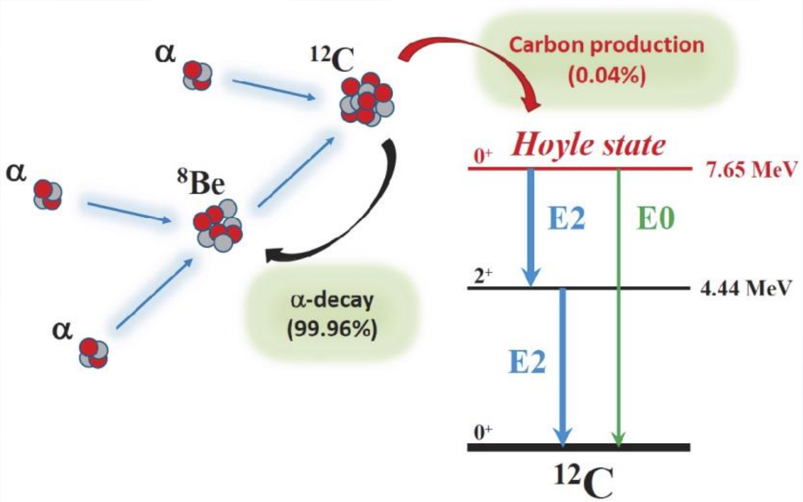
Nuclei as open quantum systems

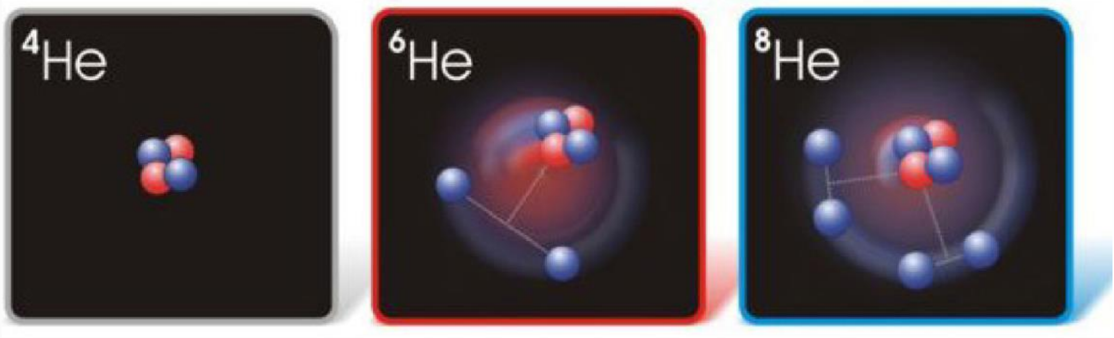


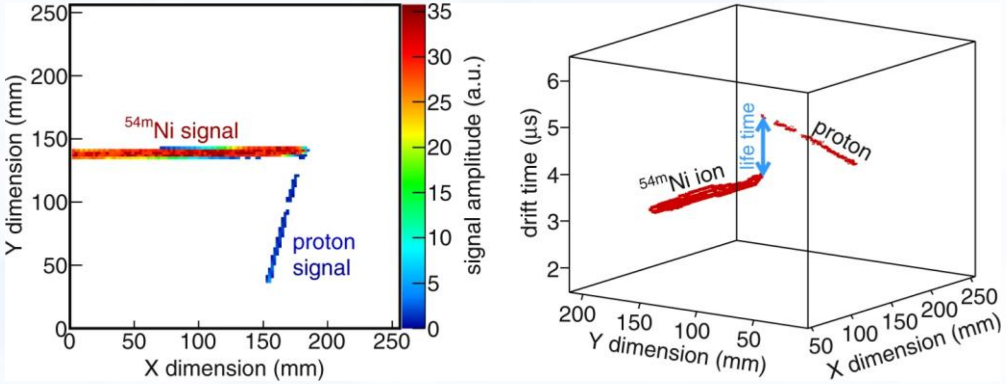


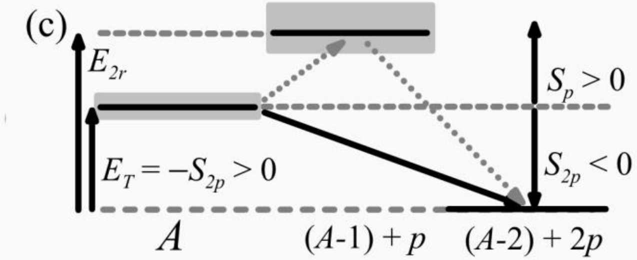
Credit: K. Fossez

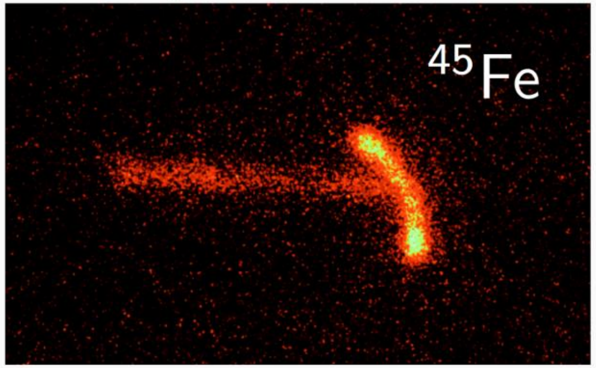
Some examples



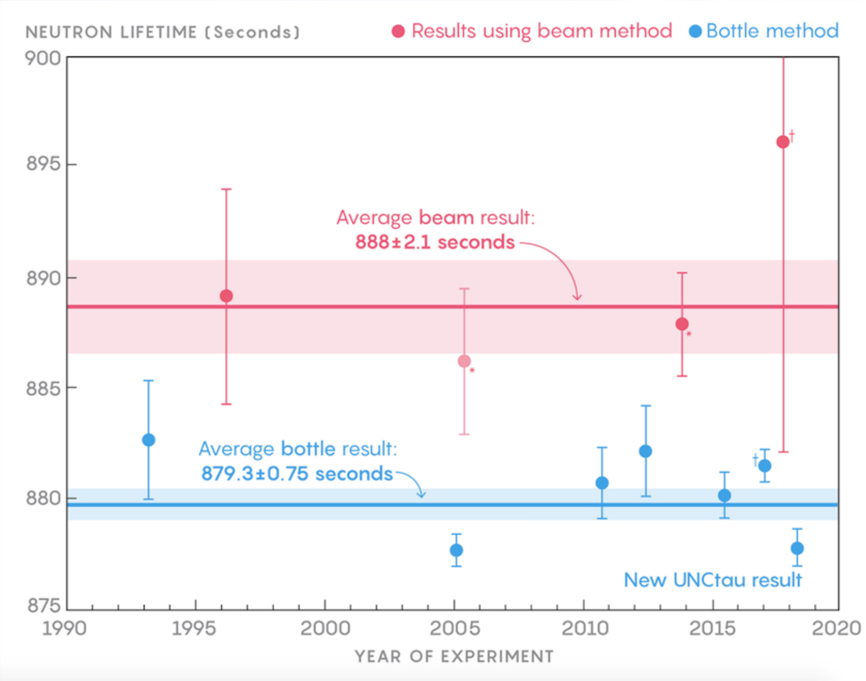






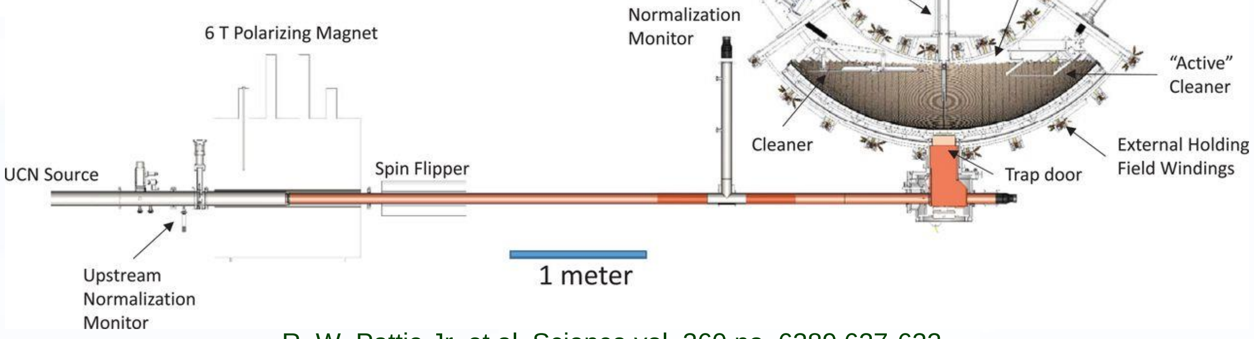


Neutron life-time problem from nuclear physics stand point



- Best precision achieved in a bottle experiment: 877.7± 0.7 (stat) +0.4/−0.2 (sys).
- 888.0 ± 2.0 s in beam experiments: 4.0σ of difference.
- This 1% of difference could be attributed to systematic uncertainties…
- …or unaccounted exotic decay modes not detected in the in-beam experiment.

$$\tau_n^{beam} = \frac{\tau_n}{\mathrm{Br}(n \rightarrow p + \mathrm{anything})}$$



R. W. Pattie Jr. et al, Science vol. 360 no. 6389 627-632

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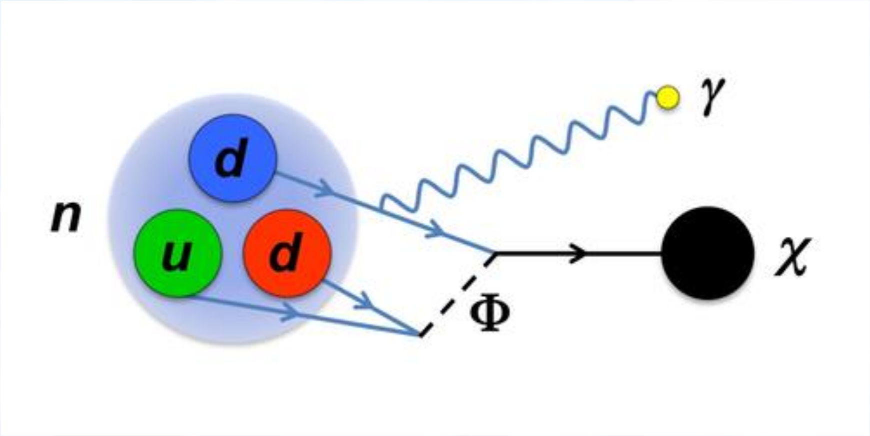
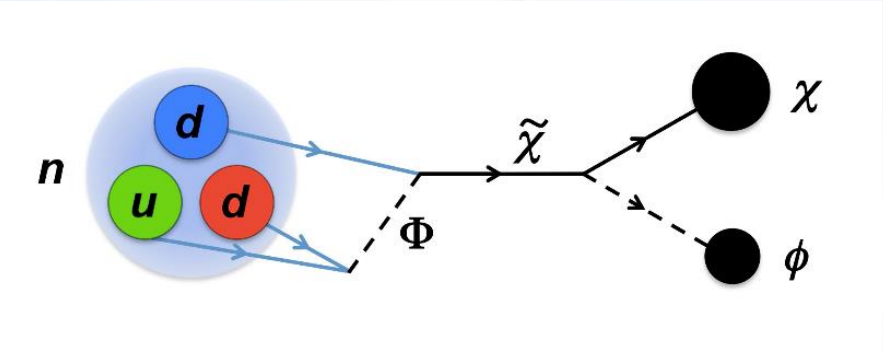
Bartosz Fornal and Benjamín Grinstein
Phys. Rev. Lett. 120, 191801 (2018).



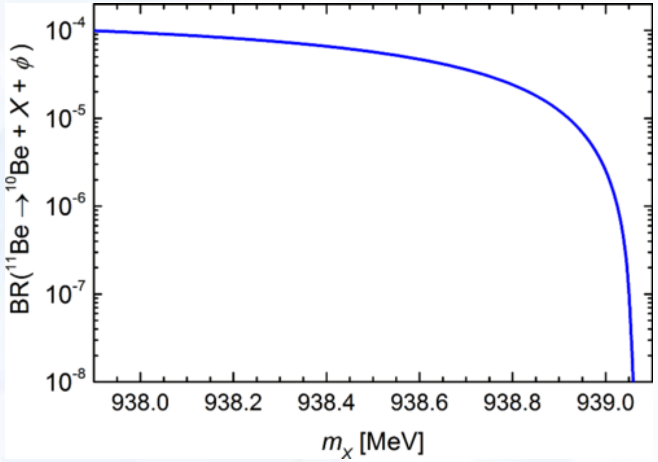


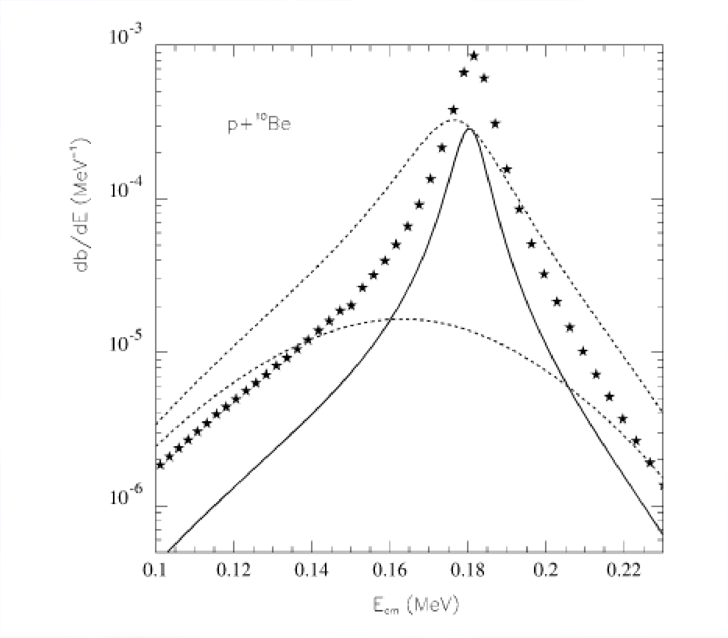
1) Neutron→dark particle + photon. In this case 937.900 MeV< m_χ< 939.565 MeV and 0.782 MeV< E_γ<1.664 MeV. No evidence was found (Z. Tang et al., Phys. Rev. Lett. 121, 022505 2018).

2) Neutron→two dark particles. 937.900 MeV< $m_\chi+m_\varphi$<939.565 MeV.

3) Neutron→dark particle + e^+e^-. Excluded Br($n\rightarrow\chi e^+e^-$)≈1% for e^+e^- pairs with energies $E_{e+e-}>2m_e$+ 100 keV. (X. Sun et al., .Phys. Rev., C97(5):052501, 2018).

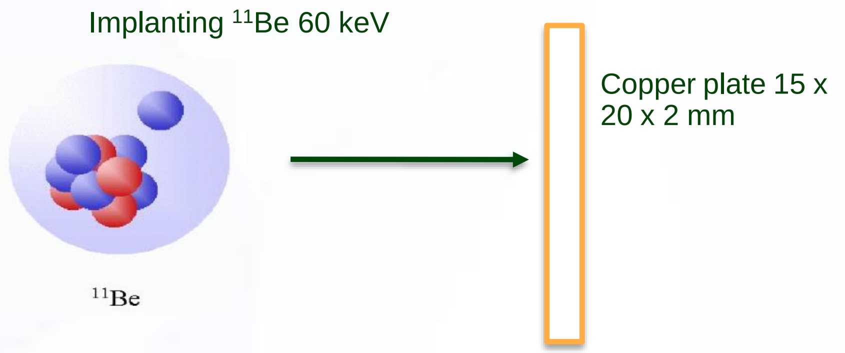
4) Nuclear dark decays: 937.9 MeV< m_χ< m_n-S_n… Fulfilled in neutron halo nuclei

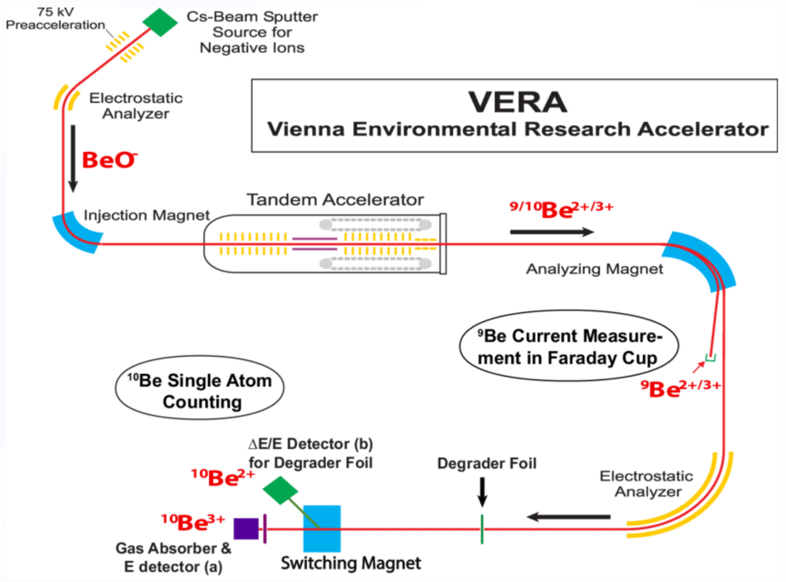


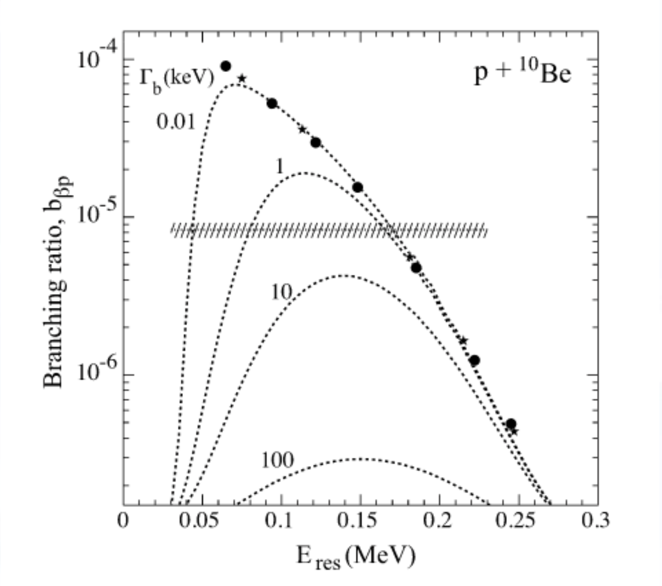


- If the neutron separation energy of a nuclei is $S_n<1.572$ MeV, the dark neutron decay could happen.
- Pfutzner and Riisager identified the candidates as: ^{6}He, ^{11}Li, ^{11}Be, ^{15}C, and ^{17}C, with ^{11}Be as the best candidate.
- ^{11}Be lifetime is 13.7 s and has several beta-delayed channels open.
- Beta-delayed proton emission is possible if $S_n<(m_n-m_p-m_e)c^2 \approx 0.782$ MeV. Q_{bp} = 280 keV.
- Branching ratio upper limit of 10^{-4}, depending on the dark particle mass.

- Riisager et al. implanted ^{11}Be in a catcher and let it decay
- Then analyzed the ratio of $^{10}Be/ ^{11}B$ in the catcher with the accelerator mass spectrometry technique
- Deduced that the $^{11}Be \rightarrow ^{10}Be$ branching ratio was $8.3(9) \cdot 10^{-6}$
- This value is orders of magnitude higher than theoretical predictions
- The neutron decays to a proton in a resonance and it is emitted, or it directly decays into the continuum
- An unobserved resonance in ^{11}B could explain it.





