Search for Triaxiality in ^{125}Te

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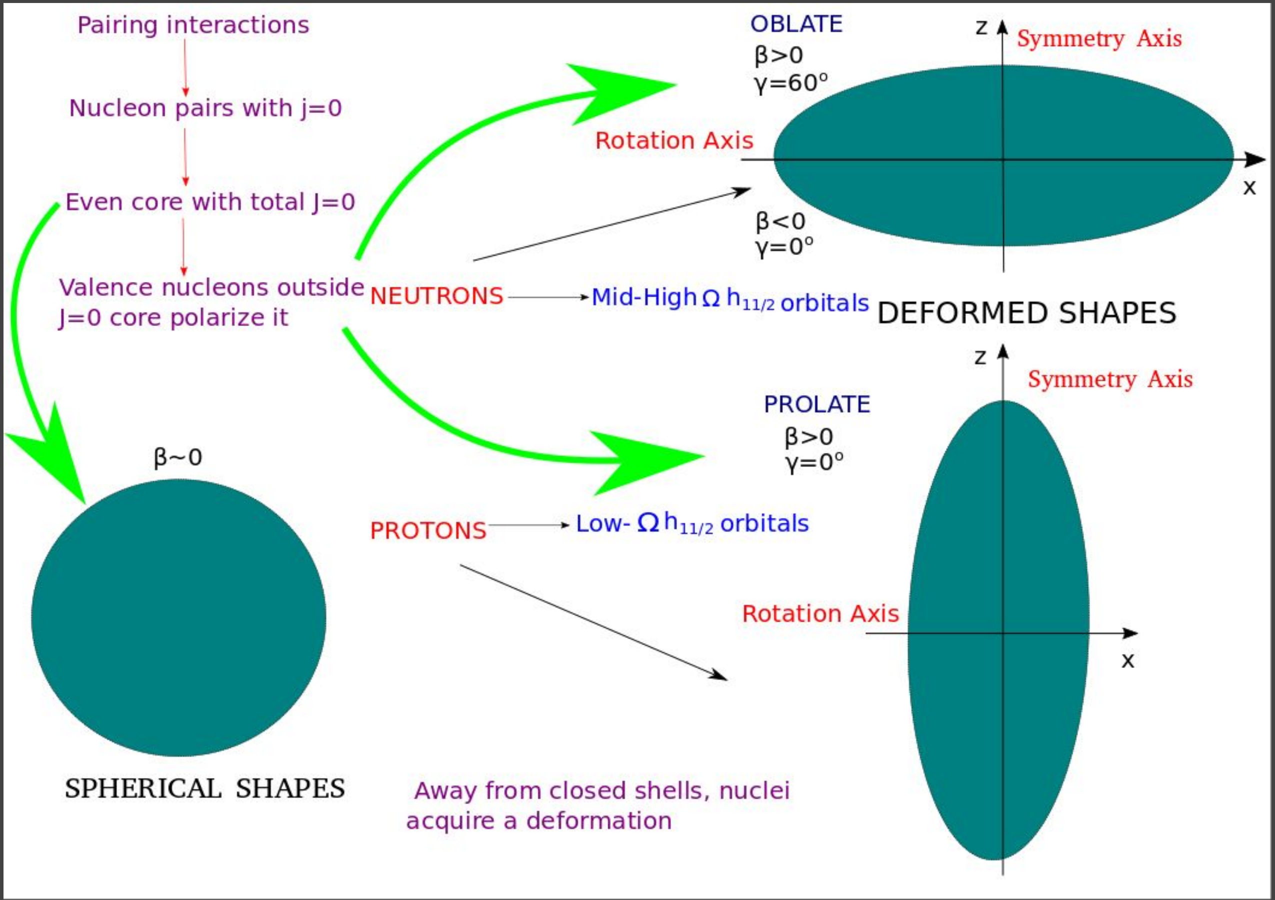
OUTLINE

