Doubly Magic Nucleus ^{208}Pb

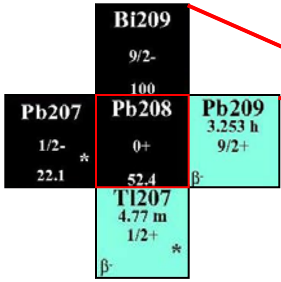
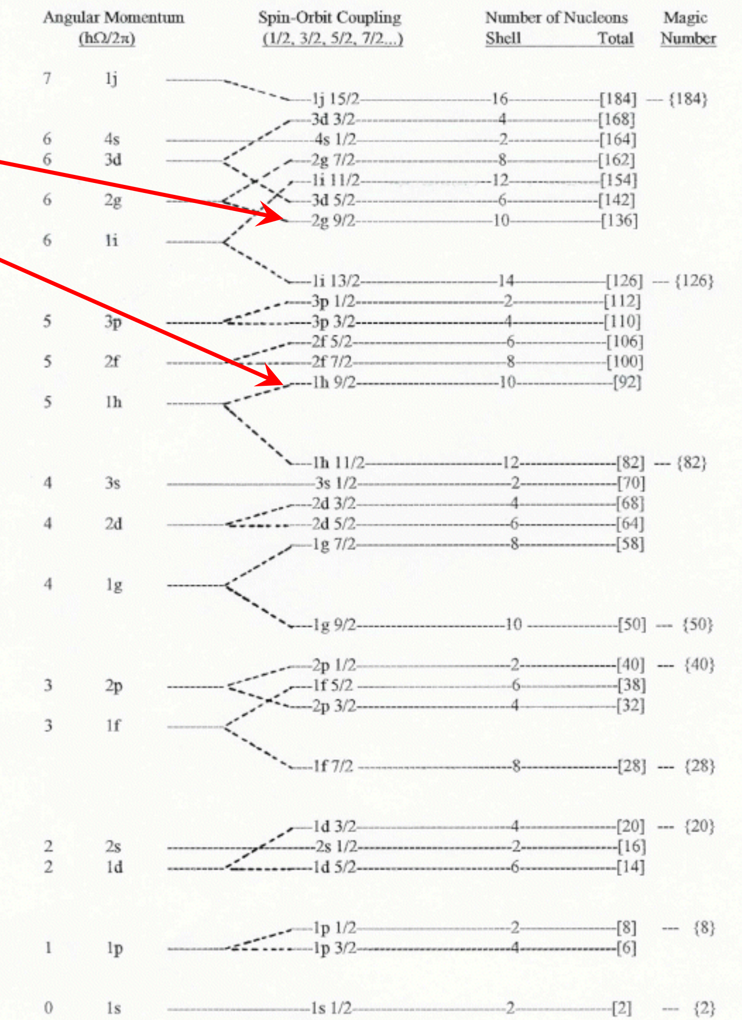


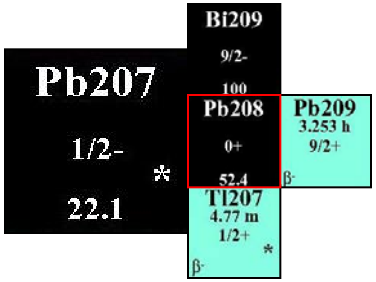
Table 1 -- Nuclear Shell Structure (from *Elementary Theory of Nuclear Shell Structure*, Maria Goeppert Mayer & J. Hans D. Jensen, John Wiley & Sons, Inc., New York, 1955.)



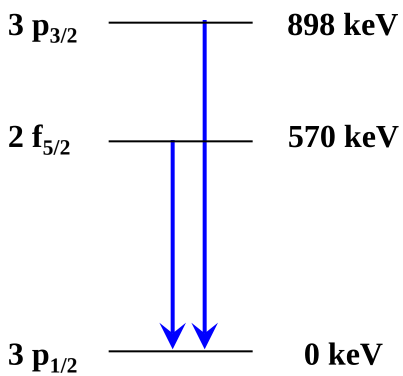
Maria Goeppert-Mayer

J. Hans D. Jensen

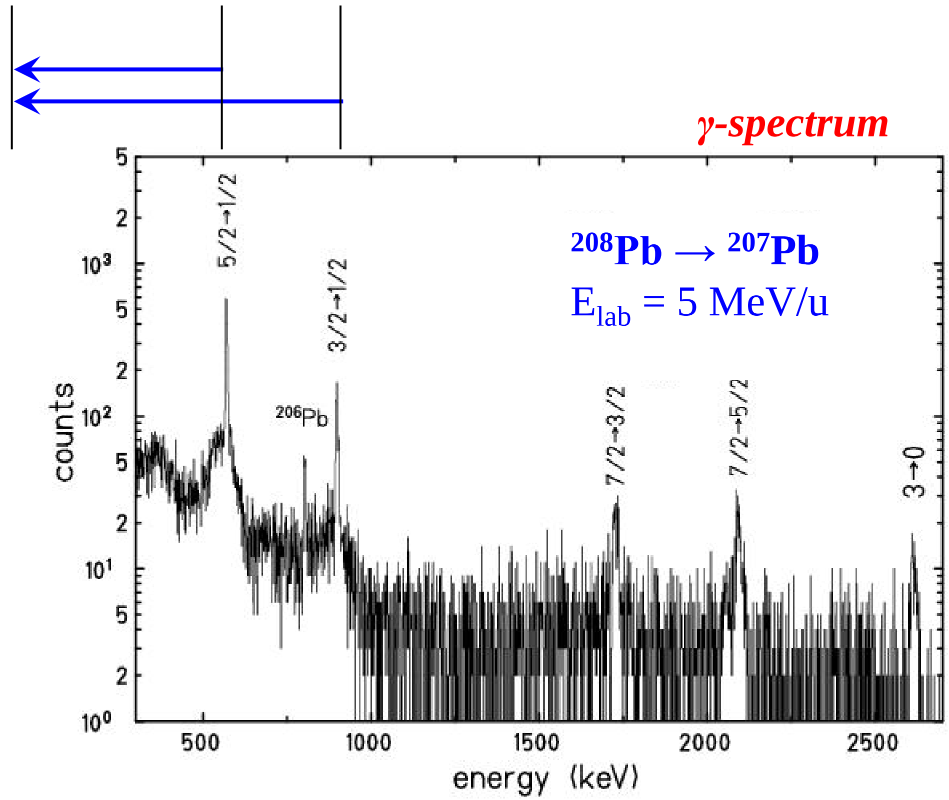
Experimental single-particle energies



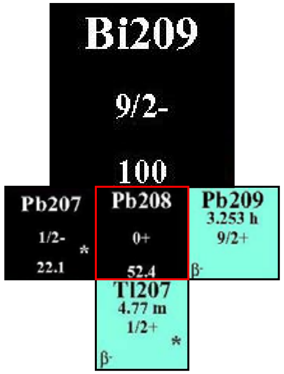
single-hole energies



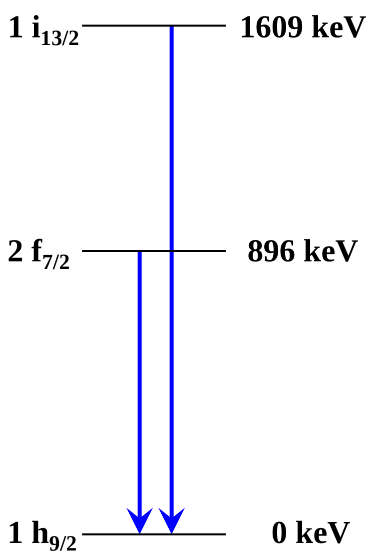
$^{207}_{82}Pb_{125}$



Experimental single-particle energies

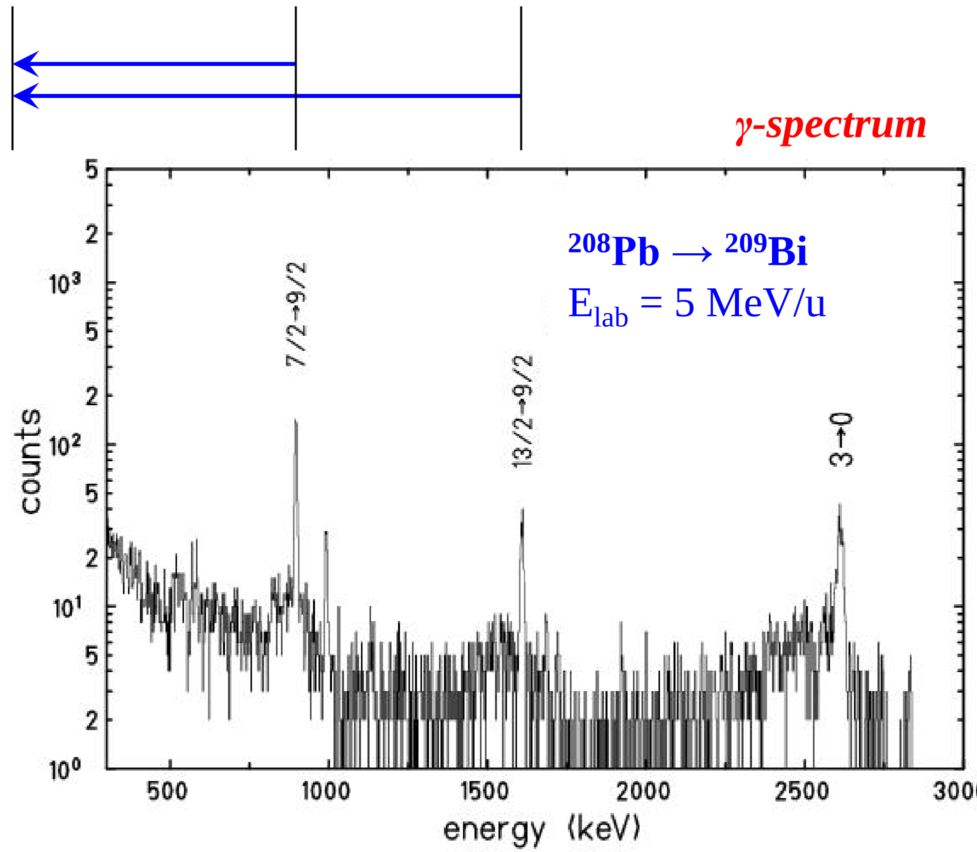


single-particle energies



$^{209}_{83}Bi_{126}$

γ-spectrum

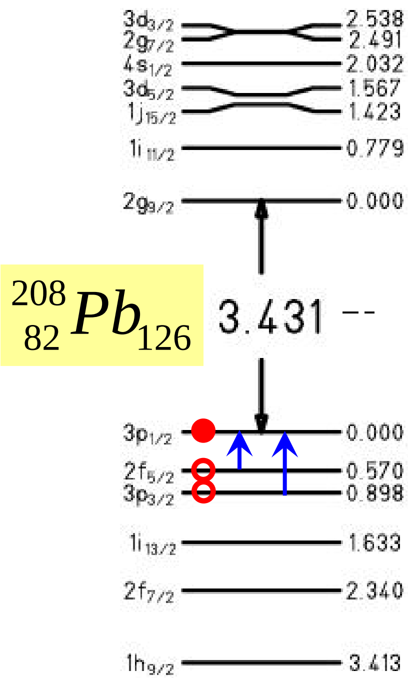


Experimental single-particle energies

particle states

^{209}Bi

^{209}Pb



^{207}Tl

^{207}Pb

hole states

neutrons

energy of shell closure:

