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A New Interpretation of Cluster Radioactivity Mechanism

The discovery of nuclear molecules [1], double nuclear system and deep inelastic transfer reactions [2, 3] allow a new interpretation to be proposed for the cluster formation mechanism.
It is assumed that nuclei of elements heavier than lead are capable of spontaneously condensing valence nucleons (nucleons above 208Pb) to nuclei of lights elements – clusters. This process results in formation of an asymmetric nuclear molecule, in which both nuclei are in the ground state and interact with each other through the nucleus-nucleus potential. The cluster is formed by successive transfer of valence nucleons to the α-particle, which is formed with a high probability in the surface of the initial nucleus, and further on the light nuclei increasing in mass. Cluster formation is an exoergic process. However, the energy release in this process-Q is below the exit Coulomb barrier and cluster emission (decay of the nuclear molecule) proceeds as a quantum-mechanical process of penetration through the potential barrier.
Realism of the proposed concept of the cluster formation mechanism can be evaluated by considering cluster radioactivity of quite heavy nuclei like 251,252Cf. Within the adiabatic approach [4] to the mechanism of cluster radioactivity the cluster to emit by these nuclei can be the 48Ca nuclei with experimentally measurable half-life. More than twenty years have passed since these adiabatic calculations but so far nobody in the world has observed cluster radioactivity in the 251,252Cf nuclei. Within the proposed approach, emission of the 48Ca cluster from 251,252Cf nuclei is impossible because the process of nucleon transfer from heavy nucleus to the light nucleus will continue after the formation of 48Ca, ending in spontaneous fission of the initial nucleus.

References

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