Electromagnetic Excitation of Neutron-Rich Nuclei

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For LAND-FRS@GSI collaboration

- Light neutron-rich nuclei (Be,C,N,O,F)

  S188, S233

- Nuclei near N=82,Z=50

  S221

Dipole response of neutron rich nuclei

Threshold strength in halo nuclei ✓

Strong fragmentation of GDR strength ✓

Appearance of low-lying strength ✓

New collective soft dipole mode ?

Deformation effect on strength distribution ?

Isospin dependance of NN effective force
Single-particle structure
Astrophysical implications

Exploring Ground State Configurations by Coulomb Breakup

	J^{π}	S_n (MeV)	Spectroscopic factors
^{11}Be	$1/2^+$	0.50	Knockout, Transfer
^{15}C†	$1/2^+$	1.21	Knockout
^{17}C†	$3/2^+$!, $5/2^+$!	0.73	Knockout
^{17}O	$5/2^+$	4.14	Transfer,Electron scat.
^{19}O	$5/2^+$	3.96	Transfer
^{21}O	$5/2^+$	3.81	Multi-nucleon transfer
^{23}O	$1/2^+$?,$5/2^+$?	2.74	Knockout

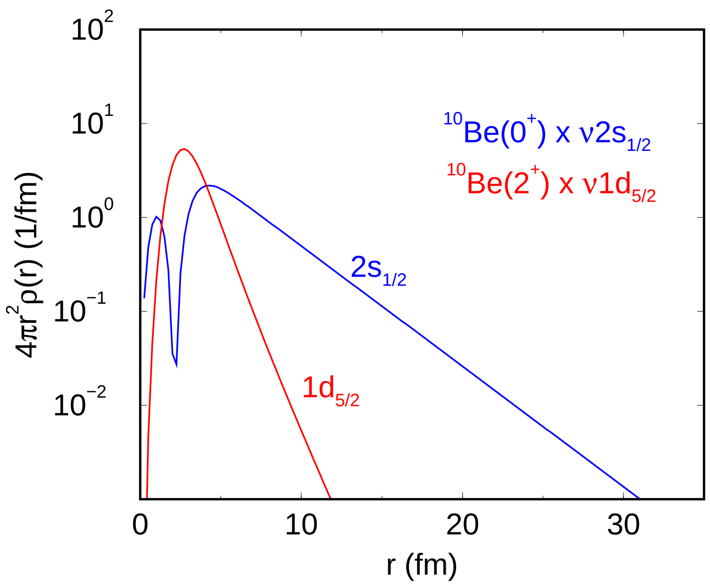
† U. Datta Pramanik *et al.* Phys. Lett. B551 (2003) 63.

Ground state configuration by Coulomb Breakup

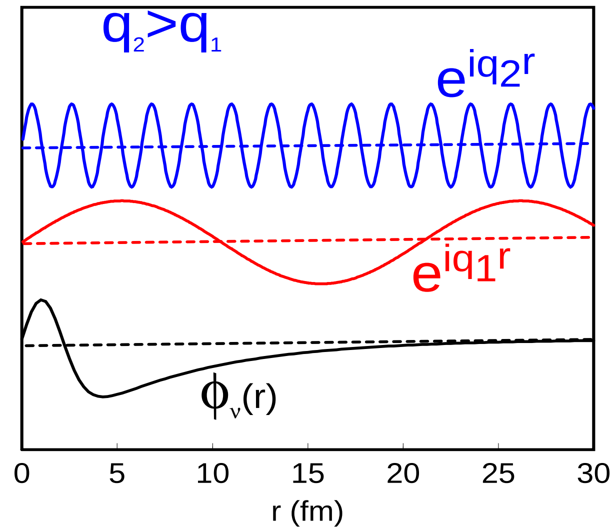
$$\frac{d\sigma}{dE^*} = \frac{16\pi^3}{9\hbar c} N_{E1}(E^*) \sum_{nlj} CS^2(I_c^\pi, nlj) \sum_m \left| \left\langle q \left| \frac{Ze}{A} r Y_m^1 \right| \varphi_{nlj}(\vec{r}) \right\rangle \right|^2$$

e.g., ^{11}Be=$\sqrt{S(0^+)}\ |^{10}\mathrm{Be}(0^+) \otimes \nu 2s_{1/2}>$ + $\sqrt{S(2^+)}\ |^{10}\mathrm{Be}(2^+) \otimes \nu 1d_{5/2}>$ +…

Why sensitive to tail?