- SHAPE CHANGES IN NUCLEI
- FINGERPRINTS OF TRIAXIALITY
- ^{125}Te : CANDIDATE TO STUDY SHAPE CHANGES
- EXPERIMENTAL DETAILS
- PRELIMINARY RESULTS
- REMARKS

SHAPE CHANGES IN NUCLEI



EXCITATION MECHANISMS

SINGLE-PARTICLE

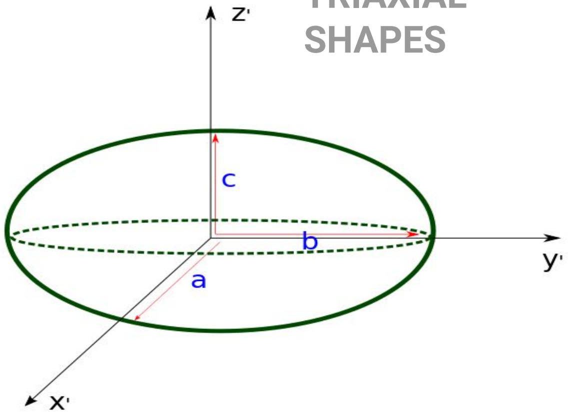
- ➔ IN NEAR-SPHERICAL NUCLEI
- ➔ ANGULAR MOMENTUM GENERATED BY NUCLEONS EXCITED OUTSIDE J=0 CORE

COLLECTIVE

- ➔ DEFORMED NUCLEI AWAY FROM CLOSED SHELLS
- ➔ COHERENT MOTION OF VALENCE NUCLEONS OUTSIDE J=0 CORE

a=b≠c : AXIALLY SYMMETRIC SHAPES

a≠b≠c : AXIALLY ASYMMETRIC OR TRIAXIAL SHAPES



A GENERAL DEFORMED NUCLEUS WITH SEMI- AXES a, b AND c IN THE BODY-FIXED FRAME (x'y'z')

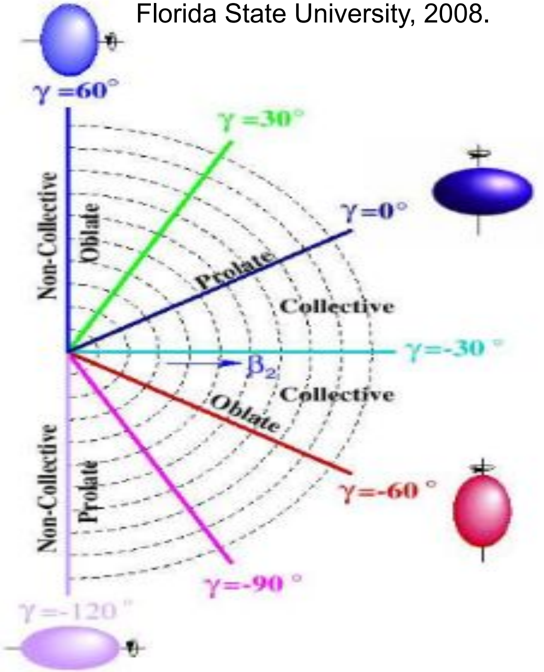
IN β- γ PLANE:

PROLATE SHAPES
$\gamma = 0^{0}, -120^{0}$

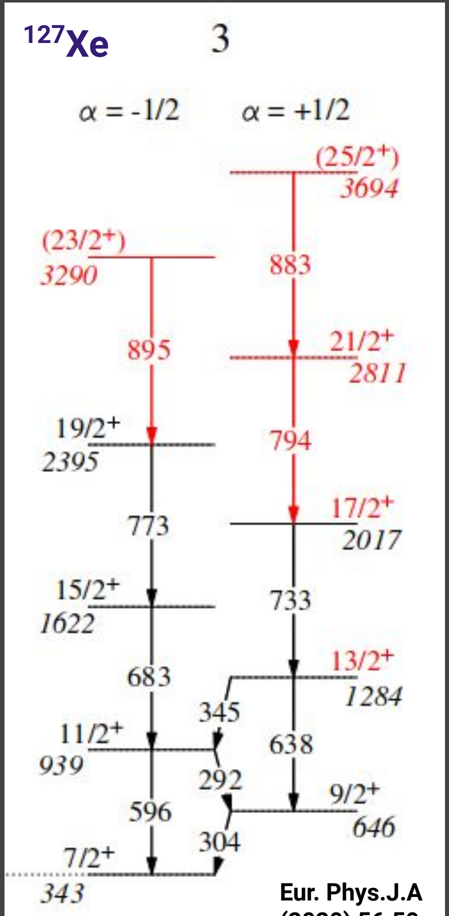
OBLATE SHAPES
$\gamma = \pm 60^{0}$

INTERMEDIATE VALUES OF γ CORRESPOND TO TRIAXIAL SHAPES

W. T. Cluff, **The high spin structure of 134,135Ba and120Te,**PhD thesis, The Florida State University, 2008.



FINGERPRINTS OF TRIAXIALITY



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REGULAR SEQUENCE ROTATIONAL BAND ($\Delta I = \hbar$)

↓

SPLITS INTO TWO BANDS ACCORDING TO THEIR SIGNATURE (α) WITH $\Delta I = 2\hbar$: **SIGNATURE SPLITTING**

↓

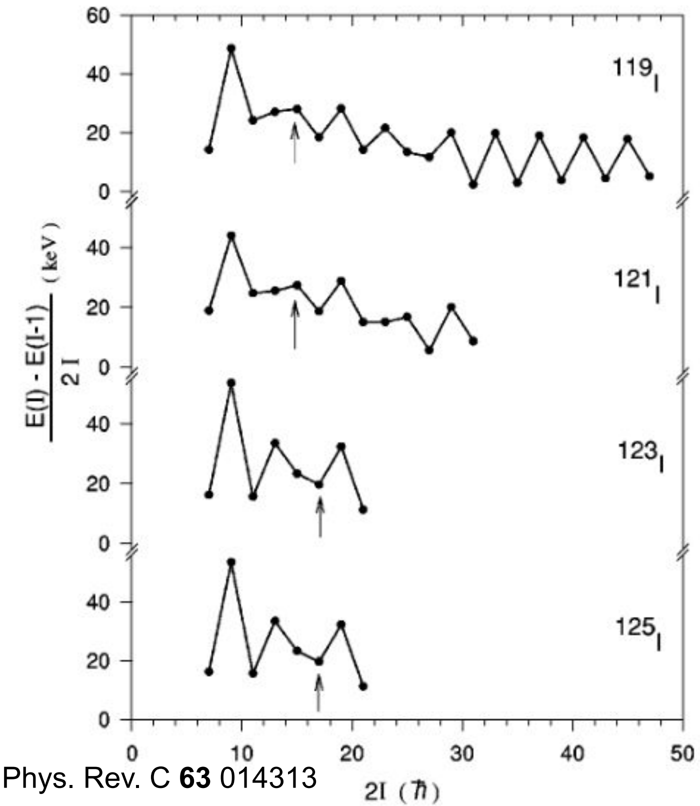
FAVORED BAND: **LOWER IN ENERGY**
UNFAVORED BAND: **HIGHER IN ENERGY**

Degree of signature splitting gives information on the coupled or decoupled nature of the band.

The band based on $g_{7/2}$ splits into two with signatures -1/2 and +1/2

Expected favored band may sometimes lie higher in energy : **SIGNATURE INVERSION**