$$BE(^{209}Pb) - BE(^{208}Pb) = E(2g_{9/2})$$

$$BE(^{207}Pb) - BE(^{208}Pb) = -E(3p_{1/2})$$

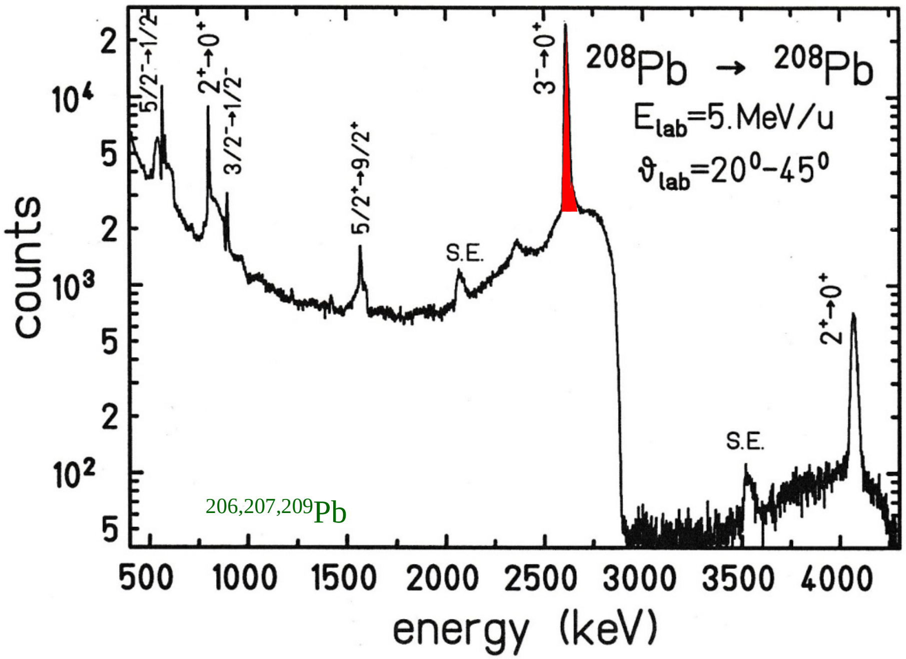
$$E(2g_{9/2}) - E(3p_{1/2}) = BE(^{209}Pb) + BE(^{207}Pb) - 2 \cdot BE(^{208}Pb)$$
$$= -3.432$$

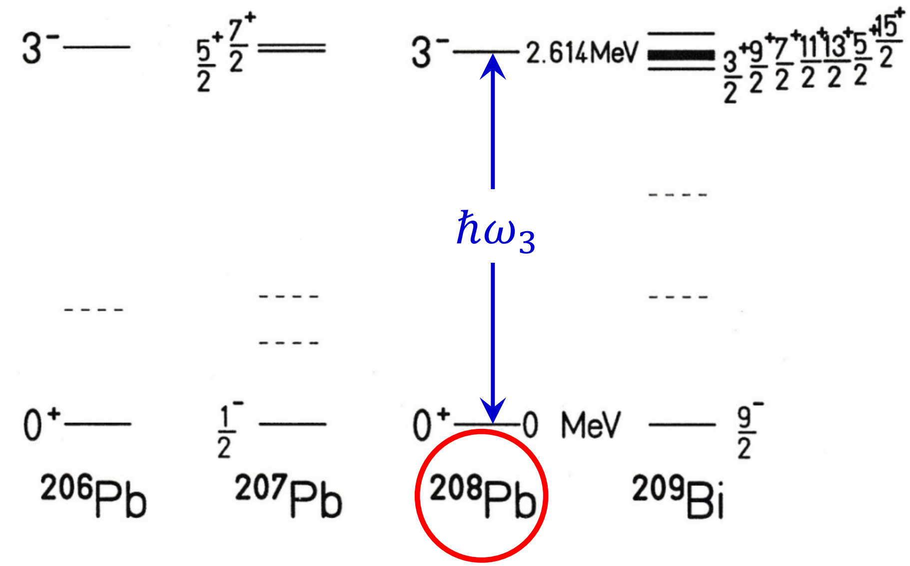
$$BE(^{209}Bi) - BE(^{208}Pb) = E(1h_{9/2})$$

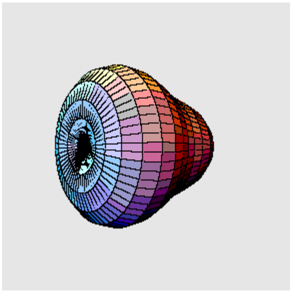
$$BE(^{207}Tl) - BE(^{208}Pb) = -E(3s_{1/2})$$

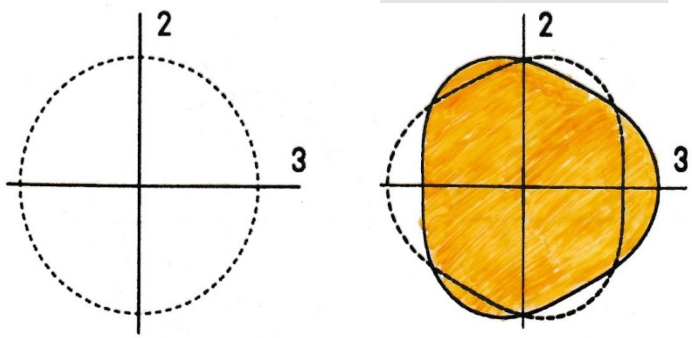
$$E(1h_{9/2}) - E(3s_{1/2}) = BE(^{209}Bi) + BE(^{207}Tl) - 2 \cdot BE(^{208}Pb)$$
$$= -4.211\,MeV$$