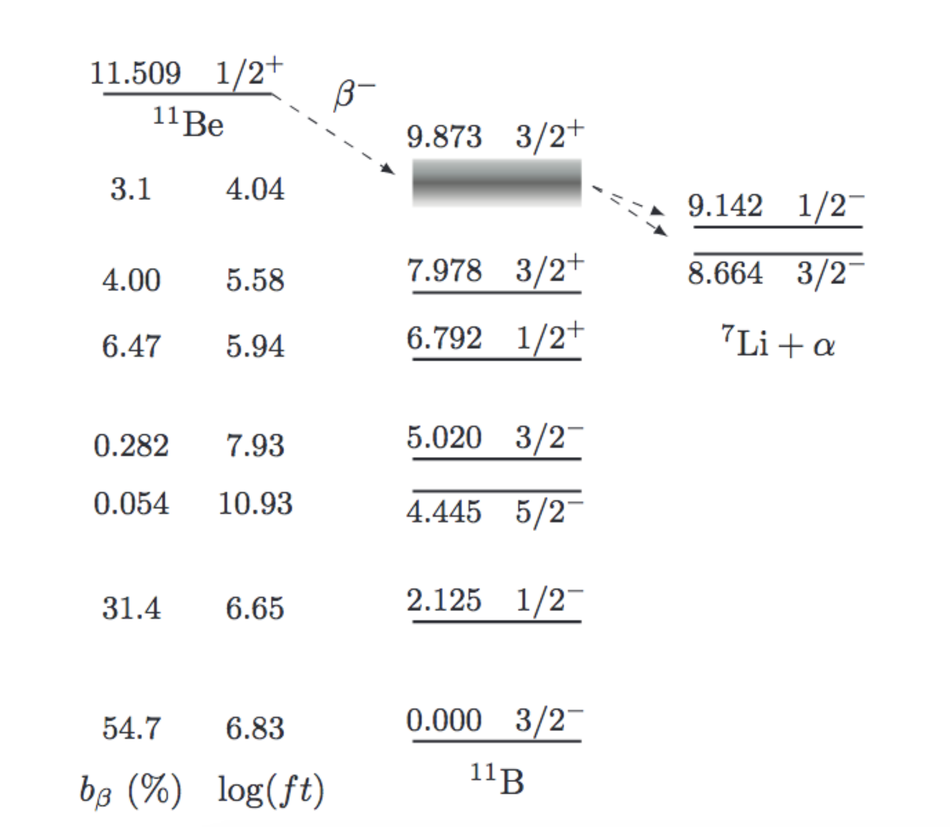


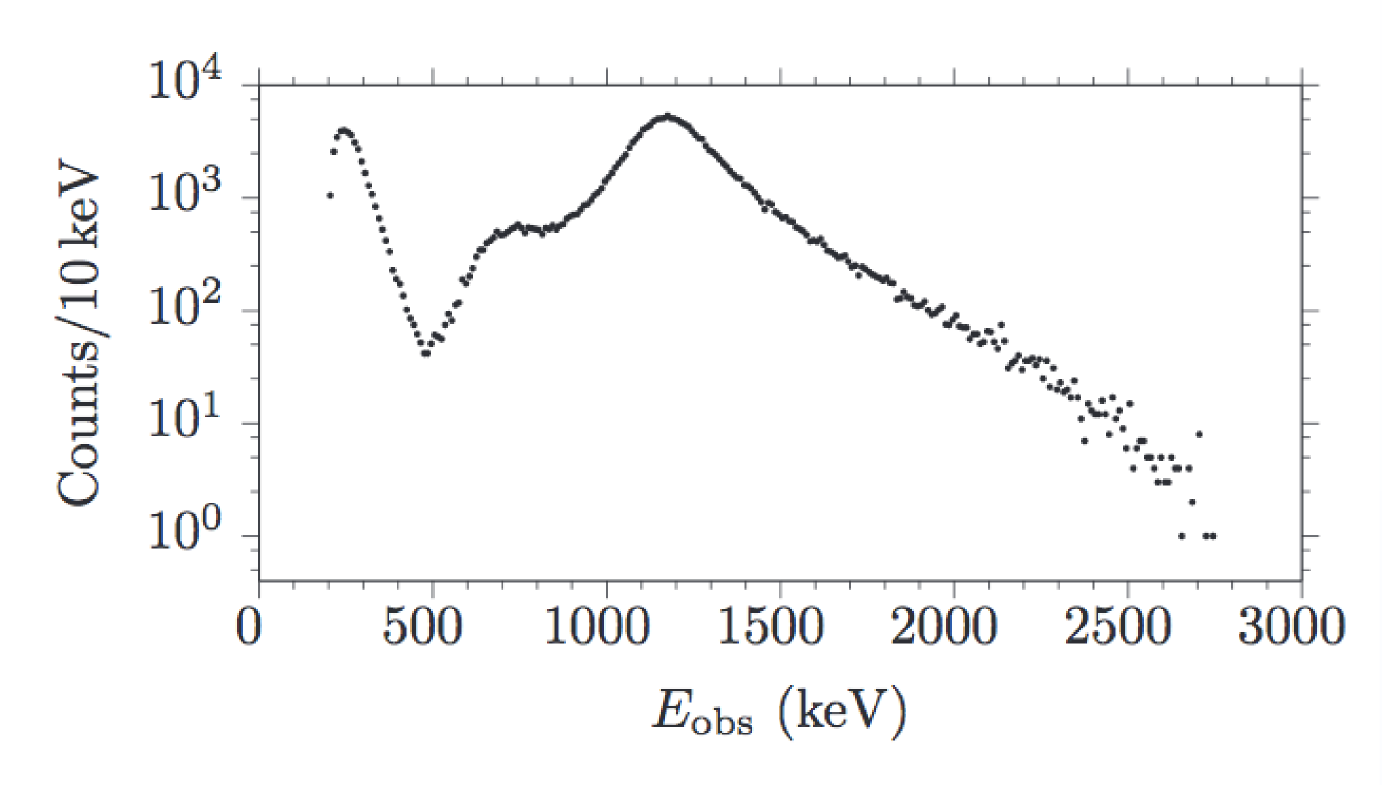
Riisager, PLB **732** 305 (2014)
Riisager, Phys. Scr. **T152,** 014001 (2013)

- Previous experiment did not observe the emitted protons.
- Measuring the energy distribution of the protons will yield information in the hypothesized resonance in ^{11}B.
- By knowing the βp energy window we can extract the B(GT).
- Free neutrons have a B(GT)=3, so this value can directly quantify how "free" are halo neutrons.
- Riisager et al. measured the combination of all decay branches leading to 11Be -> 10Be
- This experiment specifically measured the ^{11}Be -> ^{10}Be + p branch
- Any discrepancy between both results would be an indication of unaccounted decay branches, with the dark decay as a very likely candidate

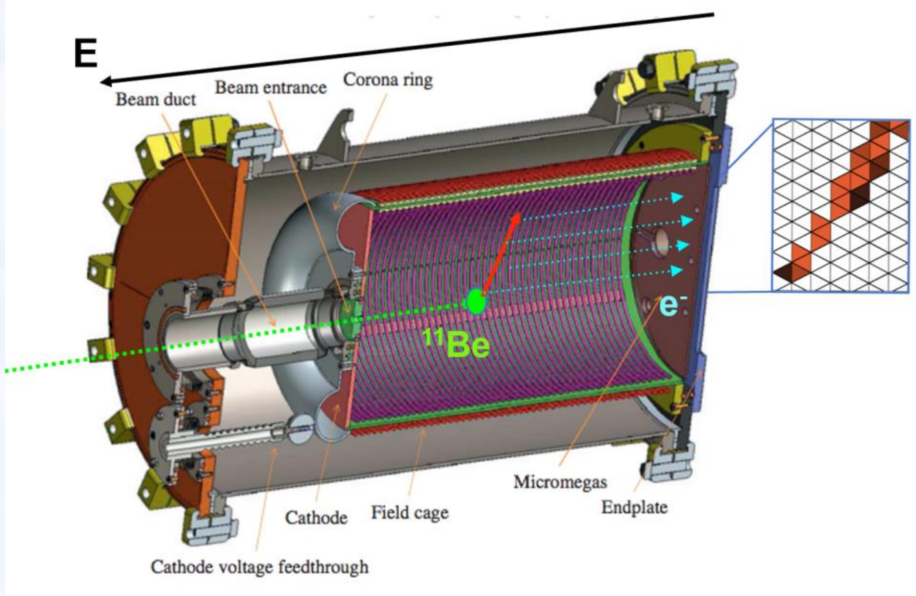
^{11}B, a "exotic" structure

Experimental method: Silicon detectors

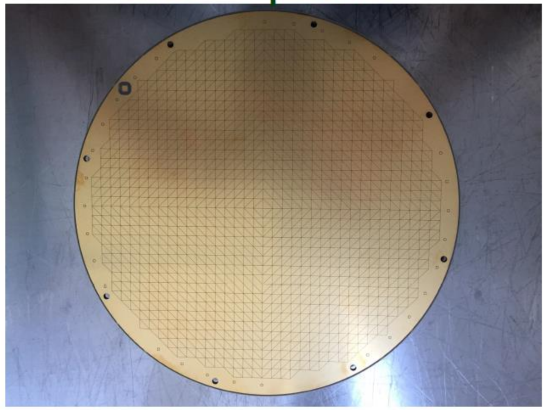


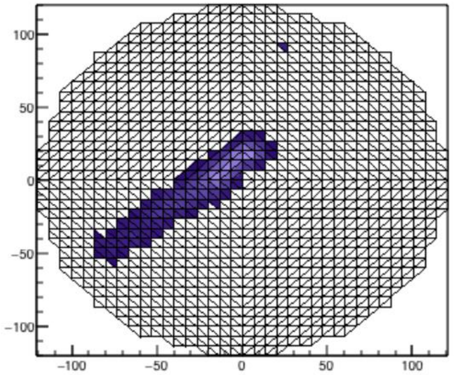


J. Refsgaard, J. Büscher, A. Arokiaraj, H. O. U. Fynbo, R. Raabe, and K. Riisager
Phys. Rev. C 99, 044316 – Published 25 April 2019

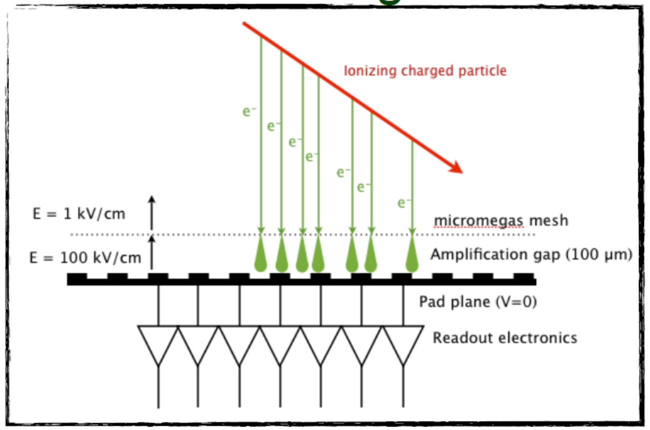


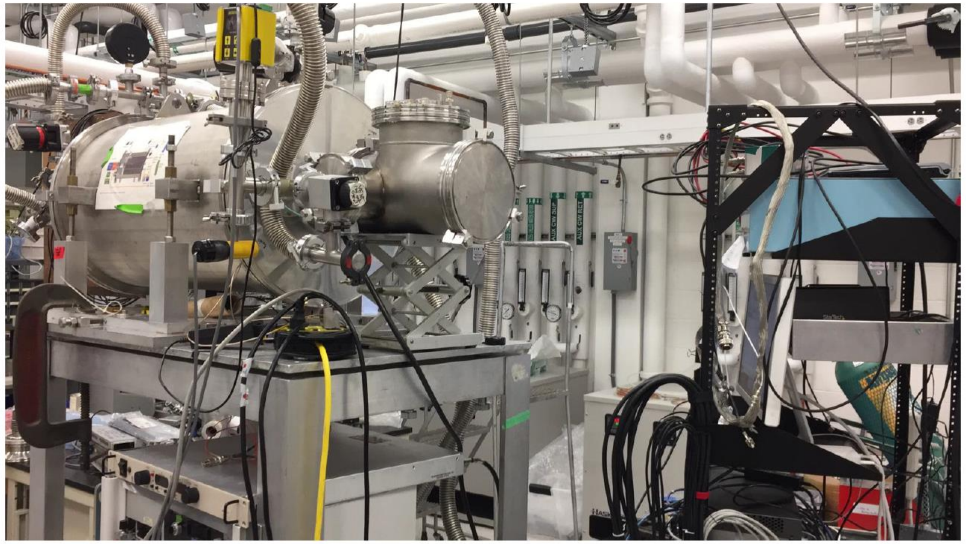
2000 pads

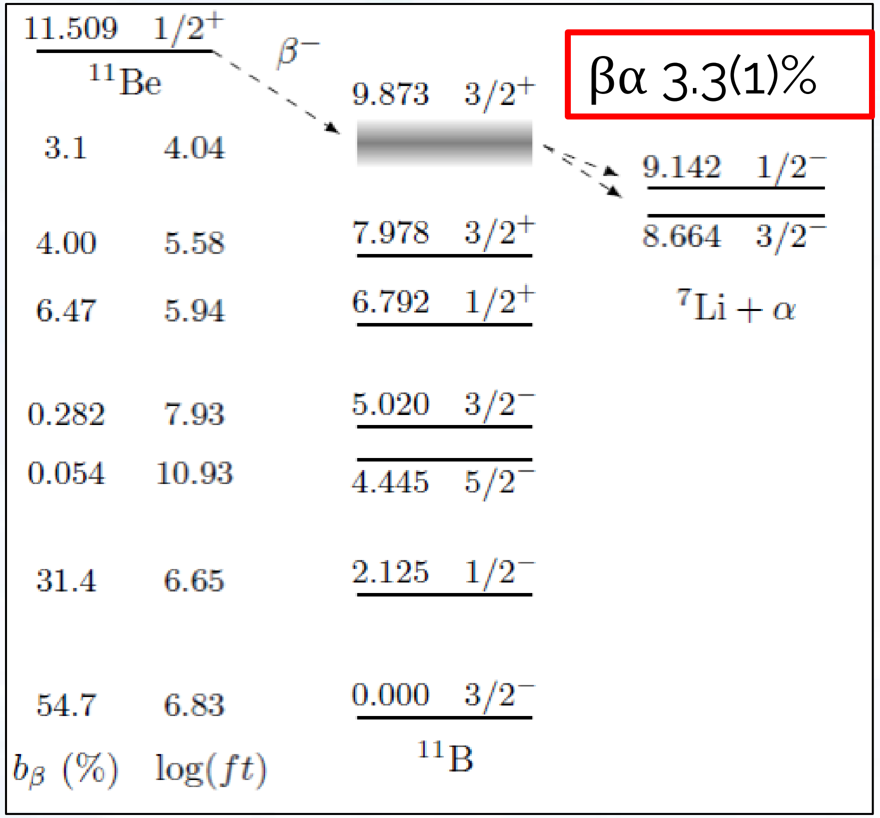


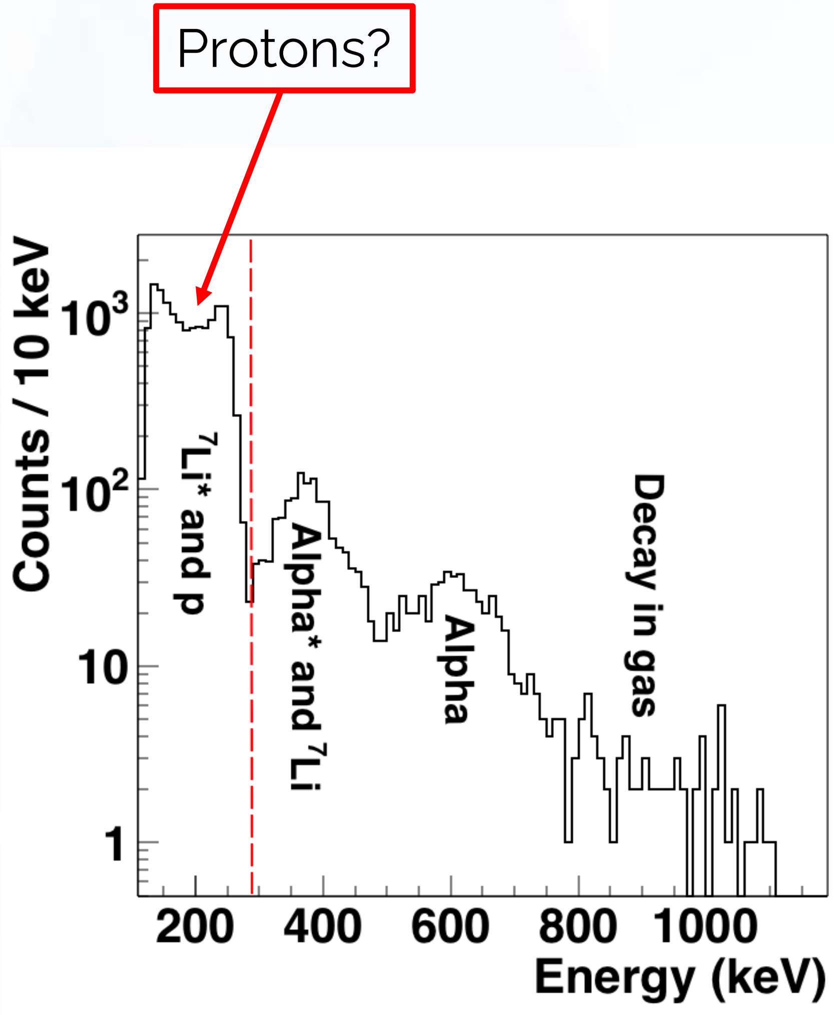


Micromegas

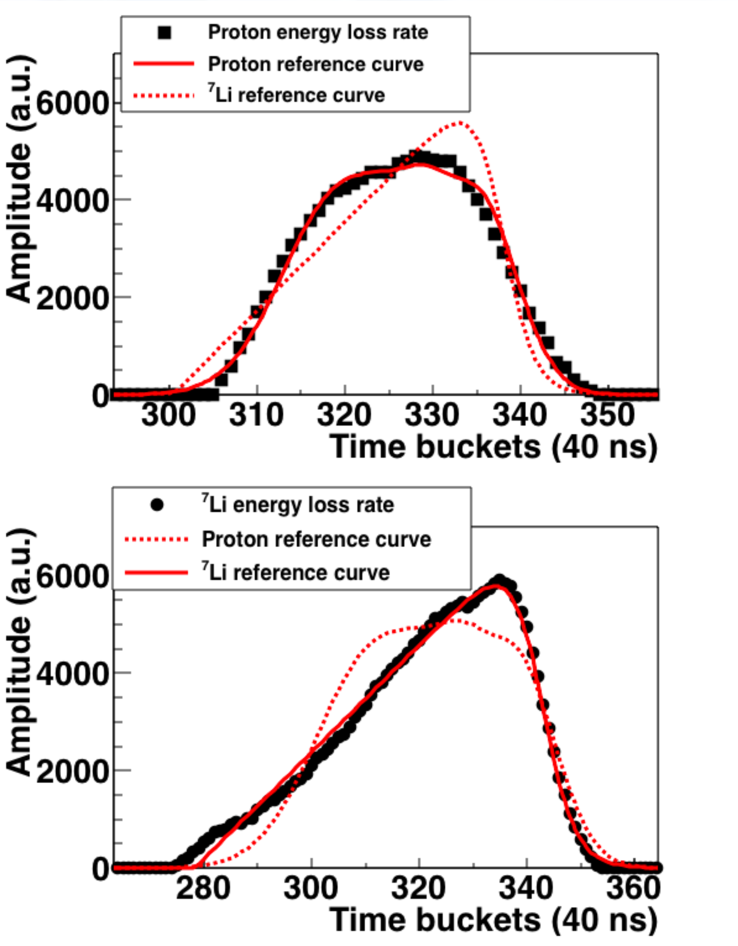


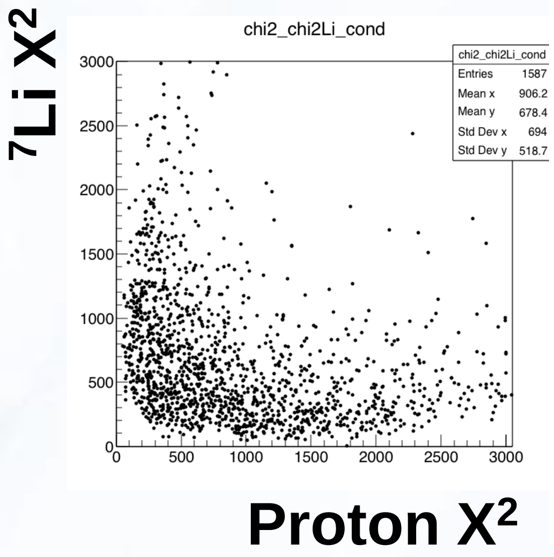


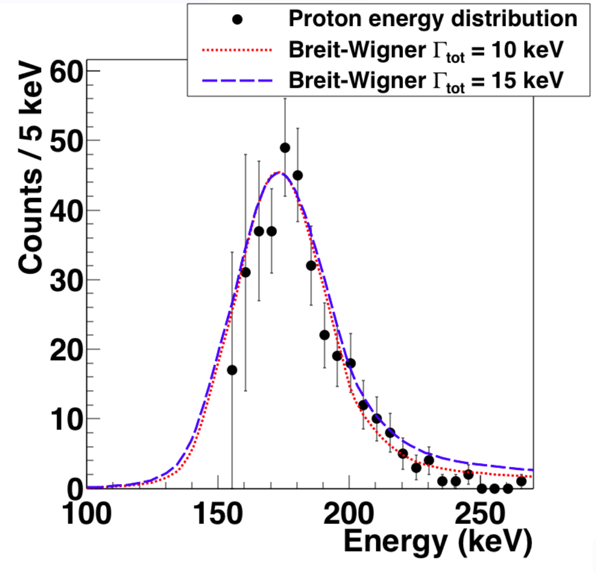

11.509 1/2+
11Be
β−
9.873 3/2+
βα 3.3(1)%
3.1 4.04
9.142 1/2−
8.664 3/2−
4.00 5.58 7.978 3/2+
6.47 5.94 6.792 1/2+
7Li + α
0.282 7.93 5.020 3/2−
0.054 10.93 4.445 5/2−
31.4 6.65 2.125 1/2−
54.7 6.83 0.000 3/2−
bβ (%) log(ft)
11B


Protons?
Counts / 10 keV
10³
10²
10
1
7Li* and p
Alpha* and 7Li
Alpha
Decay in gas
200
400
600
800
1000
Energy (keV)

Y. Ayyad *et al.*
Phys. Rev. Lett. 123, 082501 – Published 22 August 2019;
Erratum [Phys. Rev. Lett. 124, 129902 (2020)]







- First direct observation of $\beta^{-}p$ in a neutron-rich nuclei.
- Branching ratio is 1.2×10^{-5}, with 30% uncertainty… Theoretical calculations yield 8.0×10^{-6}.
- A narrow resonance (12 keV) in ^{11}B was inferred. E = 11425(20)keV, Γ=12(5) keV, J^{π} = 1/2;3/2+.
- Comment on "Direct Observation of Proton Emission in 11Be" No reliable particle identification. B(GT)>3 (above free single nucleon decay limits) (https://arxiv.org/abs/1912.06064).
- Assuming a pure Gamow-Teller (GT) transition, it yields B(GT)= 5.5+8.3−3.
- Decay into the continuum would be characterized by a much shorter branching ratio (10^{-10}).

