Coulomb Excitation measurements of Radioactive Ions

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Outline

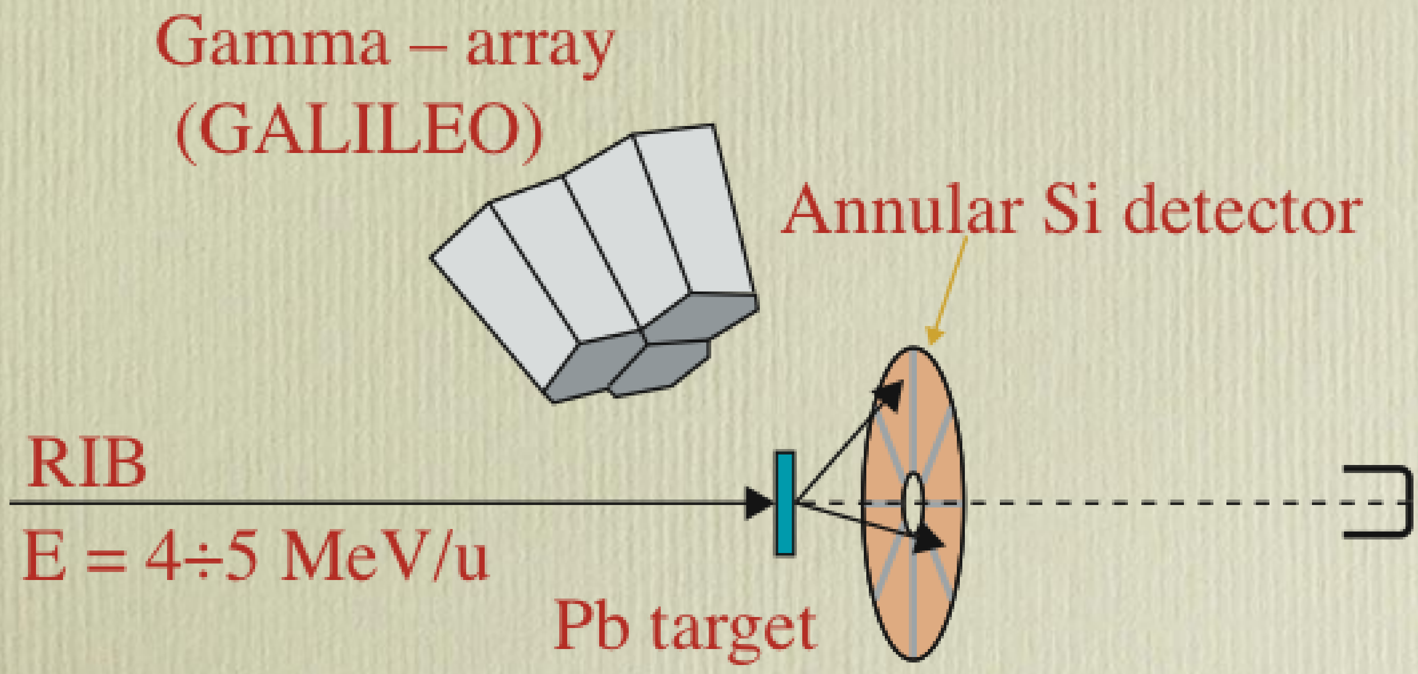
• Short description of the apparatus we are setting up for Coulomb excitation measurements

• Coulomb excitation measurements in the region N ≥82 Z ≥50

• GOSIA calculation results for ^{134}Sn, ^{136}Te, ^{146}Ba and $^{140,142}Xe$

Coulex measurements with RIBs

Coulomb excitation measurements in inverse kinematics :
projectile nuclei are scattered on a heavy target and detected at forward angles to provide a clean trigger for selecting gamma rays

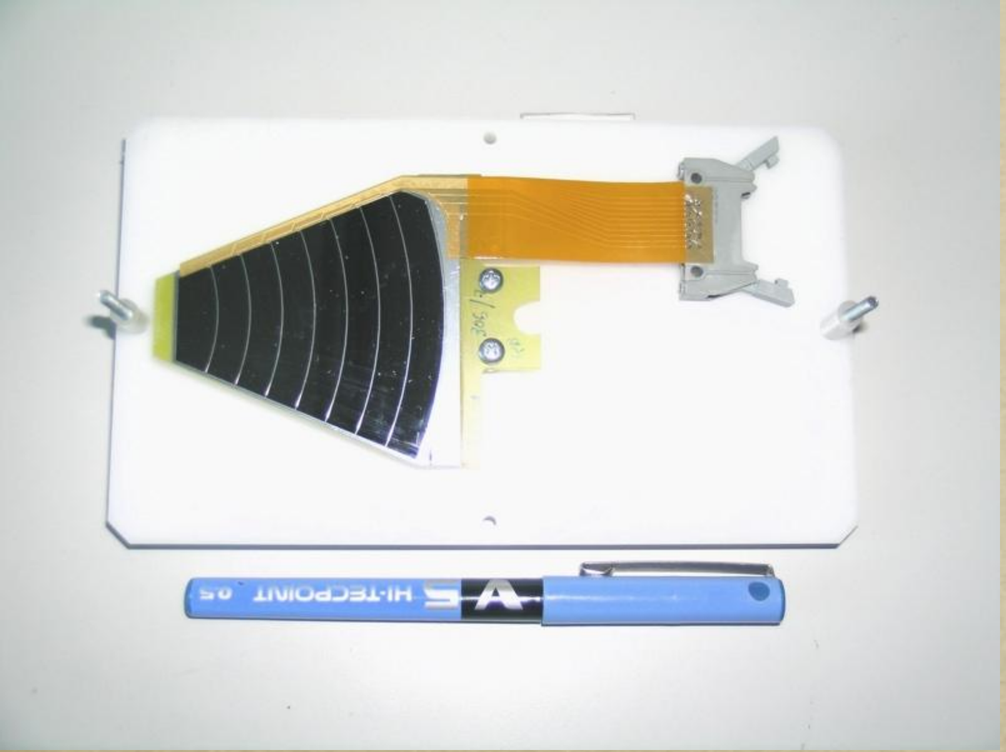


What is needed:

- beam intensity ≥ 10^5 p/s and energy ~ 4 - 5 MeV/A
- an array of gamma detectors, we assume ε_γ ~ 10% @ 1 MeV (Galileo?)
- a detector for ions to determine the energy and the scattered angle of the projectile

Apparatus for particle detection

- a pie of 8 sectors of Si Strip detectors (2-nd stage of the RCo device already used coupled with Garfield)
- the reaction chamber housing the target and the Si Strip Detector
- dedicated electronics