Octupole Vibrational States in the Lead Region

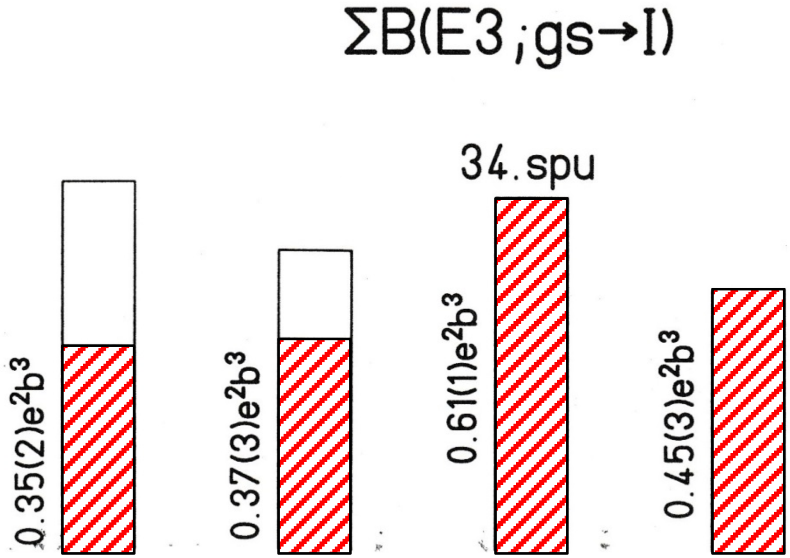


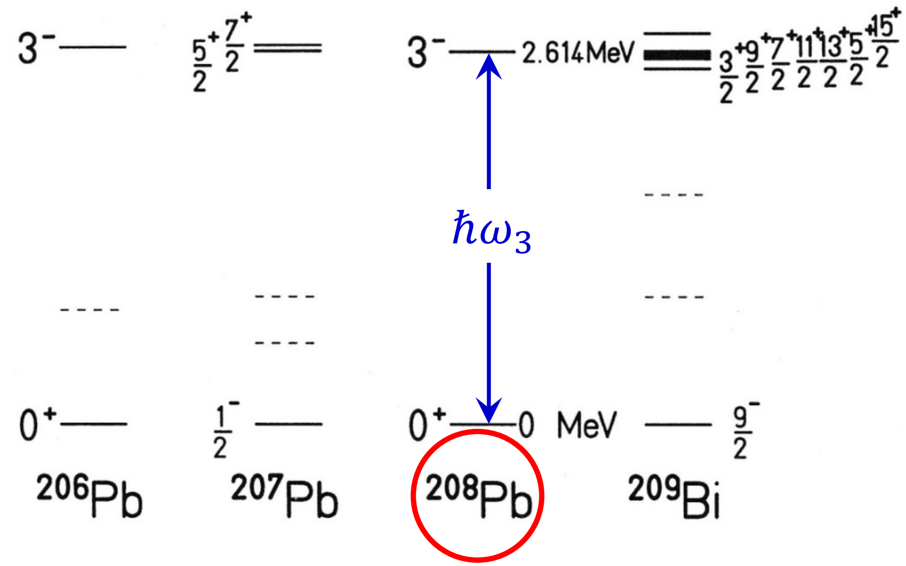


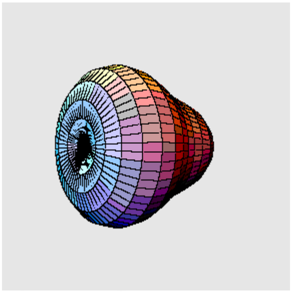


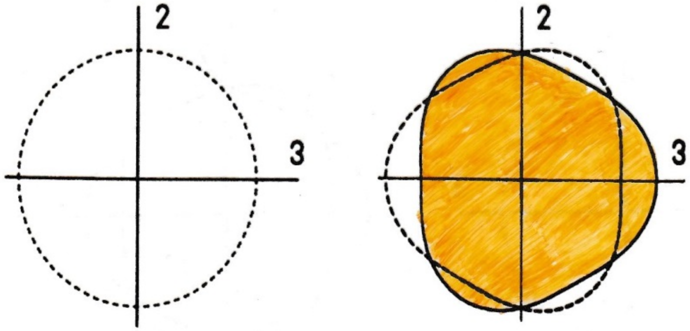


Octupole Vibrational States in the Lead Region

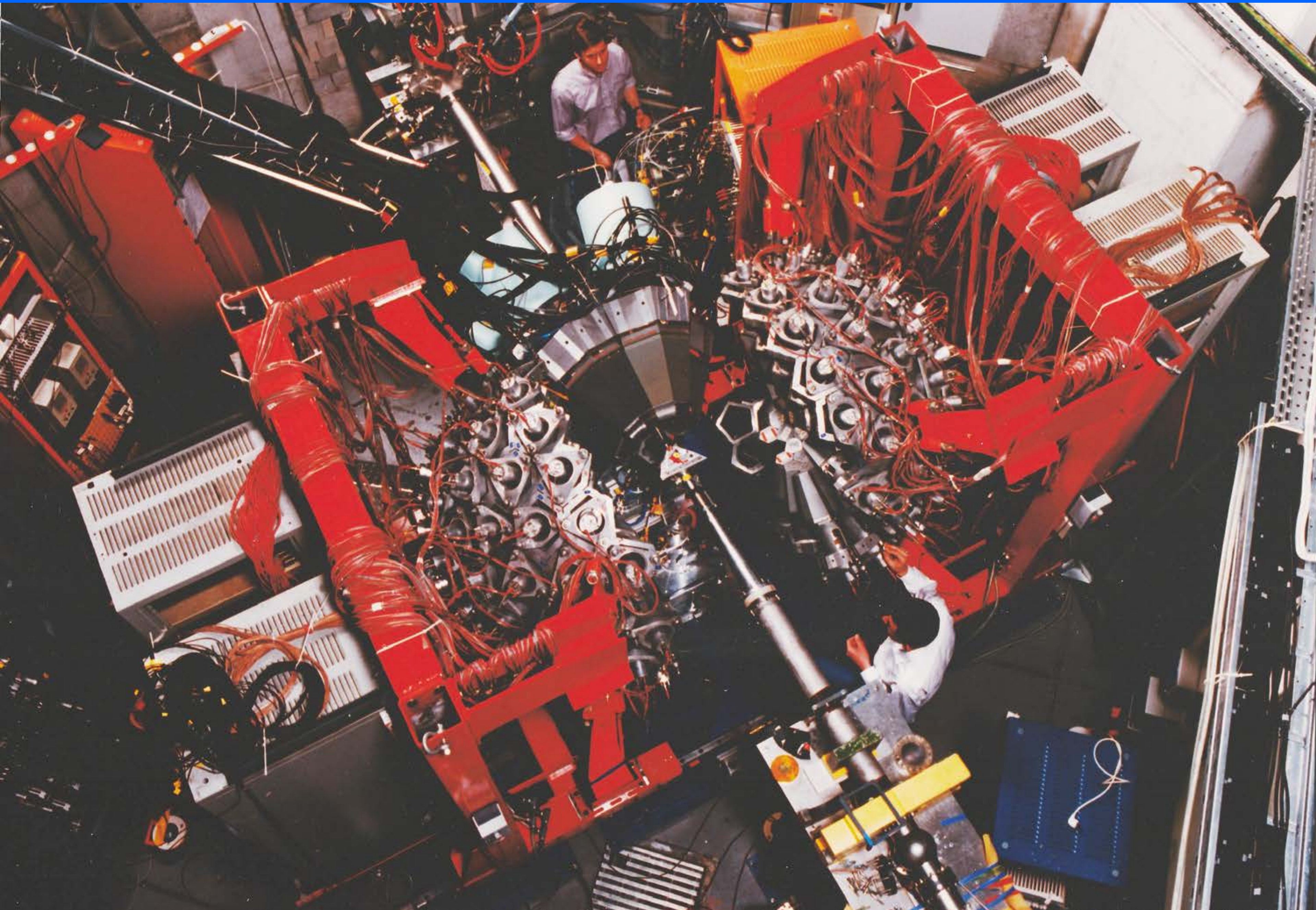




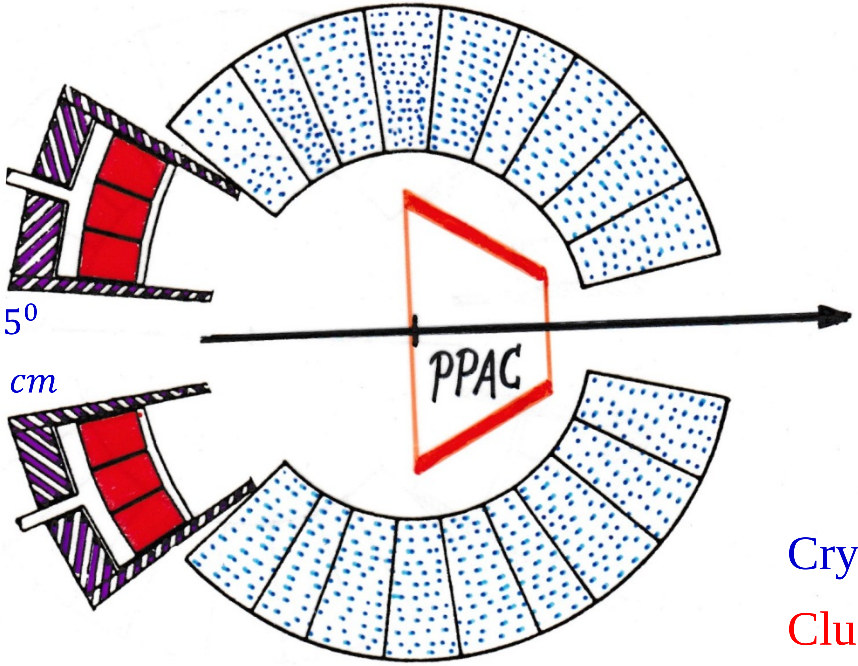




The Darmstadt-Heidelberg Crystal Ball extended by EUROBALL-3 Ge-detectors



The Darmstadt-Heidelberg Crystal Ball extended by EUROBALL-3 Ge-detectors

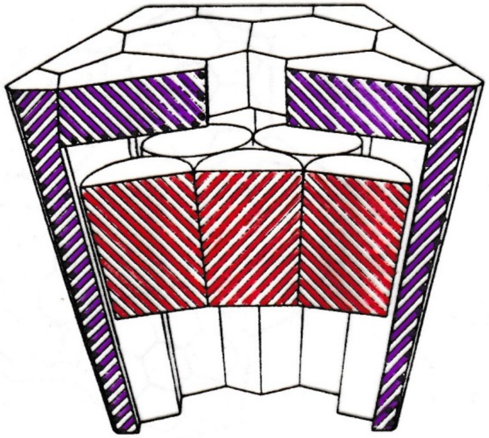


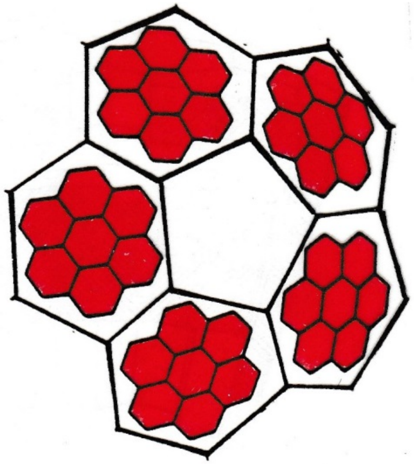
$\langle \theta_\gamma \rangle = 155^0$

$R = 36\ cm$

Crystal Ball: $\Omega_{CB} = 83\%$ $P_{photopeak} \approx 53\%$

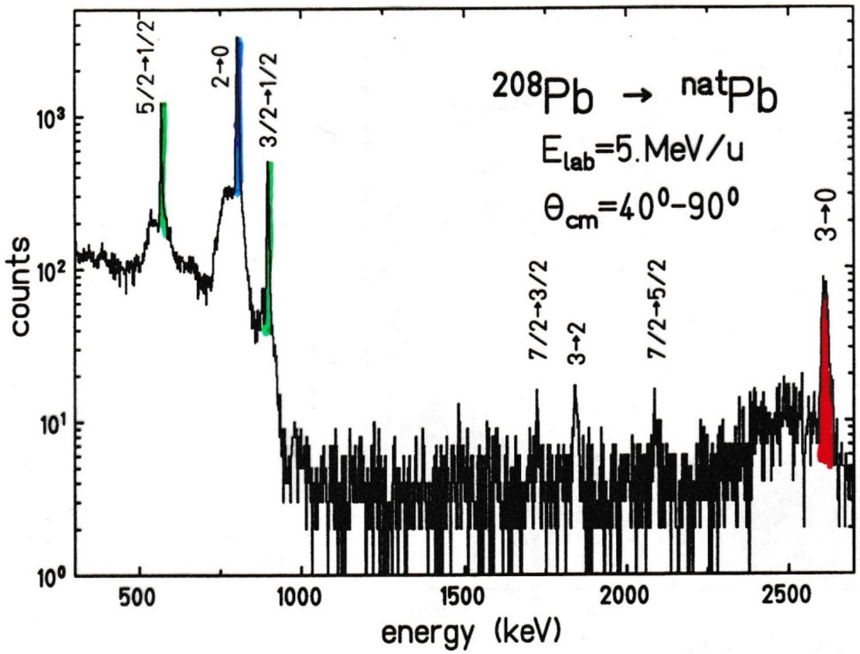
Cluster ring: $\Omega_{EB} = 7\%$ $P_{photopeak} \approx 2.2\%$