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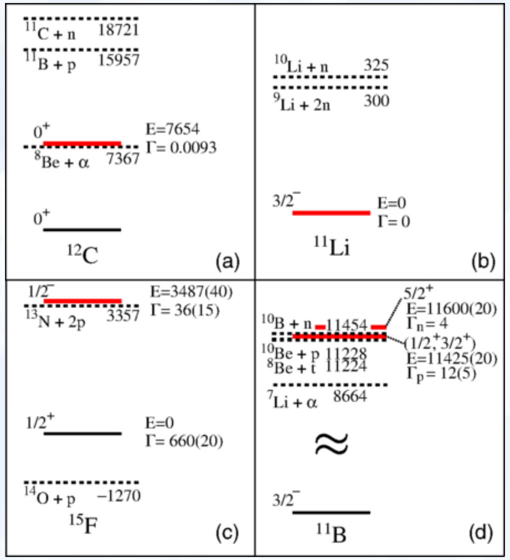
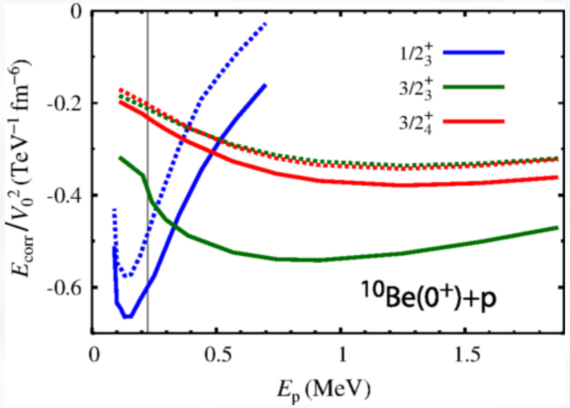
arXiv:2112.05622

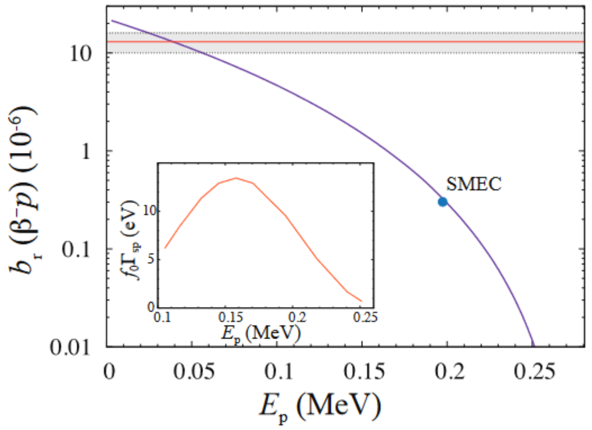
Theory tries to reproduce the result

Phys Rev Lett. 124, 042502 (2020)

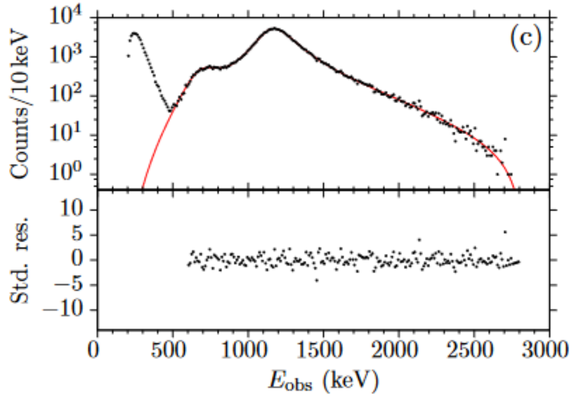




- Shell model embedded in the continuum (SMEC).
- Near-threshold collectivity driven by the interplay between nuclear interactions and decay channels.
- Single "aligned eigenstate".
- $[^{10}Be(0^+) \otimes p(s^{1/2})]^{1/2+}$, $[^{10}Be(0^+) \otimes p(s^{1/2})]^{1/2+}$ and $[^{10}B(3^+) \otimes n(d^{5/2})]^{1/2+}$
- Strongest collectivization is predicted at $E_p \simeq$ 142 keV.
- Core-coupled proton state $[^{10}Be \otimes p]$ with the negligible $[^{7}Li \otimes \alpha]$ component.
- SMEC finds a consistent description of the beta-delayed alpha branching ratio of ^{11}Be and the $\Gamma_p(1/2_3^+)$.
- However, it does not reconcile with the branching ratio for proton emission. It should be 40 times lower.
- This is based on the assumption that a neighboring $3/2^+$ state decaying by alpha emission exists (at around 11.450 keV). Such state was inferred from R-matrix calculations.



Model	I	II	III
States	$3/2^+$	$3/2^+ + 1/2^+$	$3/2^+ + 3/2^+$
χ^2_r/ndf	21.7	3.11	1.26



PRC 99, 044316 (2019)

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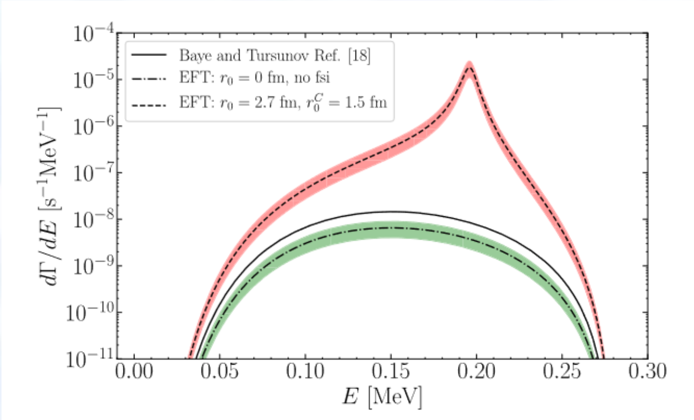
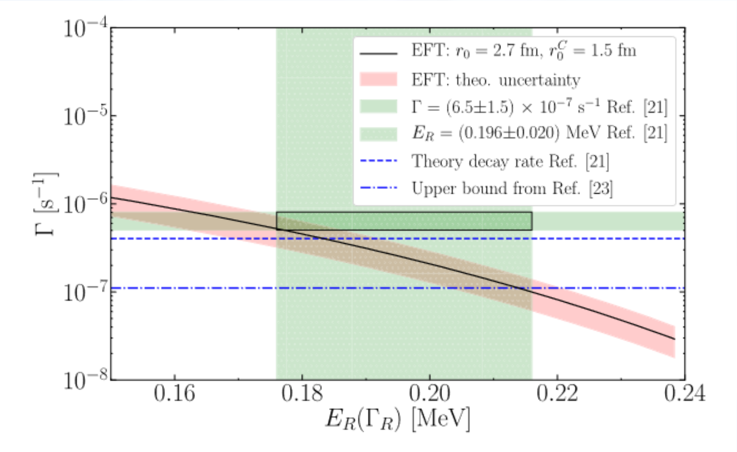
Theory tries to reproduce the result

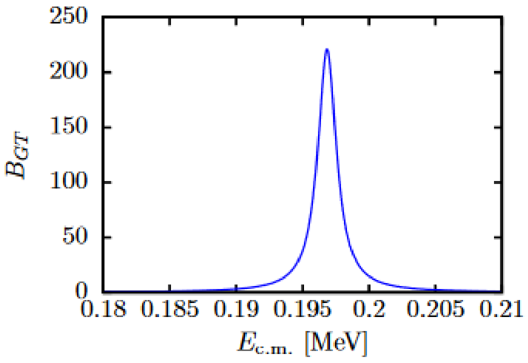
Physics Letters B 821 (2021) 136610





- Halo Effective Field theory (EFT) yields results consistent with the experiment. b_p =4.9 +5.6-2.9(exp) +4.0-0.8(theo.) and Γ=9.0+4.8-3.3(exp)+5.3-2.2(theo.) keV.
- No resonance: Γ=(6.6+-2.6) 10^{-10} s
- From ab-initio calculations with no-core shell model with continuum (NCSMC) b_p= (1.3+-0.5) 10^{-6} s
- Alpha decay spectroscopic factor is consistent with our estimate inferred from the decay width.
- From shell model calculations (A. Volya EPL 130, 1, 2020) the decay proceeds via the isobaric analog state with a lifetime of 2.6 10^{10} s SFp = 0.23. Small alpha width does not explain the experimental branching ratio.

Phys. Rev. C 105, 054316 (2022)



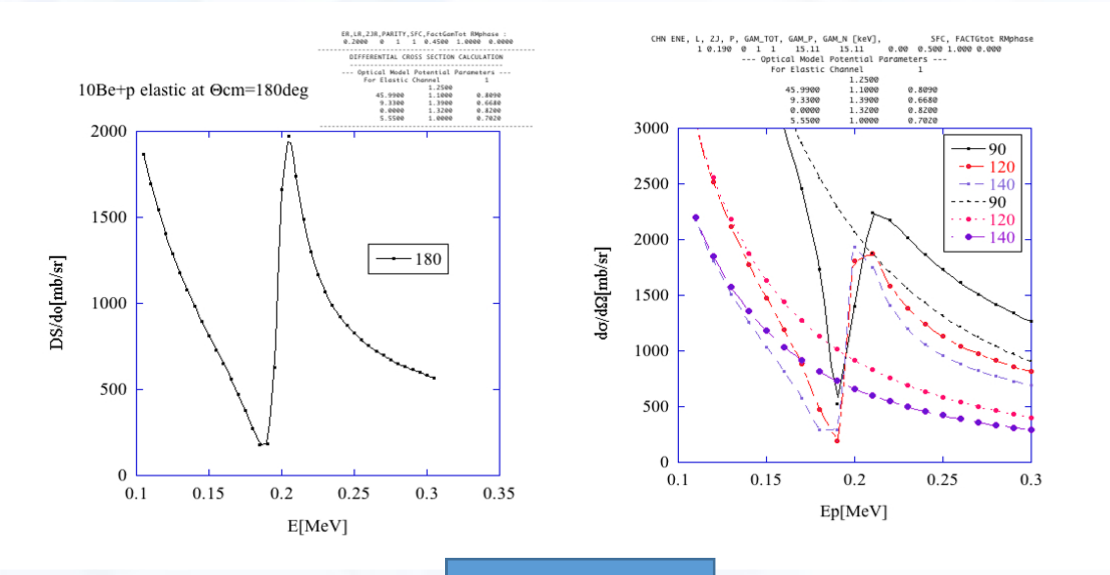
J^π	$S(^{11}B \to {}^{10}Be)$ $(0^+, 1)$	$S(^{11}B \to {}^{10}B)$ $(1_1^+, 0)$	$S(^{11}B \to {}^{10}B)$ $(1_2^+, 0)$	$S(^{11}B \to {}^{7}Li)$ $(3/2^+, 1/2)$
$1/2_1^+$	0.276	0.250	2×10^{-4}	0.218
$1/2_2^+$	0.0525	0.171	0.562	0.002
$1/2_3^+$	0.067	0.231	0.188	0.011
$3/2_1^+$	0.079	6×10^{-4}	0.215	0.009
$3/2_2^+$	4×10^{-4}	0.581	0.002	0.012
$3/2_3^+$	6×10^{-4}	0.011	0.006	0.021
$3/2_4^+$	0.067	0.034	0.35	0.006

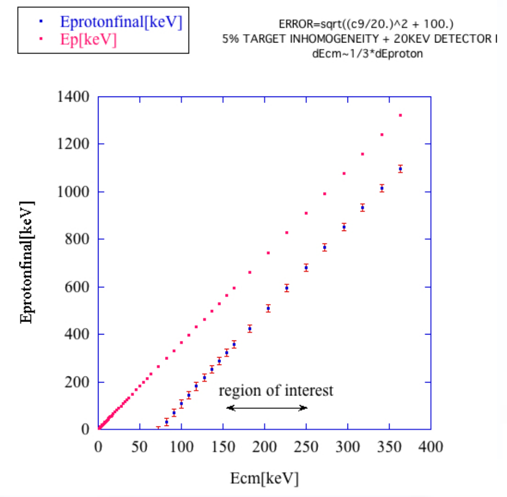
J_i^π	E (EXP)	$E(psdu)$	$E(fsu)$	$B(GT)$	$\log_{10}(ft)$	SF_p	SF_α
$1/2_1^+$	6.7918	7.1743	6.5998	0.009	5.625	0.078	0.198
$3/2_1^+$	7.9779	8.0855	8.6337	0.000	8.286	0.040	0.034
$1/2_2^+$	(9.820)	9.9360	10.9678	0.191	4.301	0.175	0.170
$3/2_2^+$	9.873	10.6324	10.6968	0.001	6.737	0.057	0.002
$3/2_3^+$	(11.450)	11.5736	10.8534	0.615	3.792	0.008	0.038
$3/2_4^+$		11.9769	11.9453	1.731	3.343	0.012	0.008
$1/2_3^+$		12.7309	12.4382	0.659	3.762	0.019	0.012
$3/2_5^+$		12.9830	12.2265	0.035	5.046	0.003	0.023
$3/2_6^+$		13.1816	12.9324	0.222	4.235	0.001	0.007
$1/2_4^+$		13.1963	13.5568	0.959	3.599	0.057	0.004
$3/2_7^+$		14.4333	13.3750	0.037	5.011	0.003	0.001
$3/2_8^+$		14.9305	14.4300	0.008	5.674	0.013	0.001
$1/2^+, 3/2$	12.554	14.7199	12.6631	0.571	3.195	0.230	0.000

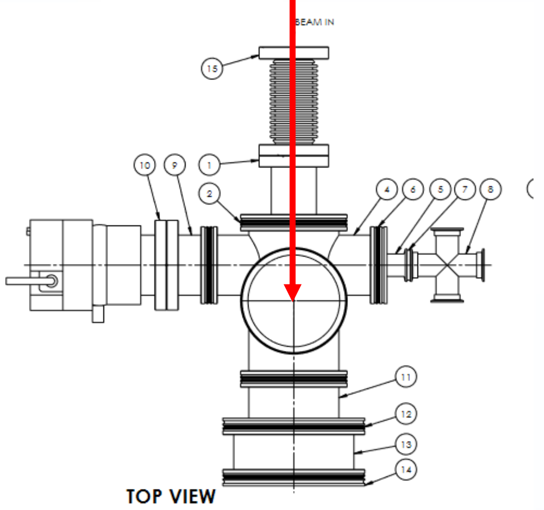
EPL 130, 1, 2020

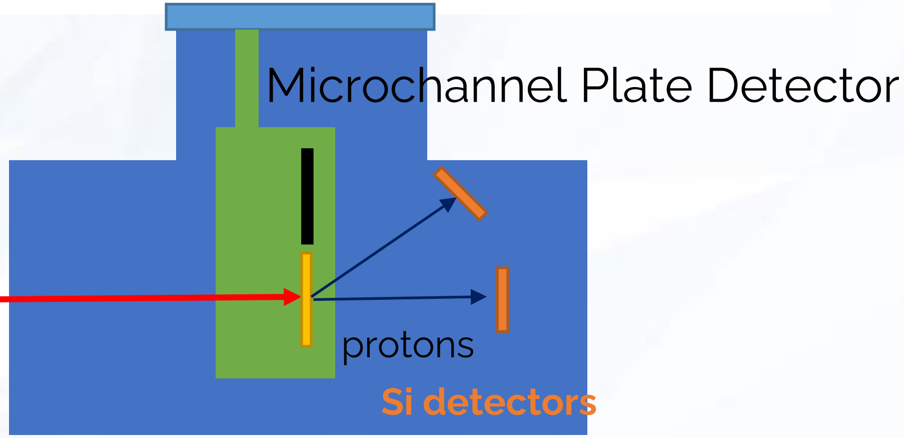
^{10}Be+p resonant scattering at ReA3 (FRIB)

