PECULIARITIES OF CLUSTERS FORMATION IN TRUE TERNARY FISSION OF ^{252}Cf AND ^{236}U*

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Experimental results demonstrating the existence of a new type of cluster decay called "collinear cluster tri-partition" (CCT) has been presented in Refs. [1-2]. The results are based on two different experiments with binary coincidences of fission fragments and measurements of the masses and energies of the two fragments [1]. In two other experiments [2] for the study of spontaneous ternary fission of ^{252}Cf, events in coincidence with neutrons are reported. The relatively high yield of the CCT-effect (more than 10^{-3}/binary fission) is likely due to the collective motion through very elongated (hyper-deformed) pre-scission shapes and a large phase space covering a larger number of mass partitions with high Q-values [3]. The formation of the third cluster occurs in the neck region between main binary fragments during pre-scission stage of the splitting. The case of alpha-cluster formation has been well studied both experimentally and theoretically. Based on this concept we have calculated potential energy surface (PES) for the ternary system – a chain of three clusters arranged collinearly along the fission axis. The PES has been calculated as a sum of the nuclear interactions between neighboring clusters, the Coulomb interactions between all of them and the binding energies of clusters:

$$V(R_1, R_2, Z, Z_1, A, A_1) = V_1(R_1, Z, Z_1, A, A_1) + V_2(R_2, Z, Z_2, A, A_2) + V_{12}^{Cou;}(Z_1, Z_2, R_1 + R_2) + Q_{ggg}.$$

The distances R_1 and R_2 are defined between the middle cluster and two clusters placed on the left and right sides, respectively. Favored decays correspond to the minima of the potential PES-wells in the nucleus-nucleus interactions connecting the ternary system, here $Q_{ggg}=B_1+B_2+B-B_{CN}$ is the balance energy for the ternary fission.

Results of the PES for the ternary fission of ^{252}Cf are presented as a binary correlation function of the charge numbers of the middle cluster Z and one, Z_1, the fragment on the side, they showed a valley corresponding to the formation of the cluster ^{132}Sn for different values of Z and Z_1. This fact reflects the long tail in the mass-mass distributions of the experimentally registered products demonstrating the persistence of shell structure in double magic nucleus ^{132}Sn. On the contour map of the PES there are local minima showing the favored population of the cluster configurations ^{132}Sn+^{50}Ca+^{70}Ni, ^{132}Sn+^{38}S+^{82}Ge, ^{132}Sn+^{36}Si+^{84}Se, ^{150}Ba+^{22}O+^{80}Ge, and others. We found that the middle cluster is more neutron rich than edge fragments. A much smaller energy minimum in the PES (by 10 MeV) for the alternative configuration, the ^{132}Sn+^{72}Ni+^{48}Ca channel, gives for this reaction a much smaller probability, the difference is due to the changed Coulomb repulsion forces. This effect is observed in the yields observed in the experiment [1]. The main aim of our work is to interpret the experimental yields of the CCT products and to find reasons causing interesting peculiarities of the mass-mass distributions.

1. Yu.V. Pyatkov *et al*., Eur. Phys. J. A 45 (2010) 29.
2. Yu.V. Pyatkov *et al*., Eur. Phys. J. A 48 (2012) 94.
3. K.R. Vijayaraghavan, W. von Oertzen, and M. Balasubramaniam, Eur. Phys. J. A 48 (2012) 27.