First observation of highly deformed bands in ^{120}Te

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Introduction

Te isotopes (Z=52) with two protons outside the Z=50 shell closure have been known to exhibit shape coexisting structures. The low energy level diagram show close resemblence with vibration-like characteristics. However, well developed rotational structures have been observed at higher spin with $\beta \approx 0.2$ based on 4p-2h configuration due to a pair of proton excitation across the Z=50 shell gap. Rotational bands with decreasing moment of inertia, termed as smooth band termination, have been observed in many nuclei in this mass region [1, 2]. Recently, highly deformed rotational bands involving the contribution of neutrons in $i_{13/2}$ at $\beta \approx 0.35$ have been observed in Xe, Ba and I with N $\simeq$ 70 [3–5]. The goal of the present work was to look for similar highly deformed bands and to study the band termination in ^{120}Te.

Experimental Details

High-spin states in ^{120}Te were populated using the heavy-ion reaction ^{80}Se(^{48}Ca,α4n)^{120}Te with beam energy 207MeV. ^{48}Ca beam with 4pnA current was provided by ATLAS accelerator at Argonne National Laboratory. Target with a thickness of 600μg/cm^2 was made by evaporating ^{80}Se onto a 300μg/cm^2 Au foil and 40μg/cm^2 thick Au layer on ^{80}Se. A total of 2.7×10^9 events were obtained using 101 Compton-suppressed Ge detectors in Gammasphere with Ge fold $\geq$ 4 in 10 days of beam-time. Radware software [6] has been used for off-line analysis of the data.

Results and Discussion

The low lying states were known upto spin 16$\hbar$ and excitation energy 5.3 MeV [7]. In the present work we confirm the previous placements of the gamma rays and the level scheme has been extended further to excitation energy $\simeq$ 28 MeV. Five new highly deformed bands feeding to the levels around spin 30$\hbar$ have been observed for the first time. Fig. 1 represents summed triple gated coincidence gamma spectrum depicting transitional energies of four of the mentioned bands.

The low lying yrast states upto spin 6$\hbar$ are representatives of phonon vibrational states coupled to the Sn core [8]. States upto 16$\hbar$ can be described by fully aligned configuration $\pi[(g_{7/2},d_{5/2})^2]\otimes\nu[h^2_{11/2}]$ whereas above 16$\hbar$ are produced by 4p-2h excitation, i.e. $\pi[(g_{7/2},d_{5/2})^2(g_{9/2})^{-2}(h_{11/2})^2)]\otimes \quad \nu[(h_{11/2})^4]$ configuration [9, 10].

Dynamic moment of inertia $J^{(2)}$ of the four bands in ^{120}Te has been plotted in Fig. 2 (upper panel). Band 1 shows a gradual decrease in $J^{(2)}$ except for irregularity near

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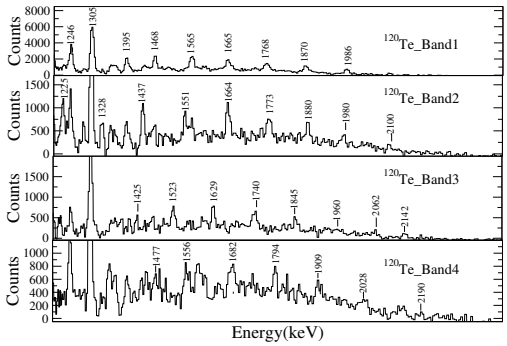

FIG. 1: Summed triple-gated γ ray coincidence spectra of four highly deformed bands in ^{120}Te.

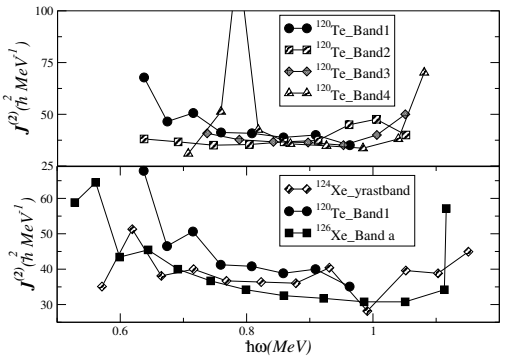

FIG. 2: Dynamic moment of inertia $J^{(2)}$ as a function of rotational frequency for four highly deformed bands in ^{120}Te(upper panel). $J^{(2)}$ vs rotational frequency for the yrast highly deformed band in ^{120}Te as well as for similar bands in ^{124}Xe [11], ^{126}Xe [3](lower panel).

$\hbar\omega = 0.71$ MeV which is most probably due to prevailing interaction between neighboring bands. Band 2 and band 3 show a relative constancy in $J^{(2)}$ value $\approx 35\hbar^2\text{MeV}^{-1}$ over a frequency range of about 300 keV. There is a prominent spike; similar to those present in some of the bands in ^{124}Ba [4] and ^{126}Xe [3]; at $\hbar\omega = 0.79$ MeV in band 4. This type of irregularity may be explained either by possible interaction between neighboring bands or alignments of pair of neutrons. At higher spin sudden increase in the value of $J^{(2)}$ is witnessed in band 3 and band 4 analogous to that observed in " band (a)" of ^{126}Xe. This has been attributed to a possible band crossing [3]. In the lower panel of Fig. 2, $J^{(2)}$ of band 1 of ^{120}Te has been compared to those of yrast band in ^{124}Xe and ^{126}Xe. It is seen that the values of $J^{(2)}$ in case of ^{120}Te are greater than those of ^{126}Xe. The quadrupole moment $Q \simeq 5.2$ b has been estimated for "band (a)" of ^{126}Xe [3]. This suggests highly deformed nature of the yrast band in ^{120}Te. The average values of J^2 for other bands are also close to the values for highly deformed bands in neighboring nuclei. The data analysis is in progress.

Acknowledgments

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