Exploring the Z=32 triaxiality corridor towards N=50 via safe Coulomb excitation at SPES

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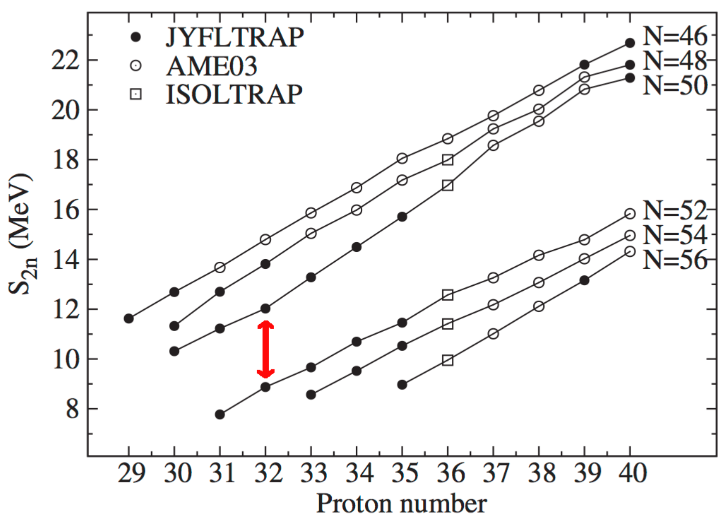
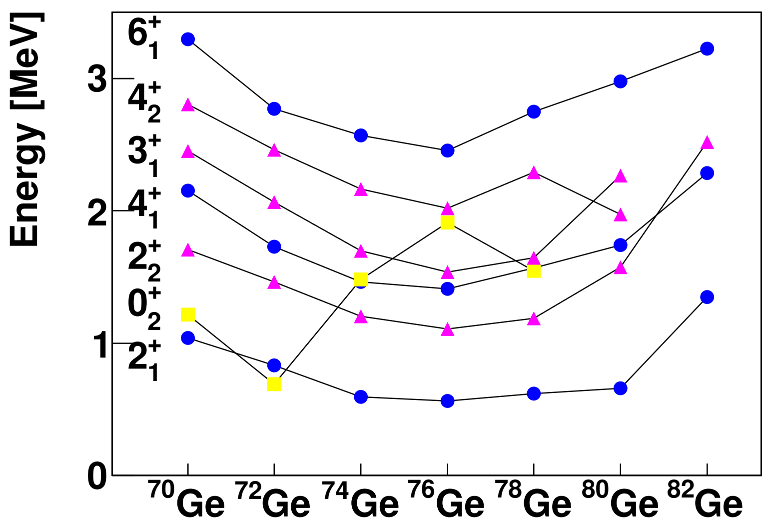
Motivation: triaxiality in Ge isotopes



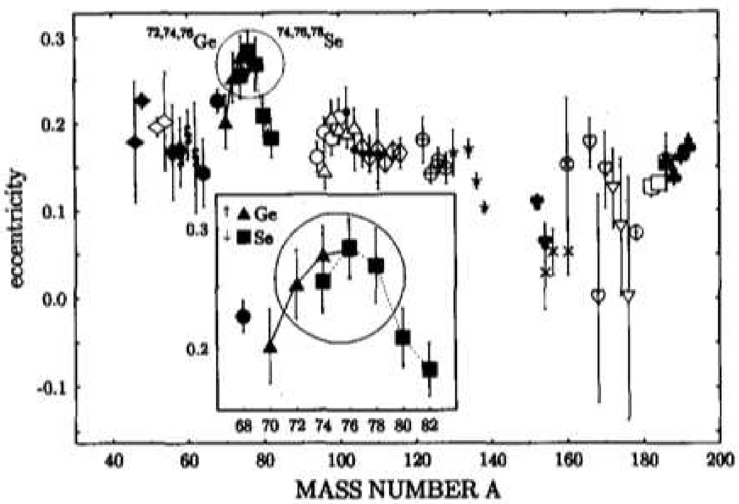
J. Hakala *et al*, PRL 101 (2008) 052502