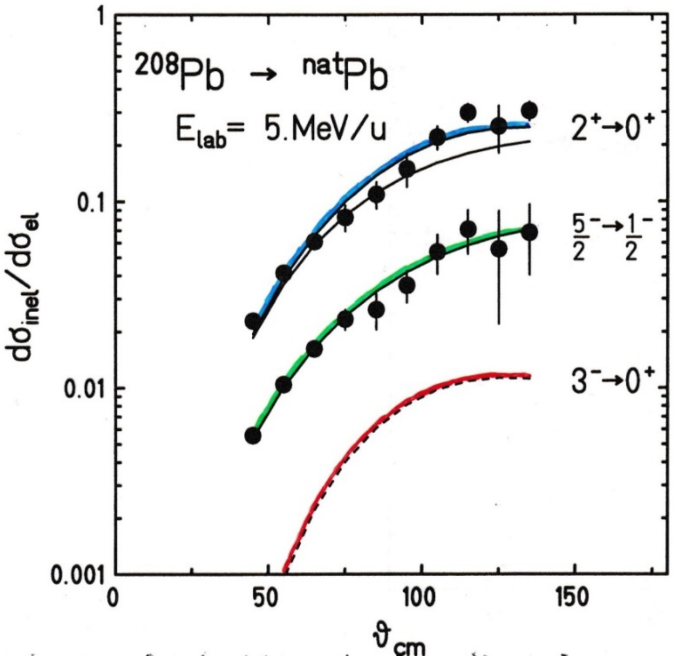
March 27 – September 6, 1996

Octupole Vibrational States in the Lead Region



^{206}Pb	24%
^{207}Pb	22%
^{208}Pb	52%

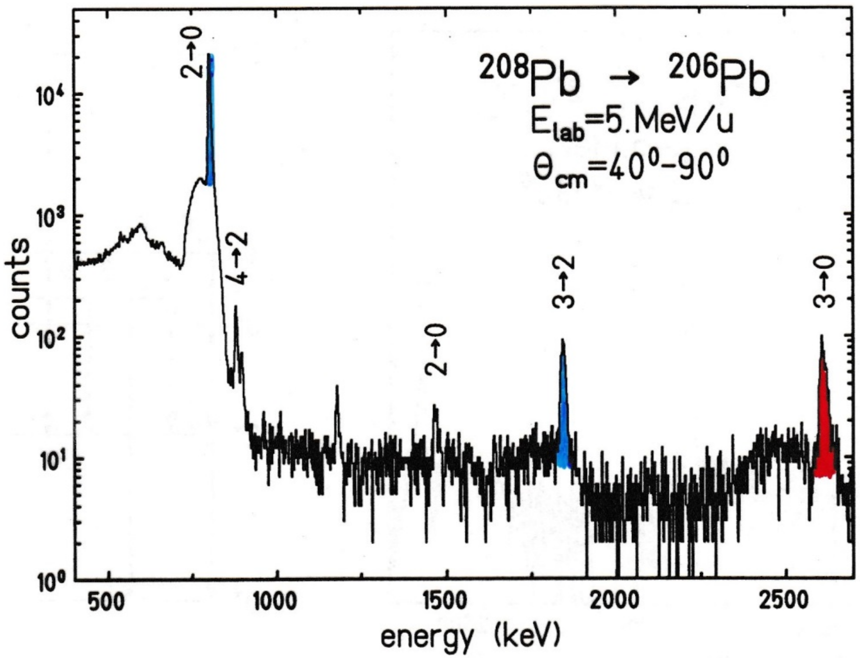
excitation probability for the 1-excited state

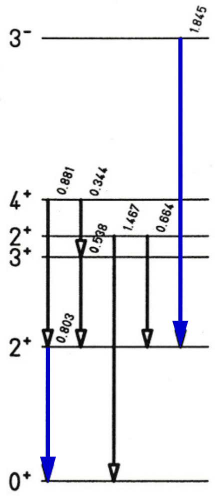


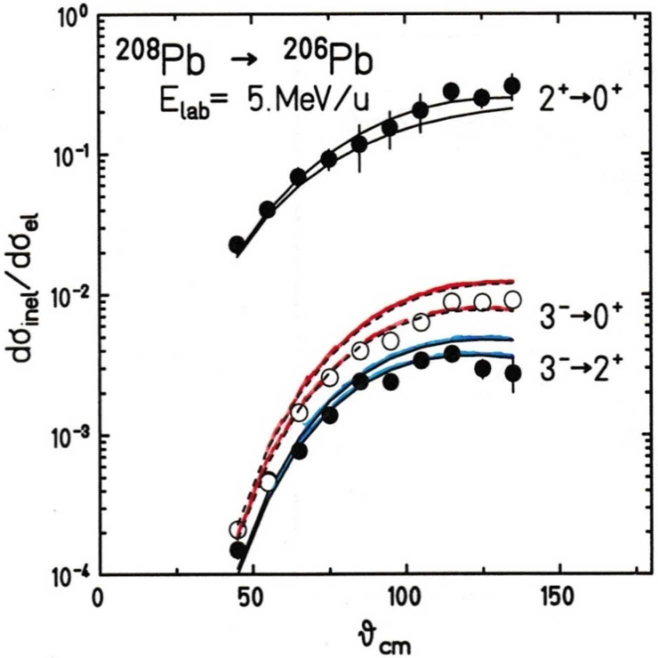
E2 excitation

E3 excitation

Coulomb Excitation for ^{208}Pb on ^{206}Pb







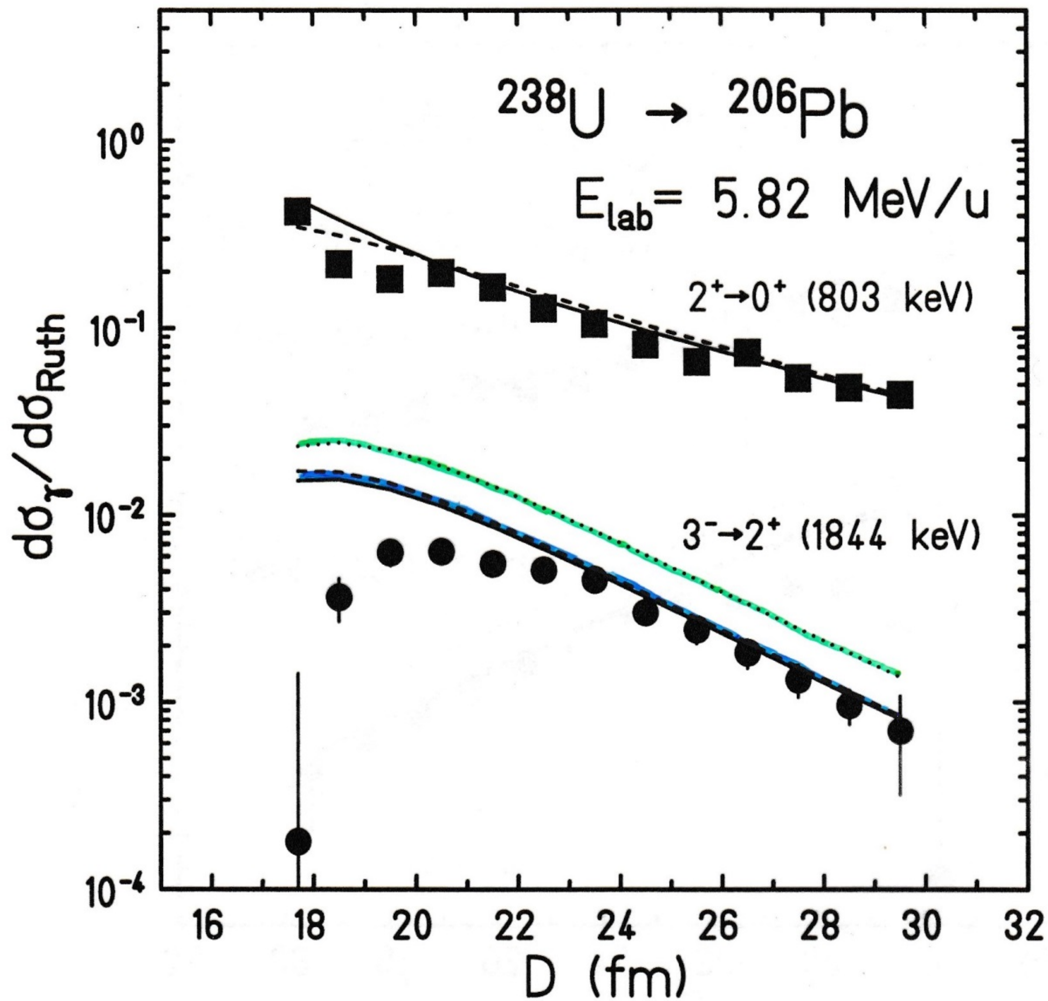
B(E3)

34 spu

20 spu

Nucl Data: 36 spu

Coulomb Excitation for ^{238}U on ^{206}Pb



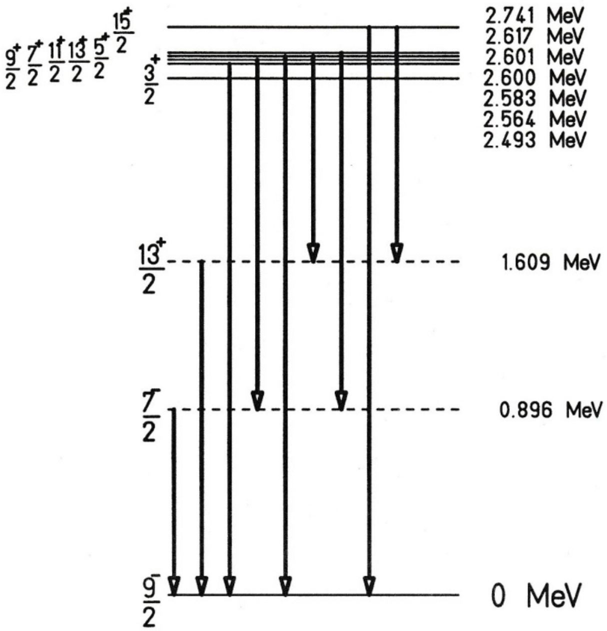
B(E3)