^{10}Be beam at 400 keV/u from ReA3



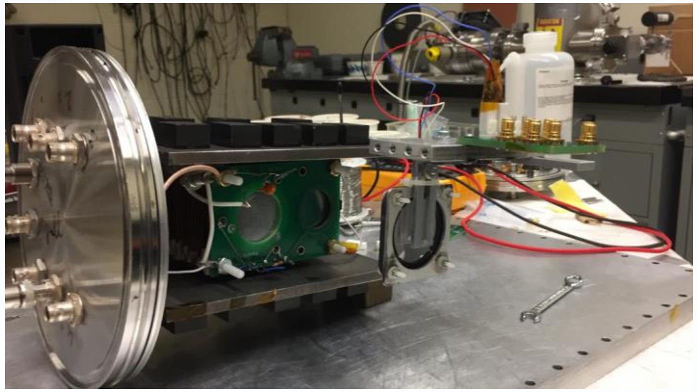






^{10}Be beam at 400 keV/u from ReA3

Aluminized thick 10 um CH_2 Target



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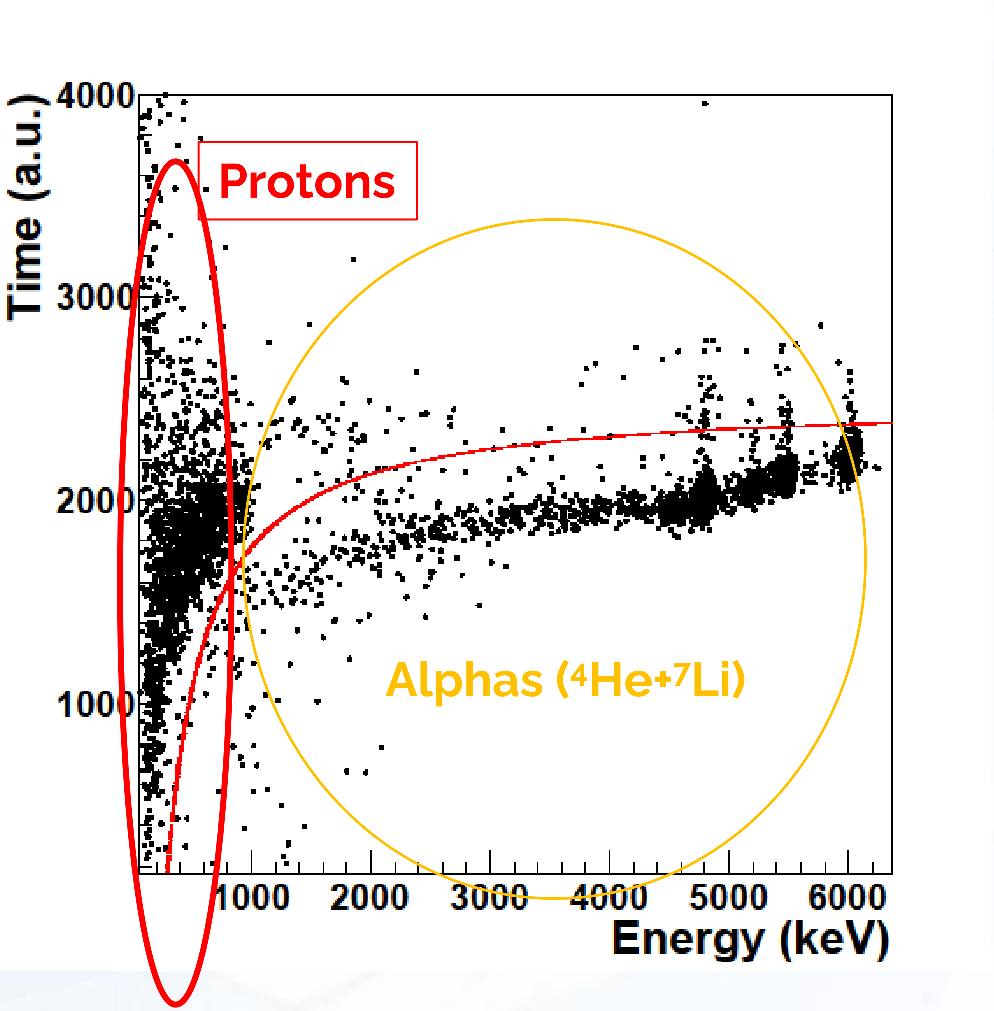
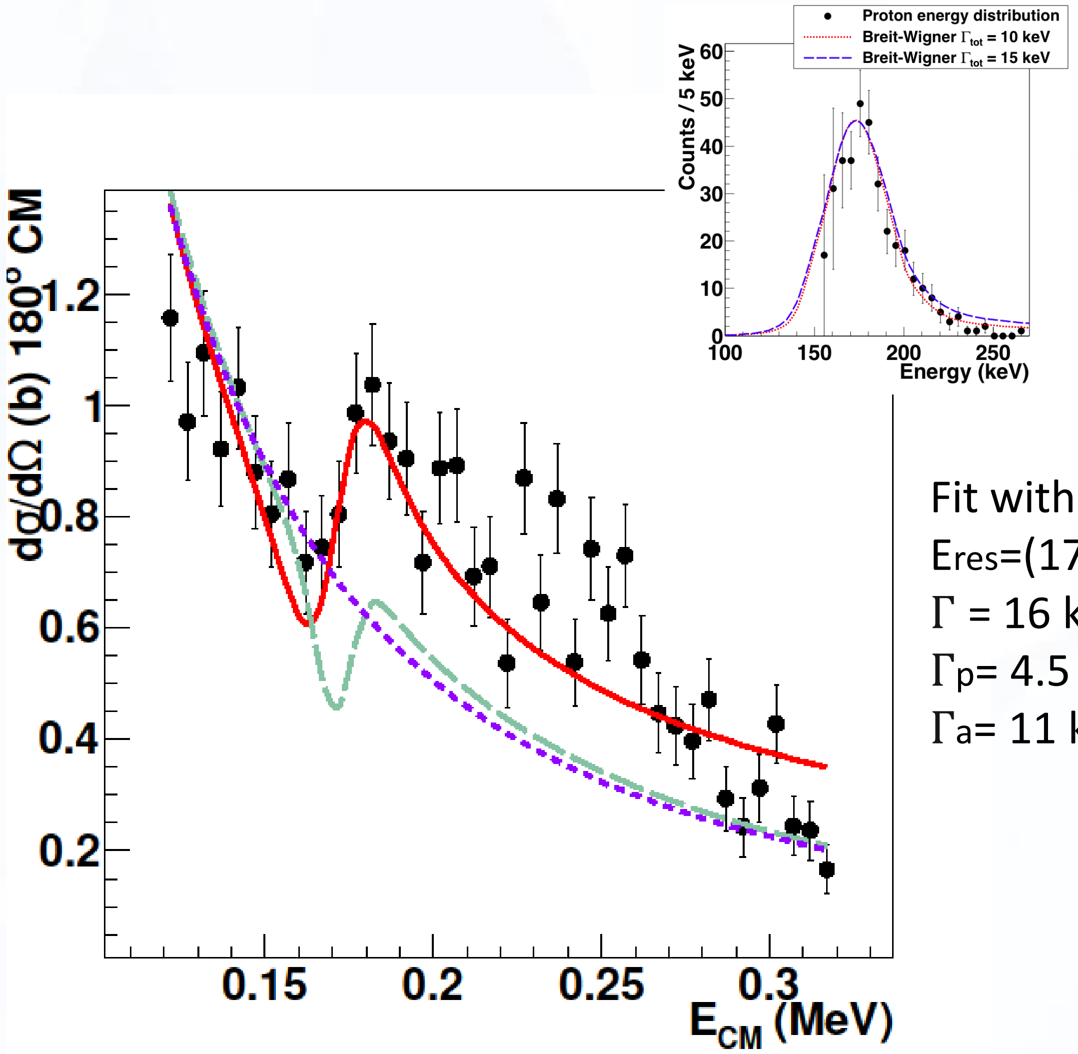




Fit with code AZURE2

E_{res}=(171 +-20) keV

Γ = 16 keV

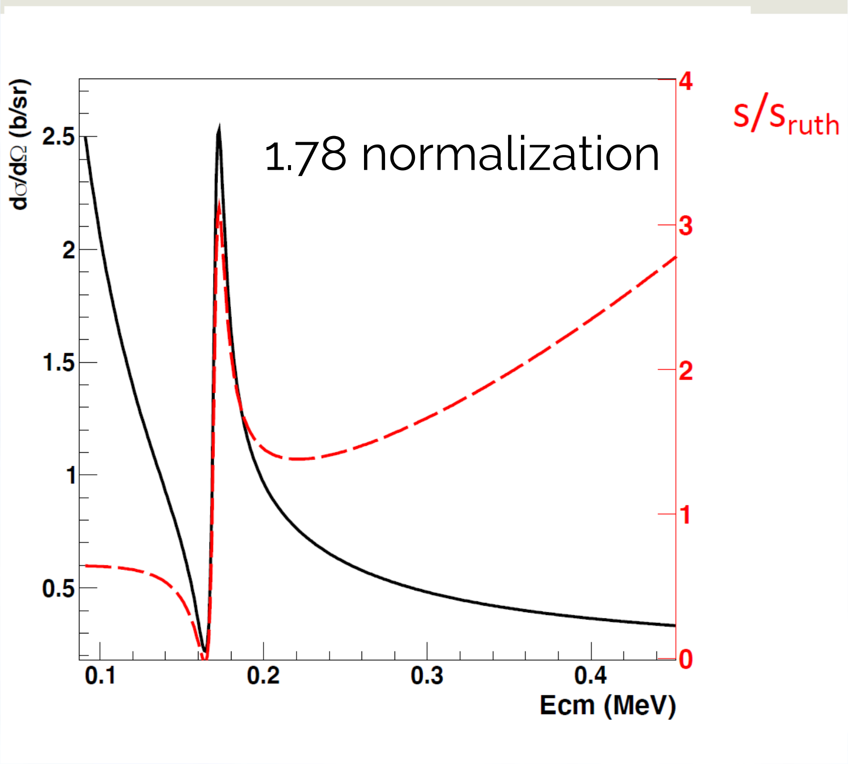
Γ_p= 4.5 keV

Γ_a= 11 keV

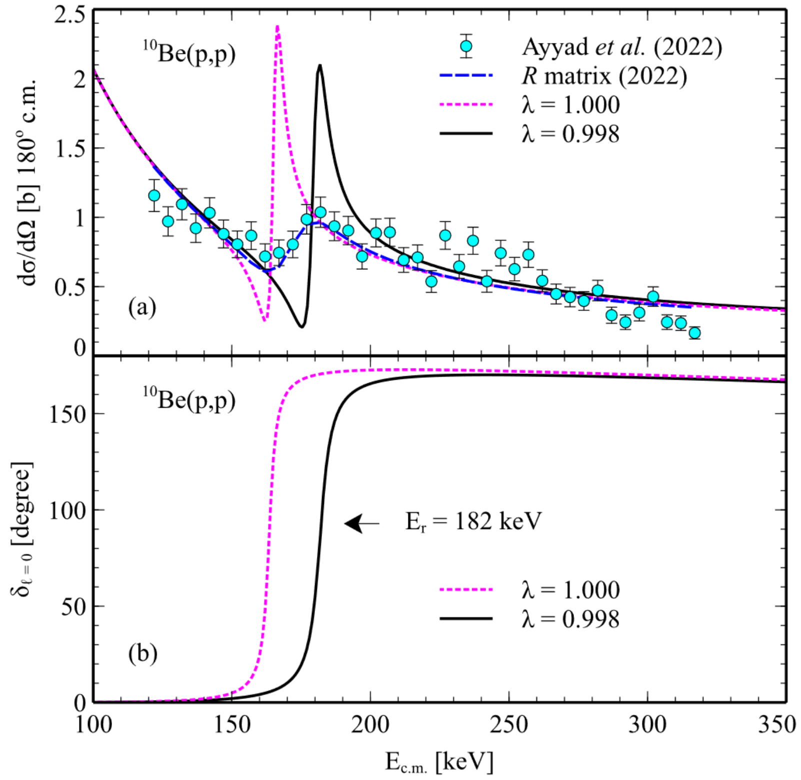
Phys. Rev. Lett. 129, 012501 (2022)

Excitation function of elastic scattering ^{10}Be+p

Sao Paulo Optical Model Potential (SPOMC)



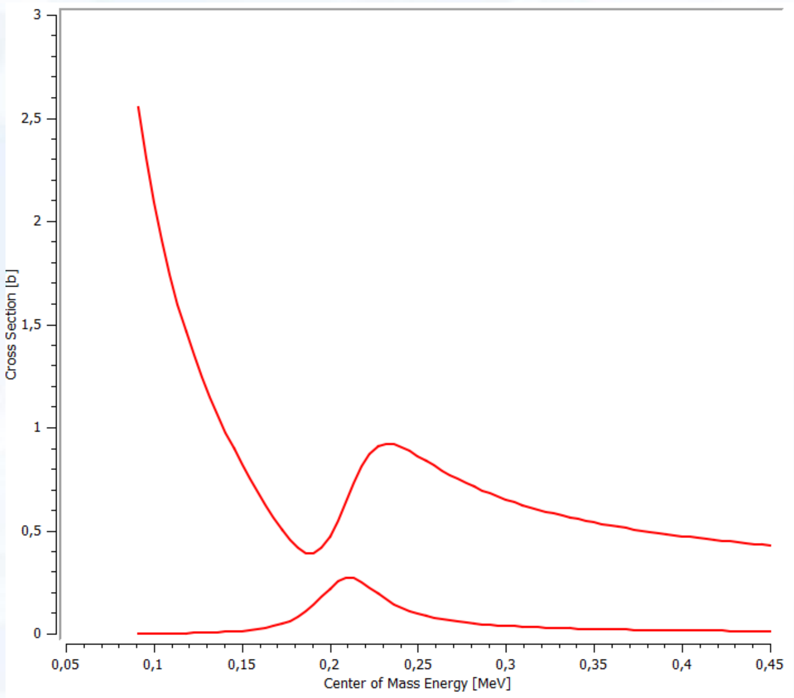
Self-consistent Skyrme Hartree-Fock in the continuum method.



MinhLoc BUI, N. Auerbach, V. Zelevinsky, https://arxiv.org/abs/2206.01350v1 and Private comm May 2022, IGFAE Instituto Galego de Física de Altas Enerxías — USC — XUNTA DE GALICIA

^{10}Be+p Narrow resonances with R-matrix code Azure2.

	Light Particle	Light Spin	Heavy Particle	Heavy Spin	Excitation Energy	Separation Energy	Channel Radius
1	*p*	1/2+	^{10}Be	0+	0	11,228	5,4
2	α	0+	^{7}Li	3/2-	0	8,664	5,4

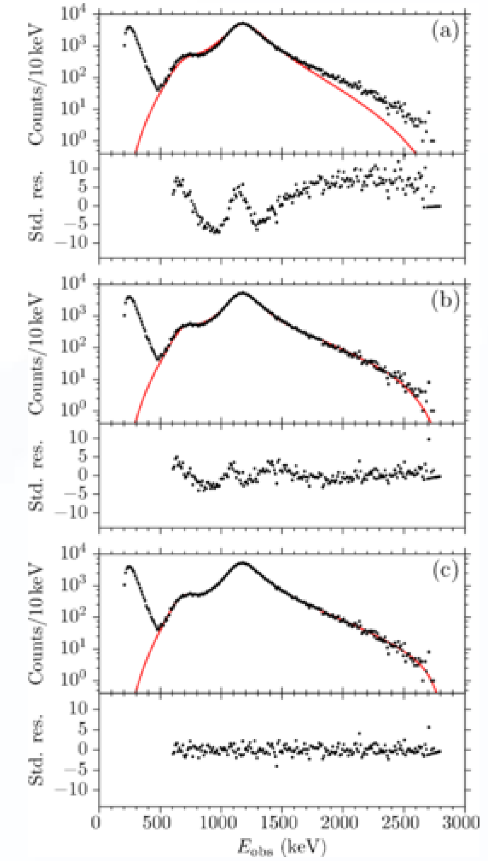


- From R-matrix we infer a Γ_a = 11+-4 keV, with a relatively large cross section of 0.5 b.
- Absence of alpha decay would give a total width 0f 4.5 keV, in clear conflict with the experimental resolution.
- Possible neighboring $3/2^+$ overlapping…
- Still does not solve the conundrum neither the B(GT), which is very sensitive to the energy and width.
- Dedicated measurement is needed!

PRC 99, 044316 (2019)

orbital angular momentum of $l = 1$ are included in the models.

Model	I	II	III
States	$3/2^+$	$3/2^+ + 1/2^+$	$3/2^+ + 3/2^+$
χ^2_L/ndf	21.7	3.11	1.26



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^{10}Be(d,n) FSU

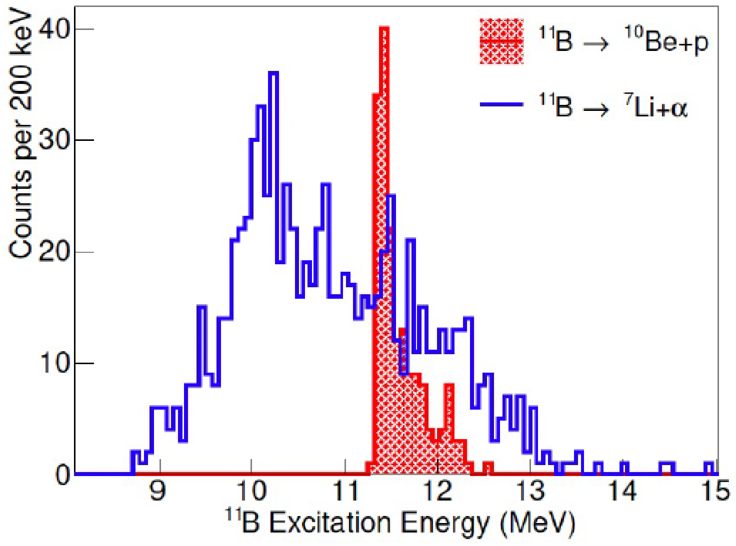

FIG. 3: Excitation energy spectrum in ^{11}B reconstructed from the $^{11}B^* \to {}^{10}Be + p$ (red) and $^{11}B^* \to {}^{7}Li + \alpha$ (blue). A prominent near-threshold peak at $E_{ex} = 11.44 \pm 0.04$ MeV is visible in the proton spectrum.

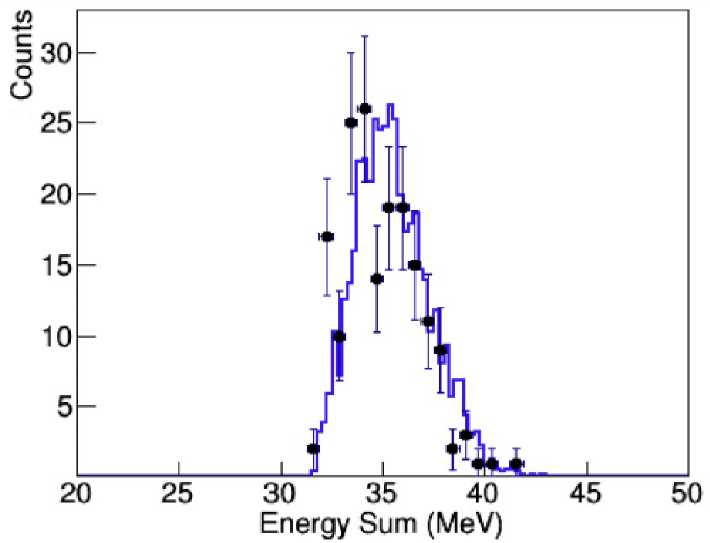

FIG. 4: Energy-sum signals of ^{10}Be + p events for the 11.44 MeV state, compared with a Monte Carlo simulation (in blue) that takes into account the DWBA-calculated angular distribution of the $^{10}Be(d,n)^{11}B^*$ reaction. A value of $\ell = 0$ fits well the experimental data.

C2S = 0.27(6)

E_x=11.44MeV→
E_{res}=11.44-11.228=
(212+-40)keV

Upper limit for alpha branch < 40%

Phys. Rev. Lett. 129, 012502 (2022)

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Theory still not happy…

β^-p and $\beta^-\alpha$ decay of the ^{11}Be neutron halo ground state

J. Okołowicz,[1] M. Płoszajczak,[2] and W. Nazarewicz[3]

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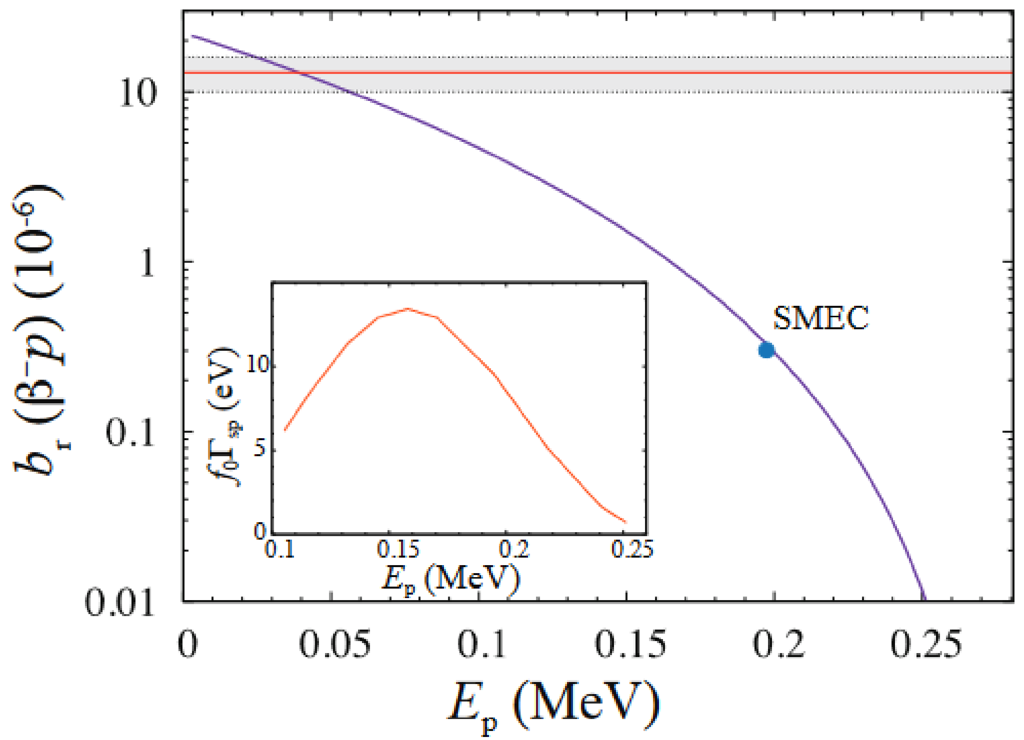
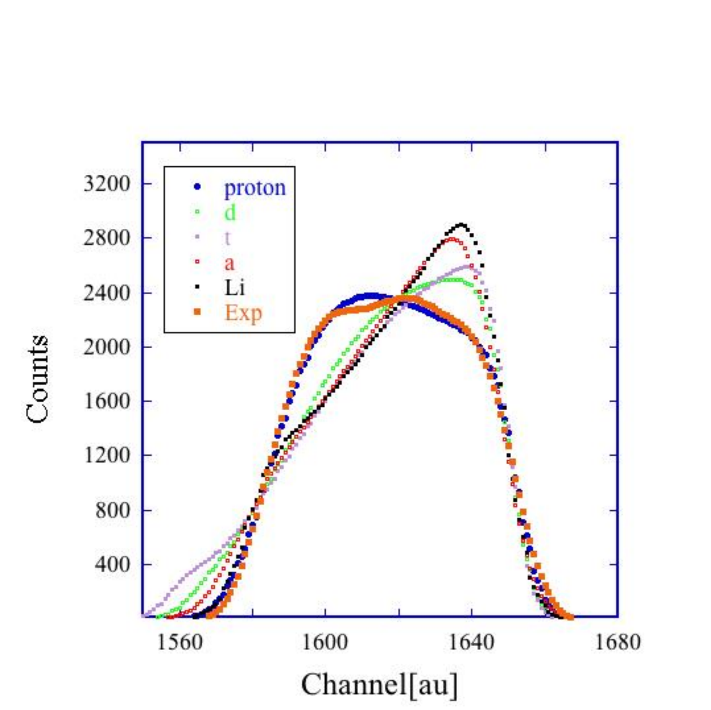
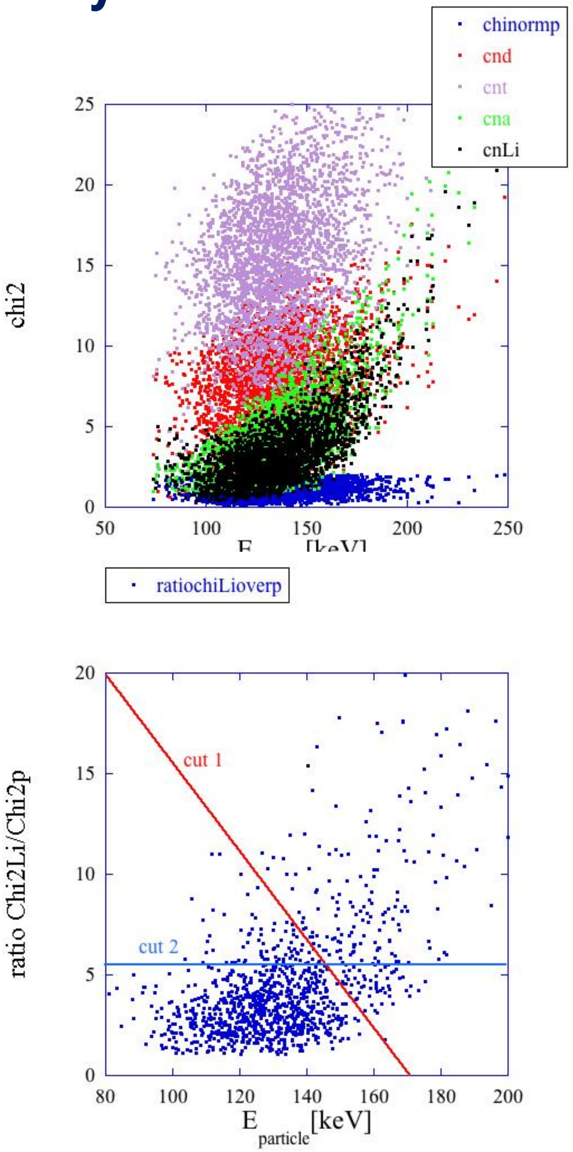
[2] *Grand Accélérateur National d'Ions Lourds (GANIL), CEA/DSM - CNRS/IN2P3, BP 55027, F-14076 Caen Cedex, France*
[3] *Department of Physics and Astronomy and FRIB Laboratory, Michigan State University, East Lansing, Michigan 48824, USA*