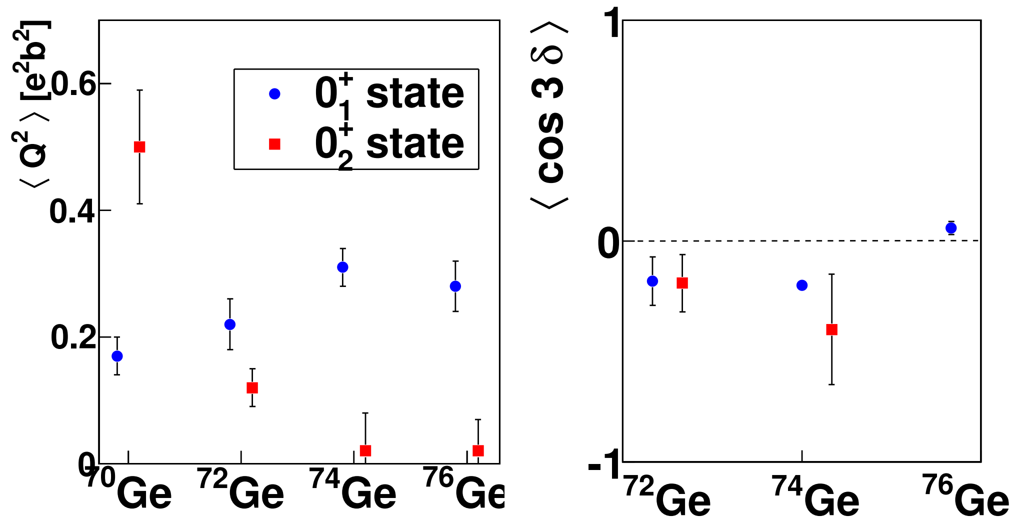
- Local minimum of the effective N=50 gap at Z=32, associated to a maximum of collectivity

- Substantial evidence for triaxiality in Ge isotopes:
  - observation of quasi-gamma bands (2^+_2, 3^+_1, 4^+_2)
  - odd-even staggering in the gamma band in ^{76}Ge interpreted as rigid triaxiality (Y. Toh *et al*, PRC 87 (2013) 041304)
  - analysis of ^{80}Ga $\rightarrow$ ^{80}Ge beta decay: coexistence of collective gamma-soft and spherical *qp* structures in ^{80}Ge (D. Verney *et al*, PRC 87 (2013) 054307)

