Low Lying States of Te-Isotopes

S S Tiwary[1], S Chakraborty[1], C Majumder[1], P K Prajapati[1] R P Singh [4], S Muralithar [4]
S Ganguly [3],P Banerjee [2] and H P Sharma[1]
[1]*Department of Physics, Banaras Hindu University, Varanasi, India*
[2]*Saha Institute of Nuclear physics, Kolkata, India*
[3]*Department of Physics, Bethune College, Kolkata, India and*
[4]*Inter University Accelerator Center, new Delhi, India*

Introduction

The systematic of the low-lying states of the even mass Te isotopes show that the first 4^+ state has nearly twice the energy of the first 2^+ state [1,2]. In $^{118-126}$Te isotopes, the 0^+, 2^+, 4^+ two phonon triplet states are also observed. Also the energy of the 6^+ state is observed nearly three times the energy of the first 2^+ state in several Te isotopes [3]. These observation indicates vibrational nature of these states in Te nuclei as also suggested by the IBA model for U(5) nuclei [1,2].

However, the systematic observation of the energy of the 6^+ and 8^+ states do not follow the pattern of 4^+ states as a function of neutron number, but remains nearly constant in energy. The energy ratio of the E_{6+}/E_{2+} clearly disagrees from the collective rotor (~7). Figure 1 show the systematic trend of the E_{6+}/E_{2+} value as a function of neutron number, which do not follow the line correspond to the vibrational value for this ratio (~3). Further, the energy of the second 2^+ state is also about 400 keV higher than the 4^+ state. These observations were understood by considering the slightly non harmonic vibration motion.

In coulomb excitation studies for $^{120-124}$Te nuclei the asymmetric rotational nature was predicted for the low lying 0^+, 2^+, 4^+ and 6^+ states [5] . Author also suggested $\gamma \sim 25^0$ (triaxial parameter) for these nuclei. Although energies of the states are predicted well with asymmetric rotor model but the experimental reduced transition probabilities for the 6^+ state do not agree. The predictions of the IBA-2 model also do not agree with the experimentally determined reduced transition probabilities for the 6^+ state [5]. Hence systematic investigation of low lying states in Te nuclei was carried out.

Results and discussion:

In the present investigation systematic study of low lying states of even mass Te isotopes were performed by collecting the available data on low lying 0^+, 2^+, 4^+ and 6^+ states. Experimental reduced transition probabilities B(E2) were calculated from the life time data available for the low lying states[8]. The B(E2) values are also compared with the prediction of rotational and vibrational models as results are given in table 1. Details of these calculations are given elsewhere [6].

Figure 2 and 3 show the plots of the experimental B(E2) and calculated B(E2) from the rotational and vibrational models for the ^{126,128}Te nuclei. These results clearly indicate the disagreement of the experimental B(E2) from the prediction of the B(E2) calculated from the rotational models and also from the vibrational model and hence more study is needed for the understanding of these behavior of low lying states.

Table 1.

	life time (in ps)	BE2 exp in wu	BE2 rot. in wu	BE2 vib. in wu
^{118}Te				
2^+	8.8	33 (5)	33	33
4^+	4.4	68 (8)	66	56
6^+	3.4	79 (8)	99	70
^{120}Te				
2^+	9.3	45 (6)	45	45
4^+			91	78
6^+			137	98
^{122}Te				
2^+	7.46	55 (7)	55	55
4^+			110	94
6^+			165	118
^{124}Te				
2^+	6.2	48 (7)	48	48
4^+	1.4	150 (12)	96	82
6^+			144	102
^{126}Te				
2^+	6.52	27 (5)	27	27
4^+	2.8	51 (7)	55	47
6^+	68	28 (5)	82	59
^{128}Te				
2^+	3.32	31 (5)	31	31
4^+			62	53
6^+	480	16 (4)	93	67
^{130}Te				
2^+	2.3	24 (4)	24	24
4^+			49	42
6^+	9800	12 (3)	73	52

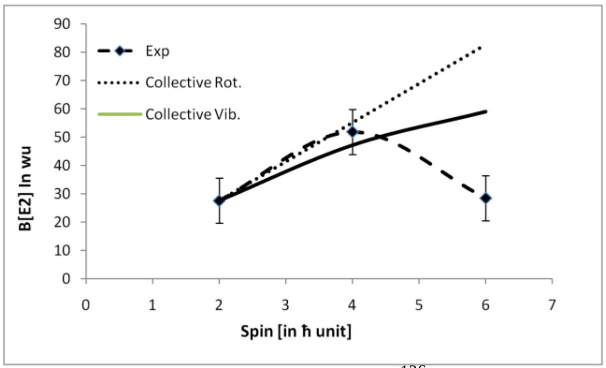

Figure2. Plots of B(E2) vs Spin of ^{126}Te, shows quite contrasting behavior with collective models.

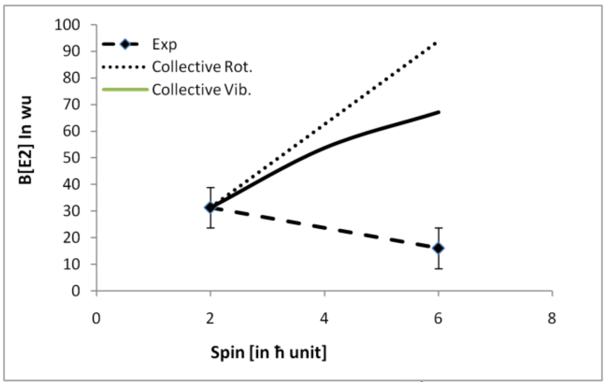

Figure3. Plots of B(E2) vs Spin of ^{128}Te, shows quite contrasting behavior with collective models.

In spite of the reasonable inconsistency in the available level systematic, the theoretical considerations should be substantiated by experimental values of the reduced E2 transition probabilities between the 6+ to 4+ states in order to clarify better the role of the different possible vibrational and quasiparticle band structures. These studies are known to require considerable efforts. From the presented results, it seems to needed a thoroughly investigation of whole isotopic chains even-even isotopes, within a single model, in order to understand better the evolution of such complex excitations in spherical nuclei. Work along this line is in progress and the results will be reported in the future.

Acknowledgement:
The first author also thankful to the UGC for financial support vide contract no. 23/06/2013(I) EU-V.

References:-

[1] W.T. Chou, R.E Casten and N.V. Zamfir, Phys. Rev. C 46 (1992) 2283
[2] J. Kern, EE. Garrett, J. Jolie and H. Lehmann, Nucl. Phys. A 593 (1995) 21.
[3] A Kerek , Nucl. Phys A176 (1971) 466.
[4] J. ott et al. Nucl. Phys. A 625 (1997) 598
[5] M Saxena et al, PRC 90, 024316 (2014)
[6] O. Moller et al, PRC 71, 064324 (2005)
[7] E. Degrieck Nucl Phys A231 (1974) 141
[8] S. Raman et al, Atomic Data and Nuclear Data Tables 78, 1–128 (2001)