Beta-delayed proton emission from the neutron halo ground state of ^{11}Be raised much attention due to the unusually high decay rate. It was argued that this may be due to the existence of a resonance just above the proton decay threshold. In this Letter, we use the lenses of real-energy continuum shell model to describe several observables including the Gamow-Teller rates for the β^--delayed α and proton decays, and argue that, within our model, the large β^-p branching ratio cannot be reconciled with other data.

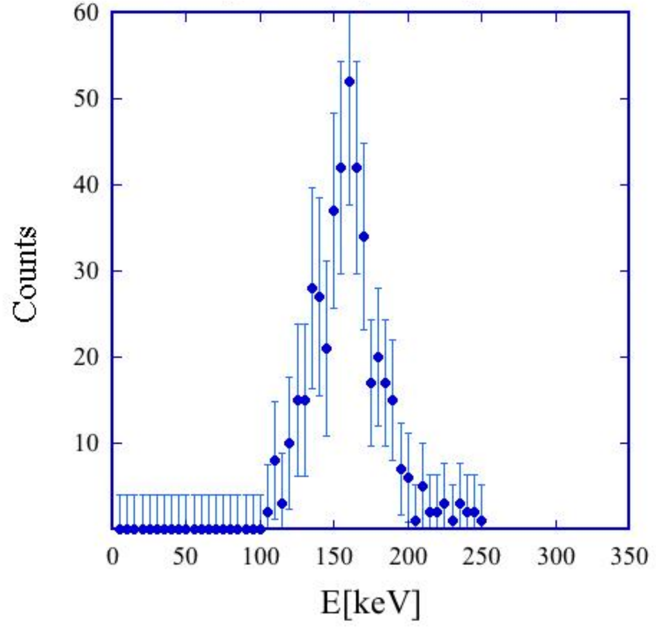


Reanalysis of ^{11}Be beta decay





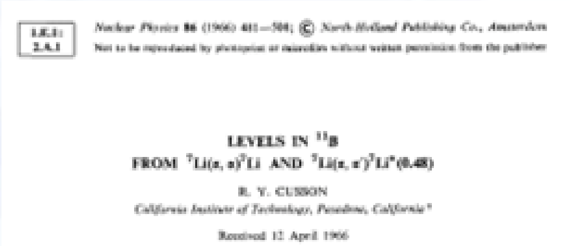
...still 10^{-5}.



In preparation...

What's next?

- Improved measurement of $^{10}Be+p \rightarrow ^{7}Li+^{4}He$ to assess the alpha decay branching ratio.
- Also, $^{7}Li+^{4}He \rightarrow ^{10}Be+p$ (already planned at TwinSol, Notre Dame).
- Search for $^{8}Be+t$ emission in the ^{11}Be beta decay data.


Nuclear Physics 86 (1966) 481—508; © North-Holland Publishing Co., Amsterdam

LEVELS IN ^{11}B
FROM $^{7}Li(\alpha, \alpha)^{7}Li$ AND $^{7}Li(\alpha, \alpha')^{7}Li^{*}(0.48)$

R. Y. CUSSON
California Institute of Technology, Pasadena, California

Received 12 April 1966

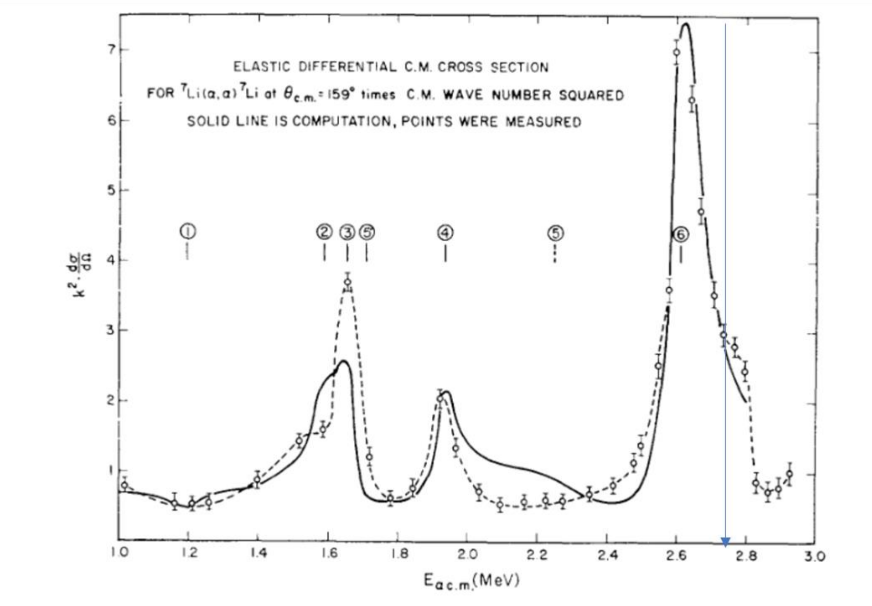
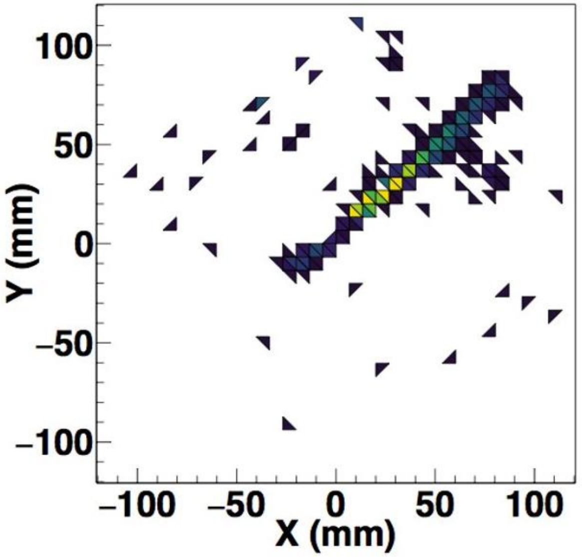
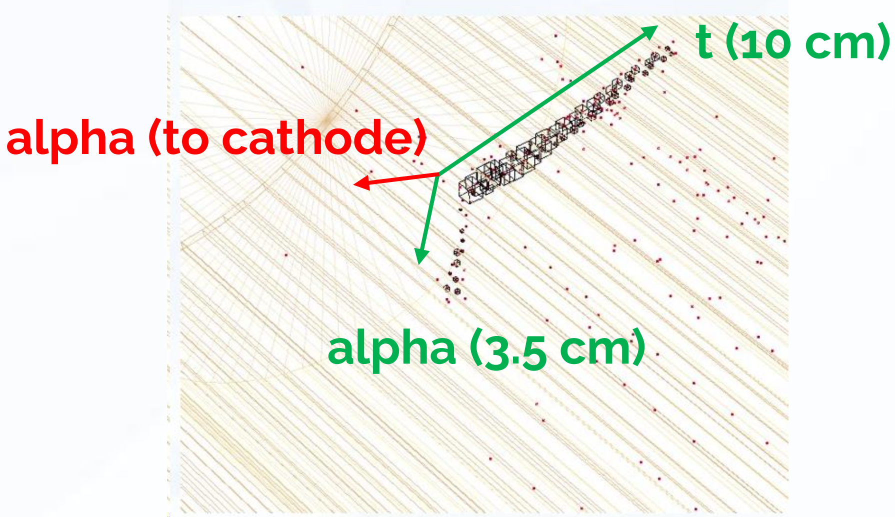


Fig. 14. Comparison of the model-program calculation with experiment for the elastic cross section at $\theta_{c.m.} = 159°$. The solid line is the model program calculation using the parameters listed in table 2. The points are experimental values. The dotted line is a smooth curve drawn through the data points.

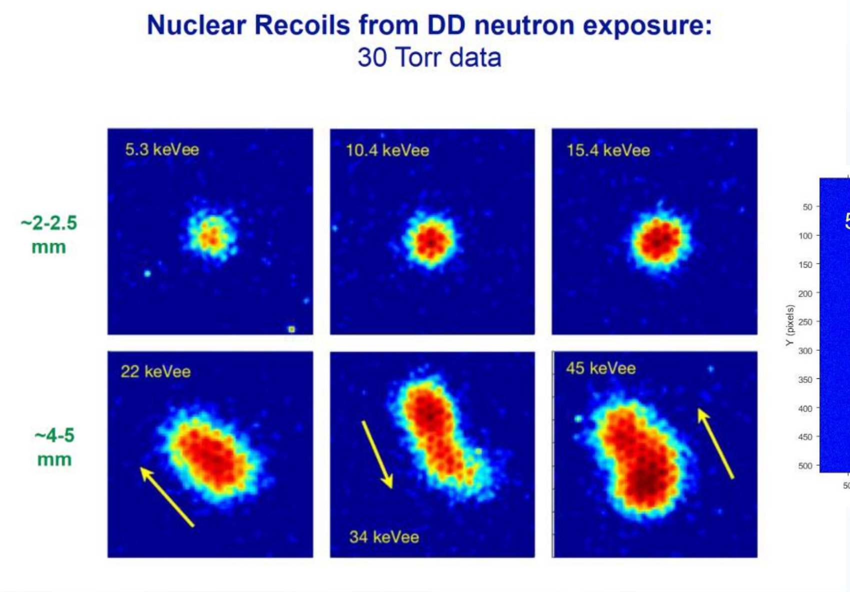


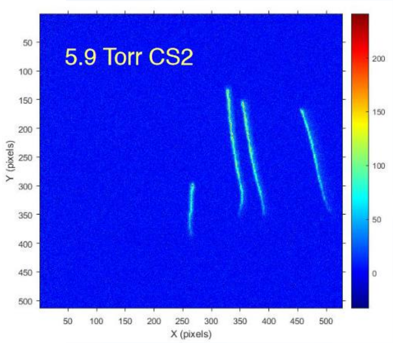


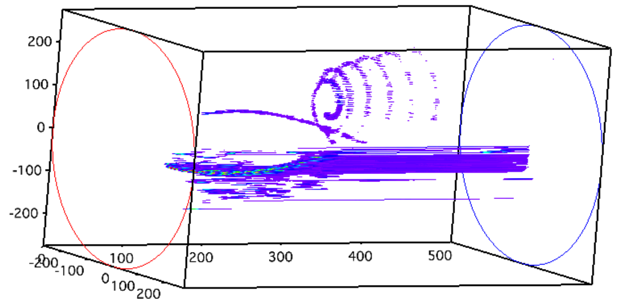
...and of course re-measure of beta-delayed proton emission of ^{11}Be

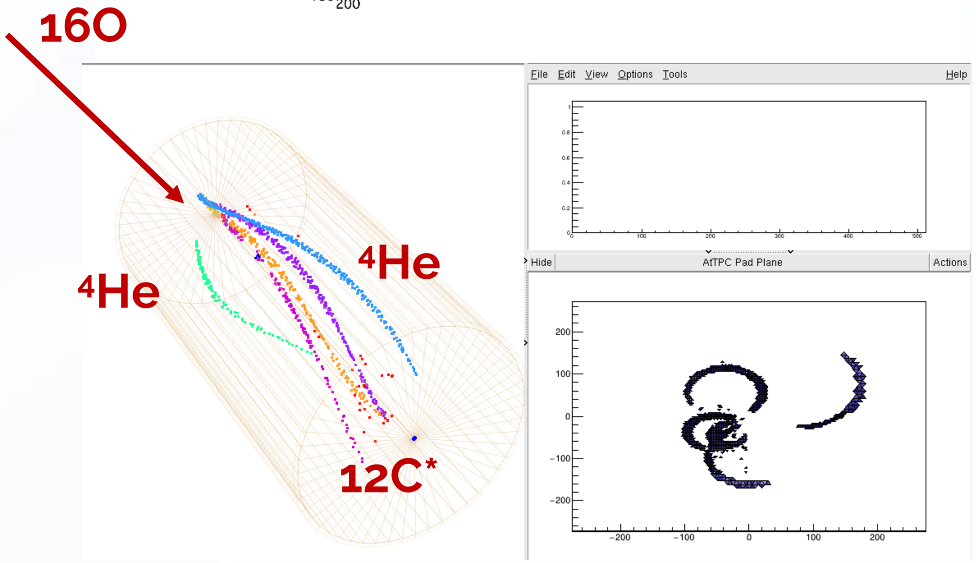
Magnetic field for enhanced particle identification

Negative Ion Drift Optical TPC
10 keV recoil
(experiment at TRIUMF, ^{16}C and ^{9}C)







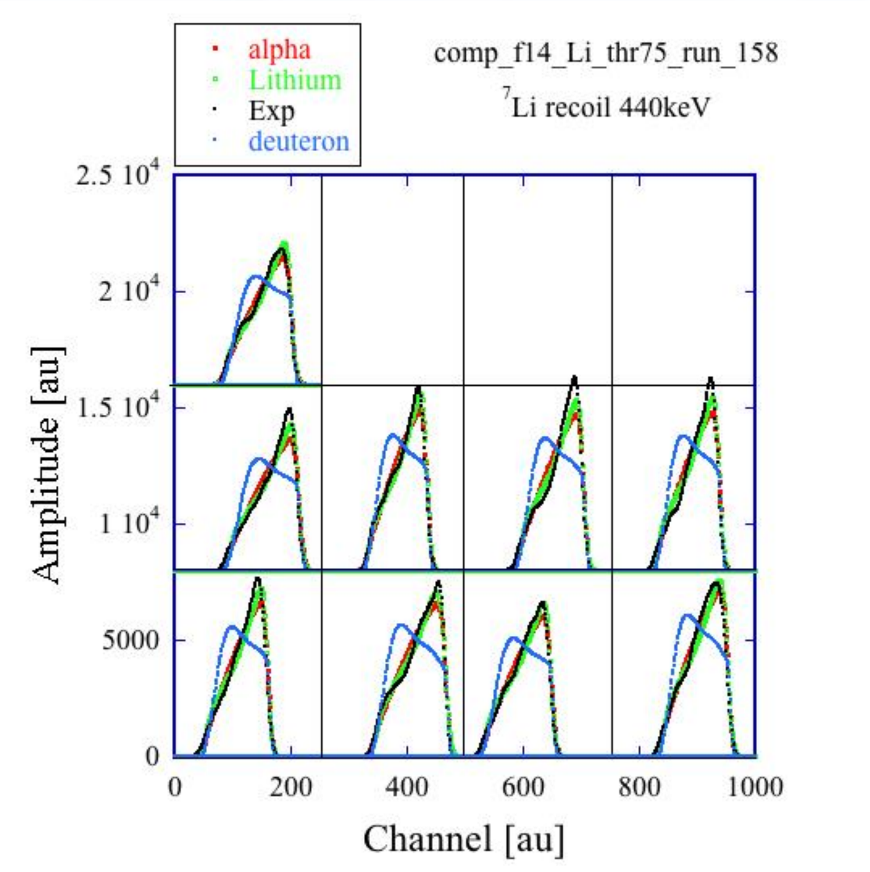


Conclusions

- Three independent experiments confirm the existence of a ½+ state at Ex~11.400MeV in ^{11}B: $^{11}Be(b,p)$, $^{10}Be(p,p)$ and ($^{10}Be(d,n)^{11}B \rightarrow {}^{10}Be+p$)
- All show a strong spectroscopic factor of ~ 0.2-0.3
- Models with coupling to the continuum can reproduce these properties
- Still needed: precise branching ratios to decay, (gs and 1st excited state of 7Li) tritium decay
- Check by independent measurement of $^{11}Be(b,p)$ branching ratio

Thank you!

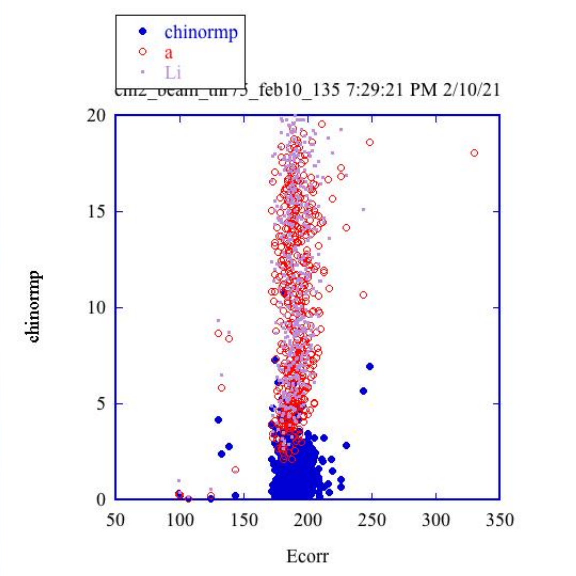
Particle identification: p,d,t,alpha and ^{7}Li



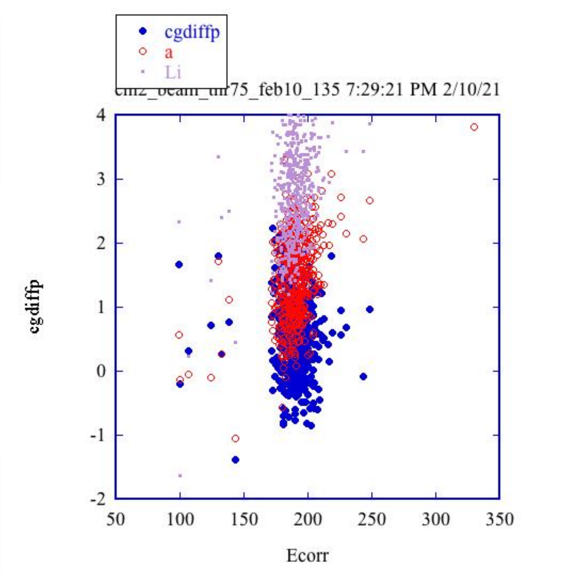
Criteria for proton event selection

- Proton beam events are used to assess the selection parameters.
- Chi2, center of gravity (shape of the pulse) and stretch factor.