36 spu

20 spu

J. Baumann for EPOS

Superposition of Vibrational and Particle Motion



$3^- | h_{9/2} \rangle$ septuplet

^{209}Bi

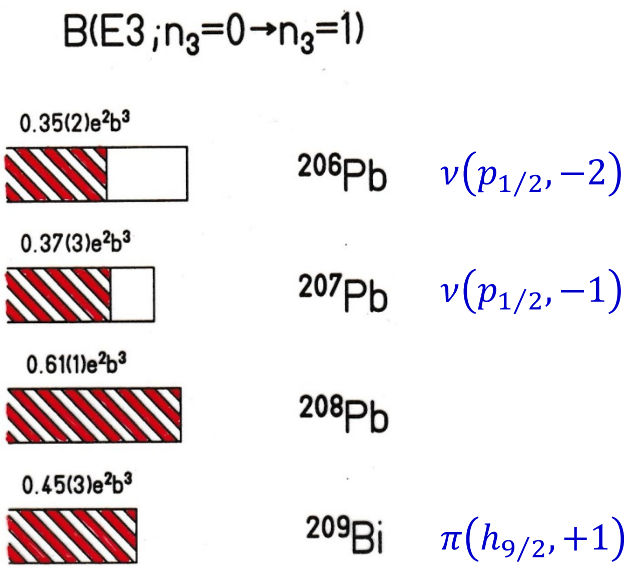
$| h_{9/2} \rangle$

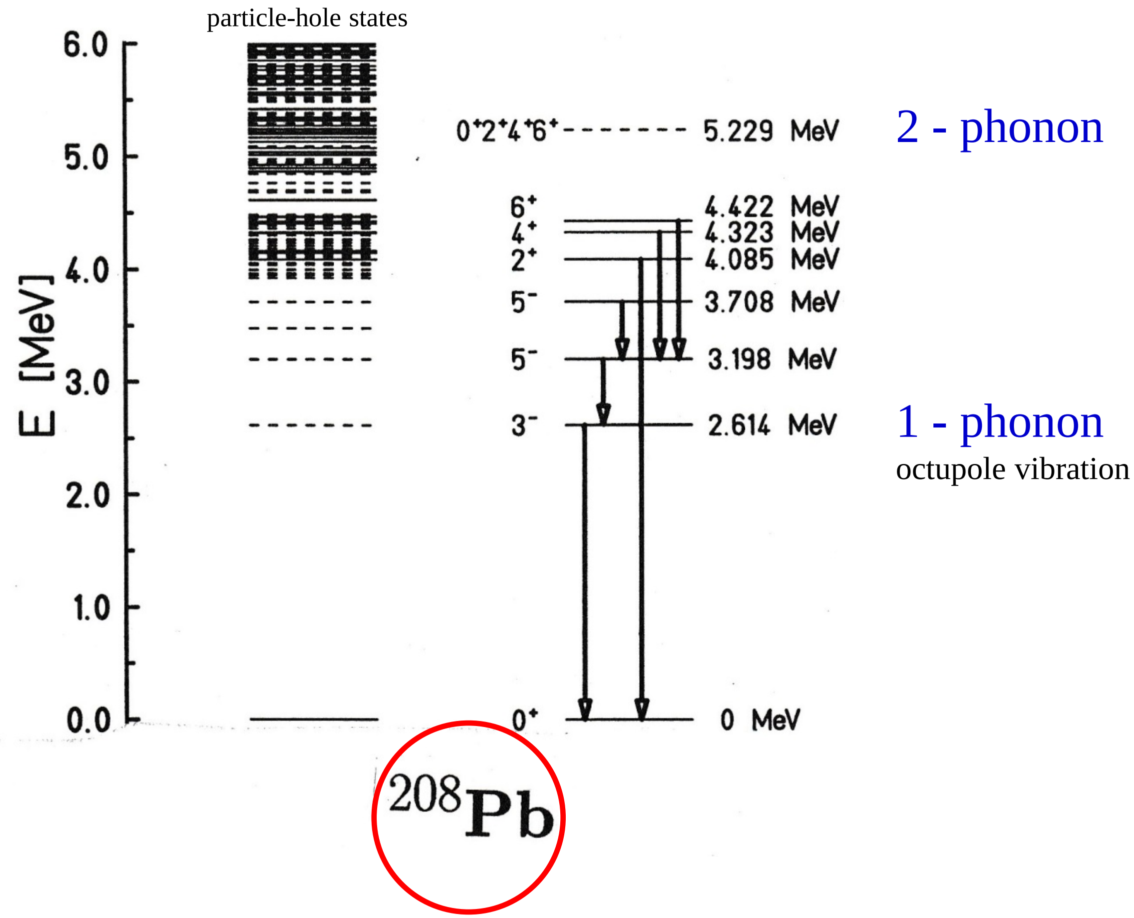
weak coupling:

$$B(E3; n_3 = 0, j \to (n_3 = 1, j)I) = \frac{2I+1}{7(2j+1)} B(E3; n_3 = 0 \to n_3 = 1)$$

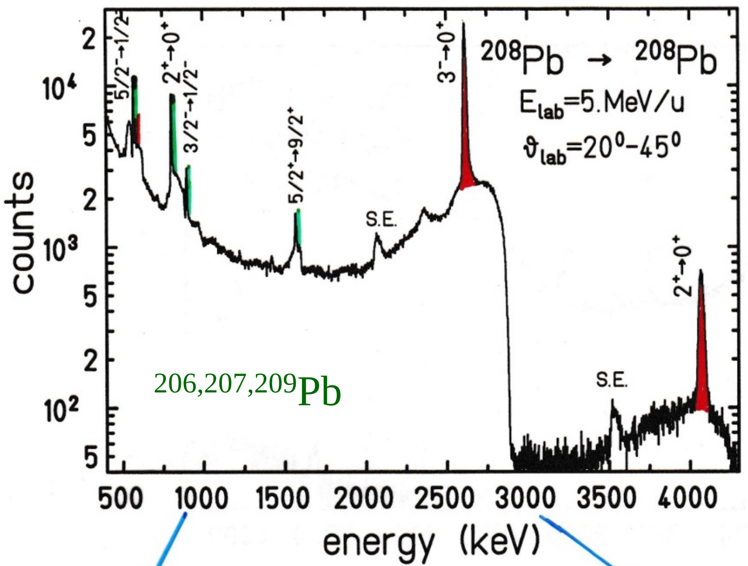
j^π I^π		$B(E3; n_3 = 0 \to n_3 = 1)$
$B(E3; 9/2^- \to 3/2^+)$	**0.017(3)**	**0.29(5)**
$B(E3; 9/2^- \to 9/2^+)$	**0.073(10)**	**0.51(7)**
$B(E3; 9/2^- \to 7/2^+)$	**0.052(8)**	**0.45(7)**
$B(E3; 9/2^- \to 11/2^+)$	**0.093(16)**	**0.54(9)**
$B(E3; 9/2^- \to 13/2^+)$	**0.080(18)**	**0.40(9)**
$B(E3; 9/2^- \to 5/2^+)$	**0.034(6)**	**0.40(7)**
$B(E3; 9/2^- \to 15/2^+)$	**0.104(17)**	**0.45(7)**
Σ:	**0.45(3)** e^2b^3	

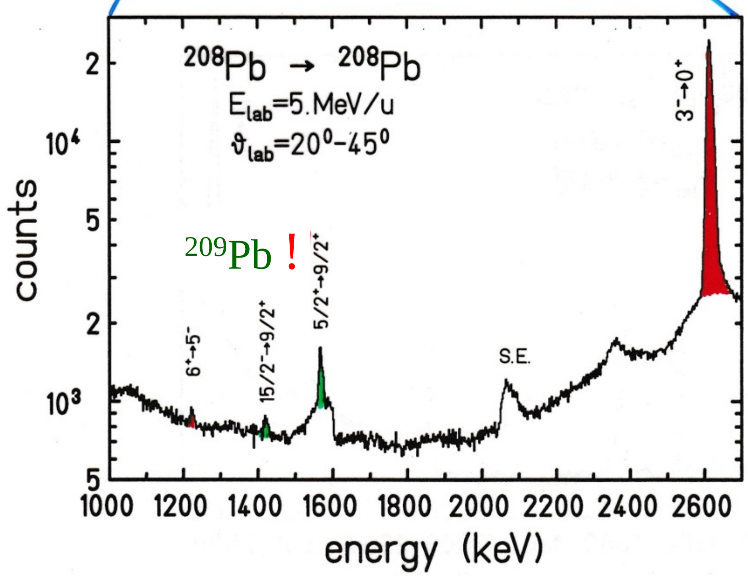
Superposition of Vibrational and Particle Motion



