Prompt-delayed coincidence for the investigation of high-spin states in ^{132}Te

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Introduction

Study of the excited states of neutron rich nuclei near ^{132}Sn remain a topic of interest in nuclear structure. Experimental data on these nuclei at high spins provide a test ground for the realistic effective interaction in mass 50 - 82 valence space. In particular, Te isotopes with neutron holes and proton particles are ideal for the testing of all parts of effective interactions. The neutron holes in $\nu h_{11/2}$ orbitals present in the isotopes of ^{124,126,128,130}Sn [1] and ^{128,130,132}Te [2, 3] are responsible for the observation of the long-lived μs isomer at the 10^+ state. The presence of the long-lived isomer provides an extra challenge in the determination of the states above the isomer, which can be studied using the prompt-delayed coincidence technique.

Experimental Details

Fusion-fission experiment was carried out in which, ^{7}Li beam at 38 MeV energy, provided by the TIFR-BARC Pelletron facility was used to bombard a 12 mg/cm^2 self-supporting ^{232}Th target. The gamma-rays emitted were detected using the INGA spectrometer. The spectrometer contained 19 Compton suppressed HPGe clover detectors. Two and higher fold clover coincidence events were recorded in a fast digital data acquisition system (DDAQ) based on Pixie-16 modules of XIA LLC [4]. The coincidence window was kept as 100 ns for finding the clover multiplicity and this trigger was kept open for 1.5 μs for recording the gamma-rays below the isomer.

The data sorting routine "MultipARameter time-stamp-based COincidence Search program (MARCOS) ", developed at TIFR was used to sort the time-stamped data to generate one-dimensional histograms, E_γ -E_γ matrices, and E_γ-E_γ-E_γ cubes. The time window for the prompt γ-γ coincidence was set to 200 ns. A set of 6.4×10^8 three- and higher-fold events were available for the subsequent analysis. The RADWARE software package was used for the analysis of the matrices and cubes. Hundreds of isotopes were produced at high spins in this reaction and these were identified using the E_γ-E_γ-E_γ cubes and the level schemes of these isotopes were obtained from Nuclear Science Reference (NSR).

Results and Summary

A program was written which sorts the data in such a manner that the prompt γ-ray transitions within a time window of 100 ns are stored on one axis of the matrix. The delayed γ-rays within a particular time window, depending on the half-life of the isomer, are stored on the other axis of the matrix. This is the prompt-delayed coincidence technique. The resultant matrix is subtracted for compton background and then analyzed using the

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RADWARE software. To check the reliability of this technique, this was applied to isotopes of ^{124,126}Sn, ^{130}Te and ^{136}Xe with states known above the isomer. Previously, the yrast rotational band of ^{132}Te has been studied up to 10^+ level which is an isomeric state with a half-life of 3.7 μs [5]. In the present work, the half-life of the 10^+ has been remeasured from the difference of the times between the emission of 901 keV and 974 keV γ-ray transitions and has been found to be 3.2(2)μs which has been shown in Fig. 1. The two new transitions namely 901 and 758 keV which have been observed above the 10^+ isomer using the prompt-delayed technique have been shown in Fig. 2. The systematics of the positive parity excited states of all the even-even Te isotopes have been shown in Fig. 3. The experimental data above the isomer are in fair agreement with the shell model calculation [6].

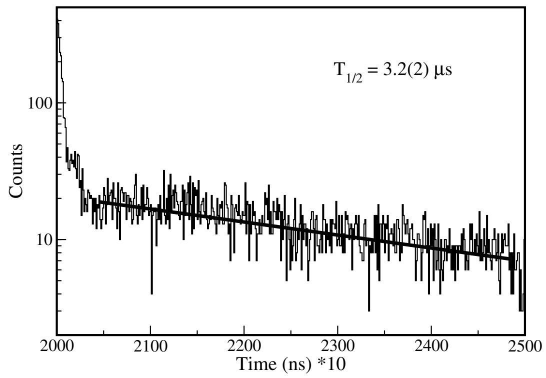

FIG. 1: Half-life ($T_{1/2}$ = 3.2(2) μs) of 2722 keV state of ^{132}Te with $I^{\pi}=10^+$ obtained from the time-difference of the emission of 901 keV and 974 keV γ-ray transitions.

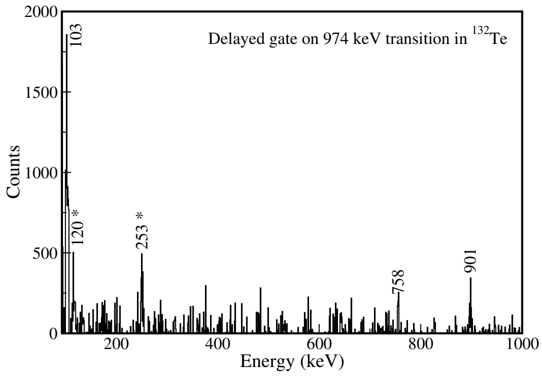

FIG. 2: The spectrum obtained by gating on 974 keV transition below the isomer in ^{132}Te (The transitions marked with an asterisk are actually the transitions of ^{124}Sn which has a 0.27 μs isomer at 5^- state and 3.1μs isomer at 7^- state).

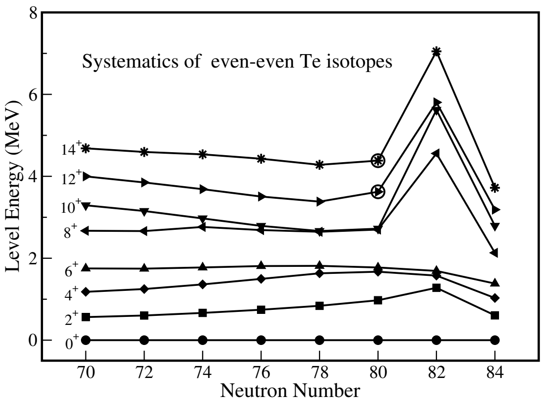

FIG. 3: Systematics of the positive parity excited states of even-even Te isotopes. The encircled data points at 12^+ and 14^+ states correspond to the two newly observed transitions in ^{132}Te.

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