Decay Spectroscopy of neutron-rich nucleus ^{132}I

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Introduction

The structure of nuclei around the doubly magic shell closure nucleus ^{132}Sn are of current interest to obtain information about the single particle structure, core excitation and the interplay of the core with the few valance particles or holes around the neutron rich major shell closure Z= 50, N=82 [1,2]. The experimental information on the various particle-hole excitations in those nuclei provide important inputs for future microscopic nuclear-structure calculations [3]. The less studied odd-odd and odd-A nuclei in this mass region are important for probing the proton-neutron residual interaction in the single particle orbits. Moreover, the involvement of relatively high-j $\pi g_{7/2}$ orbital above Z = 50 together with the $\nu h_{11/2}$ orbital give rise to low-lying isomers in neutron rich odd-odd nuclei. Presence of low lying high spin isomers have been systematically identified in all neutron-rich Iodine isotopes. In the present work, the decay of the ground state and isomeric state of neutron-rich nucleus ^{132}I (Z=53 and N=79) has been studied. The low lying states of ^{132}I has been studied earlier [4] from offline decay spectroscopy using few Ge(Li) detectors. The presence of a high spin (8^-) isomer in ^{132}I was reported in Ref. [4] and an intermediate state at around 22 keV (5^+) was proposed other than the observation of a 98 keV isomeric transition. Due to the contamination of Ag-X rays, the presence of this low energy transition could not be confirmed earlier. In our previous study [5], the life-time of the first excited state of ^{132}I have been precisely measured using $LaBr_3$(Ce) scintillators, from the decay of ^{132}Te and the presence of a low lying 22 keV (5^+) state could be confirmed following IT decay of 8^- isomer. In the present work, the results of precise measurements of the decaying transitions from the ground state and the isomeric state in ^{132}I are being reported.

Experiment and Analysis

Fission is known to be one of the most efficient routes for production of neutron-rich nuclei in medium mass region. In the present work, the neutron-rich Iodine isotopes have been produced from alpha induced fission of ^{238}U, using 32 MeV, 1 μA alpha beam from the Variable Energy Cyclotron at Kolkata. A stack of ^{238}U electrodeposited targets (~1mg/cm^2), separated by Aluminium catcher foils have been used. The catcher foils, in which the fission products were collected, were used for radiochemical separation of Iodine from all other fission products for further counting. The irradiation of ^{238}U target was restricted to about 2hr to reduce the production of other long-lived Iodine isotopes. The decay from the ground state and isomeric state of ^{132}I have been followed in various gamma-ray singles measurements using four- fold segmented planer Ge LEPS detectors, specially for low energy transitions and Clover HPGe detectors for transitions higher than 300 keV. The spectra have been stored in 10 min interval to follow the half-lives for various decay transitions. A γ–γ coincidence measurement has been carried out using a setup consisting of four Clover HPGe detectors and two segmented planer Ge LEPS detectors. For the coincidence measurement, 16 channel amplifiers and other standard NIM electronics were used to collect data in LIST mode with a VME based data acquisition system. The data were collected with a trigger condition of at least one γ-ray or X-rays detected in any of the LEPS detectors OR at least two γ-rays detected in any two of the Clover detectors. The raw data were gain matched to generate various γ–γ matrices.

Experimental Results

The ground state of ^{132}I undergoes beta decay to populate the excited states of ^{132}Xe. The 8^- isomer at 119 keV undergoes both IT decay by a 96.7 -22 keV cascade to the ground state of ^{132}I and beta decay to the higher excited states of ^{132}Xe. Fig.1 shows the decay curve of various transition of ^{132}Xe populated by decay of ^{132}I. The 173 keV (reported as 175 keV in Ref [4]), 599 keV transitions could be confirmed as transitions associated with the decay of 8^- isomer in ^{132}I. The 310 keV and 614 keV transitions could not be confirmed in the present work.

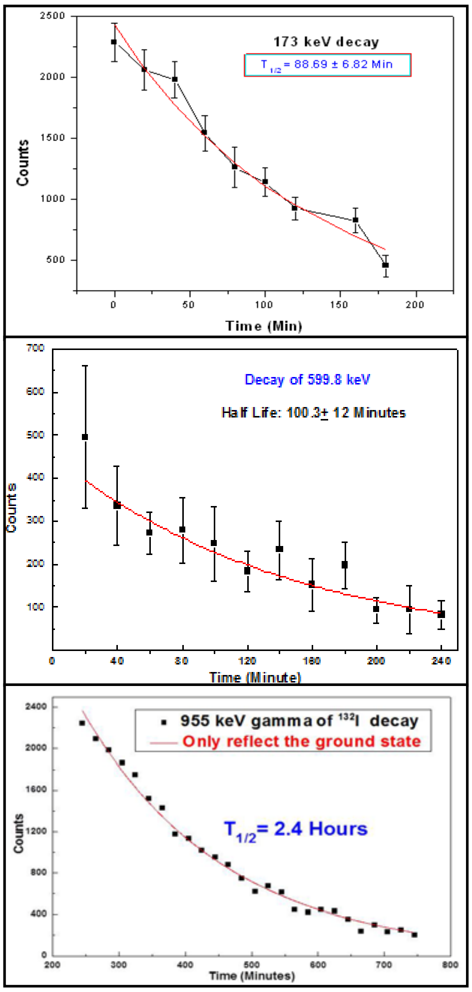

Fig. 1: Decay curves of γ-rays fed by isomeric (top and middle panel) and ground state (lower panel) of ^{132}I.

From the coincidence data it has been confirmed that 96.7 keV is not in coincidence with any of the γ-rays depopulating the excited states in ^{132}Xe, thus confirmed as the IT decay from the 8^- isomer. The other transitions identified as decaying from the same isomer are found to be in coincidence with the transitions of ^{132}Xe. A representative γ–γ coincidence spectrum corresponding to the gate of 772 keV (4+ → 2+) of ^{132}Xe and fed by both the ground state decay and the isomeric decay of 132I is shown in the upper panel of Fig.2. The lower panel of Fig.2 shows coincidence spectrum corresponding to the gate of 955 keV of ^{132}Xe, which is fed only by the ground state decay of ^{132}I.

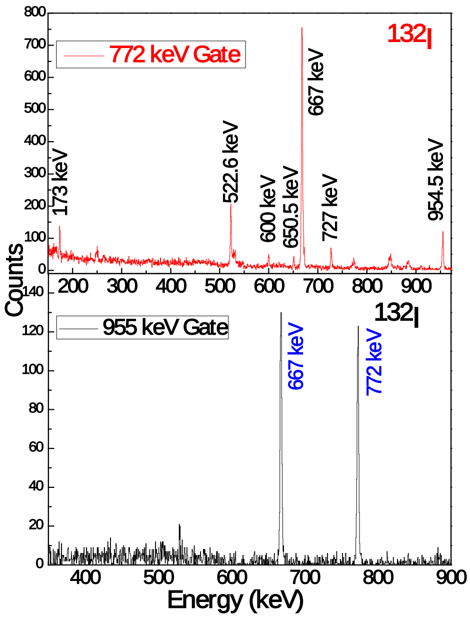

Fig. 2: Coincidence spectrum corresponding to gates of 772 and 955 keV transitions in ^{132}Xe.

References

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