Exotic decay of ^{116}Cs

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Introduction

The study of properties of nuclei near and beyond the drip lines provides unique information on n-n interaction. The nuclei having proton and neutron numbers in the range Z=56-64 and N=58-72 are called island of cluster emitters because of the probability of spontaneous cluster emission. Due to lack of availablity of experimental data, the upper mass limit of the nuclei synthesised by rp-process (rapid proton capture process) has not been confirmed yet. Because of these reasons the study of exotic decay near proton drip line may play an important role in understanding of nuclear structure as well as nuclear astrophysics. In this report, experimental observation of the decay of ^{116}Cs is presented. Due to the large Q-value ($Q_{EC} = 11MeV$ [1]) for electron capture and positron decay many different decay channels may open in the daughter nucleus. Thus after electron capture of ^{116}Cs, the daughter nucleus ^{116}Xe, can be populated in excited states above the proton and alpha threshold and it may further decay by proton or alpha emission. Thus by measuring delayed alpha or proton one can reconstruct the proton and alpha unbound states. The unbound states above particle threshold, may provide access to the component of n-n interaction due to coupling to the continuum.

Experimental Setup

This experiment has been performed by IS545-IDS collaboration at the ISOLDE facility at CERN [2]. Pulses of 1 GeV

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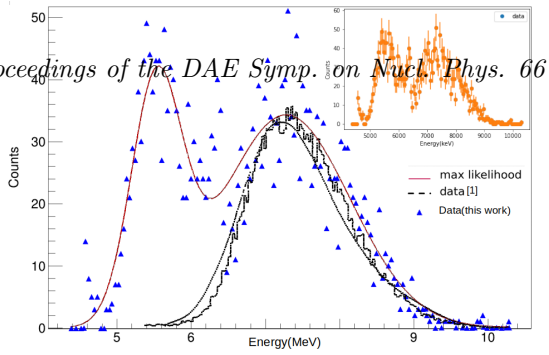

FIG. 1: Proton Unbound States of ^{116}Xe.

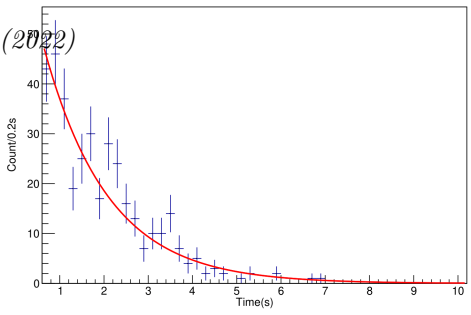

FIG. 2: Determination of Half-life of ^{116}Cs.

protons from PS Booster impacted on a Lanthanum Carbaide target, then by fragmentation/spallation reaction radioactive beam, ^{116}Cs was produced and separated by mass spectrometer(GPS). This secondary beam was transfered to the experimental hall and implanted on a carbon target. The IDS experimental set-up has been described in [3].

Data analysis and Spectrum

The raw data were unpacked and calibrated with the help of ROOT framework. For the calibration of silicon detectors, some stable Alpha sources were used which were $^{148}Gd_{64}$, $^{241}Am_{95}$, $^{239}Pu_{94}$, $^{249}Cf_{98}$. For the calibration of HPGe a stable gamma source ^{152}Eu was used. From E-ΔE spectra one can easily distinguish proton and beta bands. High energy proton events have been obtained in ΔE-E telescope array. The Low energy peotons(less than 2.5 MeV) were fully stopped by the thin ΔE ($\sim$ 65μm). The total angular coverage of the charged particle detector array $\sim$ 45.897%.

Proton Unbound States

By adding the deposited energies of protons in the thin DSSD and the corresponding PAD detectors, the delayed proton spectrum for higher energy was obtained. The low energy protons (less than 2.5 MeV) were fully stopped by the thin DSSD which has been obtained from thin DSSD spectrum, which was in anticoincidence with PAD detector.

The delayed proton spectrum has been further converted into the reference frame of ^{116}Xe and was added with the proton separation energy for obtaining the proton unbound excited states of ^{116}Xe, see (FIG.1). Inset of FIG.1 represents the proton unbound states with errorbars. The delayed proton spectrum has been fitted with Bayesian approach([4],[5]) to obtain the properties of excited states. The high energy proton spectrum is in well agreement with the previously reported result [1] but the low energy proton unbound state is being reported for the first time in this report.

Determination of Half-life

To obtain the decay half-life of ^{116}Cs, the time distributed proton spectrum was fitted with the function $N = N_0 e^{\lambda t}$ as shown in FIG.2. The obtained half-life of ^{116}Cs is 1.00(+/-0.07) sec. The previous reported value is 0.7(+/-0.2) sec. [1]

Electron capture and positron decay ratio

The ratio of electron capture and positron decay has been measured, it is found that 32.5(+/-2.7)% of the protons were emitted after positron decay, which is in agreement with the previously reported value(40+/-8%[1]). More details study of delayed alpha cluster states are in progress and we are looking forward to find some interesting results.

References

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