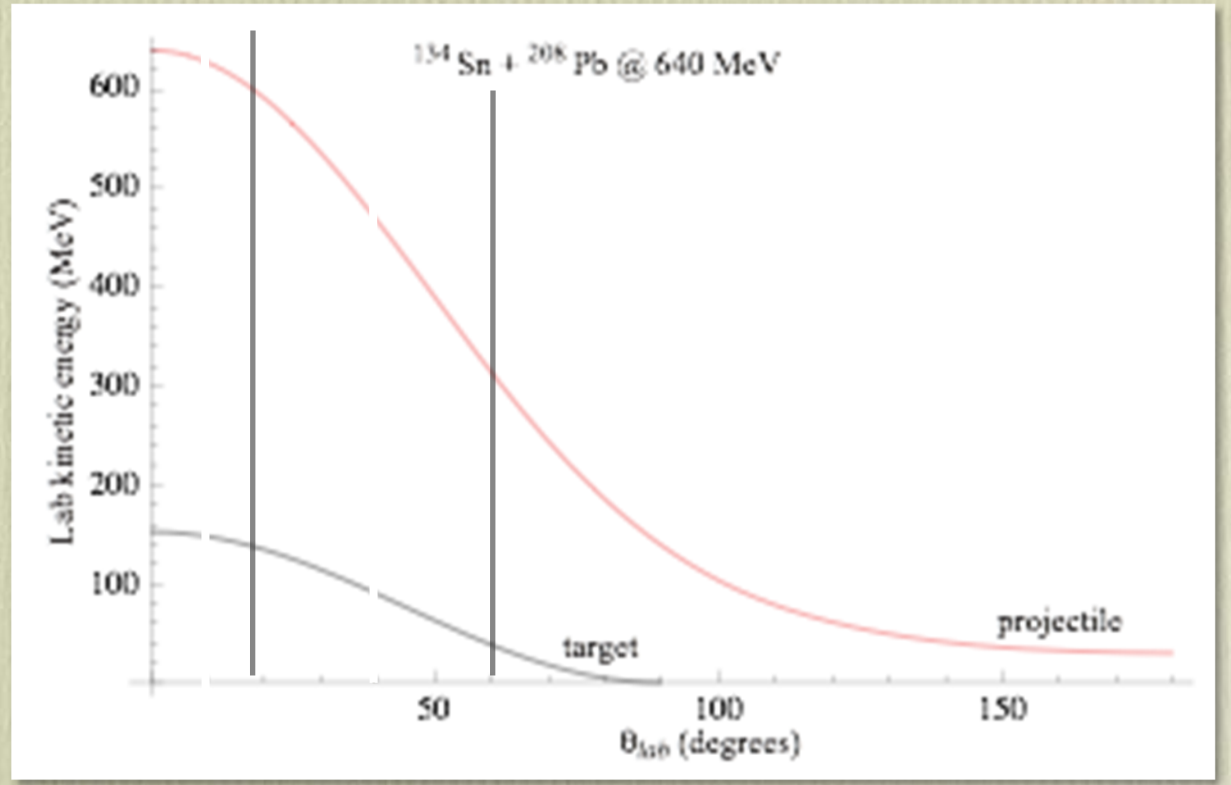
The Annular Silicon Detector

- 8 sectors of Si strip detectors arranged in a pie-shaped array
- The front surface (junction side) is segmented into 8 strips
- The thickness of the Si detector is around 300μm
- Dead layer 50nm

θ coverage when the detector is mounted at 5 cm distance from the target: 18 to 60 degrees

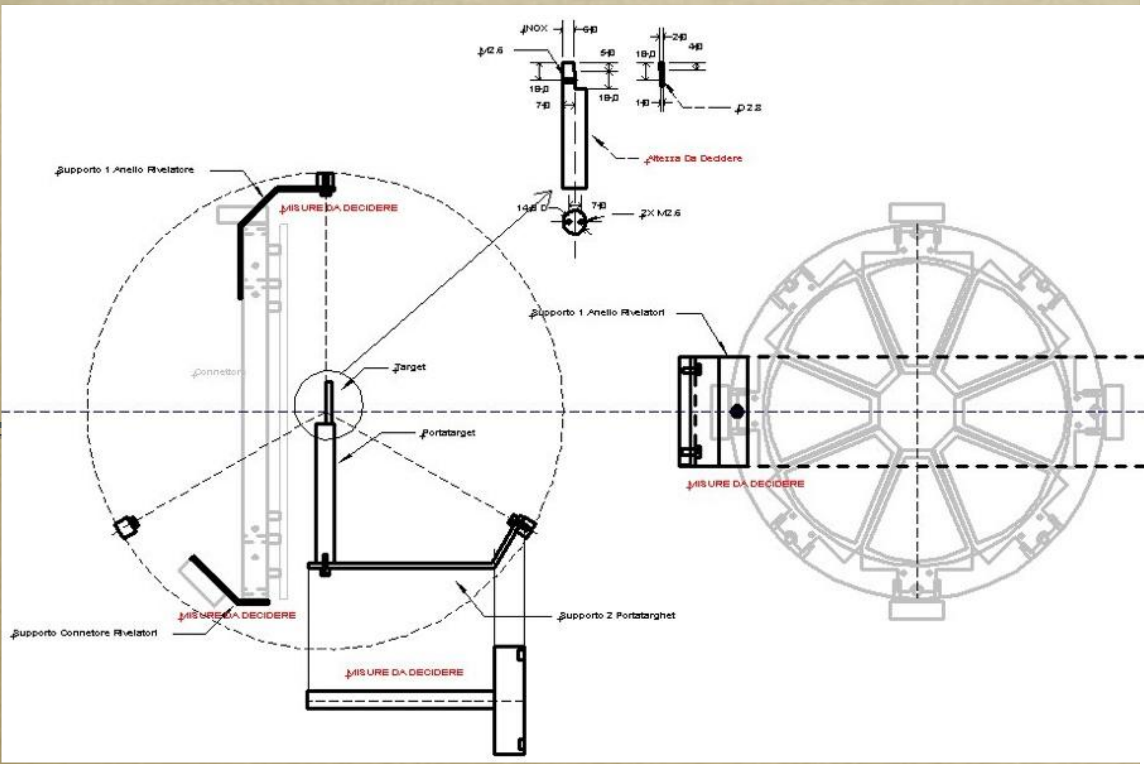
Strip no.	Inner radius (mm)	Outer radius (mm)	θ_{min} (deg)	θ_{max} (deg)
1	76.7	85.0	56.9	59.5
2	68.1	76.4	53.7	56.7
3	59.5	67.9	50.0	53.6
4	50.9	59.3	45.5	49.9
5	42.4	50.7	40.3	45.4
6	33.8	42.1	34.1	40.1
7	25.2	33.6	26.7	33.9
8	16.6	25.0	18.4	26.6

