Highly deformed collective bands in ^{124}Xe

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Introduction

The low-energy level scheme of nuclei in A $\sim$ 125 region is characterized by weakly deformed collective structures. Successive alignment of nucleons about the rotation axis leads to termination of configuration in oblate noncollective states [1]. The terminating states have been observed to be followed by high spin collective rotational bands [2–4]. The configuration for the collective bands can be produced either with or without the intruder $h_{9/2}f_{7/2}$ and $i_{13/2}$ neutrons orbitals coupled to $g_{9/2}$ proton holes. The former configurations are more deformed with $\beta \approx 0.35$ in an extended spin range [1, 3, 5]. The present work concentrates on the search for highly deformed bands in ^{124}Xe.

Experimental Details

High-spin states in ^{124}Xe were populated using the heavy-ion reaction ^{80}Se(^{48}Ca, 4n)^{124}Xe. The ^{48}Ca beam with beam energy 207MeV and 4pnA current was provided by ATLAS accelerator at Argonne National Laboratory. Target consisted of ^{80}Se with a thickness of $600\mu/cm^2$ evaporated onto a $300\mu g/cm^2$ Au backing whereas a $40\mu g/cm^2$ thin Au layer was used to protect the Se. The Au baking faced the beam. The $\gamma - \gamma$ coincidence was measured using 101 Compton suppressed Ge detectors in Gammasphere spectrometer. Ten days of beam-time yielded a total of 2.7×10^9 γ counts with Ge fold ≥ 4. Radware software has been used for off-line analysis of the data [6].

Results and Discussion

In a previous work, the level scheme of ^{124}Xe was reported up to the spin $I^\pi = 33^-$ and excitation energy E = 16.5 MeV [4]. In the present work, six new deformed bands have been observed to feed the level structure around spin $I = 21\hbar$. However, no linking transition could be placed. The band head energy and spin have been tentatively assigned to the bands, on the basis of probable decay-out paths to the low energy levels. Based upon the results reported in neighboring nuclei, $E2$ multipolarity has been assumed for the bands. With the given assignment, the level scheme of ^{124}Xe could be further extended to a maximum of $I = 52\hbar$; E = 33 MeV. Fig. 1 represents summed triple gated coincidence gamma spectrum depicting transitional energies of three of the observed bands.

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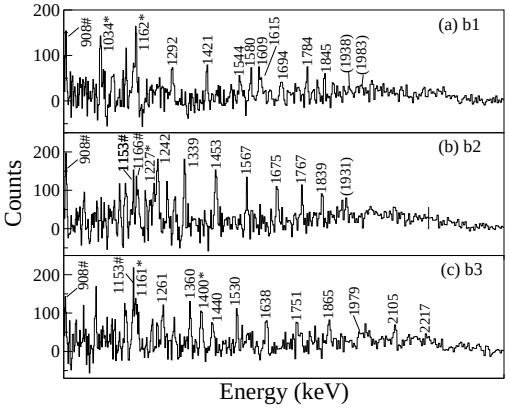

FIG. 1: Summed triple-gated γ ray coincidence spectra of three highly deformed bands in ^{124}Xe with a single gate on a list 354-, 525-, 670-, and 783- keV and double gates on transitions of each band. Peaks with "$*$" and "#" show probable decay-out and low spin transitions respectively.

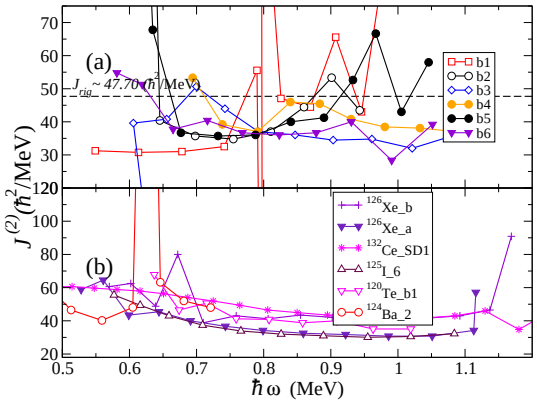

FIG. 2: (a) Dynamic moment of inertia $J^{(2)}$ as a function of rotational frequency for six highly deformed bands in ^{124}Xe and (b) for similar bands in neighboring nuclei including the superdeformed band in ^{132}Ce.

Band crossings are observed in b1 at around $\hbar\omega = 0.8$ and 1 MeV and may be in b5 at $\hbar\omega = 1$ MeV [ref. to Fig. 2]. Similar irregularities in $\mathcal{J}^{(2)}$ were observed for some of the bands in ^{124}Ba [4] and ^{126}Xe [2]. The discontinuities in $\mathcal{J}^{(2)}$ are either due to possible interaction between neighboring bands or due to alignment of particles. The average dynamic moment of inertia for all bands in ^{124}Xe is $\sim 40\ \hbar^2/MeV$ which is comparable to those in neighboring nuclei ^{125,126}Xe, ^{125}I etc. and is clearly lower than the superdeformed band of ^{132}Ce [7]. In ^{126}Xe the estimated quadrupole moment Q is approximately 5.2 b [2]. Thus, similar deformation is also expected for ^{124}Xe. Preliminary cranked Nilsson Strutinsky calculation shows the probable configurations for bands is $\pi[(g_{9/2}^{-2}(h_{11/2}^{p}))] \otimes [\nu(h_{11/2}^{n})]$ where p corresponds to one or two protons and n to five, six or seven neutron numbers.

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