Study of exotic decay near proton drip line

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Introduction

The study of nuclei at the limits of stability has recently become a central focus of nuclear structure research. The main characteristics of β-decay far from stability is the number of decay channels open[1]. At the drip line the separation energy of last nucleons become extremely small or negative, the Fermi level is found close to particle continuum[2]. The observation of the breakdown of traditional magic numbers in exotic nuclei far from stability has been an important issue in nuclear structure physics[3]. 115Cs is located beyond the proton drip line. Due to large beta-decay energy (Q value) of drip-line nuclei,they are

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source of many different decay channels. For ^{115}Cs: $Q_{EC} = 8.96(10)$MeV. In case of ^{115}Xe: S_p, S_{2p}, S_α are 3.15(15)MeV, -4.89(3)MeV and 2.506(14)MeV respectively[4].So many decay channels open:$\beta - \gamma$, $\beta - p$, $\beta - p - \gamma$, $\beta - 2p$, $\beta - 2p - \gamma$.Therefore beta-delayed proton emission take place. Beta-delayed proton emission is two step process: first,precursor or parent nucleus undergoes beta-decay,which is followed by the proton emission from the excited states of the emitter nucleus.

Experimental Setup

This experiment is done at ISOLDE facility at CERN, where pulses of 1 GeV protons from PS Booster impacted on a Lanthanum Carbaide target, then by fragmentation reaction radioactive beams are produced and from there ^{115}Cs is separated by mass spectrometer. This secondary beam goes to the experimental room and projected on a carbon target. In experimental room there are 5 DSSD (Double Sided Silicon Strip Detectors), 4 PAD detectors behind the DSSD(behind the lower DSSD there is no PAD) as shown in figure 1.Four High-Purity Germanium(HPGe) clover detectors surround the chamber to provide high Gamma-Ray detection efficiency. This DSSDs are of different thickness . Thin DSSDs are insensitive to radiation but they can fully stop low energy protons. The thick DSSDs can fully stop high energy protons, while a fifth thick horizontal DSSD is mainly used for detection of β radiation. The PADs have used for β detection[5]. The distance of each of the DSSDs from the target is nearly 3.0 cm. Each of the DSSD is made of 5cm×5cm silicon wafer of thickness around 50μm.There are 16 strips in each of the front and back side of the DSSD. Thickness of each of the strip is 3.0 mm , where the front strips are vertical and back strips are horizontal.

Data analysis and Spectrum

For the calibration of silicon detectors some stable Alpha sources were used which were $^{148}Gd_{64}$, $^{241}Am_{95}$, $^{239}Pu_{94}$, $^{249}Cf_{98}$. And for the calibration of HPGe a stable gamma source ^{152}Eu was used. After the calibration

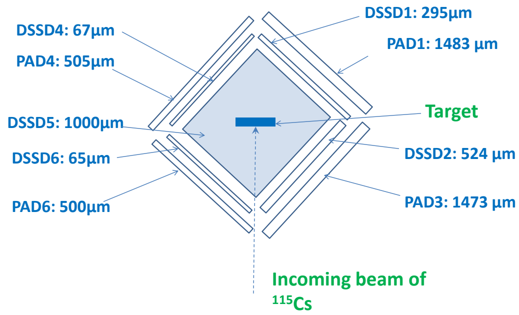

FIG. 1: Arrangement of DSSD and PAD detectors set-up during experiment(upper-view).

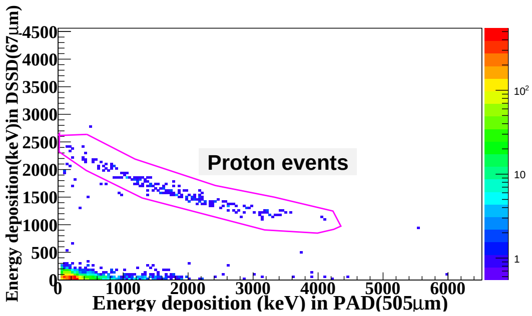

FIG. 2: Two dimensional ΔE-E spectrum where ΔE obtained from thin DSSD and E obtained from corresponding PAD detector.

of the detectors, raw datas were executed and with the help of ROOT analysis some interesting spectra has been produced. From E-ΔE spectra one can easily distinguish proton and beta bands. High energy proton events has been obtained in thin ΔE-E telescope array which is shown in figure 2.

References

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