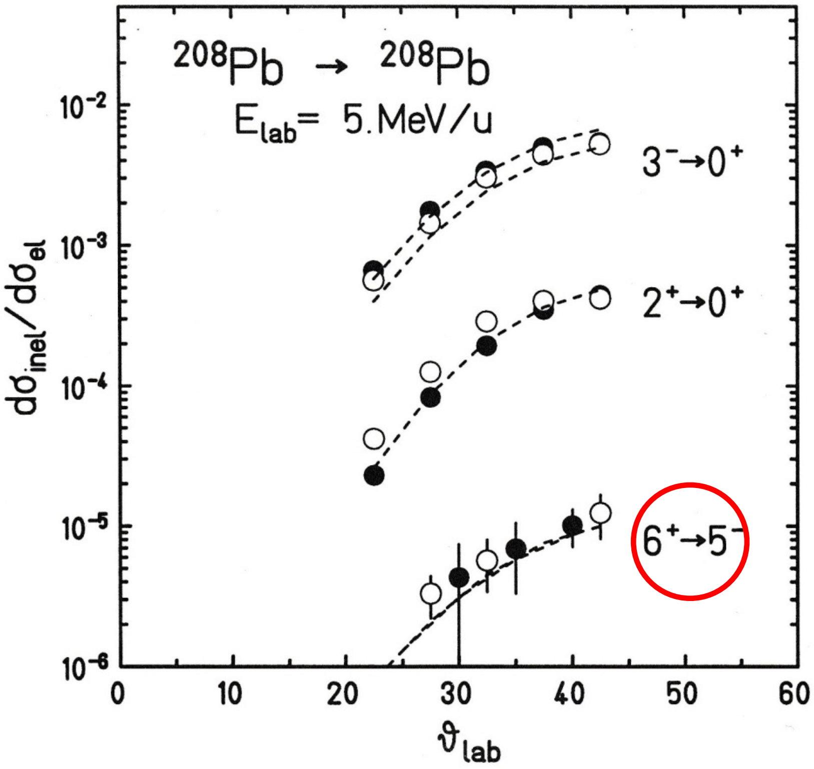


Coulomb Excitation for ^{208}Pb on ^{208}Pb



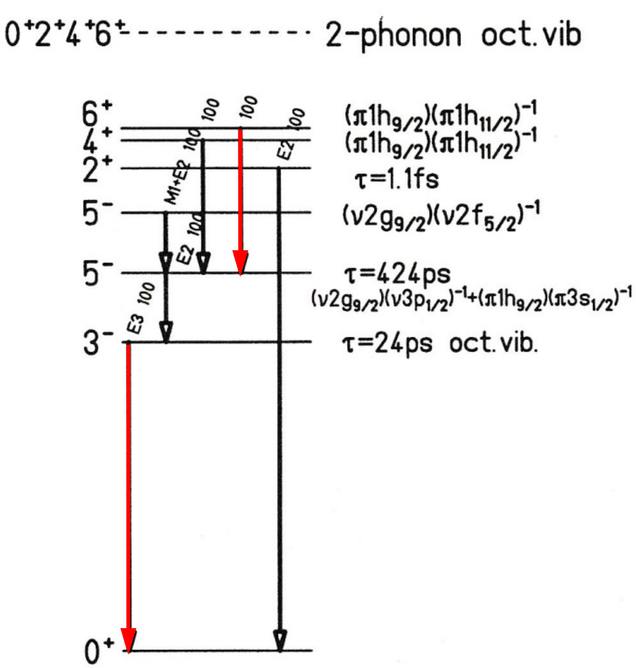


Coulomb Excitation for ^{208}Pb on ^{208}Pb at 5.0 MeV/u



$$\frac{B(E3; 6^+ \rightarrow 3^-)}{B(E3; 3^- \rightarrow 0^+)} = 0.35(11)$$

$2.0_{vibrational}$



Octupole Vibrational States in ^{206}Pb, ^{207}Pb, ^{208}Pb and ^{209}Bi

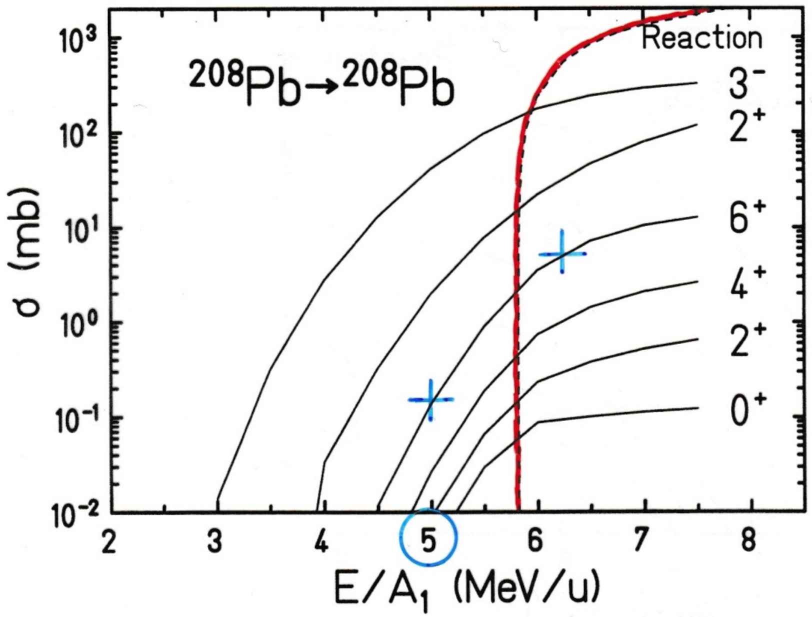
- vibrational excitation $\hbar\omega_3$ is very similar
- B(E3) values are well described in weak coupling model
- collective strength depends on particle configuration
- 2 – phonon octupole vibrational states not observed at 5 MeV/u (insufficient Compton suppression of EUROBALL detectors)
- 6^+ particle-hole state contains 18% of the collective vibrational strength
- transfer reactions (^{209}Pb) observed at 5 MeV/u

H.J. Wollersheim, E. Lubkiewicz, A. Gadea, J. Gerl, M. Kaspar, I. Kojouharov, Th. Kröll, R. Kulessa, I. Peter, M. Rejmund, J.A. Ros, H. Schaffner, Ch. Schlegel, K. Vetter
GSI-Darmstadt, Jagellonian University Cracow, I.F.I.C.-Valencia

Octupole Vibrational States in the Lead Region

^{208}**Pb** + ^{208}**Pb**; E/A$_1$ = 5 MeV/u

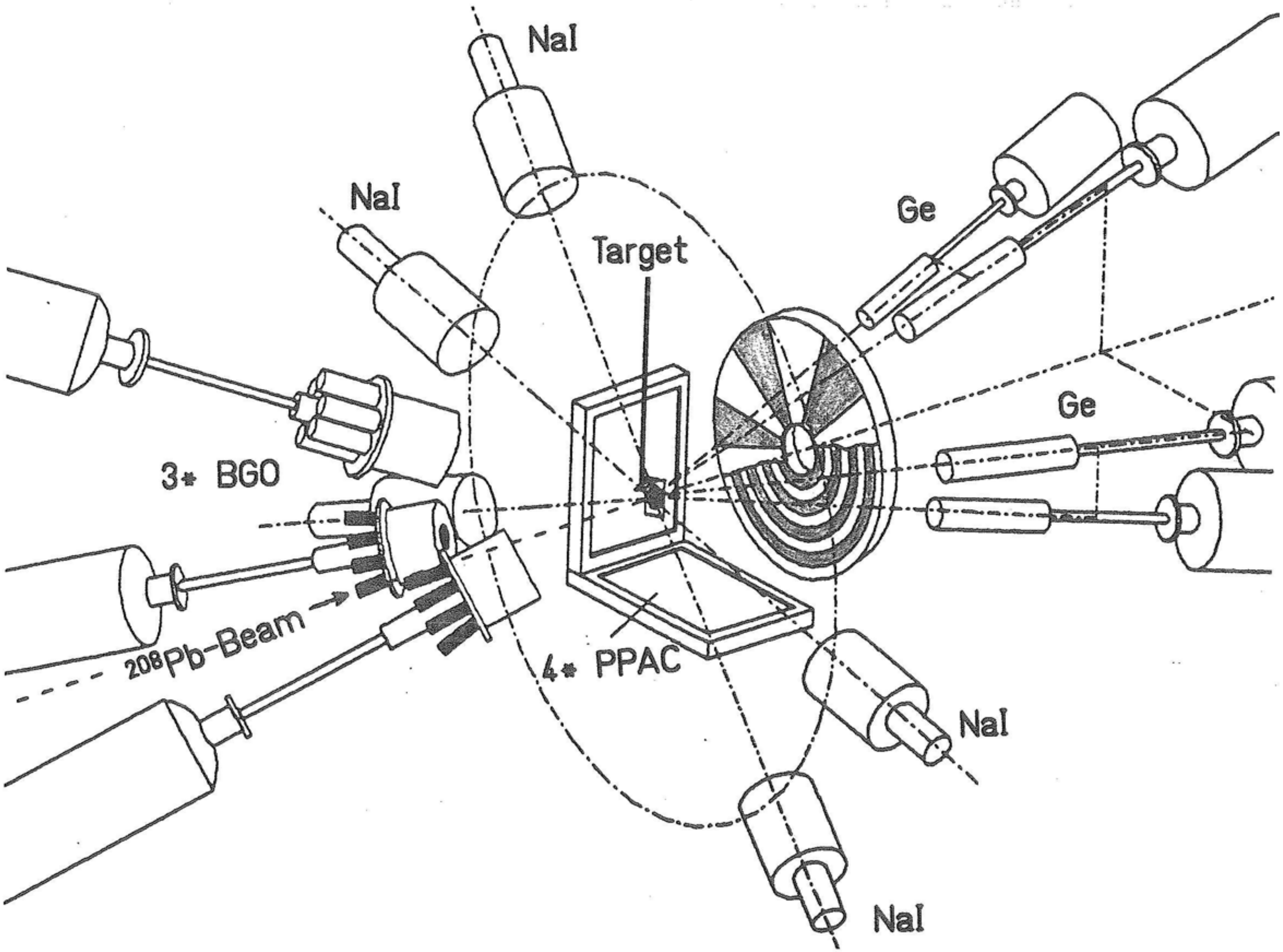
$$\sigma_{6^+} = 0.138\ mb$$
$$\sigma_{4^+} = 0.027\ mb$$
$$\sigma_{2^+} = 0.009\ mb$$
$$\sigma_{0^+} = 0.004\ mb$$