Why low-lying strength?



γ-ray coincidence identifies core state

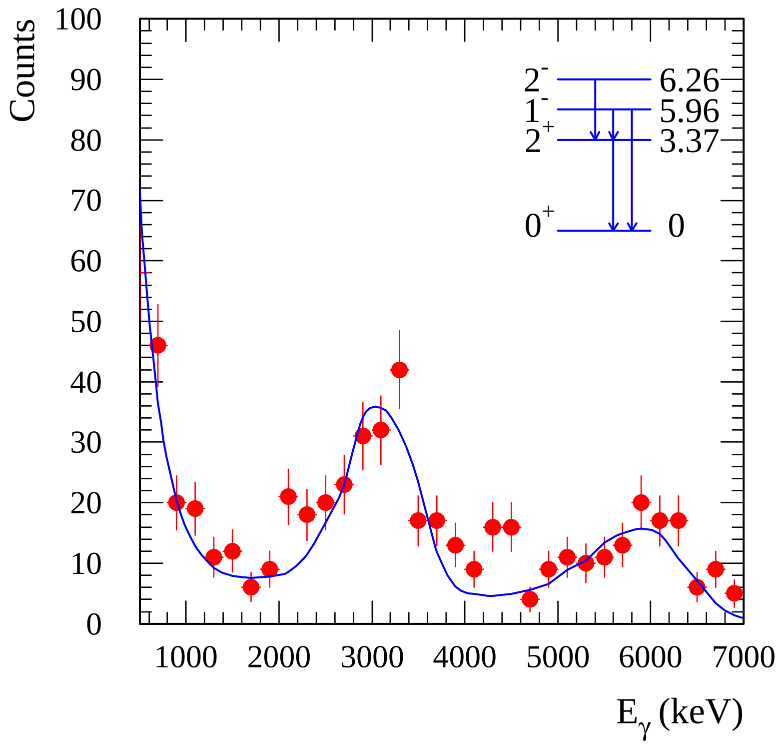
Shape of differential cross section gives l

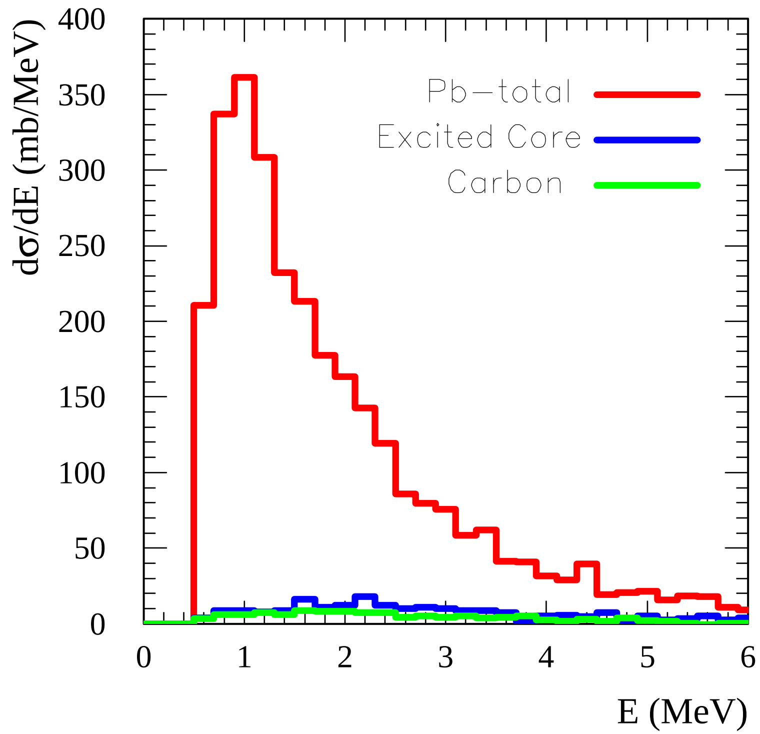
Cross section gives spectroscopic factor