Example of the kinematics

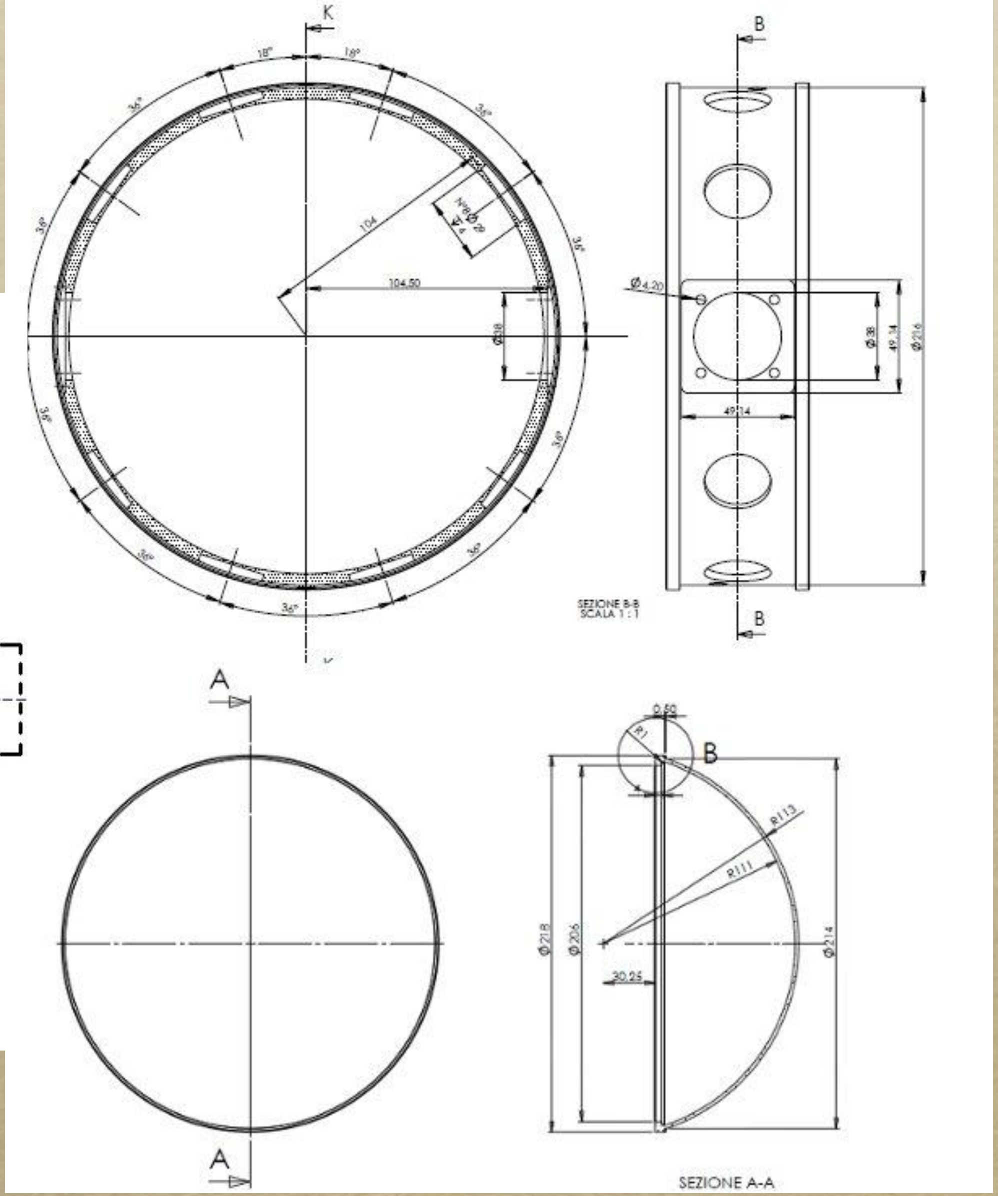


With the Si detector mounted at 5 cm distance from the target → θ coverage: 18 to 60 degrees

