Spectroscopy of long lived fission fragments in A ~100-140 region

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Introduction

Low lying level structure of n-rich nuclei around A~100 and A~140 mass region can be accessed through decay spectroscopy of radio-chemically separated fission fragments. Such studies are of contemporary interest as this gives information on the evolution of nuclear potential as a function of N/Z ratio [1]. Such a program has been taken up by a joint effort of Radiochemistry Group, VECC and Physics Group, VECC. Under this program, using recently developed VENTURE array [2], we have already explored the lifetime and quadrupole moments for few nuclei around ^{132}Sn [3].

The possibility of accessing a particular excited state through radiochemical separation depends on many factors like the population of that level, availability of appropriate radiochemical separation technique and the suitable decay half life of the parent isotope. In the present work, the population of excited levels of several n-rich nuclei in A ~100 and A ~140 region has been studied through ^{nat}U(α,f) reaction at 28 MeV, which will be used as a basis of selection of the subsequent radiochemical separation process. The isotopic yield obtained in this particular reaction has already been determined [4]. The population of excited levels has been studied through high resolution γ-spectroscopy which will be reported in the present abstract.

Experiment

The fission reaction was carried out with the natural Uranium target of thickness ~750μg/cm^2 electrodeposited on 1mil Al-backing using stacked foil technique [4]. After irradiation for 30h (current ~500nA), direct counting of the irradiated target and catcher were done after a cooling period of 1d in order to allow shorter-lived fission products to decay out. Counting was performed for about 120d in order to identify radionuclides of longer half-lives (days to months) for the detection of fission products using a setup of two Clover HPGe detectors and a low energy photon spectrometer (LEPS). Standard NIM electronics and VME ADC were used for the pulse processing and data acquisition with LAMPS software [5]. The raw data were gain matched to generate γ–γ matrices using the LAMPS software. The subsequent data analysis with the background subtracted matrix was performed using the RADWARE package [6].

Results and Discussion

Many n-rich isotopes in A ~100 and A~140 region were confirmed to be populated in this reaction through the measurement of decay half lives [4]. However, the γ–γ coincidence could be performed only for those nuclei which, through beta decay, populate a significant number of excited levels having substantial strength for the decay γ-rays with multiplicity two or more. The total projection obtained from the γ–γ matrix is shown in Fig. 1. The two bumps observed in this spectrum, in the 165-265 keV (bump1) and 524-620 keV (bump2) regions, as shown in Fig. 1, come from the coincidence between two fragments of the Compton scattered 511 keV and 811 keV γ-rays coming from the irradiated Al catcher. This is possibly due to the absence of BGO anti-Compton shield in the Clover HPGe

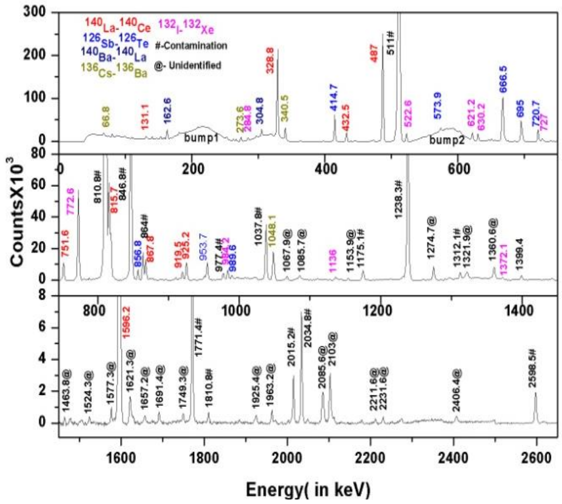

Fig. 1: *Total projection of the γ–γ matrix obtained in the present work.*

detectors and the placement of three detectors in a closed geometry, at an angular separation of 90^o with each other. The γ–γ coincidence analysis could yield the observation of the excited levels of several nuclei, viz., ^{140}La, ^{140}Ce, ^{136}Ba, ^{132}Xe and ^{126}Te from the β$^-$ decay of their respective fission fragments. For all these isotopes a significant portions of their decay schemes have been populated. Representative gated spectra at the most intense γ energies of ^{140}Ce and ^{126}Te nuclei are shown in the Fig. 2 and 3, respectively.

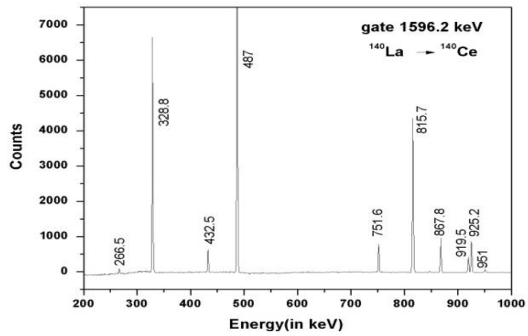

Fig. 2: *1596 keV gated projection in which the γ-rays from ^{140}Ce are seen.*

All the γ-rays are marked and most of the observed gamma rays are found to be already known in their decay scheme. For some of these nuclei, new γ-lines are also observed which will be placed in the decay scheme following their coincidence relationships.

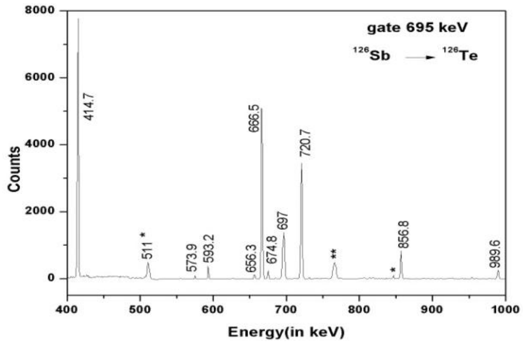

Fig. 3: *Gated spectrum for 695keV transition of ^{126}Te. Peaks marked with '*' are due to contamination.*

Following this measurement, our future outlook is to explore the possible radiochemical separation process for the spectroscopy of rare earths which are very challenging in general. It is observed that for many nuclei populated in this experiment, the level lifetime and quadrupole moments are not known till date and this will also be taken up following the successful exploration on the radio-chemical separation techniques.

References

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