Breakup of classic one neutron halo: ^{11}Be

$^{11}Be = \sqrt{S(0^+)}\,|^{10}Be(0^+) \otimes \nu 2s_{1/2}\rangle + \sqrt{S(2^+)}\,|^{10}Be(2^+) \otimes \nu 1d_{5/2}\rangle + \ldots$

$^{208}Pb(^{11}Be, ^{10}Be+n+\gamma)X$





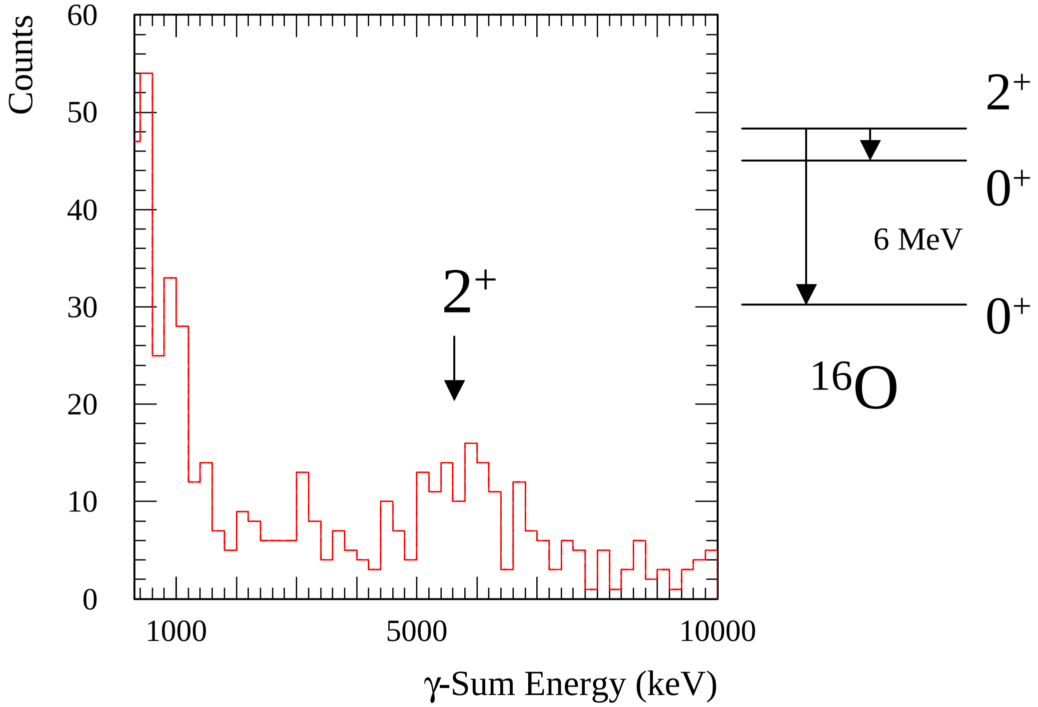
Excited state contribution from γ-coincidence