The reaction chamber



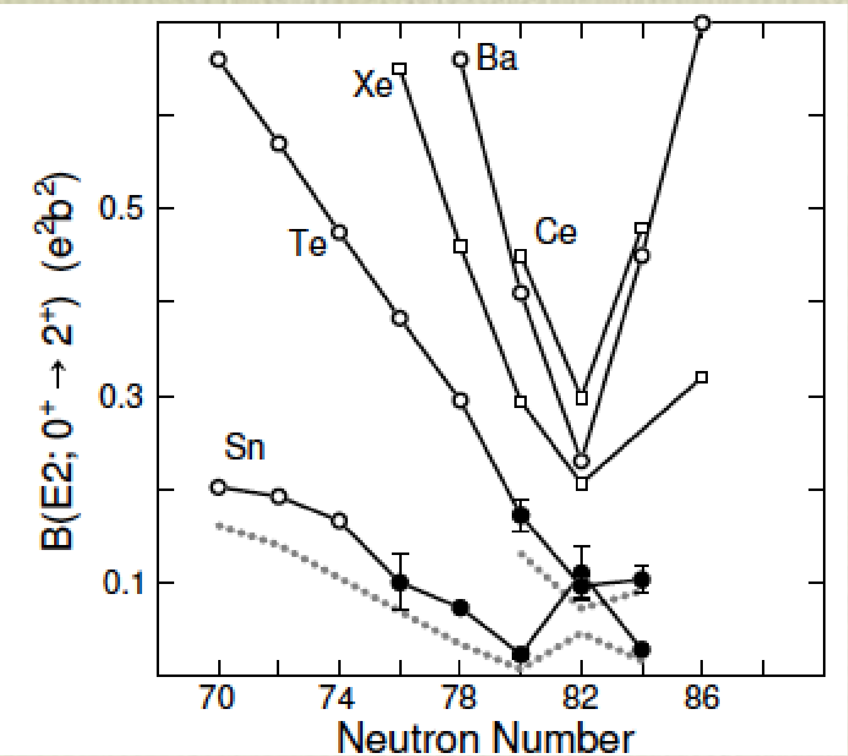
Courtesy of M. Ottanelli



Provided by the group of Padova

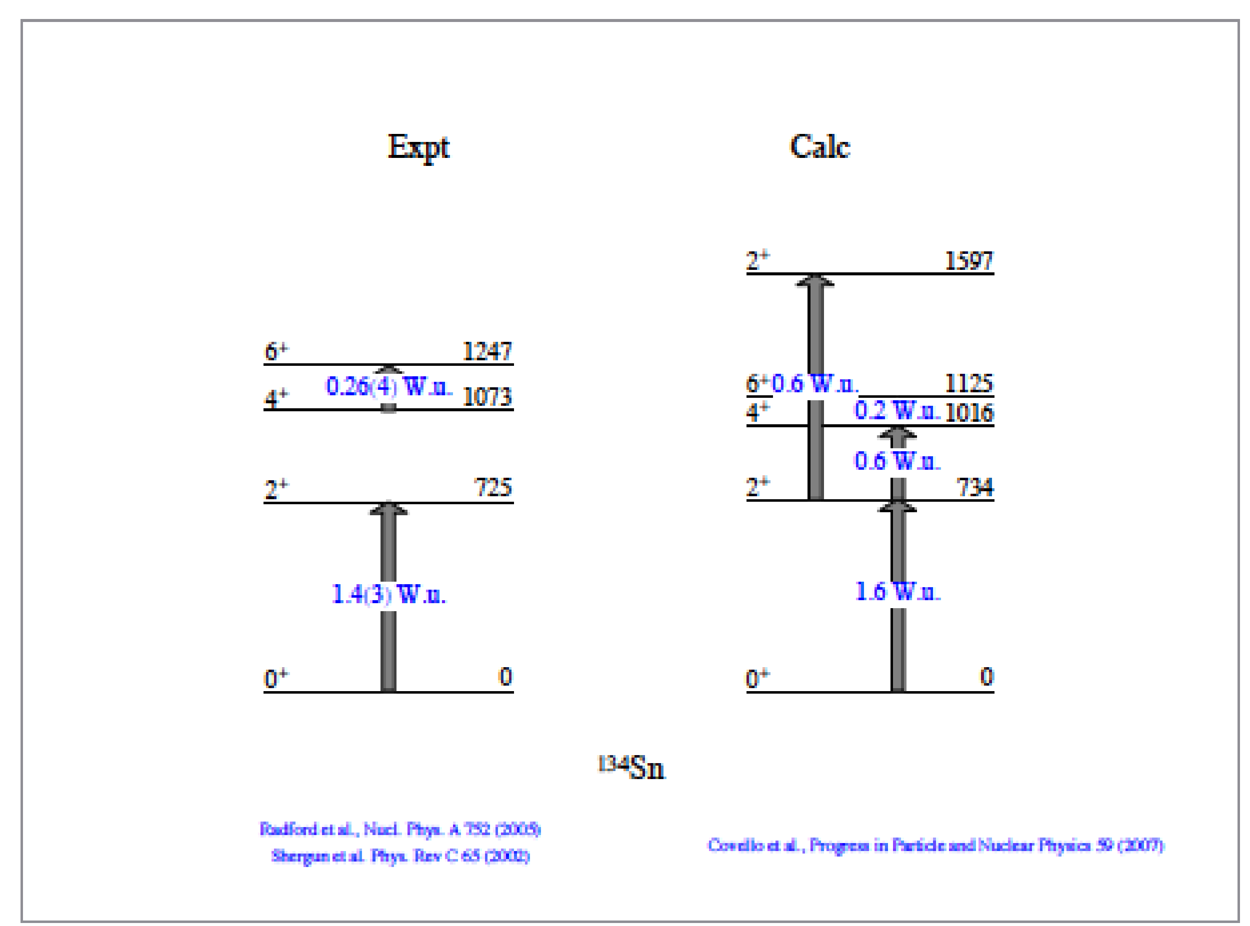
The north east region of Z=50 and N=82

The study of exotic nuclei in the regions of shell closures is drawing much attention.
The advent of SPES neutron-rich radioactive beam facility opens the possibility for a wide range of experimental investigations of nuclei in the region around N=82 and Z=50 shell closures, whose properties are still poorly known.



D.C. Radford, Eur. Phys. J A 25, s01,383-387 (2005)

Coulex of ^{134}Sn



output of GOSIA code:

beam intensity: $5 \cdot 10^5$ ion/sec
beam energy: 570 MeV

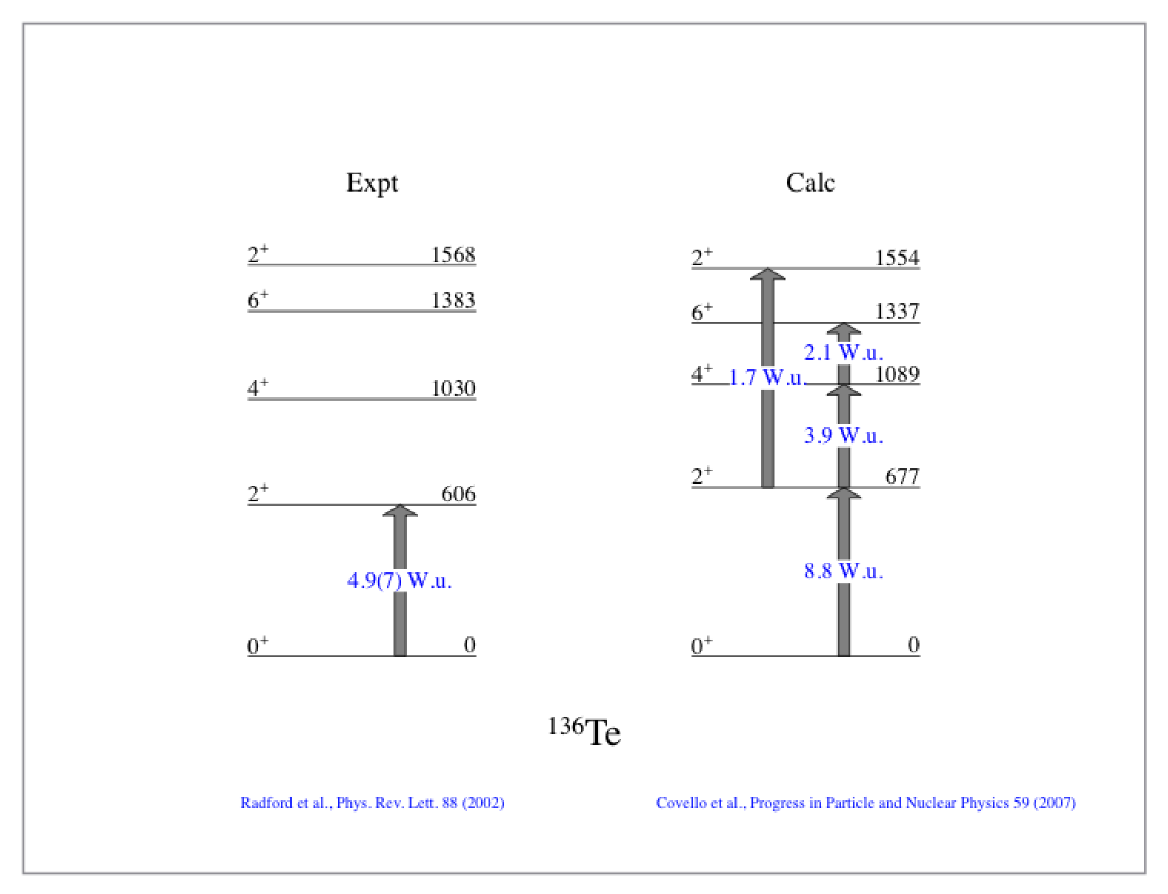
ε_γ : 8% @ 1 MeV
θ coverage: 18 to 60 degrees

^{134}Sn	Energy [keV]	Y [mb·mg/cm^2/sr]	counts/hour
$2_1 \rightarrow 0_1$	726	35	16
$4_1 \rightarrow 2_1$	348	0.32	0.1
$2_2 \rightarrow 2_1$	863	0.44	0.2

Coulex of ^{136}Te

The B(E2; $2_1^+ \to 0_1^+$) transition strength in ^{136}Te reported in literature has caused some discussions in the past, as its value seemed to be lower than predicted by theory