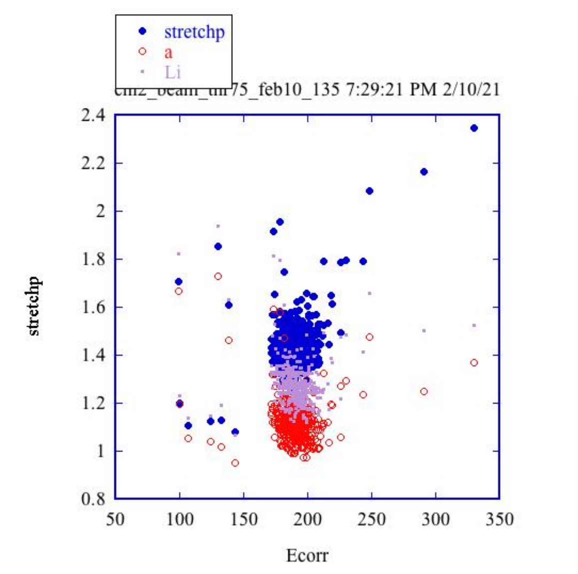
Chi2



Center of gravity

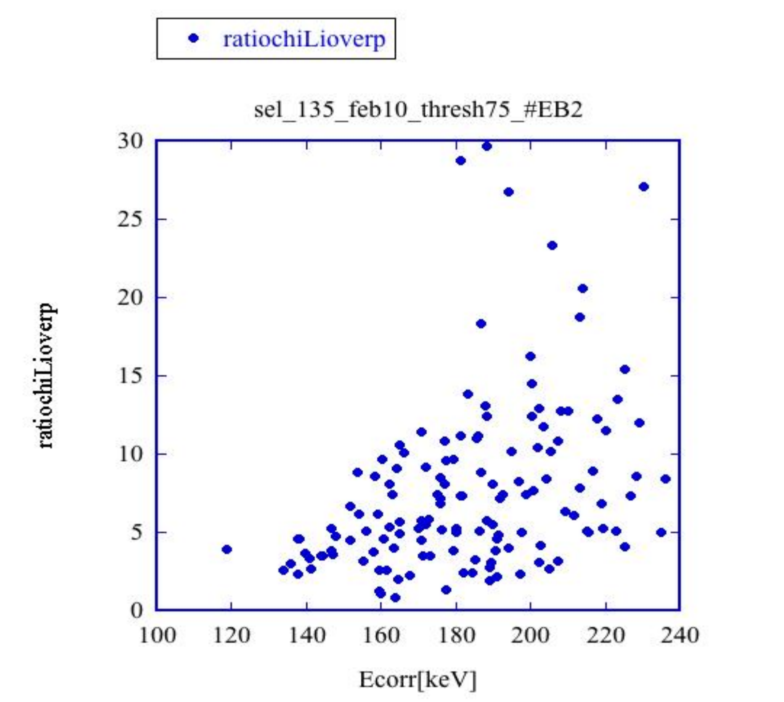


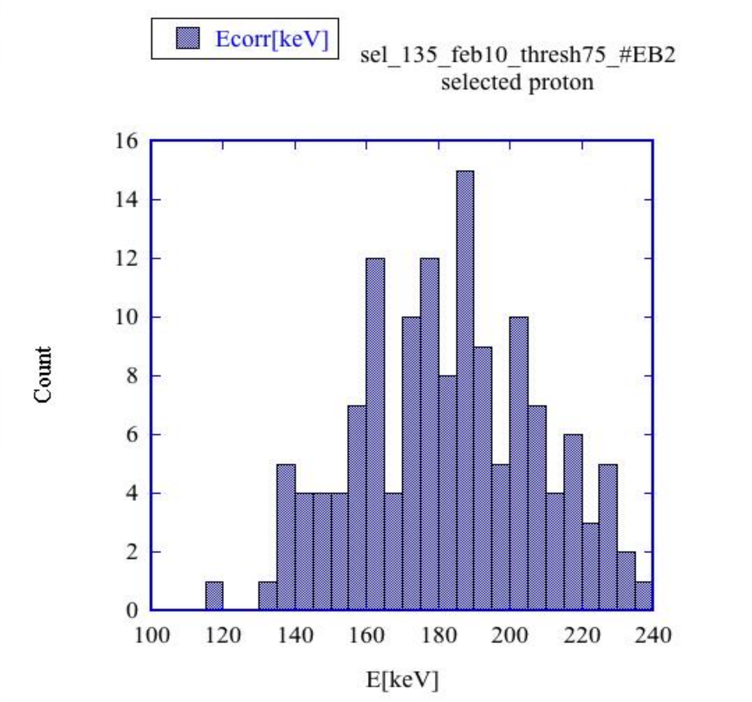
Stretch



Criteria for proton event selection

- Proton beam events are used to assess the selection parameters.
- Chi2, center of gravity (shape of the pulse) and stretch factor.
- This method is complementary to the one we used before: no selection in chi2.
- The energy distribution obtained in the last analysis is compatible with the published result.





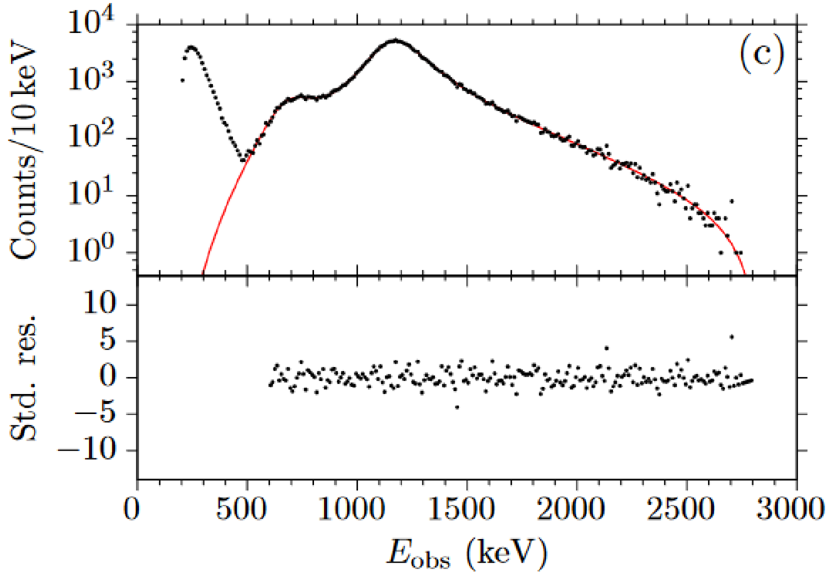
FONDO EUROPEO DE DESENVOLVEMENTO REXIONAL
“Unha maneira de facer Europa"

Clarification of large-strength transitions in the β decay of ^{11}Be

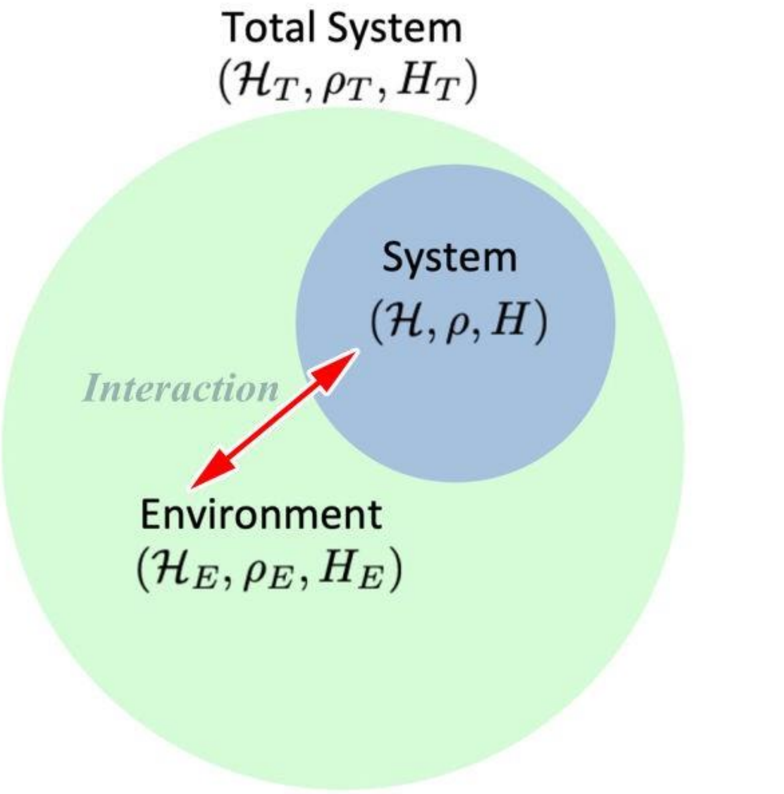
J. Refsgaard,[1,*] J. Büscher,[1] A. Arokiaraj,[1] H. O. U. Fynbo,[2] R. Raabe,[1] and K. Riisager[2]
[1]*Instituut voor Kern- en Stralingsfysica, KU Leuven, B-3000 Leuven, Belgium*
[2]*Institut for Fysik og Astronomi, Aarhus Universitet, DK-8000 Aarhus, Denmark*

(Received 6 November 2018; published 25 April 2019; corrected 7 May 2019)

The shape and normalization of the β-delayed α spectrum from ^{11}Be was measured by implanting ^{11}Be ions in a segmented Si detector. The spectrum is found to be dominated by a well-known transition to the $3/2^+$ state at $E_x = 9.87$ MeV in ^{11}B. A significant increase in the observed decay strength towards the higher end of the Q_β window means, however, that the 9.87 MeV state cannot alone be responsible for the transition. Using the R-matrix framework we find that the inclusion of an extra $3/2^+$ state at $E_x = 11.49(10)$ MeV is required to obtain a satisfactory description of the spectrum. Both states show large widths towards α decay, exhausting significant fractions of the Wigner limit, a typical signature of α clusterization. The observed Gamow-Teller strength indicates large overlaps between the two states and the ground state of ^{11}Be.



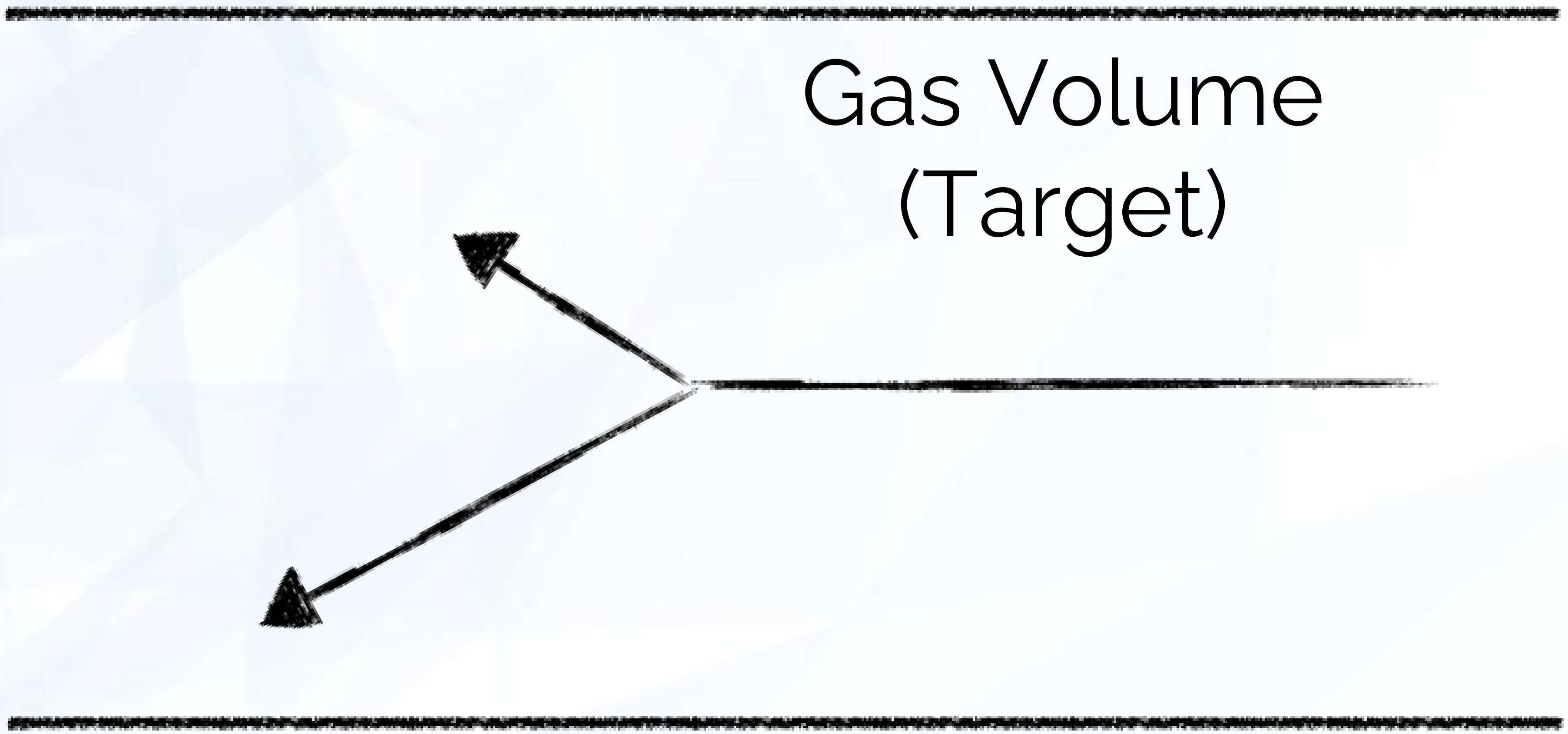
r_0 (fm)	1.4	1.5	1.6
a_c (fm)	4.90	5.25	5.60
E_1 (keV)	9850(1)	9848(1)	9846(1)
Γ_{11} (keV)	240(3)	237(3)	233(3)
Γ_{12} (keV)	21.3(3)	20.8(3)	20.4(3)
$B_1/\sqrt{N}$	0.265(5)	0.190(2)	0.161(2)
$[\theta_{11}^2]$	4.30(5)	1.99(3)	1.31(2)
$[\theta_{12}^2]$	3.19(5)	1.38(2)	0.84(2)
$[M_{\text{GT},1}]$	0.726(18)	0.722(13)	0.717(12)
$[B_{\text{GT},1}]$	0.326(16)	0.322(12)	0.318(11)
$[\log(ft)_1]$	4.067(49)	4.072(36)	4.078(33)
E_2 (keV)	11474(71)	11475(75)	11492(79)
Γ_{21} (keV)[a]	−361(163)	−388(157)	−431(145)
Γ_{22} (keV)	76(71)	66(68)	47(59)
$B_2/\sqrt{N}$	0.181(34)	0.166(29)	0.156(26)
$[\theta_{21}^2]$[a]	−0.18(8)	−0.19(8)	−0.21(7)
$[\theta_{22}^2]$	0.049(45)	0.041(43)	0.029(37)
$[M_{\text{GT},2}]$	1.21(23)	1.11(19)	1.05(17)
$[B_{\text{GT},2}]$	0.90(35)	0.77(26)	0.67(22)
$[\log(ft)_2]$	3.63(39)	3.70(34)	3.75(33)
$\mu a_c^2/\hbar^2$ (keV)	683.2	595.1	523.0
χ_L^2	269.42	269.30	269.33



A total system (belonging to a Hilbert space $\mathcal{H}_T$, with states described by density matrices ρ_T, and with dynamics determined by a Hamiltonian H_T) divided into the system of interest, "system," and the environment.

An open quantum system is a quantum system interacting with its Environment which is sometimes called Bath or Reservoir, In reality every system is open and an isolated quantum system is an idealization and consequently our famous Schrodinger equation is also idealization for only closed quantum systems.

- Quantum optics
- Quantum information processing
- Quantum computing
- Quantum biology
- Quantum Chemistry
- Relativistic quantum mechanics
- Quantum cryptography
- Quantum Thermodynamics
- Foundations of quantum mechanics


Gas Volume
(Target)