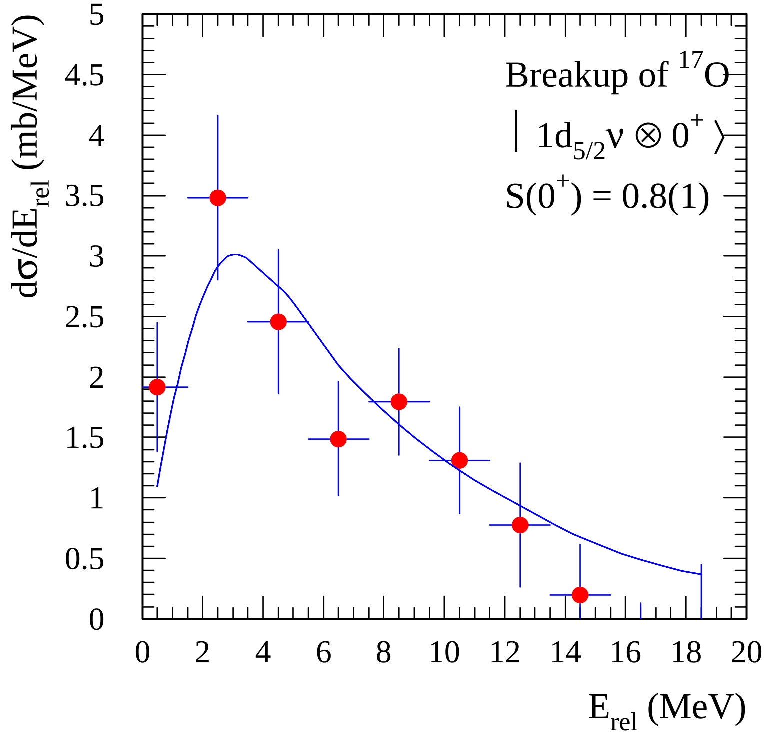
Nuclear contribution from Carbon target

Total–excited state–Scaling factor *(Carbon) ⇨ Ground state

Coulomb breakup of ^{17}O: Test of breakup model

^{208}Pb(^{17}O,^{16}O+n+γ)X





Transfer reaction and magnetic electron scattering gives $S(0^+)=1.04\pm0.10$

S. Burzynski et al. Nucl. Phys. A399(1983) 230

However, a small contribution is also present from excited core states

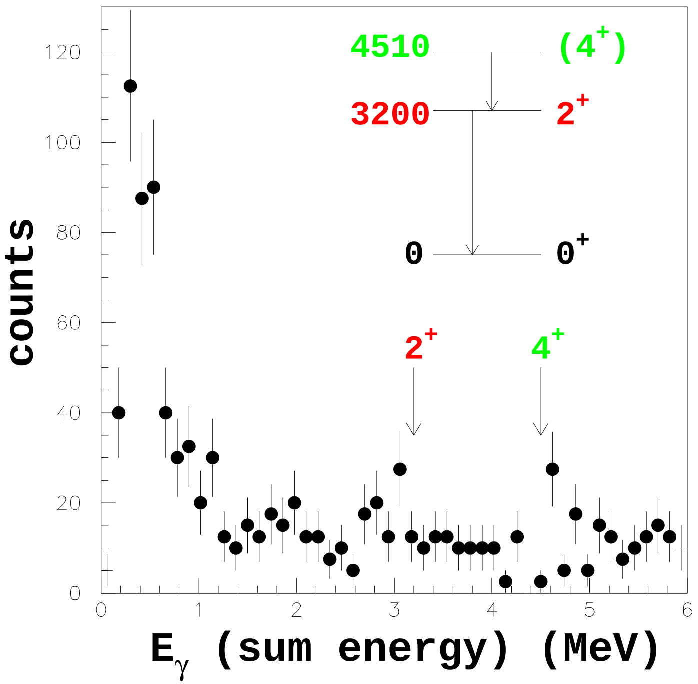
H.T. Fortune et al. PRL 41 (1978) 527

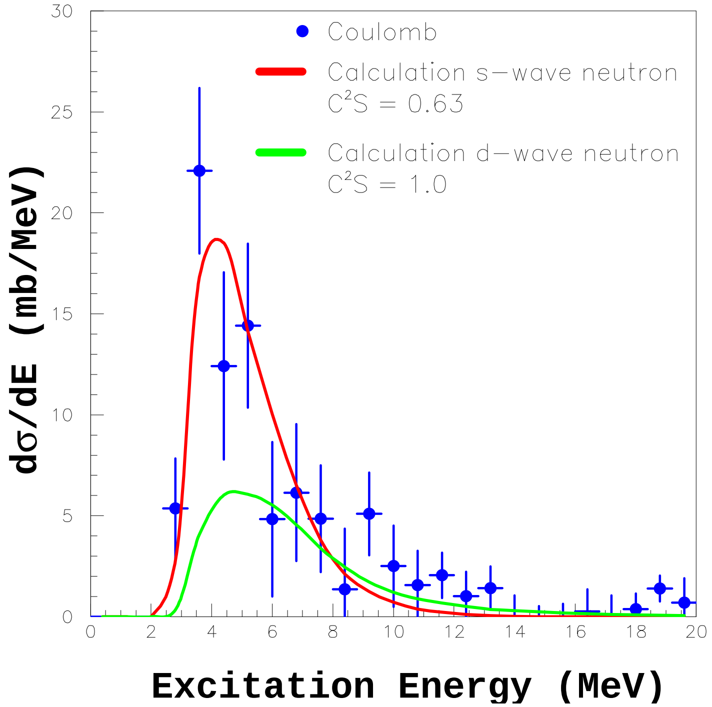
^{23}O: Candidate for 1n halo?

Preliminary results

K.L. Jones *et al.*

^{208}Pb(^{23}O,^{22}O+n+γ)X





At most, 25% ^{23}O ⇨ ^{22}O in excited state