New question: for the second 2^+ state the predictions of different shell model approaches are in strong disagreement



GOSIA calculation:

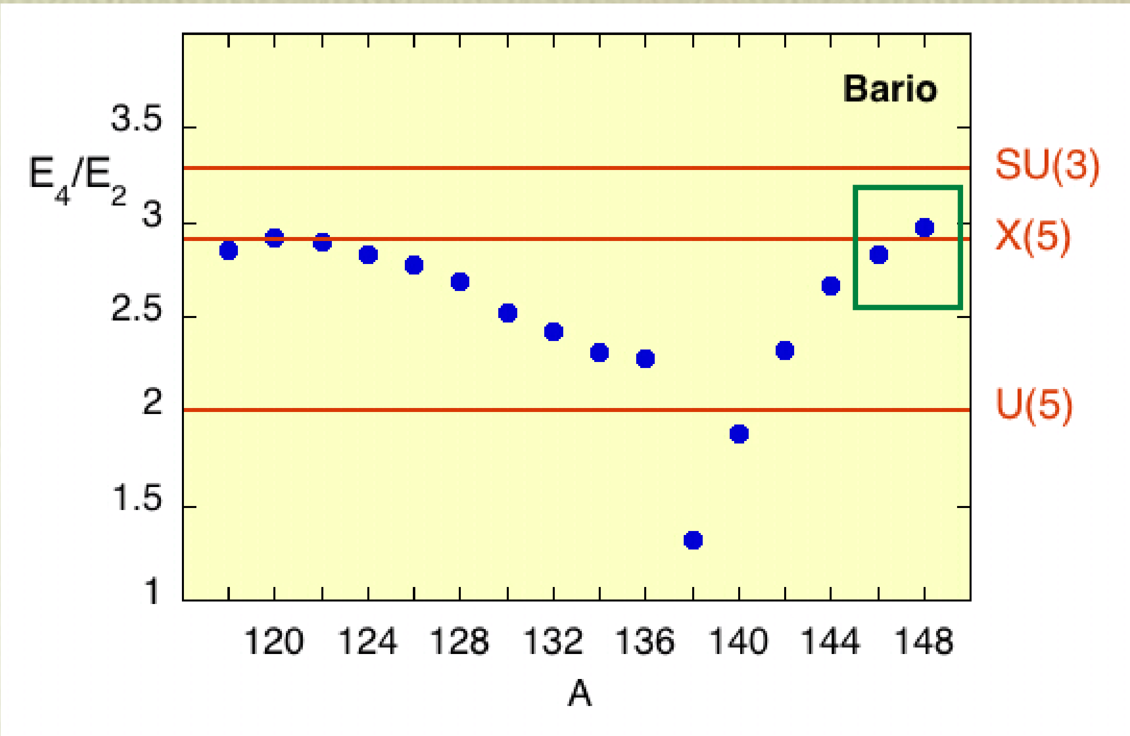
beam intensity: 1.1·10^7 ion/sec
beam energy: 600 MeV

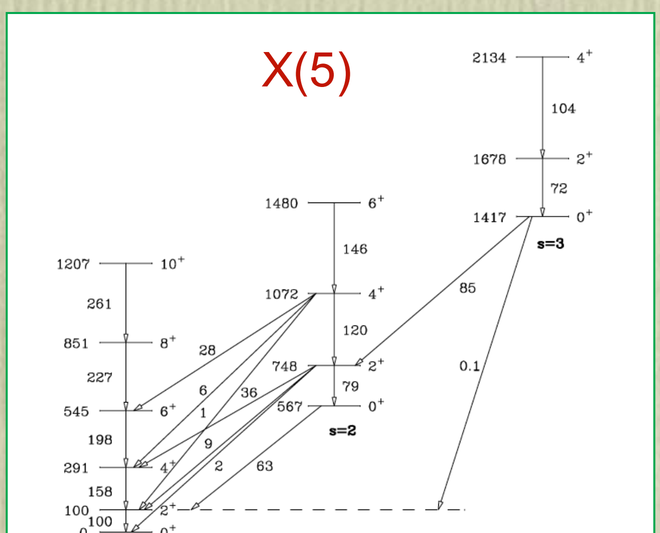
^{136}Te	Energy [keV]	Y [mb·mg/cm^2/sr]	counts/hour
$2_2 \rightarrow 0_1$	670	127	1164
$4_1 \rightarrow 2_1$	423	7	64
$2_2 \rightarrow 2_1$	962	0.88	8

xxxx

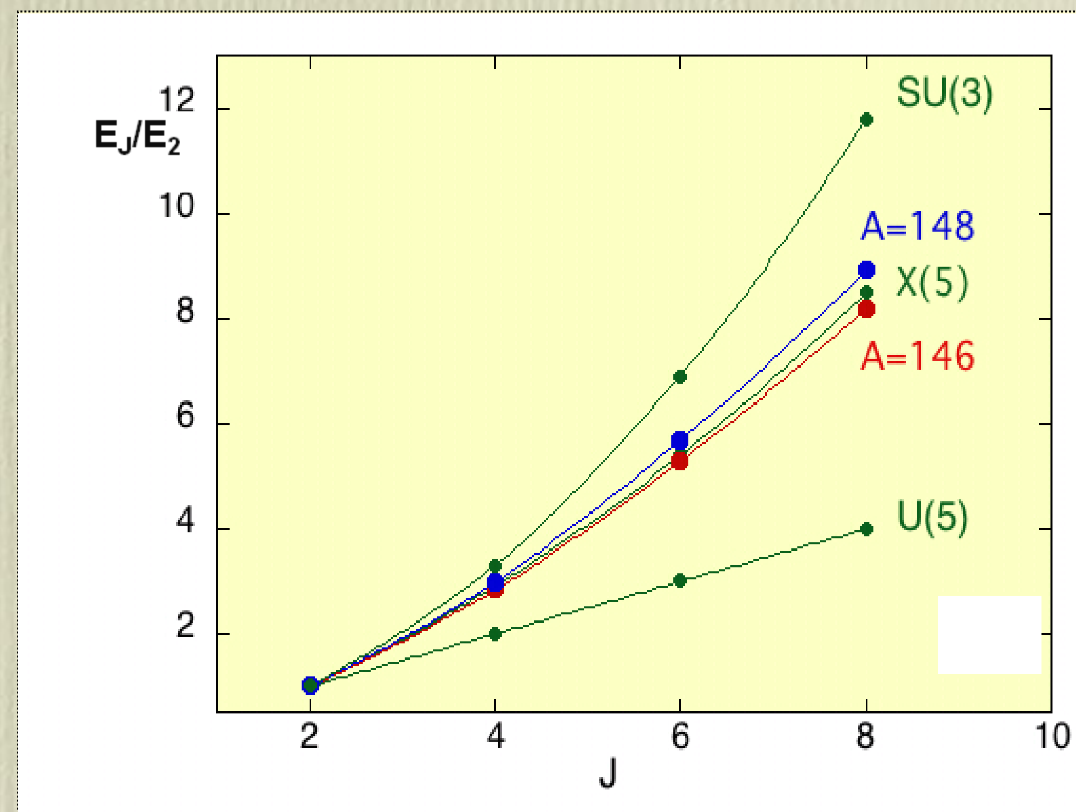
Coulex of ^{146}Ba:

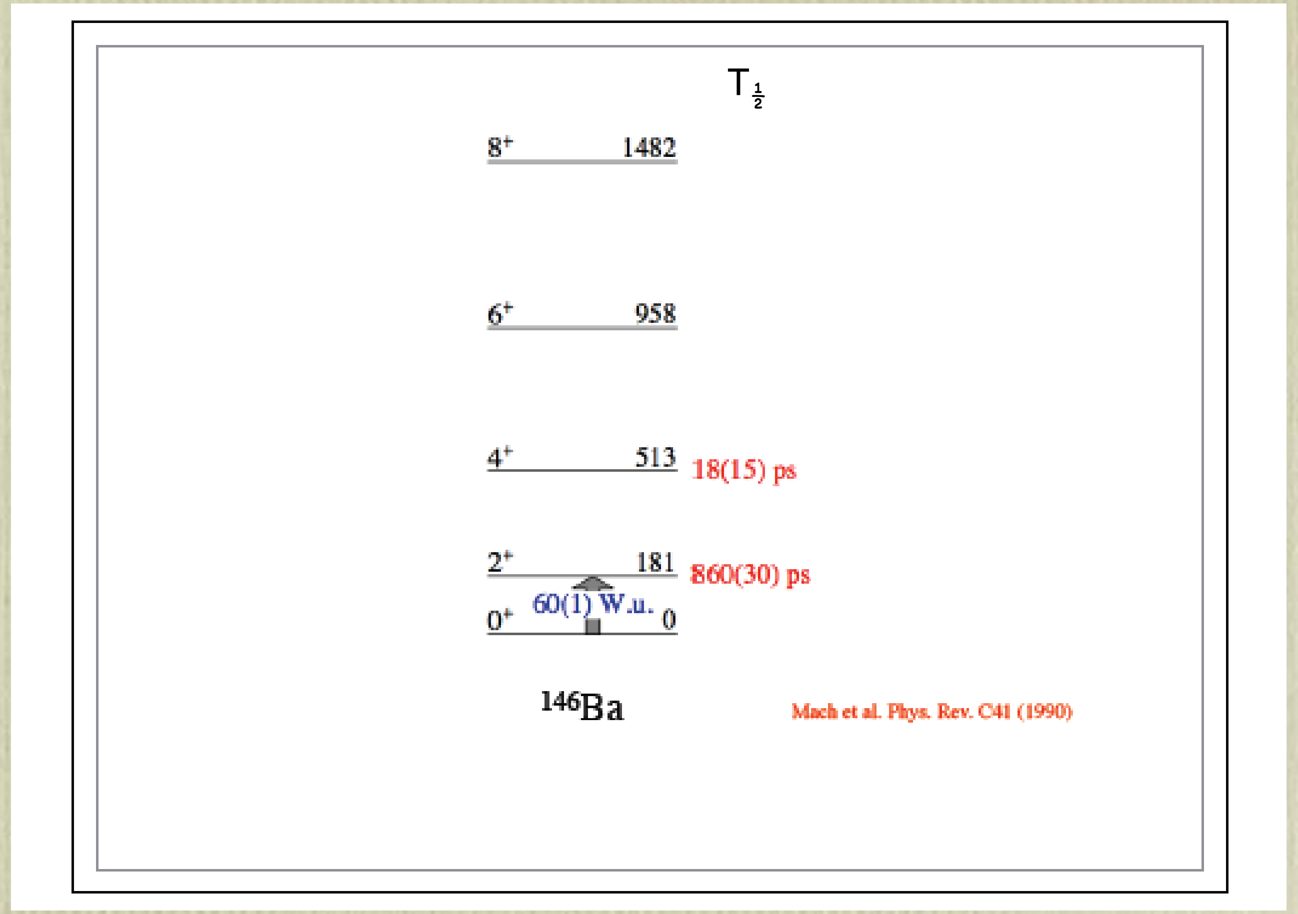
phase transition phenomena and dynamical symmetries can be studied by multiple Coulomb excitation

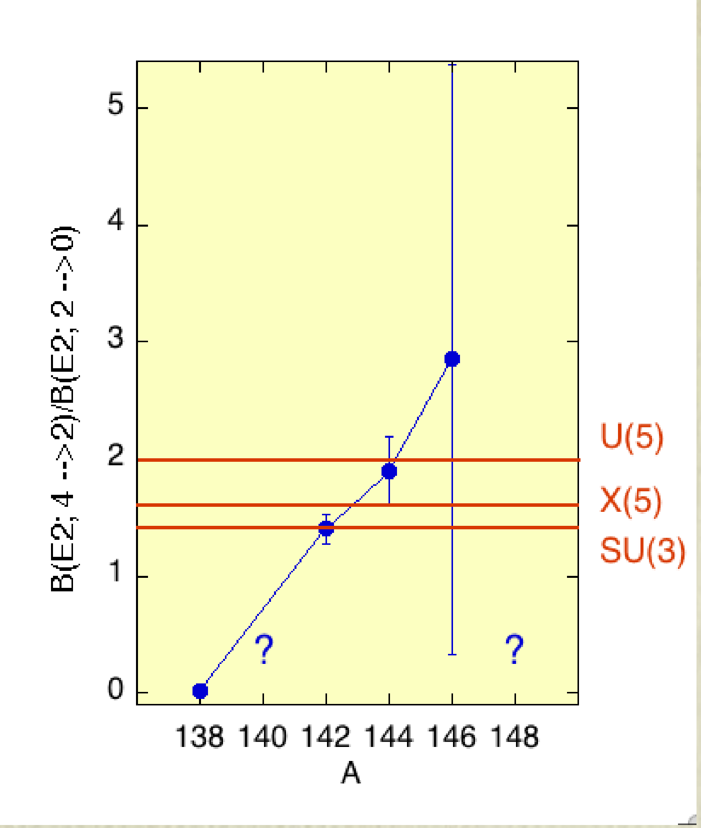




Iachello, Phys.Rev.Lett. 87 (2001)







