Decay properties of superheavy element ^{285}Cn

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INTRODUCTION:

In current years the superheavy element up to atomic numbers Z=118 have been synthesized either by cold fusion reactions using ^{208}Pb or ^{209}Bi targets or hot fusion reactions with ^{48}Ca as a projectile [1-4]. Previous workers [5] were made an attempt to synthesis superheavy element Z=120. The alpha decay is the very important decay mode to examine the nuclear structure and its properties in the unstable nuclei. Alpha decay is also an important decay mode in identifying the recently synthesized elements [6-11]. Hence the alpha decay and also the spontaneous fission is an essential factor which determines the stability of recently synthesized superheavy nuclei. Experimentally spontaneous fission half-lives were measured in the different laboratories [12–17]. The cluster radioactivity of ^{14}C was experimentally observed in ^{223}Ac [18] and there are many experimental evidence for ternary fission also [19-22].

Since the alpha decay, spontaneous fission, ternary fission and cluster radioactivity are essential to determine the stability of nuclei and also the nuclear structure, we perform detail study of these decay modes in the superheavy nuclei ^{285}Cn using coulomb interaction, proximity potential and centrifugal potential. The aim of our work is to perform detailed studies on different decay modes and to identify the most possible decay mode in the superheavy nuclei ^{285}Cn, from the systematic study of half-lives and branching ratios.

THEORITICAL FRAME WORK

The total potential is the sum of Coulomb potential, proximity potential and centrifugal potential. The total potential for spontaneous fission, ternary fission, cluster radioactivity and alpha decay were studied as explained in previous work [23]. Once the total potential is studied, we have studied barrier penetrability using WKB approximation [24]. Then we have studied half-lives and branching ratios of these different decay modes given by previous workers [23].

RESULTS AND DISCUSSIONS:

The amount of energy released during the spontaneous fission, ternary fission, cluster radioactivity and alpha decay are energetically possible only if the *Q* value of the reaction is positive. The amount of energy released during the process are studied using the mass excess values available in the reference [25-29]. We studied total potential of spontaneous fission, ternary fission, cluster radioactivity and alpha decay as mentioned in the theoretical frame work. The value of angular momentum from ground state to ground state is taken to be minimum ($l=l_{min}$) which leads to minimum centrifugal potential. The driving potential is the difference between total potential and amount of energy released during the fission process. We studied barrier penetration probability using WKB approximation method. The calculated logarithmic half-lives of spontaneous fission and ternary fission alpha decay is as shown in figure 1. From the figure it is observed that the most probable fission fragments in spontaneous fission are ^{132}Xe+^{153}Ce and for alpha accompanied ternary fission, the most probable fission fragments are ^{118}Sn+^{163}Nd. The variation of logarithmic half-lives of cluster radioactivity (^{12}C, ^{14}N, ^{16}O, ^{20}Ne, ^{28}Si, and ^{40}Ca) in ^{285}Cn with the mass number A_2 is as shown in figure 2. A comparison of logarithmic half-lives of different decay modes are as shown in figure 3. From the figure it is observed that the logarithmic half-lives of cluster radioactivity (^{12}C, ^{14}N, ^{16}O, ^{20}Ne, ^{28}Si, and ^{40}Ca) are of higher order and the logarithmic half-lives of spontaneous fission is of the order of μs which can't be detected experimentally. Hence the alpha decay half-lives are of the order of 10^{-1} and it is also dominant decay mode in ^{285}Cn.In order to predict the dominant decay mode in ^{285}Cn, we have also calculated branching ratios. The branching ratios of different decay modes are tabulated in table 1.

Fig 1: The calculated logarithmic half-lives of spontaneous fission and ternary fission alpha decay with the mass number A_2.

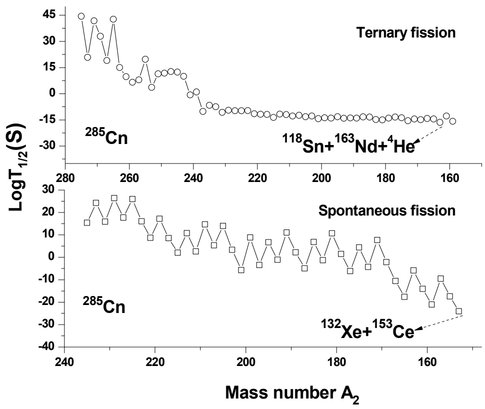

Fig 2: The variation of logarithmic half-lives of cluster radioactivity (^{12}C, ^{14}N, ^{16}O, ^{20}Ne, ^{28}Si, and ^{40}Ca) in ^{285}Cn with the mass number A_2.

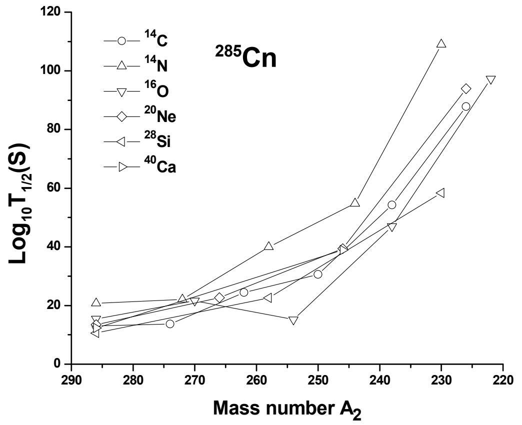

Fig 3: A comparison of logarithmic half-lives with different decay modes.

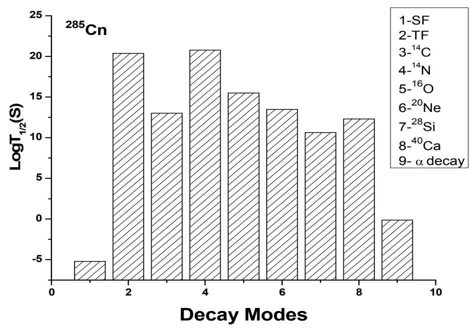

Table 1: Branching ratio of alpha decay with respect to the spontaneous fission, ternary fission, cluster decay for ^{285}Cn.

Branching Ratio	Corresponding Values
$\lambda_\alpha / \lambda_{SF}$	8.22378E-06
$\lambda_\alpha / \lambda_{TF}$	3.11E+20
$\lambda_\alpha / \lambda_{^{14}C}$	1.40E+13
$\lambda_\alpha / \lambda_{^{14}N}$	7.83E+20
$\lambda_\alpha / \lambda_{^{16}O}$	4.15E+15
$\lambda_\alpha / \lambda_{^{20}Ne}$	4.11E+13
$\lambda_\alpha / \lambda_{^{28}Si}$	5.73E+10
$\lambda_\alpha / \lambda_{^{40}Ca}$	2.80E+12

CONCLUSIONS:

We systematically studied different decay modes such as spontaneous fission, ternary fission, alpha decay and cluster radioactivity in ^{285}Cn. The comparison of different decay half-lives informs that the alpha decay half-lives are smaller than the other decay modes such as spontaneous fission, ternary fission and cluster radioactivity. The detail study of half-lives results in most dominant decay mode in ^{285}Cn. A detail study of branching ratio of alpha decay with respect to other decay modes also confirms that alpha decay is most dominant decay mode for the super heavy nuclei ^{285}Cn. The detail study of different decay modes and the branching ratio reveals that the alpha decay is the most dominant decay mode in ^{285}Cn.

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