

Decay Study of Neutron-rich ^{43}K using Total Absorption (TAGS) and High Resolution (HRGS) Gamma Spectroscopy Methods

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Introduction

β -decay measurement has importance in both basic nuclear physics and in the applied field. The excited states in the neutron-rich nuclei can be studied by β -decay using low intensity radioactive ion beams (RIB). Decay spectroscopy and $T_{1/2}$ measurement of the neutron-rich ^{43}K were performed to address the anomalous beta-feeding intensities to some of the levels in the ^{43}Ca daughter nucleus [1],

Experimental Details

Radioactive ^{43}K ($t_{1/2} = 22.3$ h) have been produced at the RIB facility [2] of Variable Energy Cyclotron Centre (VECC), Kolkata, India using the reaction $^{40}\text{Ar}(^4\text{He},1p)^{43}\text{K}$ at 18 MeV. The target was gas cell of Ta window filled with ^{40}Ar at 1 atm. of pressure placed in the RIB beam line inside the vault area. The primary alpha (^4He) beam (up to 1 μA of beam current) of energy 28 MeV, from the K130 cyclotron at VECC, was degraded by about 10 MeV within the gas cell window. The reaction products were transferred to a low background site by Gas Jet Recoil Transport (GJRT) technique [3] and allowed to deposit on an 'Al' catcher foil. Off-line decay measurements of the 'Al' catcher foils were done in both High-Resolution Gamma-ray Spectroscopy (HRGS) and Total Absorption Gamma-ray Spectroscopy (TAGS) methods.

In HRGS, a clover HPGGe detector and the single-crystal HPGGe detector, procured under

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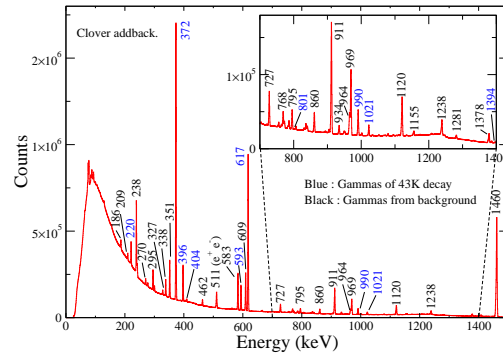


FIG. 1: Gamma spectrum shows the γ -lines from ^{43}K decay (blue) and room background.

Nuclear Data Physics Centre of India (ND-PCI) were used in singles and coincidence modes. A representative γ -ray spectrum from the clover addback is shown in Fig. 1. This spectrum shows only the ^{43}K -decay γ lines and the standard identified room background lines with no other contaminants. For the measurement of decay half-life, data on fixed time interval of 1 hr. each were also collected in the singles mode. For the TAGS measurement the modular TAGS facility [4] at VECC with 50 element BaF2 detectors in a 4π geometry with capabilities of different fold selections has been used.

Results and Discussion

We have obtained a decay half-life of $T_{1/2} = 22.4(1)$ hr for ^{43}K by fitting the decay curve of the most intense 372-keV γ -ray as shown in Fig. 2. This is one of the most precise values known so far for this nucleus [5]. The β -feeding intensity in each level of ^{43}Ca is be-

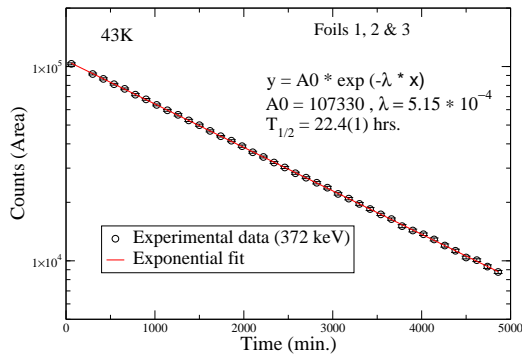


FIG. 2: Decay curve for 372 keV γ of ^{43}K decay.

ing estimated from both the HRGS and TAGS data. In the HRGS data, this is obtained from the difference of feeding-in and feeding-out intensities in each level. In the TAGS data the sum-energy peaks correspond to the level energies. The intensities of these sum-energies directly give the feeding intensities. In this work, the sum energy spectra are obtained by putting different multiplicity fold-gates as shown in Fig. 3. In Fig. 3(a), the spectra are gated by multiplicity fold greater than a set value whereas the spectra in Fig. 3(b) are obtained with a particular multiplicity fold gate. It can be seen that the peaks which result from the summing (e.g 990 keV and 1394 keV) of more than one γ -rays could easily be identified in the spectra of Fig. 3(b). The intensities of these sum-peaks will give the feeding intensities of the corresponding level. Detailed analysis of the TAGS data is in progress to obtain the feeding intensities.

Summary

The neutron rich ^{43}K nucleus has been produced using the RIB beam line at VECC by α -induced fusion evaporation reaction using gas target and the gas-jet system was used to move the products for offline decay spectroscopy study using high resolution and total absorption spectroscopy methods. Precise value of the decay half-life has been obtained and the preliminary analysis of the β -feeding intensity show deviation from the reported values. Detailed analysis is in progress.

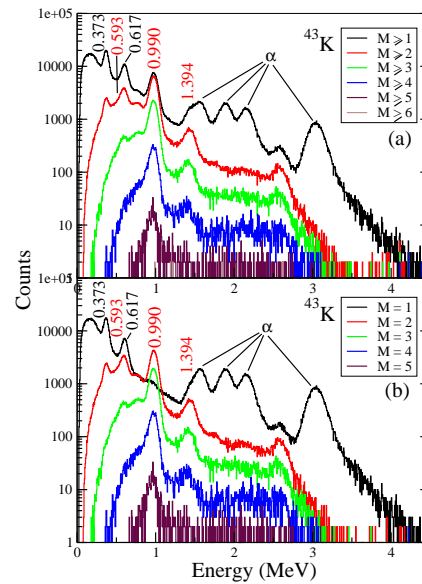


FIG. 3: Sum spectra of ^{43}K decay from the TAGS data obtained with different minimum multiplicity gate (a) and with exact multiplicity gate (b). The sum peaks (e.g at 990 keV) are easily identified from the spectra in (b).

The experimental details and the results will be discussed during the presentation.

Acknowledgments

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