Observation of the rotational bands in ^{123}Te

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Introduction

A~120 mass region depicts rich variety nuclear shapes as well as coexistence of collectivity and single particle excitations [1]. Few valance protons above Z=50 major shell closure mainly depicts non-collective states. The deformation is mainly driven by the presence of the intruder $\pi g_{9/2}$ and the unique parity $\pi h_{11/2}$ and $\nu h_{11/2}$ orbitals. The presence of both low-Ω and high-Ω neutron $h_{11/2}$ orbitals promotes the shape driving effect.

For Te-isotopes in A~120 region, both the protons and neutrons can occupy $g_{7/2}$, $d_{5/2}$, $h_{11/2}$, $d_{3/2}$, $s_{1/2}$ orbitals. From the systematic study of odd-A Te-isotopes, it has been noticed that there is scanty of study in the nuclei with N=71 whereas, there are quite extensive study present in the neighboring isotopes reporting band structures based on 4p-2h, 3p-1h excitations as well as the presence of both positive and negative parity bands based on available orbitals [2-5]. The strongly coupled band structure based on high-*K* $d_{5/2}$ and $g_{7/2}$ as well as decoupled bands based on low-*K* $s_{1/2}$ and $d_{3/2}$ orbitals were already well studied in ^{121}Te (N=69) [3]. In this context, it may be noted that in ^{123}Te [6] only negative parity bands with tentative placement of the spin and parity of excited levels were reported. The high spin states are also not explored much.

In this present work, the observation of the different positive and negative parity bands in ^{123}Te has been investigated via α-induced reaction. Several new γ-rays are observed and assigned to ^{123}Te, other than the confirmation of those previously known. In this paper, the first observation of positive parity bands in ^{123}Te are reported.

Experimental Details

The excited yrast and non-yrast states of ^{123}Te were populated using ^{122}Sn(α, 3n)^{123}Te fusion evaporation reaction. The α-beam of 40 MeV from K-130 cyclotron at VECC, Kolkata, was bombarded on 5 mg/cm^2 thick self-supporting ^{122}Sn target. The Indian National Gamma Array (INGA) setup, coupled to PIXIE-16 based digital data acquisition system [7] has been used to collect the γ-γ coincidence data. The INGA setup consisted of 11 Compton suppressed HPGe clover detectors and 1 LEPS detector arranged in 40°, 90° and 125° angles.

Data Analysis

The list-mode raw data were processed through BiNDAS [8] sorting program and all detectors were calibrated to generate the addback spectra. Gamma-gamma symmetric matrix for coincidence analysis and angle dependent asymmetric matrices for DCO and IPDCO analysis were generated for offline data analysis. The placement of newly observed gamma rays to the level scheme of ^{123}Te was done from their coincidence relationship extracted from the gamma-gamma symmetric matrix. To assign the spin of the different excited energy levels, the angular correlated DCO asymmetric matrix was formed from the events at θ=90° at one axis and for the same events at backward angle in another axis.

Result and Discussion

In this α-induced reaction, several low lying as well as high spin states of ^{123}Te have been populated.

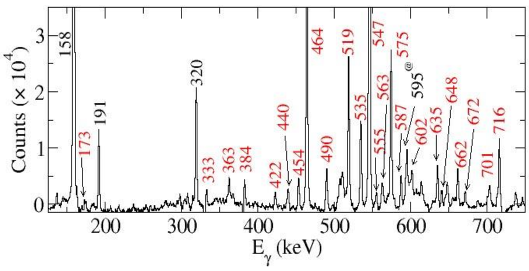

Fig. 1: Coincidence spectrum showing the γ rays corresponding to $s_{1/2}$ and $d_{3/2}$ bands in ^{123}Te. The newly observed γ-rays are marked with red colour.

The coincidence spectrum corresponding to the bands based on $\nu d_{3/2}$ & $\nu s_{1/2}$ orbitals are shown in the Fig.1. The newly observed γ-rays are marked by red colour. The connecting transitions among different excited energy levels of the above mentioned bands have been also identified.

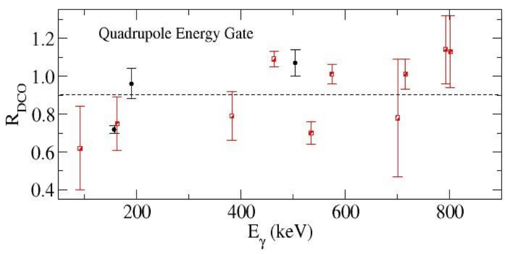

Fig. 2: R_{DCO} of some of the known (black) and new transitions (red) as a function of γ ray energy of ^{123}Te.

In Fig:2, the R_{DCO} of the newly observed γ-transitions, as well as that of previously known transitions are shown. The new transitions are marked by red colour. The R_{DCO} value of the quadrupole transitions are close to 1.1 and for dipole transitions, R_{DCO} value comes out to be around 0.6 in a quadrupole gate.

The energy systematics of the positive parity states of Te isotopes are plotted in Fig.3, as a function of neutron number. The excited states of the positive parity band structures of ^{123}Te, reported in the present work, are found to match well with the neighboring Te isotopes.

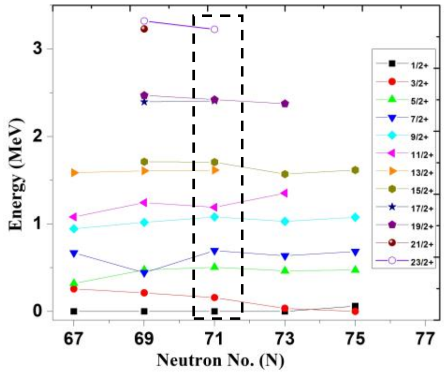

Fig. 3: Energy systematics of excited states based on $3s_{1/2}$ and $2d_{3/2}$ orbitals for different Te-isotopes. The new states of ^{123}Te, identified from the present work are marked by a dotted box.

Summary

From the present analysis, several new γ-rays corresponding to the positive parity bands are identified. The placement of all the previously reported γ-transitions in negative parity band in ^{123}Te are also verified and are found to be in agreement. Further data analysis is in progress and the detailed results will be presented.

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