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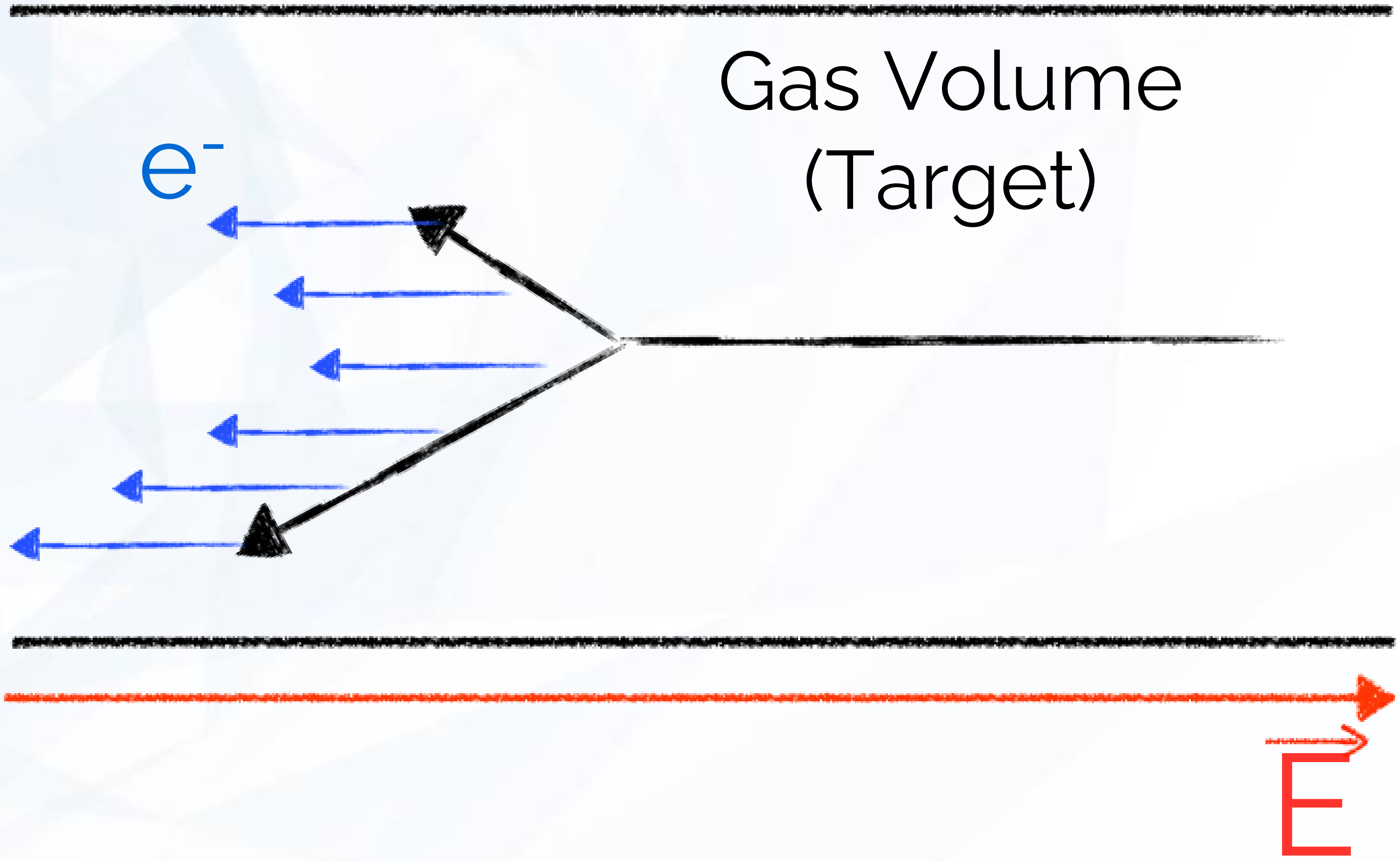
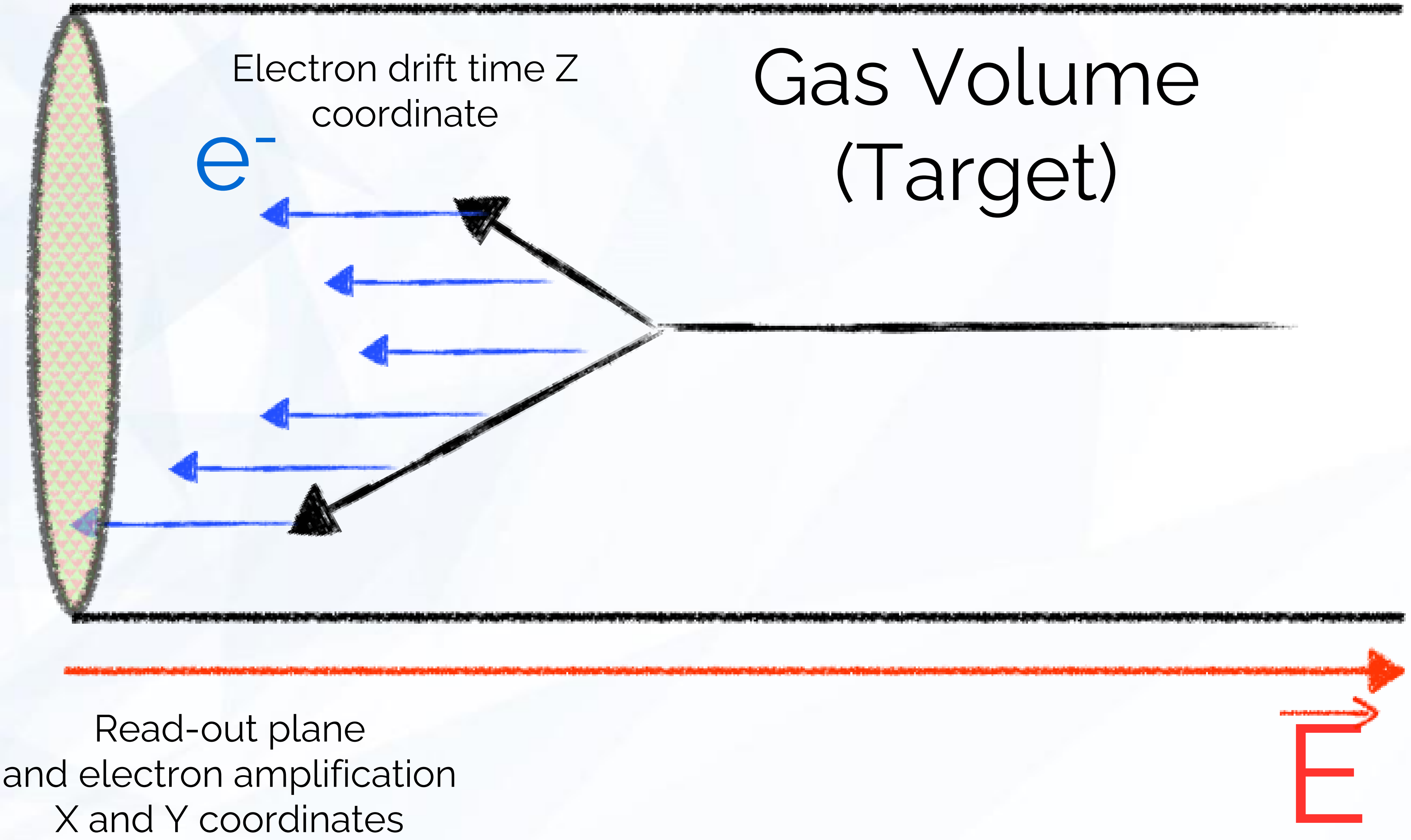
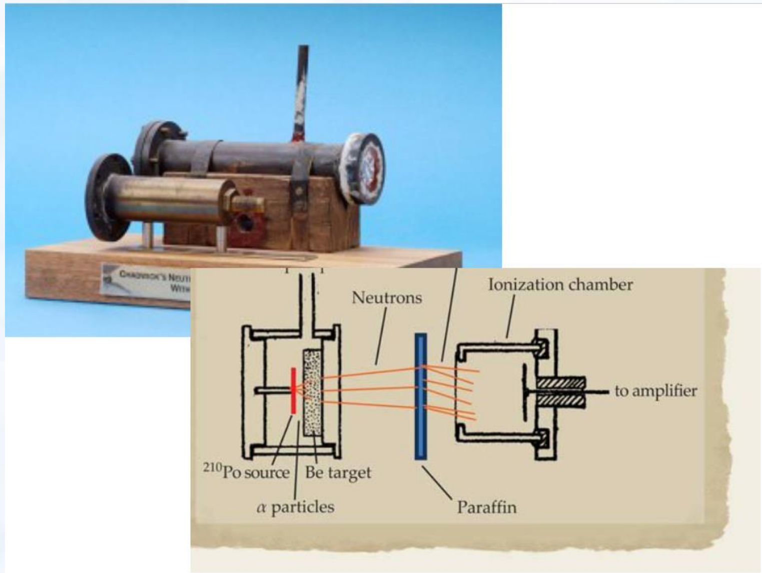
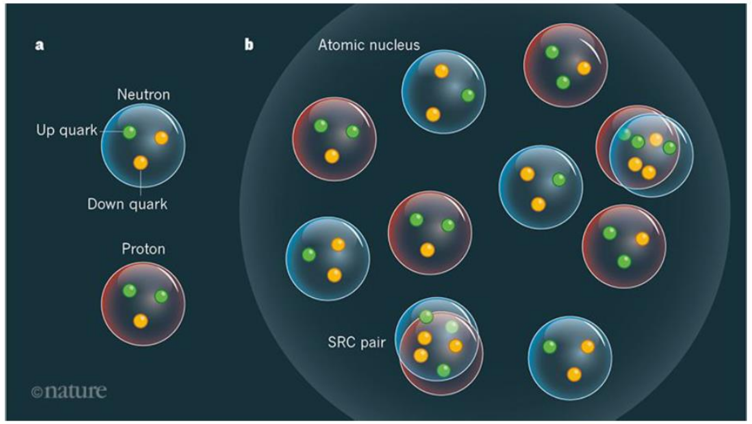


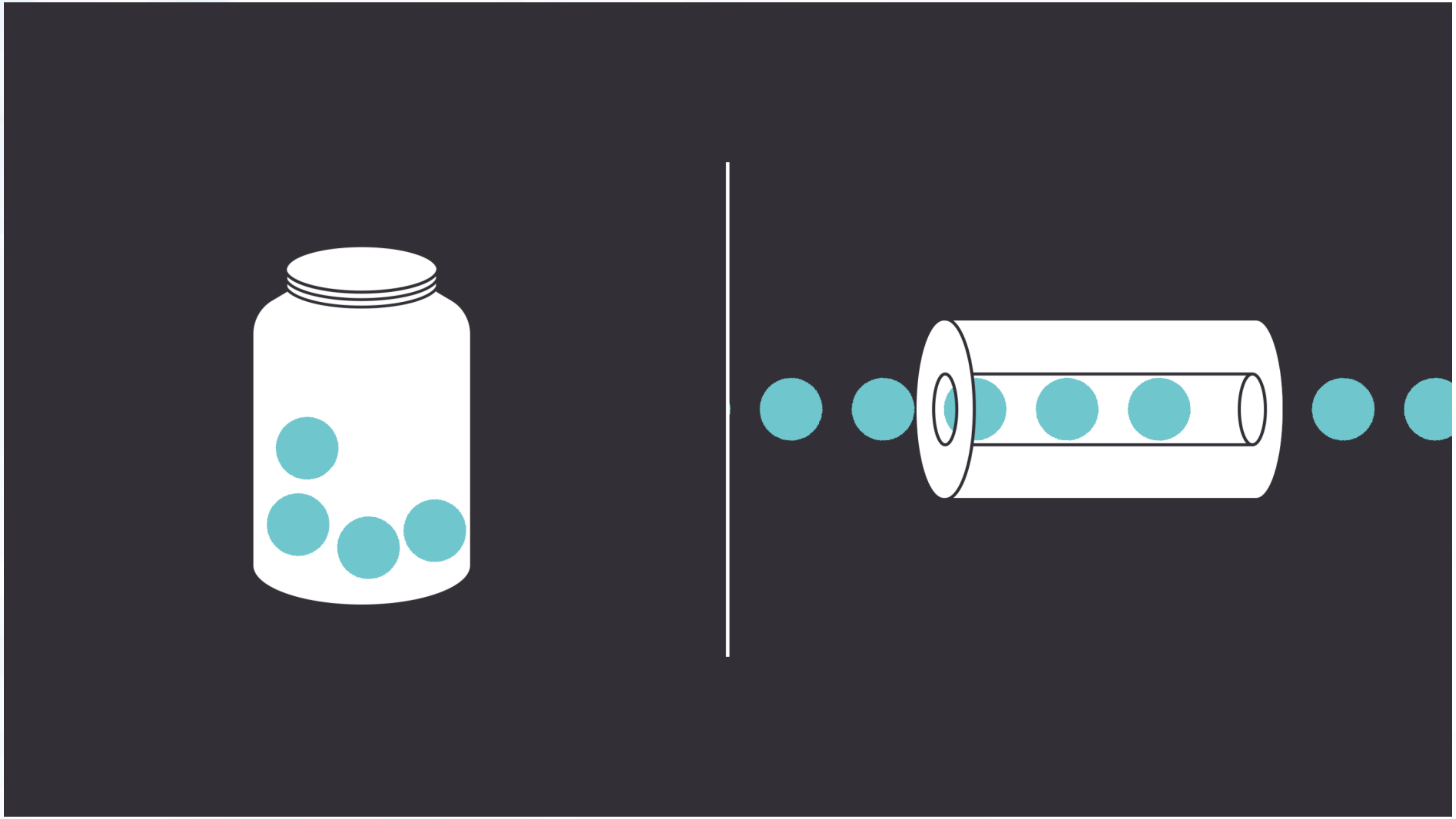

Electron drift time Z coordinate
Gas Volume (Target)
e-
Read-out plane
and electron amplification
X and Y coordinates
E



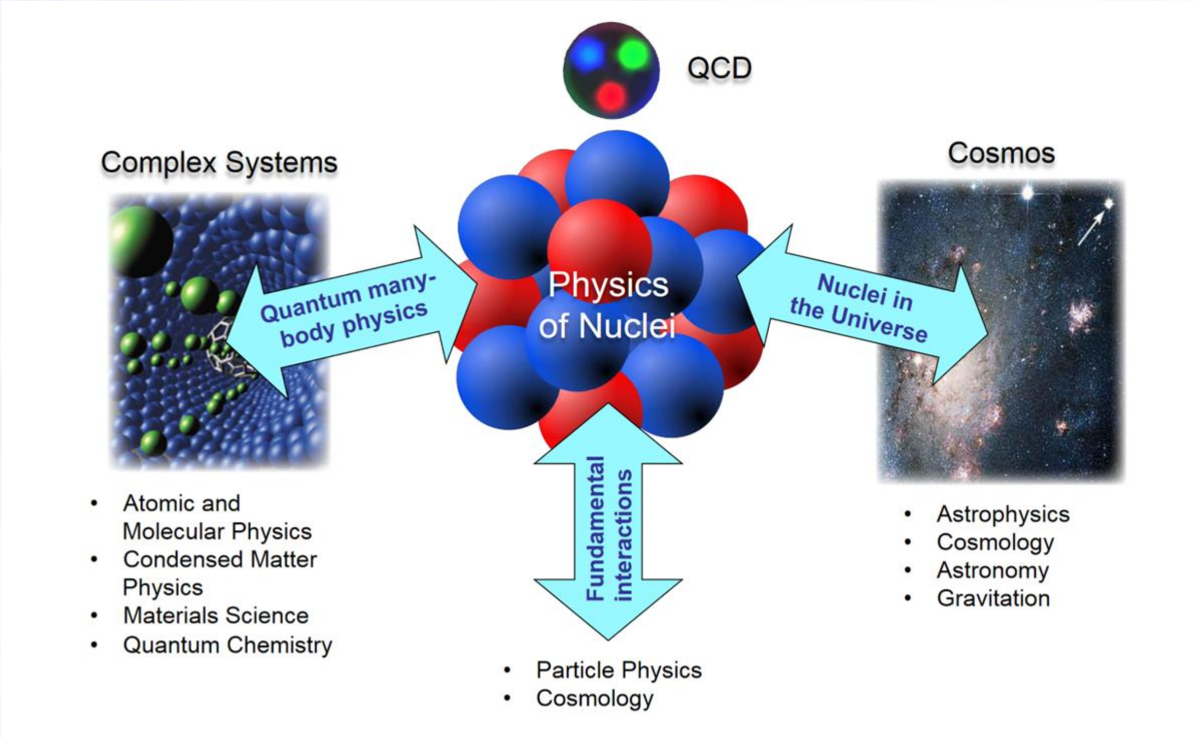


Nature 566, 332-333 (2019)

- Discovered in 1932 by James Chadwick.
- Neutrons have non-zero magnetic moment. And possible electric dipole moment (nEDM 3.0×10^{-26} e·cm).
- Neutron structure is modified when embedded inside a nucleus: Short range correlations, n-n and n-p cooper pairs, condensates, giant pairing vibration…
- Neutrons can exist in a quasi-free mode inside the nucleus: neutron halo.
- Free neutrons decay into protons through beta decay. Lifetime measured 70 years ago: 14 min 39 s. But the value depends on the method…

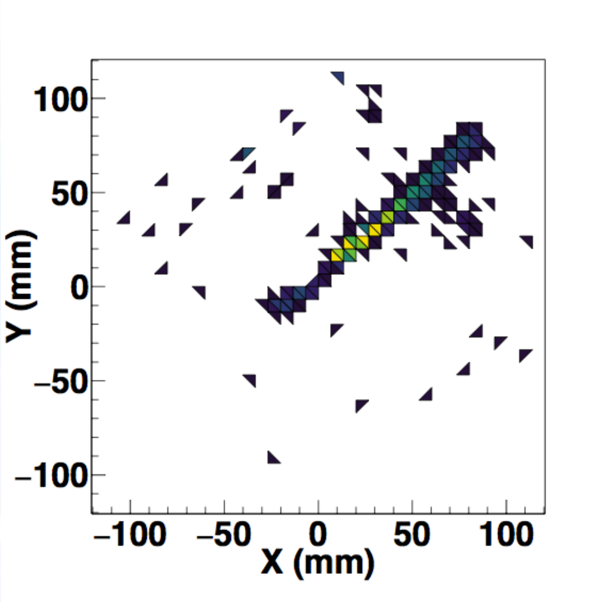


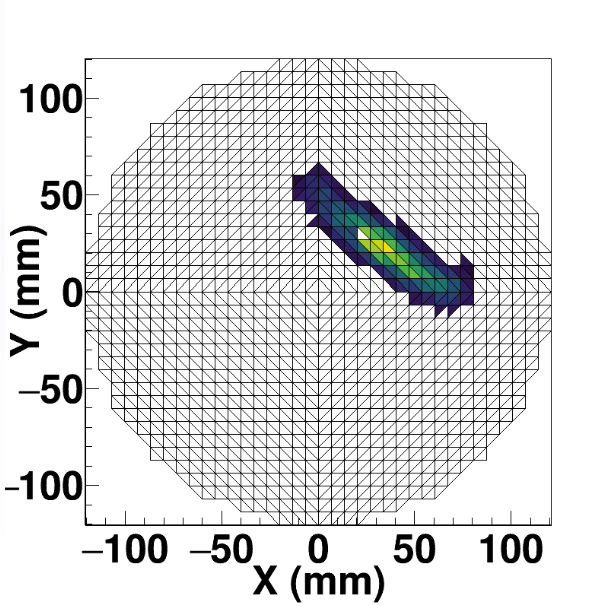
(Quantum) Physics research crossroads

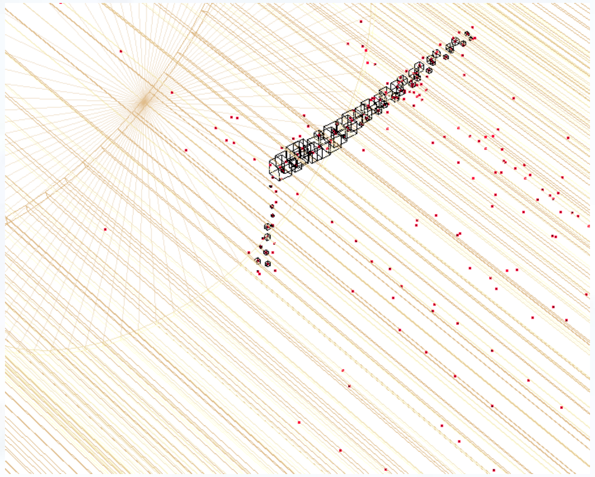


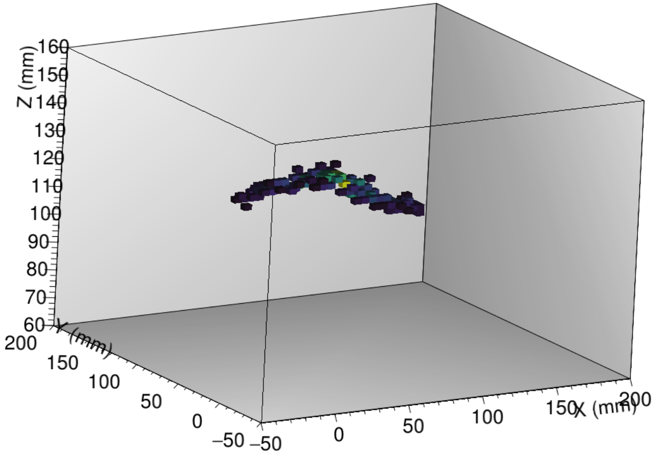
W. Nazarewicz, J. Phys. G43, 044002 (2016)

- Strongly coupled super fluid systems.
- Phase-transitional behavior.
- Spectral fluctuations and statistics.
- Properties of open quantum systems.
- Clustering.
- Studies of neutron-rich matter as in neutron stars and supernova.
- Nuclear matrix elements for fundamental symmetry tests in nuclei and for neutrino physics.