Ground state $J^{\pi} = 1/2^{+}$

Spectroscopic factor: $^{22}\mathrm{O}(0^{+}) \otimes \nu 2s_{1/2} = 0.63$

In conflict with Kanungo *et al.*, RIKEN preprint ⇨ $(s_{1/2})^2 d_{5/2}$

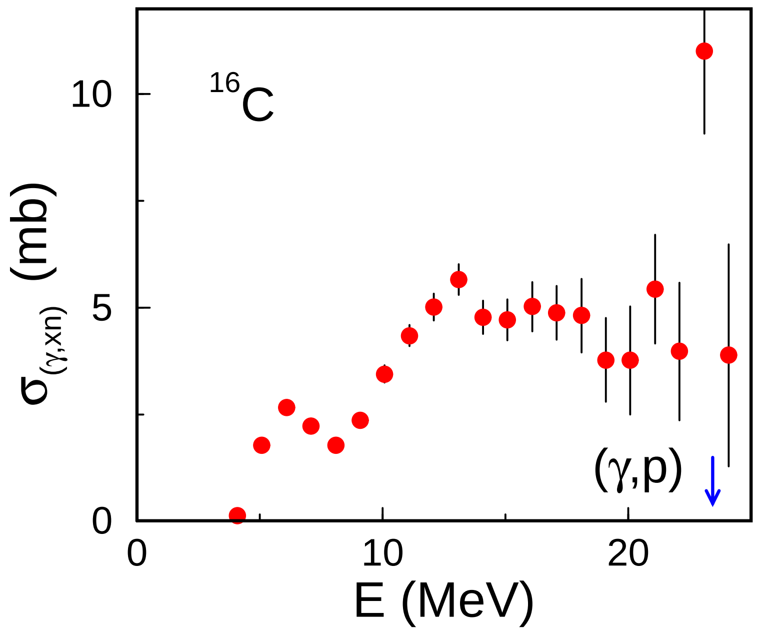
Dipole strength distribution of n-rich nuclei

^{16}C (550 MeV/u) +Pb $\rightarrow$ $^{16\text{-}x}C+\gamma+x n$

⇨ Photo-neutron cross sections

Low-lying dipole strength

Preliminary



Large deformation of
n-rich C isotopes will have
interesting effect on
strength distribution

n-rich O isotopes

A. Leistenschneider et al, PRL 86 (2001) 5442.

Electromagnetic excitation of heavier neutron-rich beams produced via uranium fission