SIGNATURE SPLITTING IN $^{119,121,123,125}I$, ^{127}Xe



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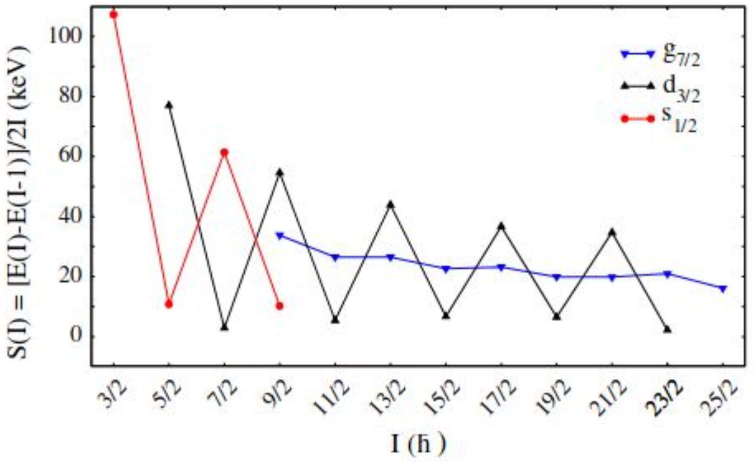


- ➢ Signature Inversion observed when a triaxially deformed nucleus (with γ>0) is cranked around the **shortest axis** ("positive-γ rotation") .
- ➢ Predicted to be observed in nuclei that are soft w.r.t γ-deformations.
- ➢ Alignment of the quasiparticles polarizes the core to give a triaxial deformation.

^{125}Te : CANDIDATE TO STUDY SHAPE CHANGES

- A~125 mass region is susceptible to shape changes

- Presence of the $h_{11/2}$ intruder orbitals drives nuclear shape-
  Protons drive the nucleus to a prolate shape
  Neutrons drive the nucleus to an oblate shape

- Structure of ^{125}Te characterized by a neutron hole coupled to the even-even ^{126}Te core.

- The Te isotopes lie in the transitional region between the SU(5) and O(6) limits → transition to a triaxial shape can be expected at certain spin values

EXPERIMENTAL DETAILS

- **Target:** **^{124}Sn of 8.1mg/cm^2 thickness**
- **Projectile:** **α-beam operated at 35 and 31 MeV energies**

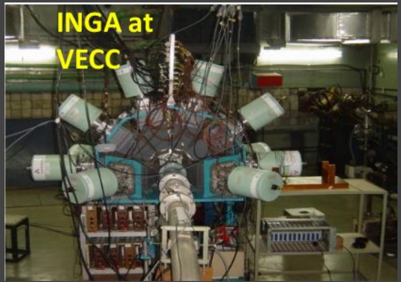
Beam obtained from **K-130 cyclotron** at **VECC, India.**

Gamma-Gamma coincidences were recorded by the **Indian National Gamma Array (INGA)**

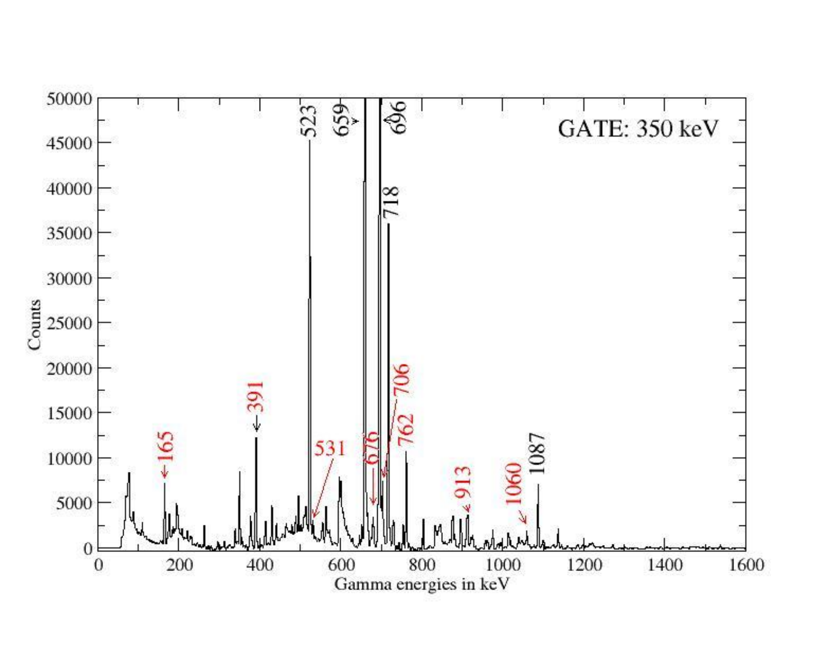
INGA Set-up:

7 Compton suppressed HPGe detectors arranged in a ring: 4 detectors at 90°, 2 at 125° and 1 at 40°

- **Total events recorded:** **5.3x10^6**



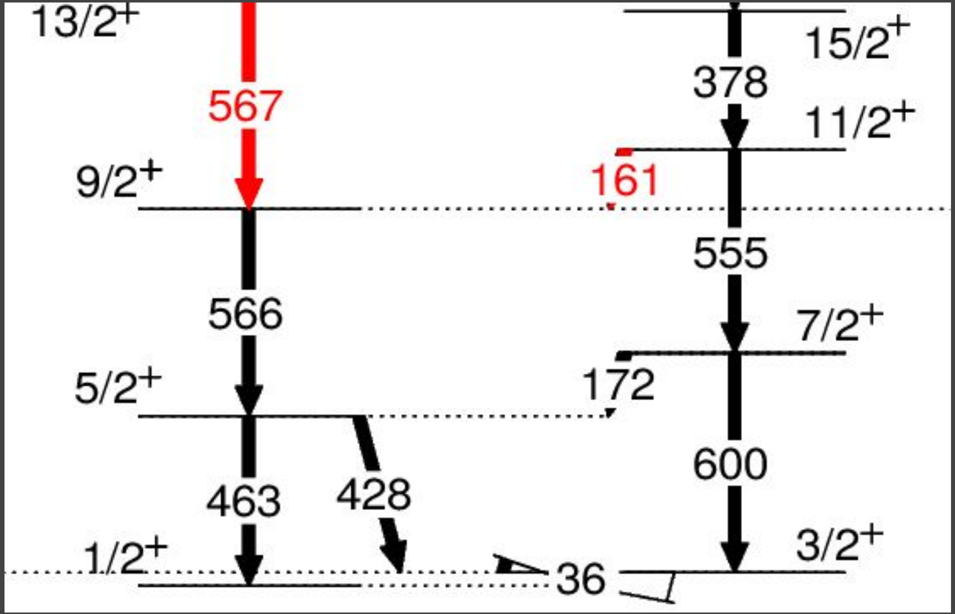
The INGA setup at VECC (2017). (G. Mukherjee, International Conference on recent issues in Nuclear and Particle Physics, 2019)



Some of the transitions obtained in the present work. New ones are marked in red.

