Exotic Decay Mode Of Nuclei Near Proton Drip Line

J. Ray[1], U. Datta Pramanik[1],* R. K. Bhowmik[2], S. Chakraborty[1], A. Chakraborty[3], R. Garg[4], S. Goyal[4], S. Ganguly[5], S. Kumar[6], S. Mandal[4], B. Mukherjee[4], S. Muralithar[2], D. Negi[2], A. Rahaman[1], M. Saxena[4], K. Selvakumar[6], I. Ray[1], Purnima Singh[6], A. K. Singh[6], and R.P. Singh[2]

[1]*Nuclear Physics Division, Saha Institute Of Nuclear Physics, Kolkata*
[2]*Inter University Accelerator Centre New Delhi*
[3]*Viswa Bharati University, santiniketan*
[4]*University of New delhi, New Delhi*
[5]*Chandannagar College, Chandannagar and*
[6]*Indian Institute of Technology, Kharagpur*

Introduction

The nuclei near drip lines show various special features, like halo structure [1] [2], skin [3], Pygmy resonance [4], cluster structure [5], exotic shapes and exotic decay modes etc. To study clustering in nuclei near drip lines is very interesting as it gives structural information of the nuclei. As the drip-lines (proton or neutron) are approached then it is predicted that the driving forces related to clustering, compared to the stable nuclei, change. Cluster radioactivity [6] is a well established fact in the trans-lead region where emission of cluster heavier than α but lighter than fission fragments are observed[7]. In this article we shall report our experimental studies on exotic decay mode of ^{124}Ce compound nucleus and the observed anomaly in comparison with the standard statistical model calculation (PACE4).

Experiment

The experiment was carried out at the Inter University Accelerator Centre (IUAC), New Delhi, utilizing beam of 150 MeV ^{32}S beam (from 15UD pelletron accelerator). The beam was bombarded on self supporting ^{92}Mo target with thickness of 7.3 mg/cm^2.The compound nucleus ^{124}Ce was produced in a state of high excitation and high angular momentum. This compound nucleus evaporates protons, neutrons, α etc to de excite itself. As a result a number of exotic nuclei such as ^{121}La, ^{120}Ba, ^{118}Xe, ^{116}Xe etc.. have been populated, in excited state and get de excited by emitting γ rays. Two fold γ-γ coincident events were collected using the Indian National Gamma Array (INGA)[6]. INGA is designed to hold 24 Compton suppressed clover detectors. Among 24 detectors , only 12 were in proper working mode during the experiment. Those were at angles 148°, 128°, 90,°, 46°, 57°, 32° with respect to the beam direction. Another experiment was done for same purpose using beam of 140 MeV ^{32}S on ^{92}Mo thin target (200μg/cm^2) with Gold-backing. The detector system contained 11 HpGe detectors. In both the cases list mode data were sorted into different 4096 x 4096 matrices after gain matching of all the spectra. For analysis of data INGASORT [8] software,was used.

$$^{32}\mathrm{S} + {}^{92}\mathrm{Mo} \longrightarrow {}^{124}\mathrm{Ce}^*$$

Result

Isotopes populated in the present experiment is shown in the all-gated spectra, fig[1]. To confirm the population of those isotopes each of their characteristic γ were gated and checked whether corresponding gated spectrum follow the previous experimental results. All though most of the nuclei are populated from the fusion evaporation reaction, but some nuclei near the target nucleus, such as ^{93}Tc (p), ^{94}Tc(pn)...etc, are also observed.These channels are supposed to be pop-

*Electronic address: ushasi.dattapramanik@saha.ac.in

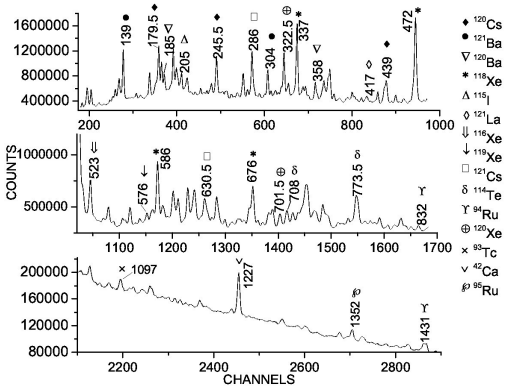

FIG. 1: All-gated spectra.

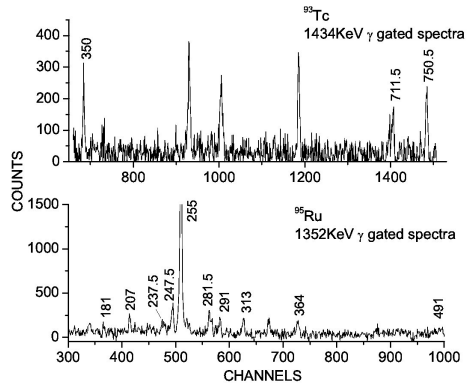

FIG. 2: Gated spectrum of ^{93}Tc and ^{95}Ru

ulated due to transfer reaction as high spin of these nuclei are not populated. M. Hausmann [9] showed spin state of ^{93}Tc upto $43/2^+$ obtained in ^{64}Zn(^{35}Cl) reaction, whereas only first three transitions (upto $17/2^+$) have been observed in present experiment. Population of ^{95}Ru is little unlikely and high spin of this nucleus is populated. The mechanism of population of this nuclei is yet to be solved.

Most of the isotopes are populated due to the fusion evaporation reaction, like ^{122}Ba, ^{121}La, ^{120}Ba, ^{119}Cs, ^{118}Xe, ^{117}I, ^{114}Te ..etc. The present experimental data for high spin states is in agreement with the previously obtained well established results.

The yield of various populated nuclei were determined through ground state γ-ray intensity and normalised w.r.t yield of ^{120}Cs for respective cases. The comparison between the two normalised cross-sections (experimental PACE4) shows enhancement of 4p(^{120}Xe) and α2p(^{118}Xe) channels, whereas population of all the other isotopes are quite close to the model prediction. So, ^{124}Ce might have some favourable cluster structure which causes such enhancement. Fig.2 shows the comparison of yields of the various populated isotopes (Experimental and PACE4). Results obtained from the experiment using thin target shows similar trend.

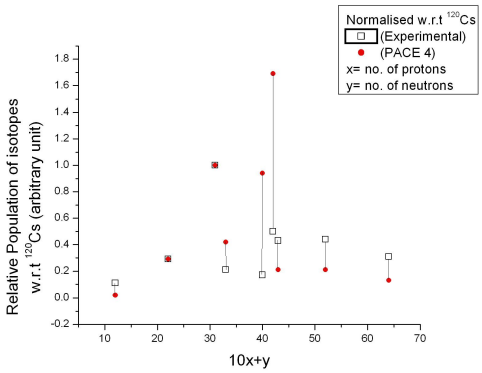

FIG. 3: Relative population of various nuclei through decay of compound nucleus ^{124}Ce (both experimental and PACE4).

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