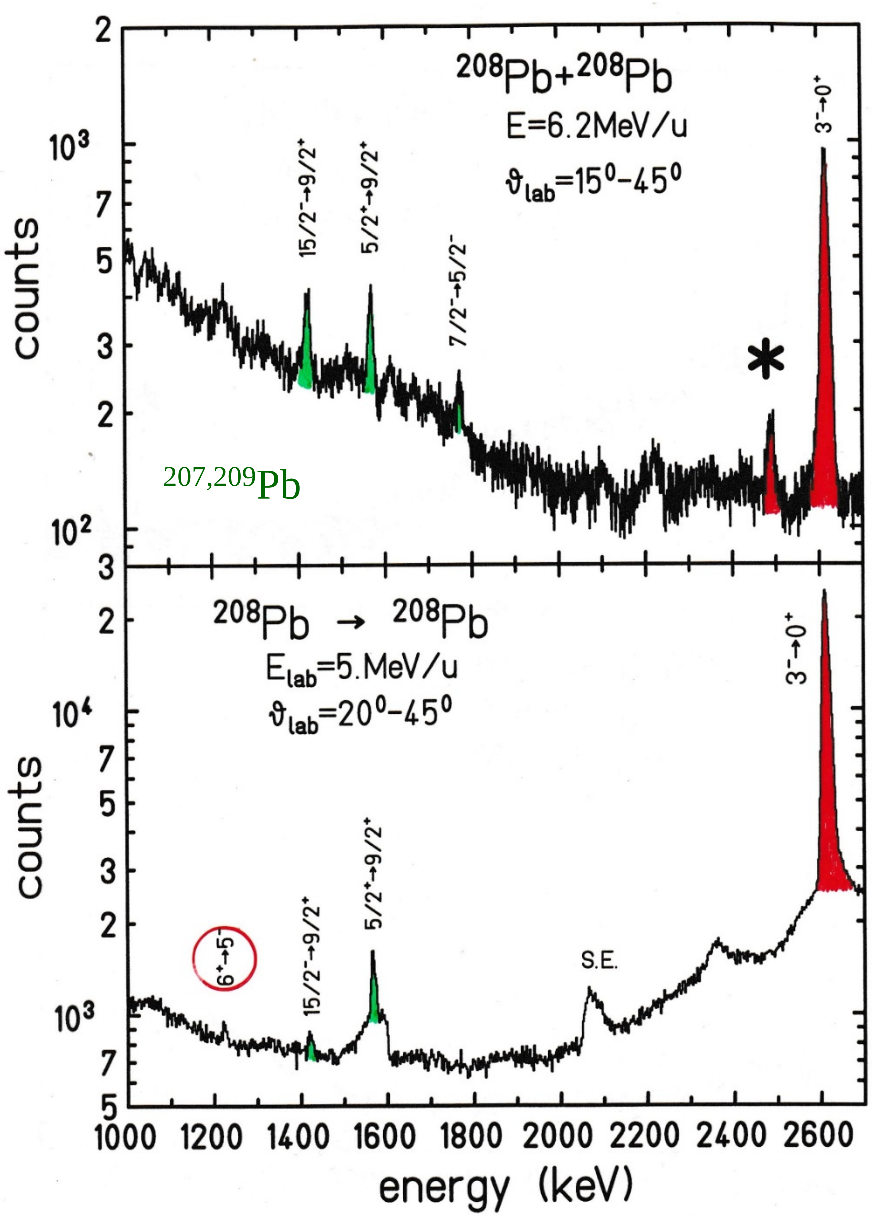
1-phonon

2-phonon

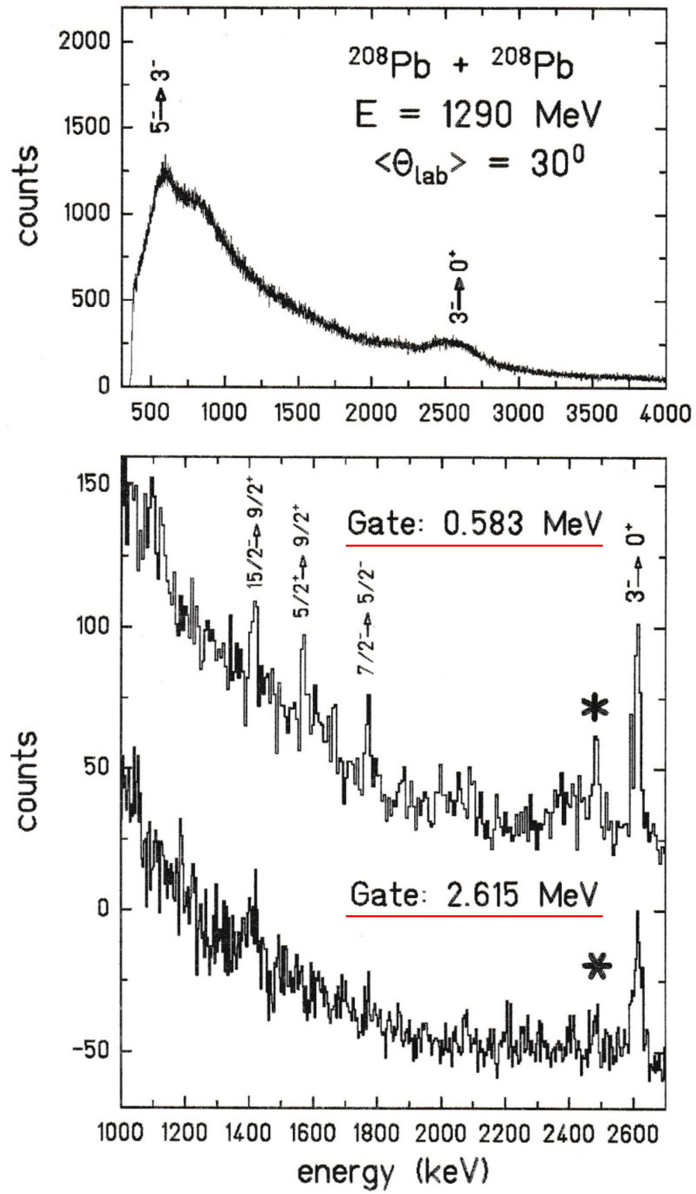
Experimental Setup for ^{208}Pb on ^{208}Pb at 6.2 MeV/u

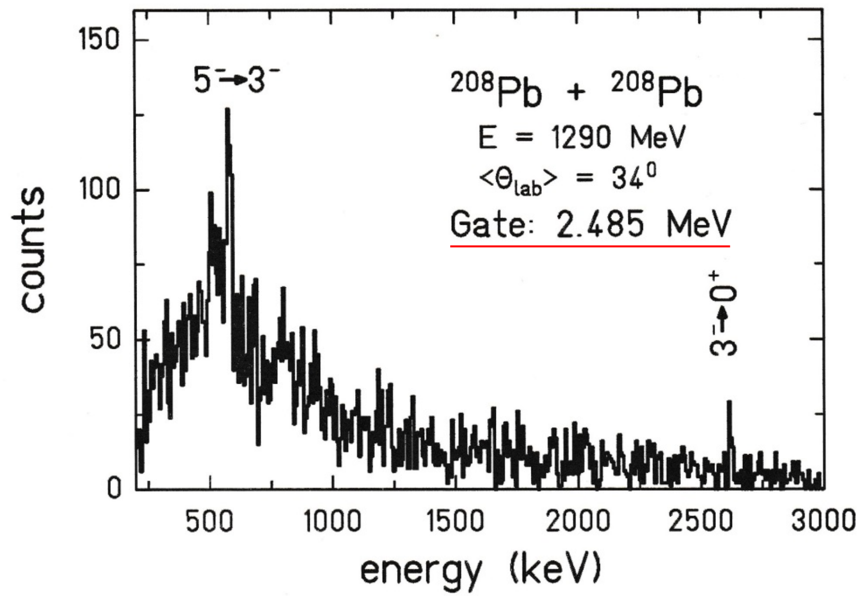


Coulomb Excitation for ^{208}Pb on ^{208}Pb at 6.2 MeV/u

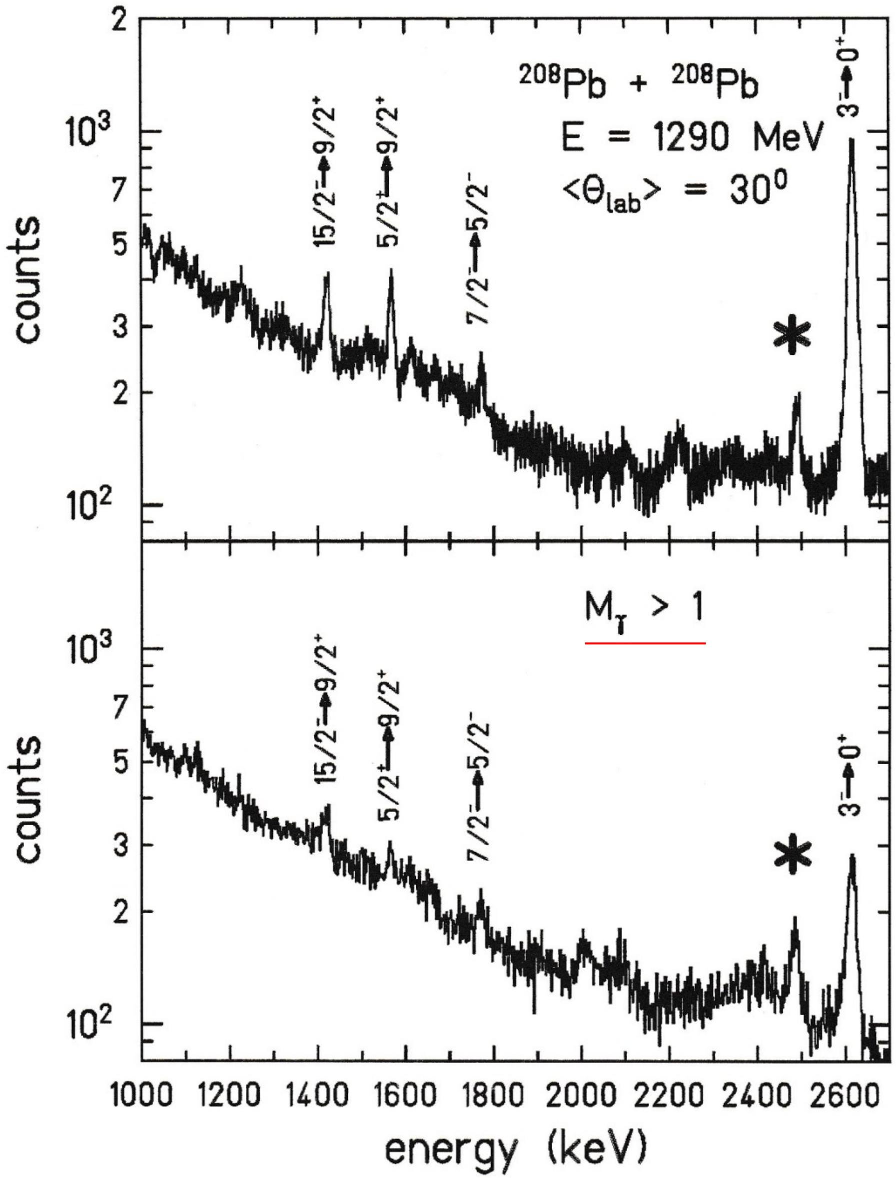


Coulomb Excitation for ^{208}Pb on ^{208}Pb at 6.2 MeV/u

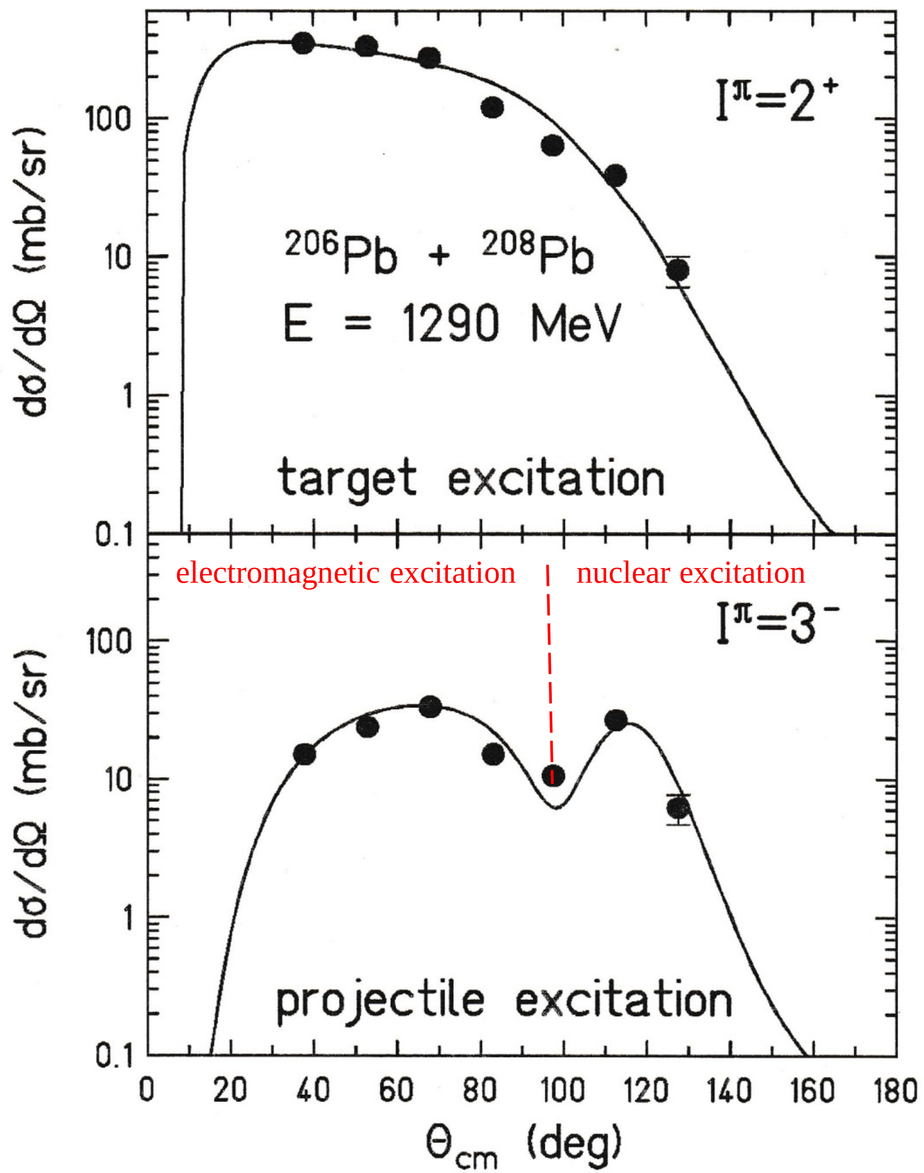




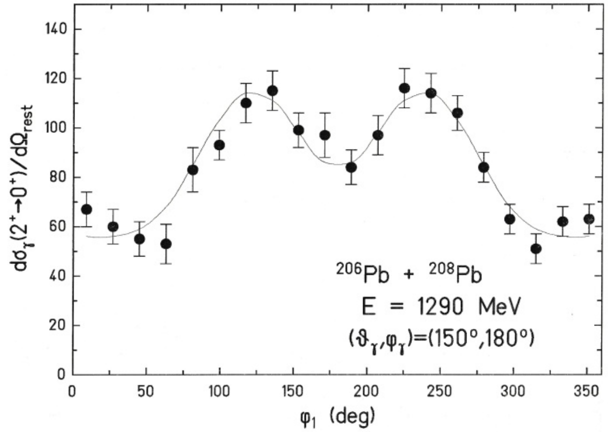
Coulomb Excitation for ^{208}Pb on ^{208}Pb at 6.2 MeV/u