PRELIMINARY RESULTS

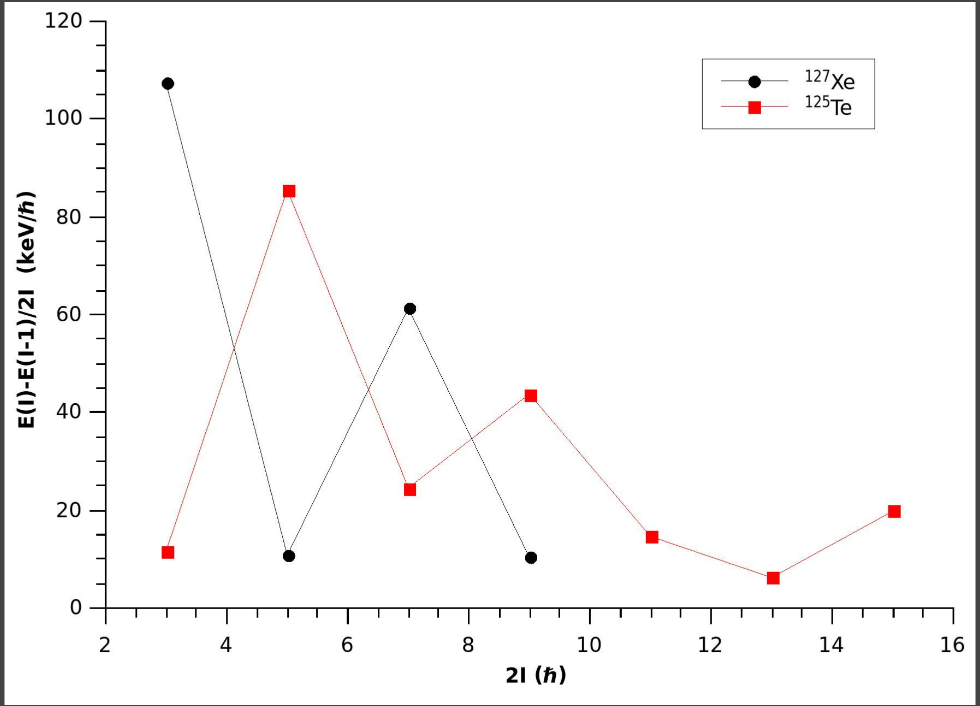
- Level Scheme extended by placement of 30 new gammas.
- Based on the positive parity 1/2 and 3/2 levels, two structures have been extended to spin 23/2 ℏ
- They have been identified as the favored and unfavored partners of the one-quasi particle band based on $s_{1/2}$
- Possible signature inversion at 13/2 ℏ



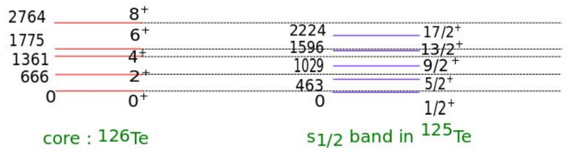
Partial level scheme obtained in the present work