Motivation: triaxiality in Ge isotopes



A. Andrejtscheff *et al*, Phys. Lett. B 329 (1994) 1



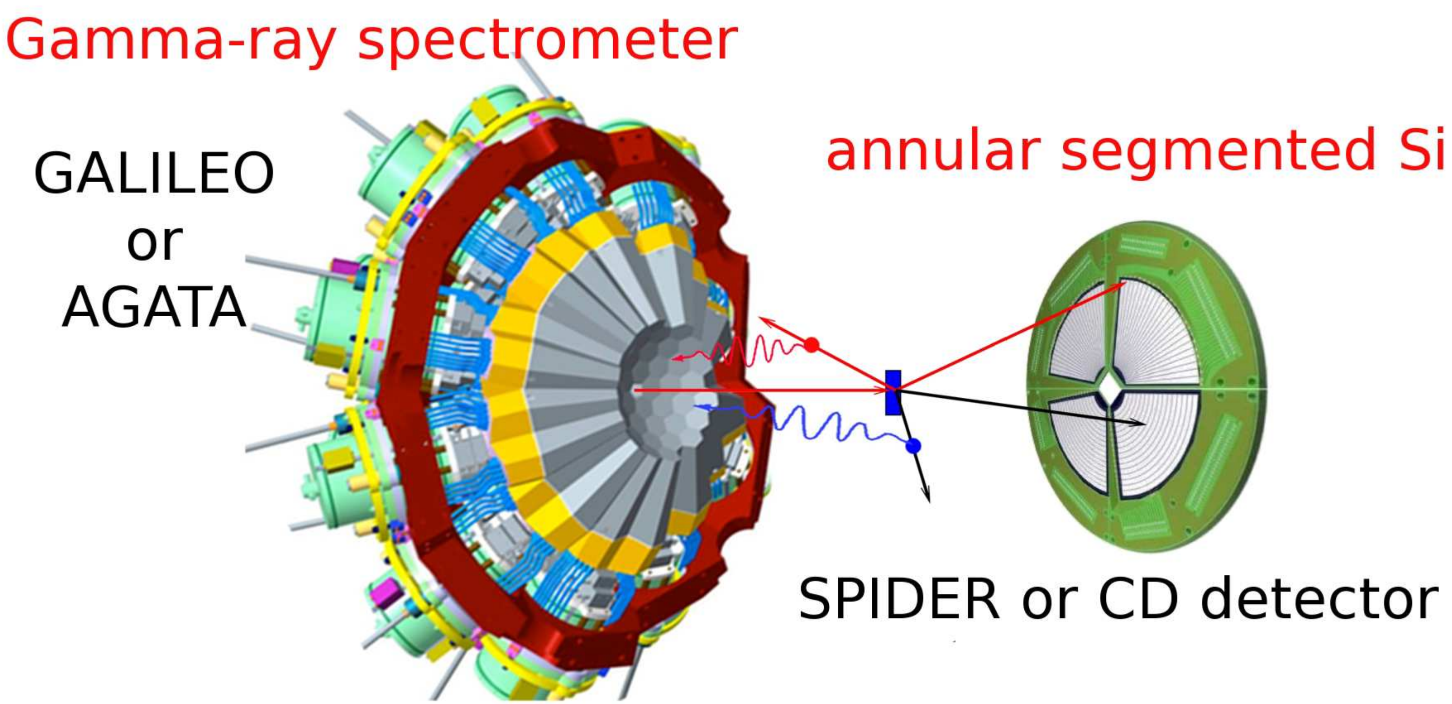
M. Sugawara *et al*, EPJ A 16 (2003) 409

- Triaxiality in stable Ge isotopes confirmed by measured transition probabilities
  - Full quadrupole sum rules approach or approximate evaluation consistent

- Transition probabilities and quadrupole moments in neutron-rich Ge isotopes crucial to understand evoultion of triaxiality towards N=50
- Expected high intensities of Ge beams from SPES make a low-energy Coulex experiment feasible in a short measuring time