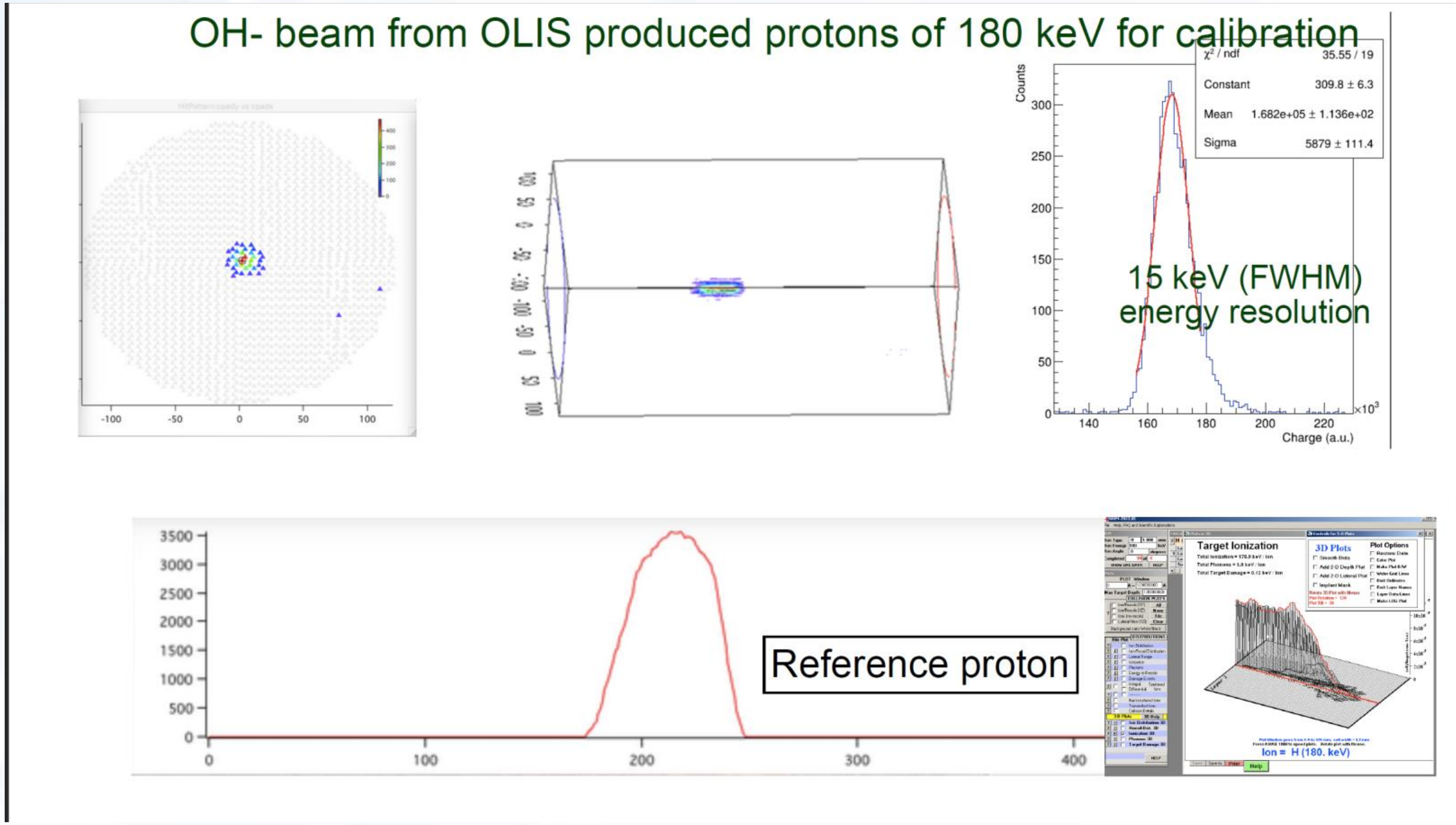

Y (mm)
X (mm)
100
50
0
−50
−100

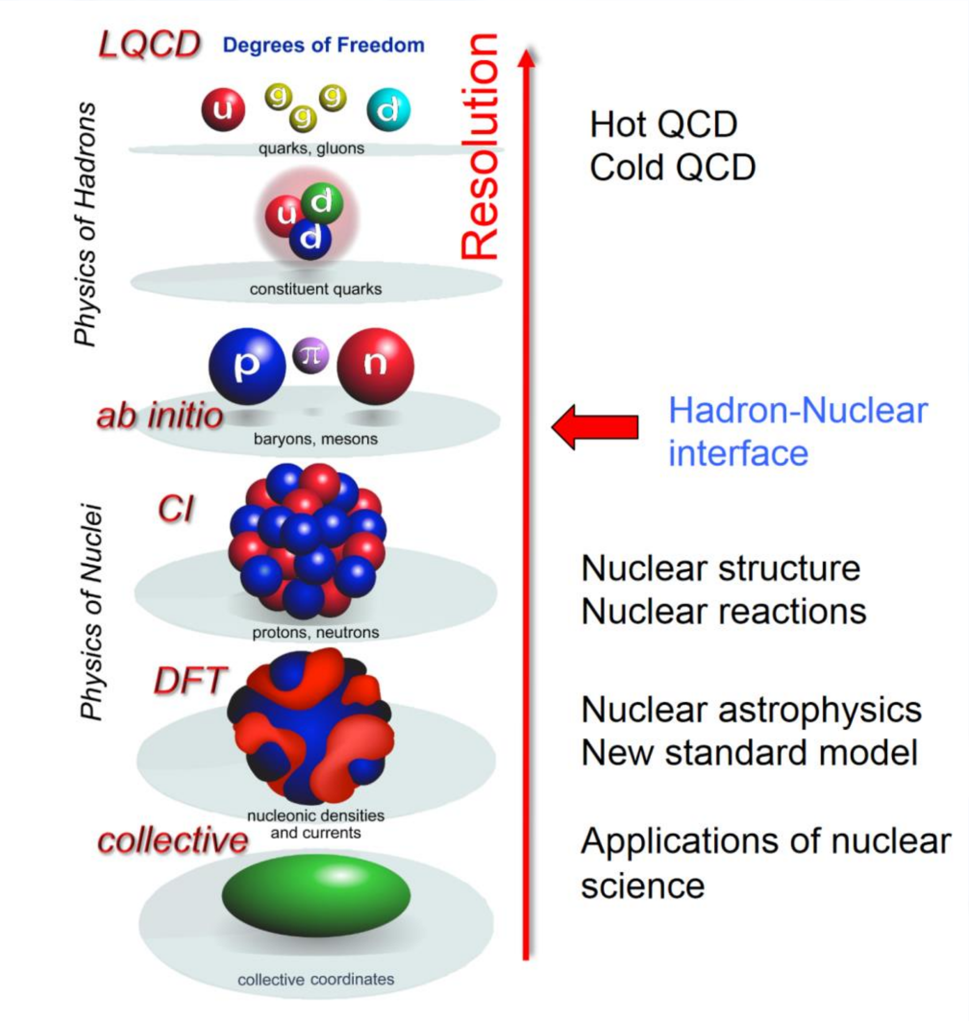

Y (mm)
X (mm)
100
50
0
−50
−100




Z (mm)
Y (mm)
X (mm)

Proton beam calibration





- Degrees of freedom that atomic nuclei are made of depend on the energy of the experimental probe and the distance scale.
- Quantum chromodynamics building blocks: quarks and gluons, lurking inside mesons and baryons.
- Low-energy nuclear physics experiments, nuclei can be well described in terms of individual protons and neutrons, their densities and currents, collective coordinates (rotations and vibrations of the nucleus).
- Major theoretical approaches to the nuclear many-body problem: Lattice QCD, ab-initio models, configuration interaction techniques, nuclear Density Functional Theory, and collective model)…


Please

Criticisms

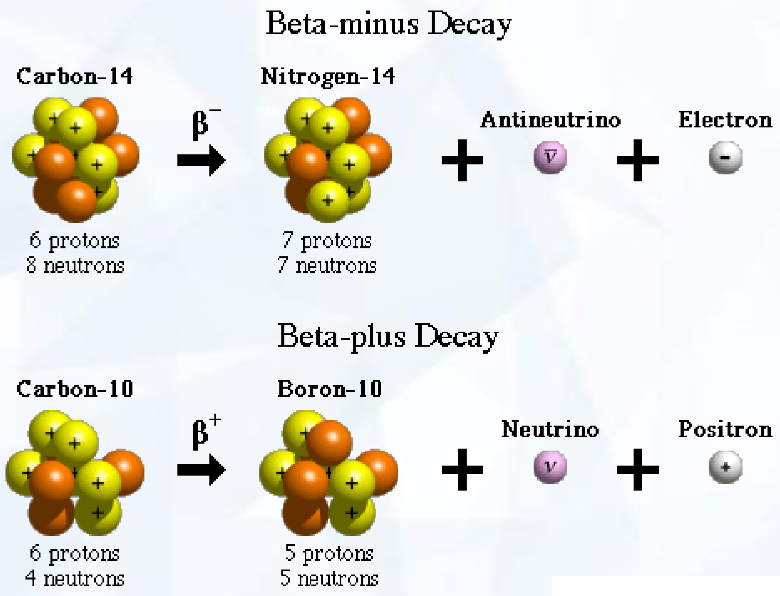
Comment on "Direct Observation of Proton Emission in ^{11}Be"

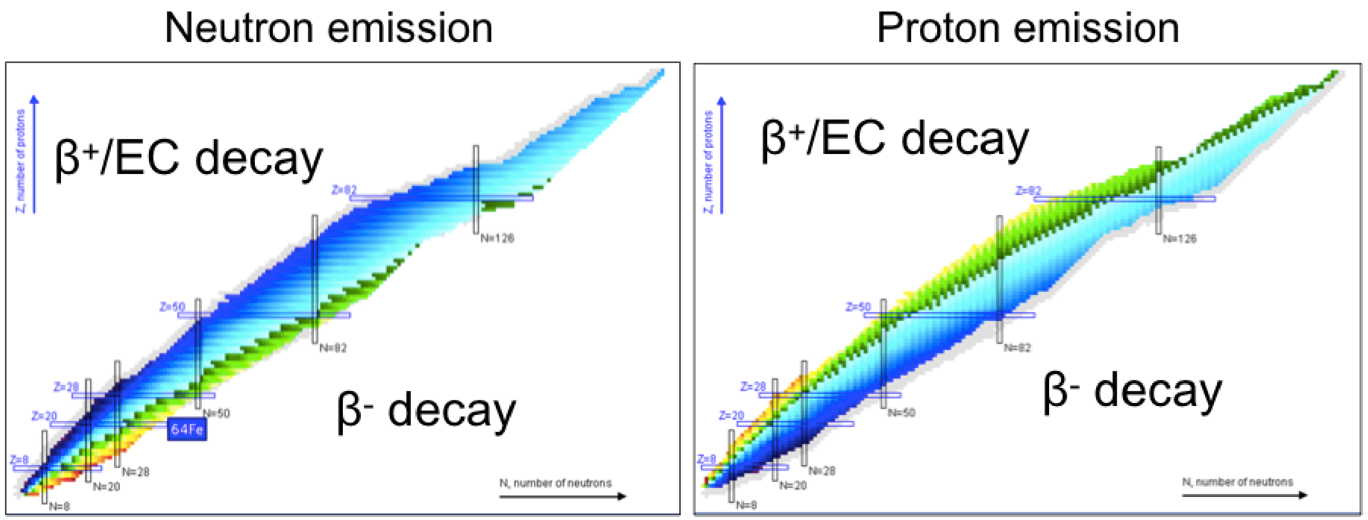
H.O.U. Fynbo,[1] Z. Janas,[2] C. Mazzocchi,[2] M. Pfützner,[2,*] J. Refsgaard,[3,4] K. Riisager,[1] and N. Sokołowska[2]

[1] *Institut for Fysik og Astronomi, Aarhus Universitet, DK-8000 Aarhus, Denmark*
[2] *Faculty of Physics, University of Warsaw, 02-093 Warszawa, Poland*
[3] *Department of Astronomy and Physics, Saint Mary's University, Halifax, Nova Scotia, B3H 3C3 Canada*
[4] *TRIUMF, 4004 Wesbrook Mall, Vancouver BC, V6T 2A3 Canada*

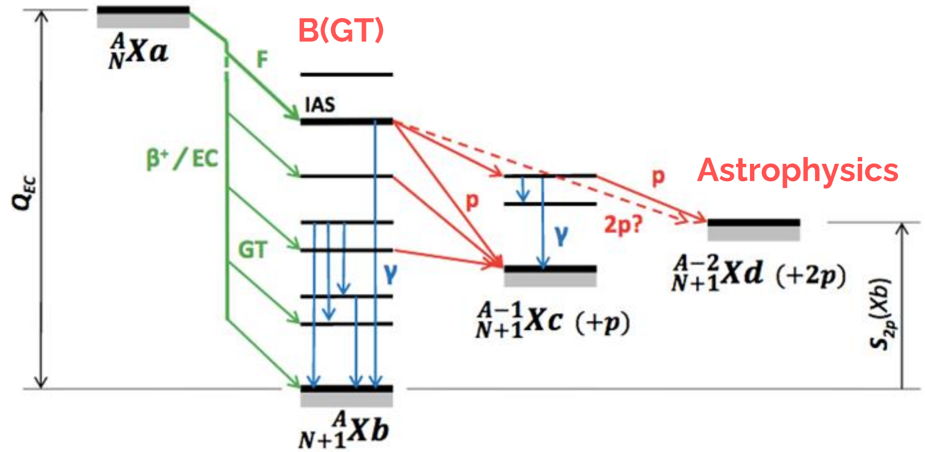
We argue that conclusions of [PRL 123, 082501 (2019)] are incorrect. The authors present the direct observation of beta-delayed proton emission in the beta decay of ^{11}Be. From the determined branching ratio for this process and from the energy spectrum of emitted protons the existence of a so far unobserved narrow resonance in ^{11}B was deduced. The given beta strength for the transition to this state is however wrong. In addition, we show that the combination of peak position and branching ratio is in strong disagreement with models considered by the authors. Furthermore, we identify several deficiencies in the analysis, and we provide possible sources of background, that could explain the error.

- No reliable particle identification.
- B(GT)>3 (above free single nucleon decay limit).





Isobaric Multiplet Mass Eqation



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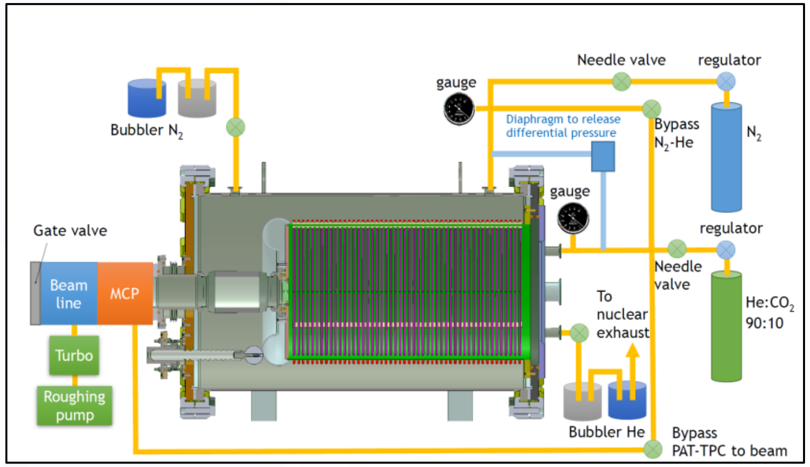
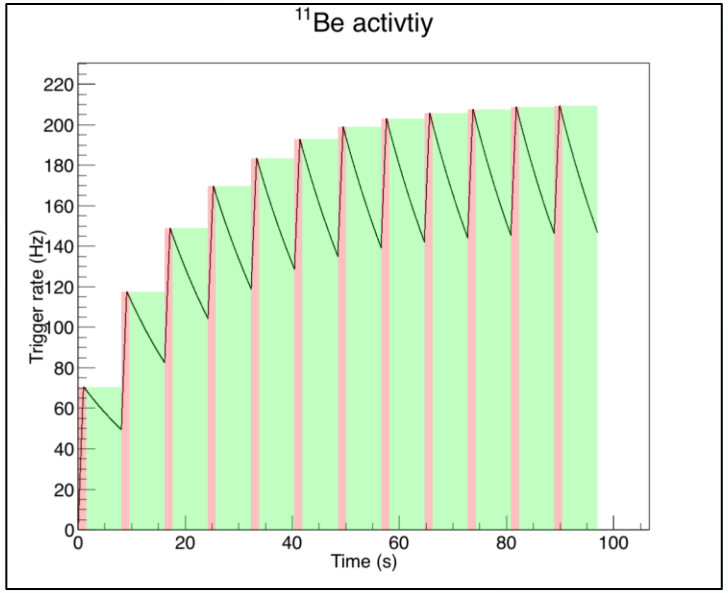
Experimental method: Experiment at ISAC (TRIUMF)

- Implant-decay on the pAT-TPC: High detection efficiency (80%) and resolution (σ(E)~5%, (σ(θ)=1 deg)
- Full reconstruction and identification of p+ and α.
- He(+10% CO_2) as thin tracking medium: low straggling and β-blind.
- The pAT-TPC was filled with 60 torr of He(+10% CO_2)
- Beam energy of 390 keV/u deposited ^{11}Be at the center
- ^{11}Be ions drifted to the cathode
- Protons of ~180 keV stopped in 10 cm tracks
- Normalization ^{11}Be -> ^{7}Li + α, 3.47(1)%
- Experiment run in pulsed mode 1 sec implantation, 0.5 sec relaxation, 6.88 sec decay
- It was optimized for a peak activity of 200 α pps, to minimize dead time
- We run for 4.33 days or 13 8-hour shift





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Regular Article - Experimental Physics

Search for beta-delayed proton emission from ^{11}Be

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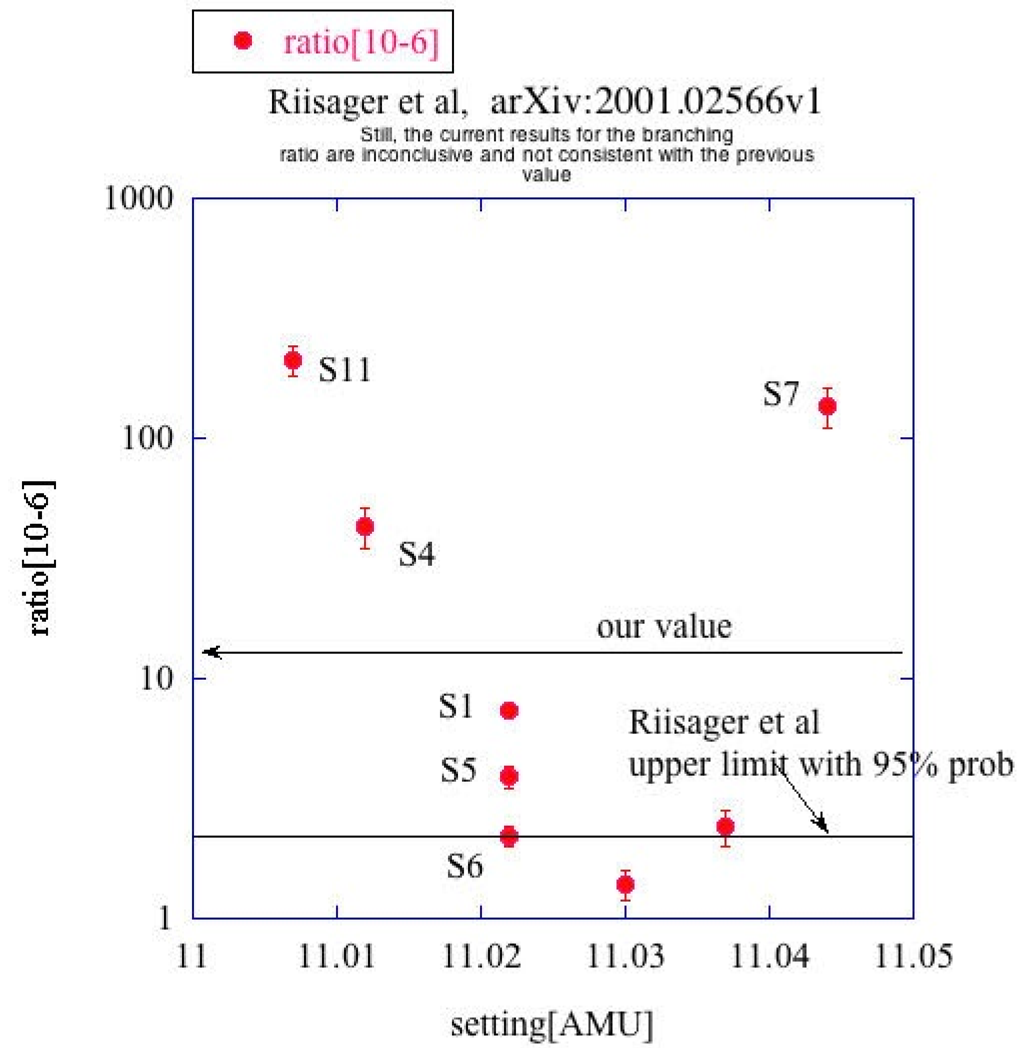

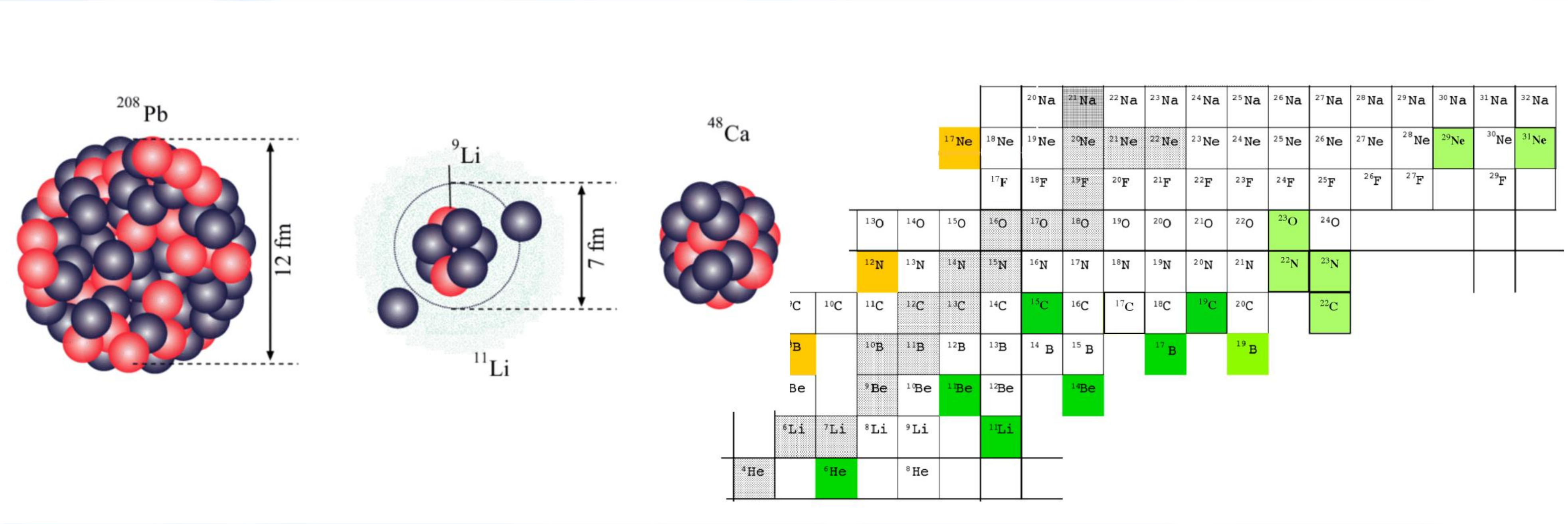

- The halo is a long tail in the density distribution of a nucleus.
- An important concept of a halo is the decoupling of the halo wave function from the core of the nucleus.
- Very weak binding of the last one or two valence nucleons (usually neutrons).
- Single-particle behavior.