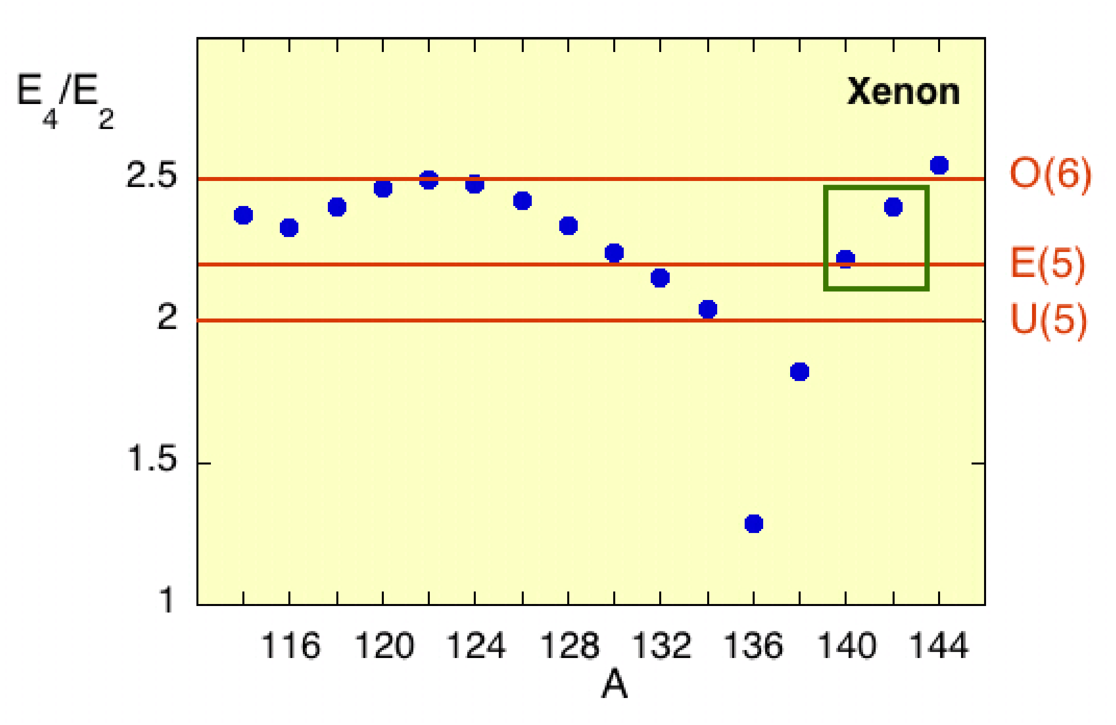
The present information does not allow to draw a definite conclusion

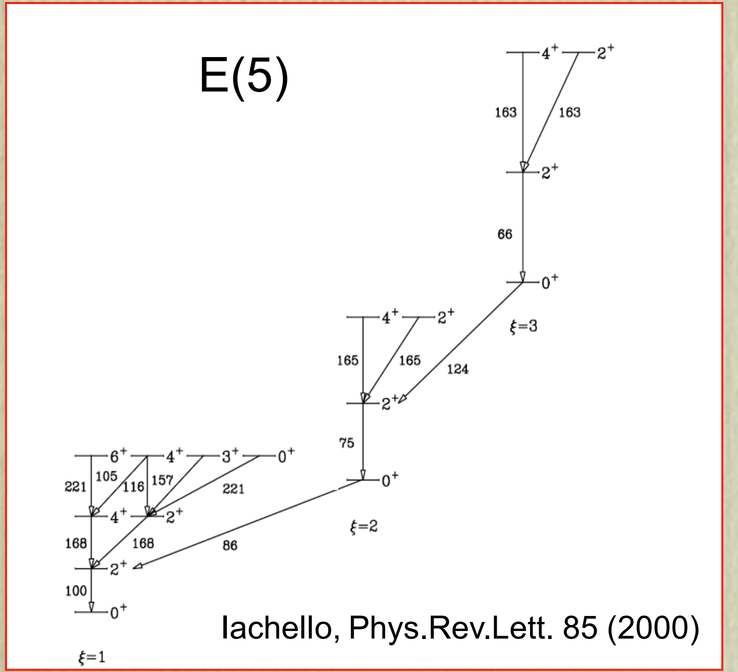
output of GOSIA code:

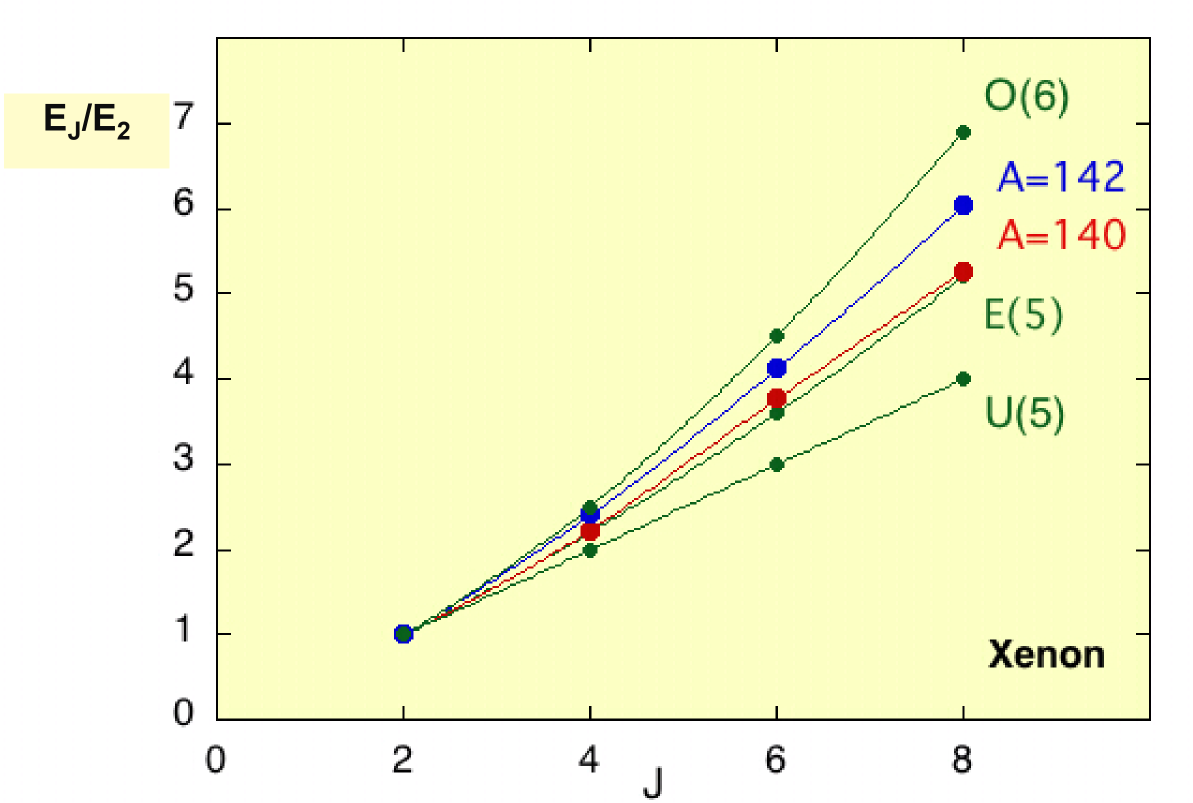
beam intensity: 1.4·10^4 ion/sec
beam energy: 600 MeV