Phase of energy staggering is reversed after I=13/2ħ → Signature Inversion

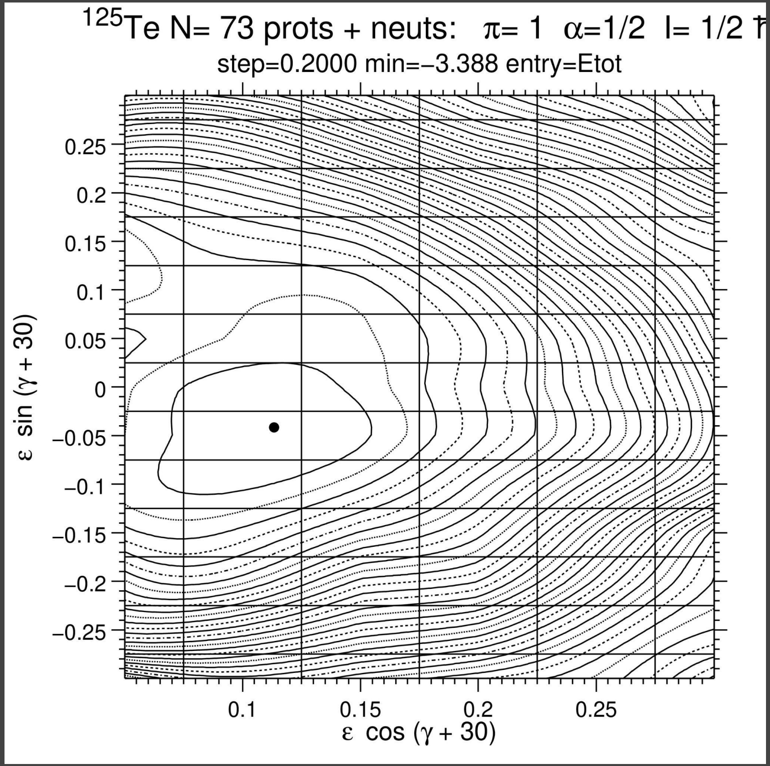
Indications of coupled nature of band

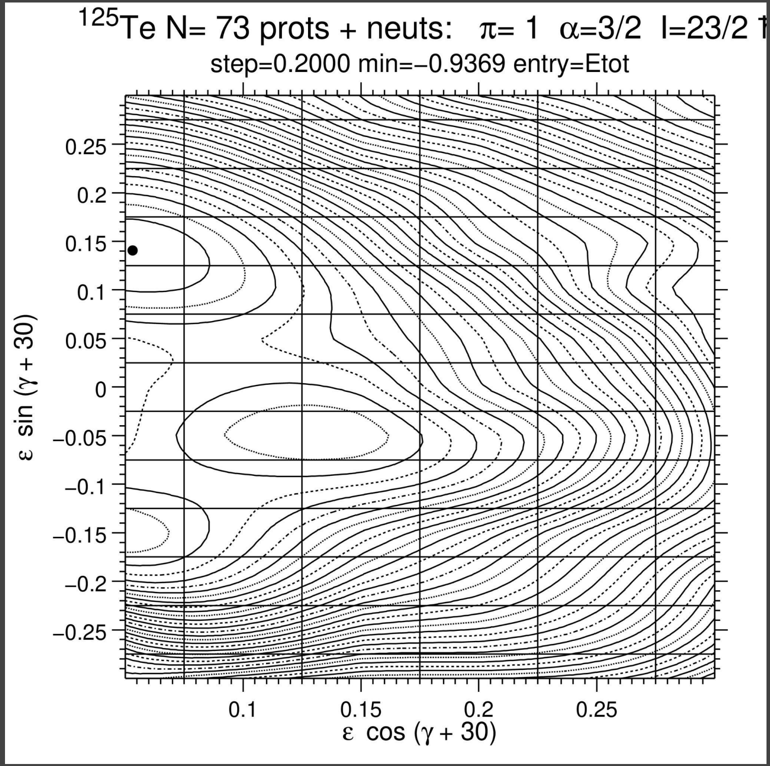


OBSERVED STAGGERING IN THE POSITIVE PARITY BAND OF ^{125}Te COMPARED WITH ^{127}Xe (ISOTONE WITH N=73)