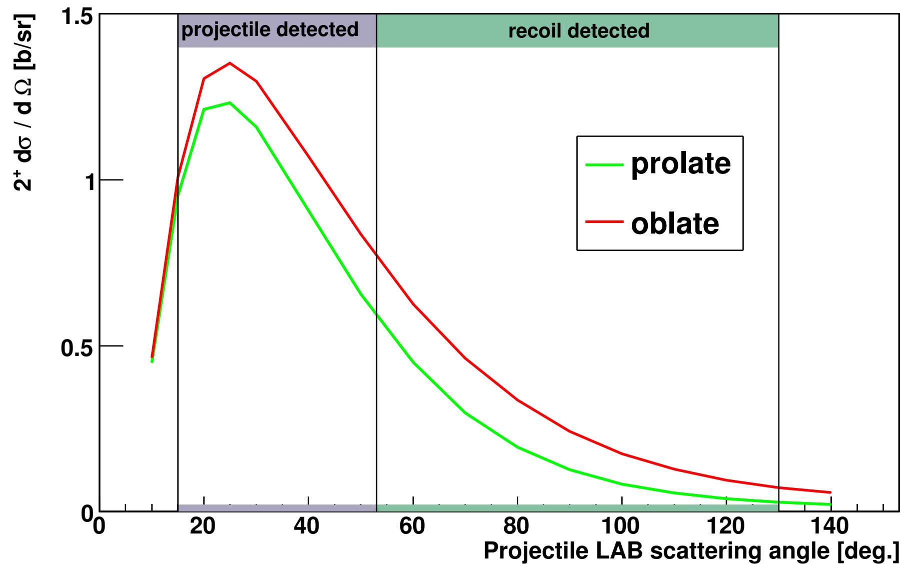
Experimental setup

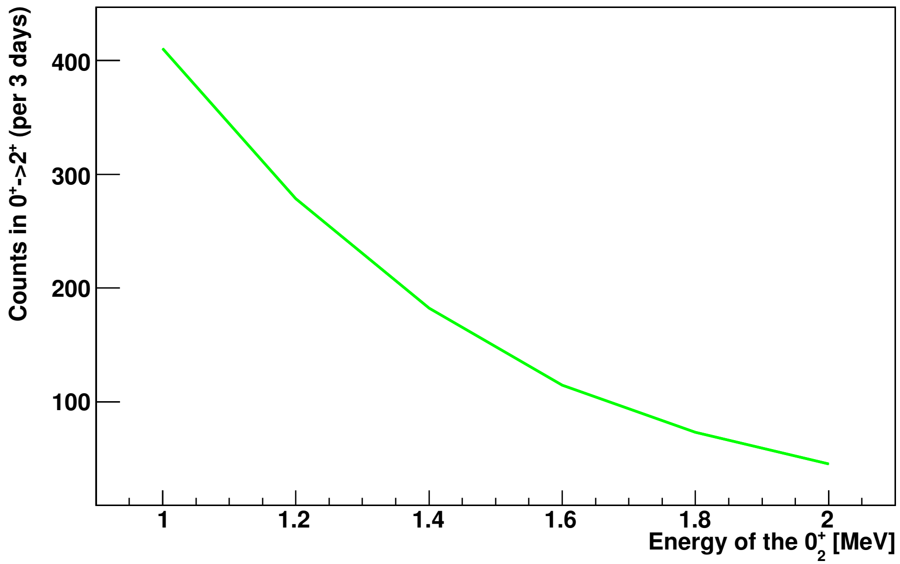
- standard Coulex setup with annular DSSSD detector placed at forward angles; detection of recoils and scattered projectiles



- intense SPES beams (^{78,80}Ge: 10^6 pps, ^{82}Ge: 10^5 pps)
- heavy targets (Pb, Pt) to maximise Coulex cross section
- GOSIA calculations for 2 mg/cm^2 Pb target

What can we obtain with SPES beams?





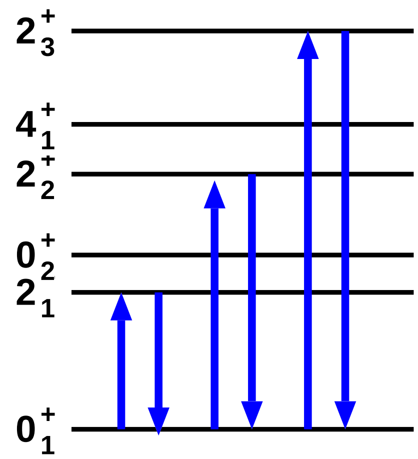
- quadrupole moments of 2_1^+ states in ^{78,80,82}Ge: rough estimate in one day of beamtime at 10^5 pps, precise measurement (20-30% accuracy) possible at 10^6 pps
- quadrupole moments of 2_2^+ states in ^{78,80}Ge measurable at 10^6 pps
- lifetimes of higher lying states – few days at 10^5 pps enough to get lifetimes of 4_1^+ and 2_2^+ states in N=50 ^{82}Ge
- possibility to identify the (unknown but predicted) 0_2^+ state in ^{80}Ge in a few days measurement at 10^6 pps
- detailed information on transition probabilities and static moments for ^{78,80,82}Ge, possibility to extract triaxiality parameters for ^{78,80}Ge via quadrupole sum rules approach