^{146}Ba	Energy [keV]	Y [mb·mg/cm^2/sr]	counts/hour
$2_1 \rightarrow 0_1$	181	1205	14
$4_1 \rightarrow 2_1$	513	382	4
$6_1 \rightarrow 4_1$	958	102	1

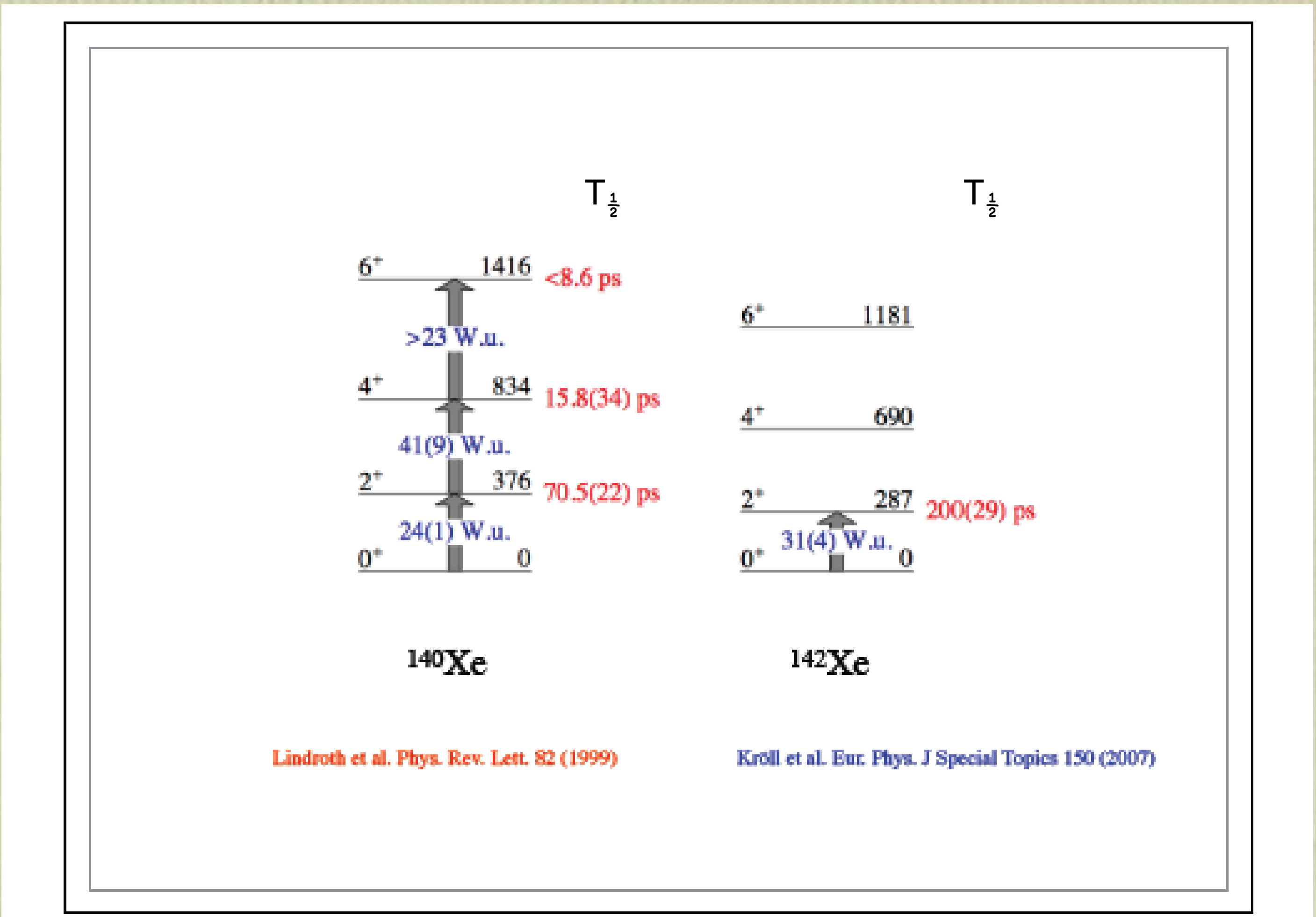
Coulex of $^{140,142}Xe$

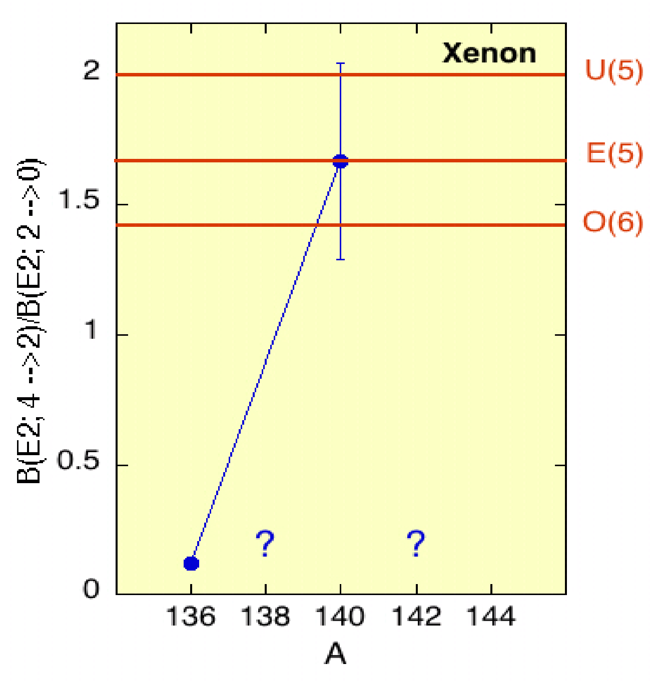






^{140,142}Xe isotopes: what is known





Also in this case the available information does not allow to draw a definite conclusion

output of GOSIA for $^{140,142}Xe$:

beam intensity: $1.3\cdot10^7$ ion/sec
beam energy: 580 MeV

^{140}Xe	Energy [keV]	Y [mb·mg/cm^2/sr]	counts/hour
$2_1 \rightarrow 0_1$	376	567	6333
$4_1 \rightarrow 2_1$	458	160	1787
$6_1 \rightarrow 4_1$	582	23	257

beam intensity: $7.5\cdot10^5$ ion/sec
beam energy: 600 MeV

^{142}Xe	Energy [keV]	Y [mb·mg/cm^2/sr]	counts/hour
$2_1 \rightarrow 0_1$	287	735	459
$4_1 \rightarrow 2_1$	403	138	86
$6_1 \rightarrow 4_1$	490	23	14

Conclusions

- We are setting up an apparatus for detection of radioactive ions. It can be coupled to a Gamma array (Galileo, Agata, Gasp)

- We propose measurements in ^{134}Sn, ^{136}Te, ^{146}Ba and ^{140,142}Xe

- We present the results of GOSIA calculations for ^{134}Sn, ^{136}Te, ^{146}Ba and ^{140,142}Xe

We are open to proposal of measurements in other regions of the chart of nuclides