De-excitation of hot rotating nuclei near proton dripline

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Relative population of various nuclei obtained from ^{32}S+^{92}Mo $\longrightarrow$ ^{124}Ce* fusion-evaporation reaction have been measured through observation of corresponding γ-rays. Comparison of experimentally obtained relative population of various isotopes with statistical model calculation (with default and changing parameter) shows that most of the evaporation channels are in agreement with the statistical code calculation PACE4 except ^{118}Xe, ^{120}Xe, ^{121}Cs and ^{122}Ba.

1. Introduction

The de excitation of hot compound nucleus, near β-stability line, produced in fusion-evaporation reaction in general follows the standard statistical process. This type of statistical calculations have been implemented in various statistical codes like PACE, CASCADE, GEMINI etc depending upon some significant ingredients like particle transmission coefficients, level densities, fission barriers etc. [1], extracted from different phenomenological models. It is of special interest to check whether the standard statistical model (SSM) is applicable for the nuclei far from the stability. Here we shall report the details comparison of the experimentally obtained result for de excitation of the compound nucleus ^{124}Ce, produced from ^{32}S + ^{92}Mo reaction, with the SSM calculation varying input parameters.

2. Experimental Details

Two experiments were carried out using same target- projectile combination; one with self supporting ^{92}Mo target (thickness 7.3mg/cm^2 and 97.5% enriched) and another using thin ^{92}Mo target (thickness $\sim$200μg/cm^2 and 99% enriched) with gold backing, at IUAC, New Delhi, utilizing beam of ^{32}S. The beam energy for the thick and thin target experiments were 150MeV and 140 MeV, respectively. The details of the experiments have been given in [2].

3. Data Analysis and Results

For data analysis INGASORT software has been used. Isotopes like $^{122-120}$Ba, ^{121}La, $^{121-118}$Cs, $^{120-117}$Xe, ^{117}I, ^{114}Te etc. have been populated through evaporation of protons, neutrons, alpha etc from the highly excited compound nucleus ^{124}Ce. High spin states of exotic Cs isotopes have been populated [3]. The relative cross-section of population of various isotopes have been obtained by considering the intensity of lowest excited state transitions of those isotopes and then by normalizing them with respect to that of ^{120}Cs (^{120}Cs could be populated only by evaporation of 3pn from the ^{124}Ce). Experimentally obtained result have been compared to the statistical model calculation PACE4, for both the experiments.

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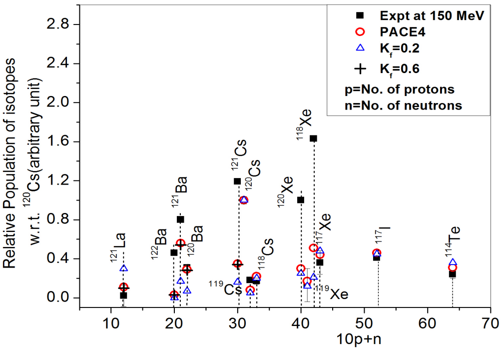

FIG. 1: Relative population of various isotopes with varying fission barrier scaling factor; showing enhancement in population of ^{118}Xe, ^{120}Xe, ^{121}Cs, ^{122}Ba for the experiment with thick target.

FIG.[1] represents the observation of the experiment with thick ^{92}Mo target (energy 150MeV) and shows that population of most of the nuclei like ^{121}La,^{120}Ba,^{117}Xe, ^{117}I, ^{114}Te etc. closely follow the statistical model calculation. However ^{122}Ba, ^{121}Cs, ^{120}Xe and ^{118}Xe show huge deviation. Both the experimental data follow similar trend. Varying the fusion barrier scaling factor, k$_f$ (TABLE I), the enhancement of population of these isotopes could not be reproduced. Changing level density parameter, K (TABLE II) also shows no significant change in the obtained result and could not reproduce the anomaly consistently.

4. Summary

^{120}Xe, ^{121}Cs, ^{122}Ba are produced due to 4p, 3p and 2p evaporation respectively although production mechanism of ^{118}Xe is yet to be investigated. Enhancement of 2p, 3p and 4p evaporation could be explained as the compound nucleus is close to the proton drip line.

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TABLE I: Comparison of the calculated evaporation cross sections using different fission barrier scaling factors (k_f) with present experimental data

Populated isotope	k_f = 0.2	k_f = 0.6	k_f = 1.0	Expt
^{121}La	0.03	0.10	0.11	0.02
^{122}Ba	0	0.03	0.03	0.46
^{121}Ba	0.17	0.54	0.56	0.80
^{120}Ba	0.07	0.28	0.29	0.31
^{121}Cs	0.16	0.34	0.35	1.19
^{120}Cs	1	1	1	1
^{119}Cs	0.05	0.07	0.08	0.18
^{118}Cs	0.20	0.21	0.22	0.17
^{120}Xe	0.25	0.31	0.30	1.0
^{119}Xe	0.12	0.17	0.17	0.13
^{118}Xe	0.21	0.49	0.51	1.63
^{117}Xe	0.48	0.43	0.44	0.36
^{117}I	0.45	0.42	0.46	0.41
^{114}Te	0.36	0.30	0.31	0.24

TABLE II: Calculated evaporation cross section with different level density parameters (K) and comparison with present experimental data

Populated isotope	K = 10	K = 12	K = 13	K = 15	Expt
^{121}La	0.11	0.19	0.25	0.38	0.02
^{122}Ba	0.03	0.06	0.10	0.17	0.46
^{121}Ba	0.56	0.81	0.96	1.21	0.80
^{120}Ba	0.29	0.35	0.37	0.45	0.31
^{121}Cs	0.35	0.42	0.46	0.52	1.19
^{120}Cs	1	1	1	1	1
^{119}Cs	0.08	0.11	0.12	0.23	0.18
^{118}Cs	0.22	0.42	0.56	0.92	0.17
^{120}Xe	0.30	0.24	0.23	0.20	1.0
^{119}Xe	0.17	0.1	0.07	0.05	0.13
^{118}Xe	0.51	0.81	0.97	1.37	1.63
^{117}Xe	0.44	0.59	0.63	0.71	0.36
^{117}I	0.46	q 0.46	0.48	0.49	0.41
^{114}Te	0.31	0.38	0.44	0.46	0.24

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