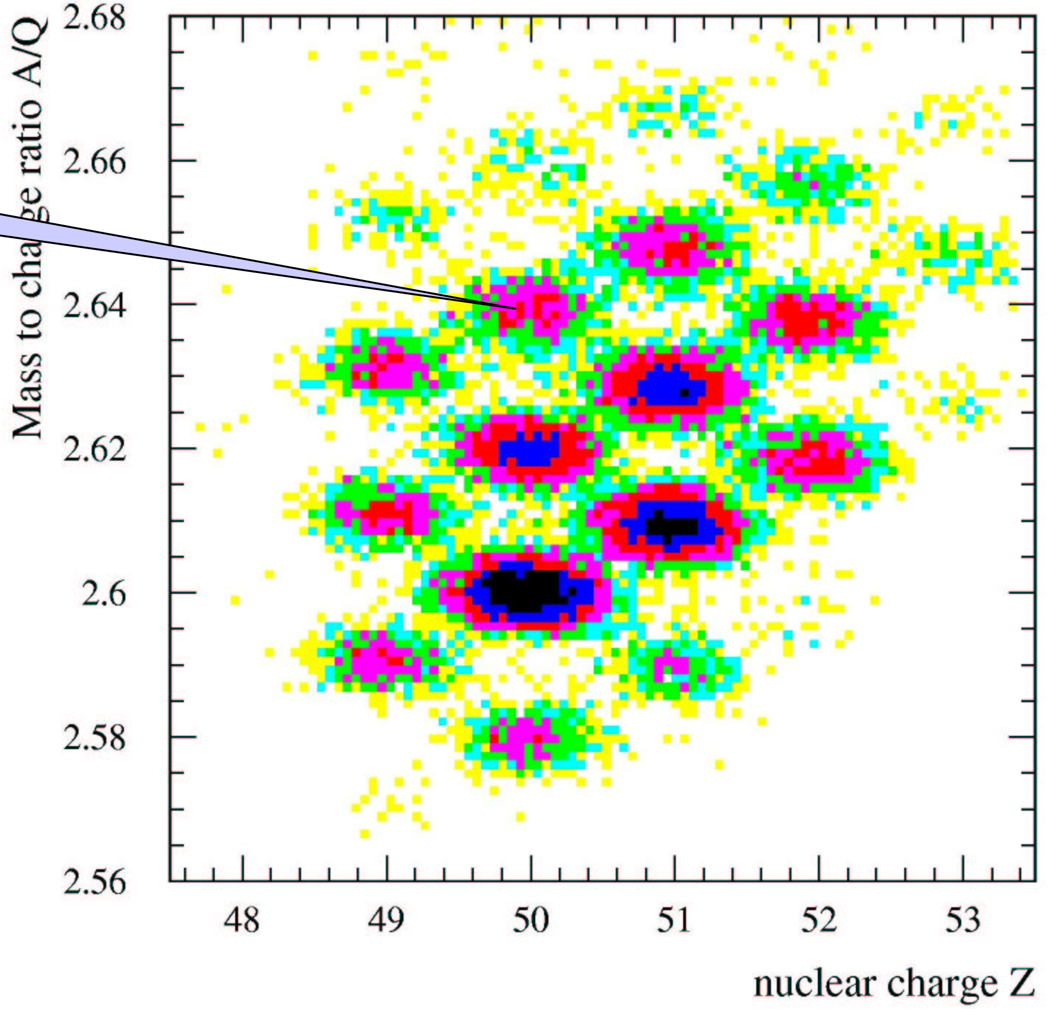
Aim: Measurement of the

giant dipole strength

near ^{132}Sn

S221, October 2002

Very Preliminary!!!



Summary

- Dipole strength distribution in n-rich C, N and O isotopes
- Ground state configuration
  - ^{11}Be has major contribution from ^{10}Be$(0^+)\otimes\nu 2s_{1/2}$
  - ^{17}O $\Rightarrow$ ^{16}O $(0^+) \otimes \nu 1d_{5/2}$
  - ^{19}O ground state has large core excitation contribution
  - ^{21}O $\Rightarrow$ ^{20}O$(0^+)\otimes\nu 1d_{5/2}$ and ^{20}O$(4^+)\otimes\nu 1d_{5/2}$
  - ^{23}O $\Rightarrow$ ^{22}O$(0^+)\otimes\nu 2s_{1/2}$