COMPARISION OF EXCITATION ENERGIES OF POSITIVE PARITY BAND OF ^{125}Te WITH THE CORE ^{126}Te

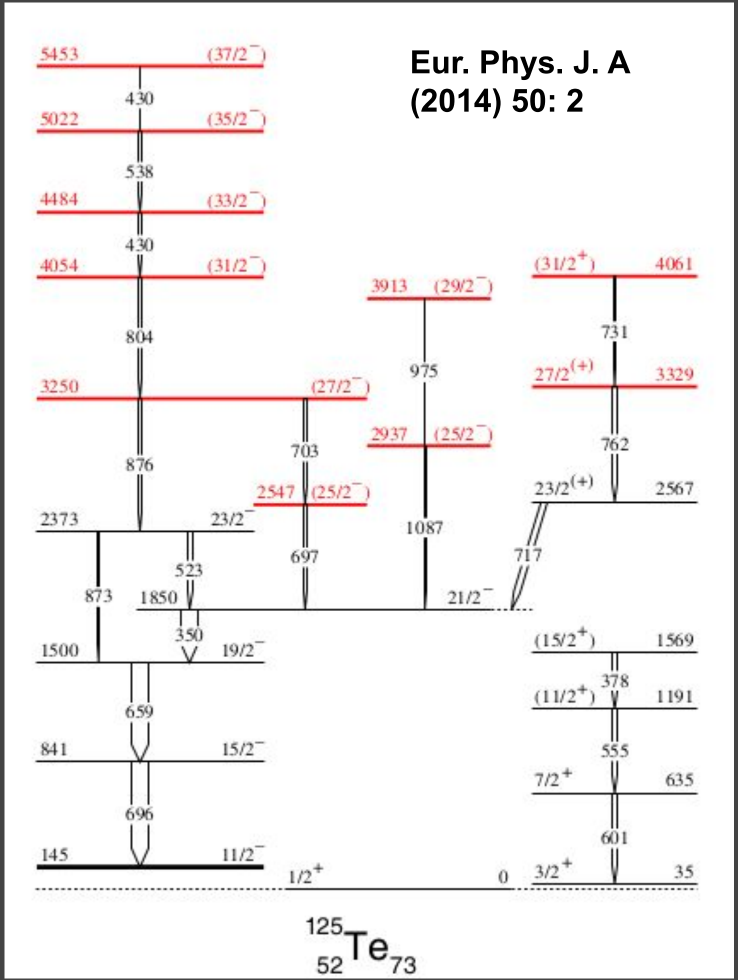


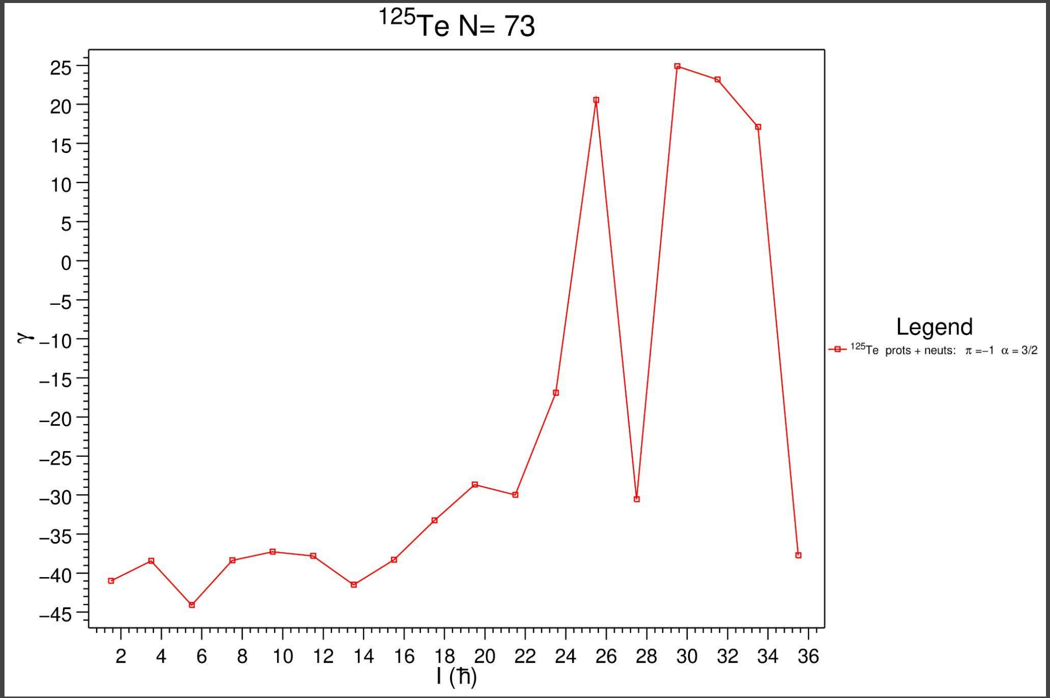


Spin I=1/2ħ : Minimum is obtained for ϵ=0.12 and γ=-50.5°

Spin I=23/2ħ : Minimum is obtained for ϵ=0.15 and γ=39.0°

(Potential energy surfaces generated using Ultimate Cranker)





γ values plotted as a function of spin

Rapid changes in shape observed for spin values greater than 25ħ

REMARKS

- Observation of the favored and unfavored partners of the band based on the $s_{1/2}$ orbital.
- Signature splitting and signature inversion observed - presence of triaxiality.
- γ values vary from -40° to 25° indicating the γ-soft nature of the nucleus.
- Similar bands observed in ^{127}Xe, N=73 isotone of ^{125}Te. Particle-rotor model calculations indicated a mixed configuration for these bands with maximum contribution from $d_{3/2}$ followed by the $s_{1/2}$ orbitals. (Eur. Phys.J.A (2020) 56:50)
  Similar configuration can be expected in ^{125}Te.

  Further study to include the assignment of the configurations of the bands obtained.

Thank you!