Quadrupole sum rules

D. Cline, Ann. Rev. Nucl. Part. Sci. 36 (1986)
K. Kumar, PRL 28 (1972)

- electromagnetic multipole operators are spherical tensors $\rightarrow$ products of such operators coupled to angular momentum 0 are rotationally invariant
- operator products may be expressed using the intermediate state expansion formula

$$\frac{\langle Q^2\rangle}{\sqrt{5}} = \langle i|\,[\mathrm{E2}\times\mathrm{E2}]^0\,|i\rangle = \frac{1}{\sqrt{(2I_i+1)}}\sum_t \langle i\|\mathrm{E2}\|t\rangle\langle t\|\mathrm{E2}\|i\rangle \left\{\begin{array}{ccc} 2 & 2 & 0 \\ I_i & I_i & I_t \end{array}\right\}$$



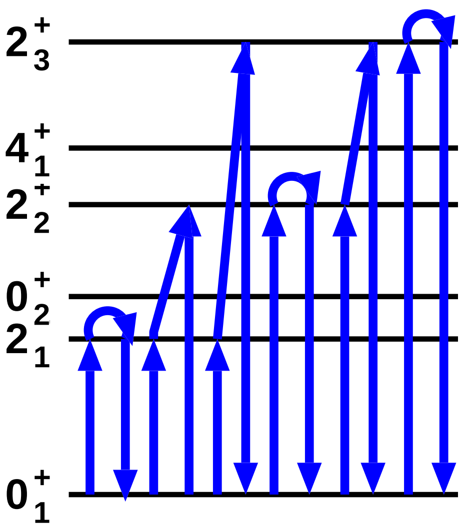
$\langle Q^2\rangle$: overall deformation parameter

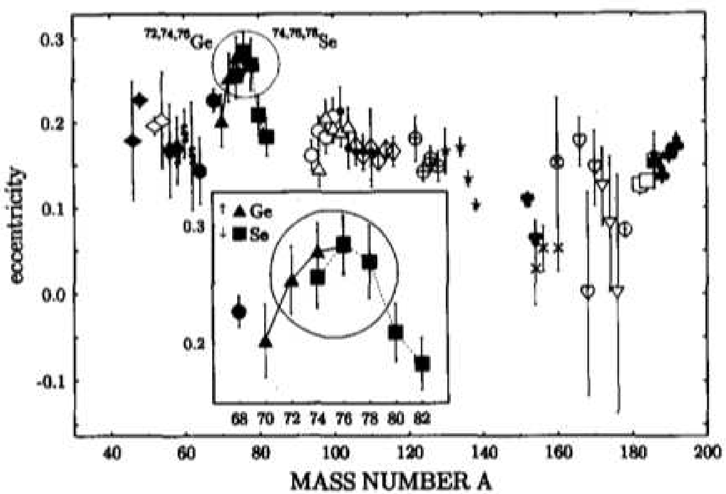
Quadrupole sum rules: triaxiality

D. Cline, Ann. Rev. Nucl. Part. Sci. 36 (1986)
K. Kumar, PRL 28 (1972)

$$\sqrt{\frac{2}{35}}\langle Q^3 \cos 3\delta\rangle = \langle i|\{[E2 \times E2]^2 \times E2\}^0|i\rangle$$

$$= \frac{1}{(2I_i+1)}\sum_{t,u}\langle i\|E2\|u\rangle\langle u\|E2\|t\rangle\langle t\|E2\|i\rangle \begin{Bmatrix} 2 & 2 & 2 \\ I_i & I_t & I_u \end{Bmatrix}$$





A. Andrejtscheff *et al*, Phys. Lett. B 329 (1994) 1

$\langle\cos 3\delta\rangle$: triaxiality parameter