Coulomb and Nuclear Excitation for ^{208}Pb on ^{206}Pb at 6.2 MeV/u



particle-γ angular correlation

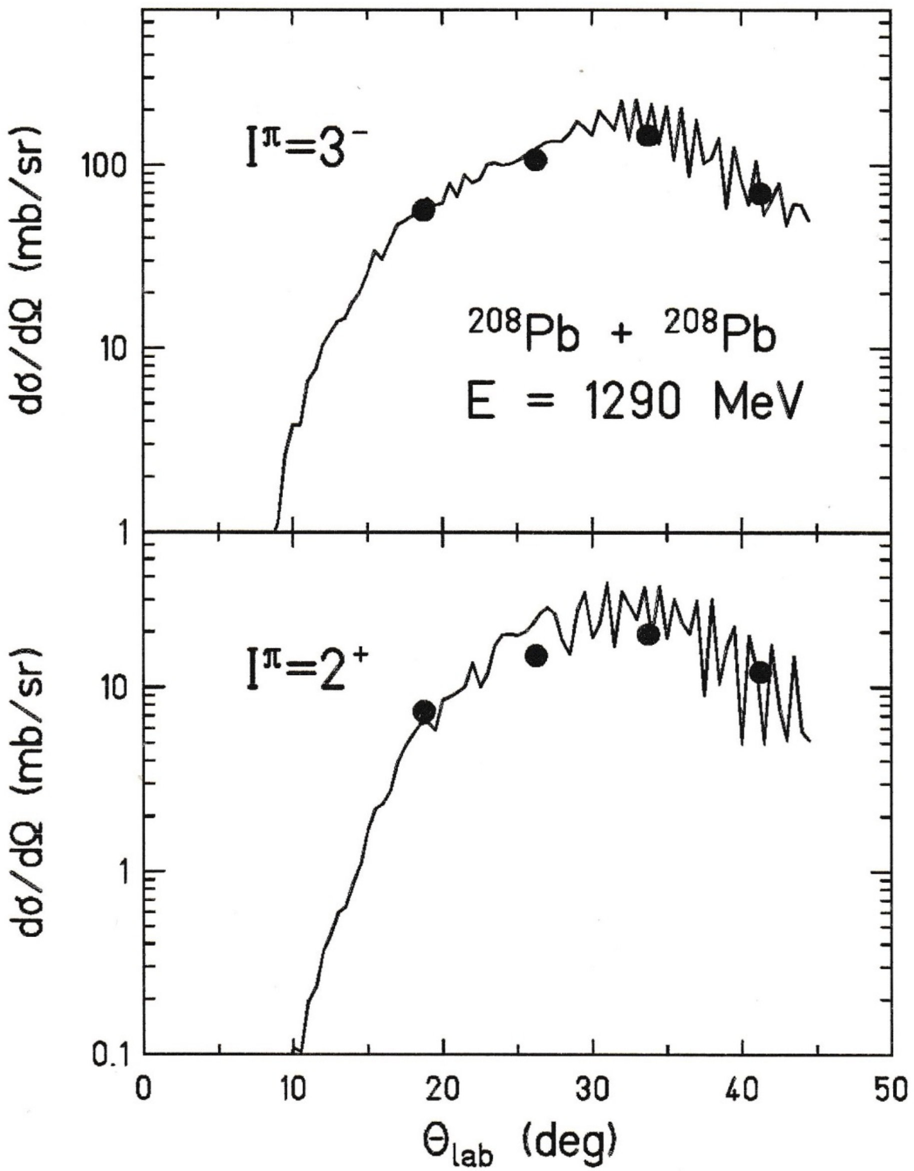


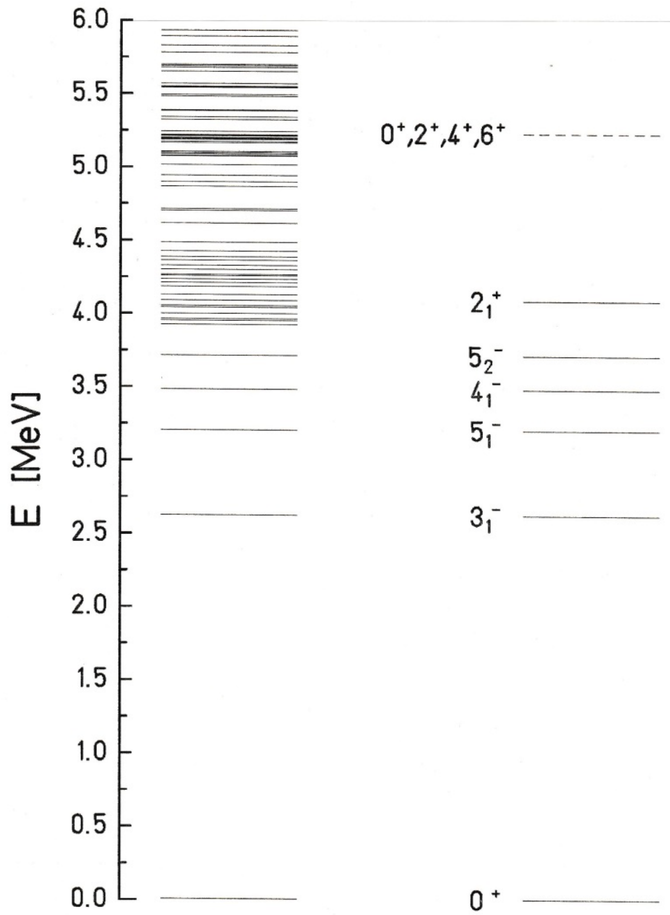
- $g(2^+) = 0$ → unperturbed p-γ angular correlation

$$\frac{\sigma_{nucl}}{\sigma_{total}} = 63\%$$

analysis with Ptolemy code

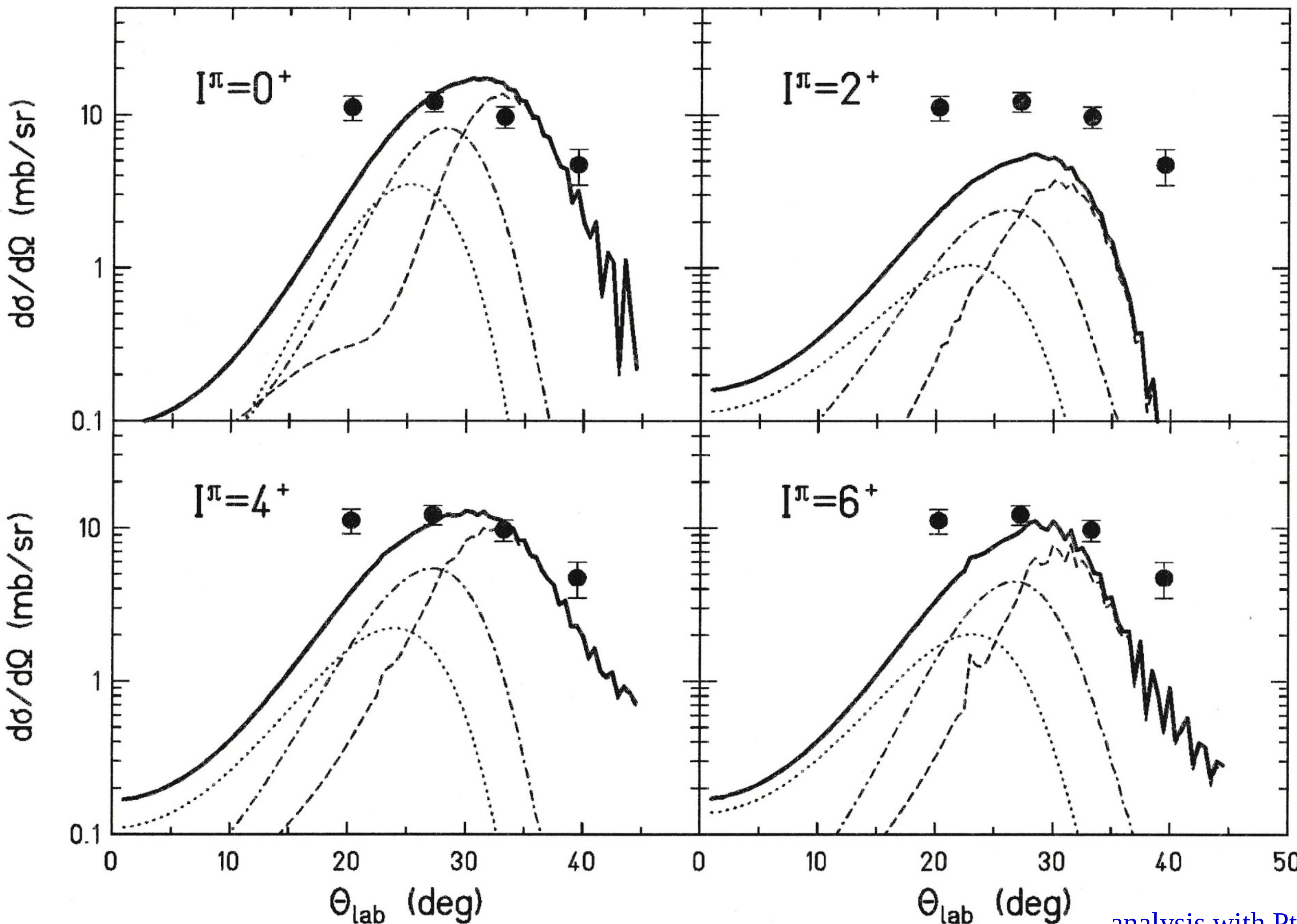
Coulomb and Nuclear Excitation for ^{208}Pb on ^{208}Pb at 6.2 MeV/u





analysis with Ptolemy code

Coulomb and Nuclear Excitation for ^{208}Pb on ^{208}Pb at 6.2 MeV/u



analysis with Ptolemy code

Energy Splitting of the 2-Phonon States