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Newest Developments in Cluster Radioactivity

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The analytical superasymmetric fission (ASAF) model was successfully employed to make a systematic search and to predict, with other models, cluster radioactivity [1,2]. The experiments confirmed the half-lives and the crucial importance of shell effects for parent nuclei with atomic numbers Z=87-96 and established a rare phenomenon in a strong background of alpha particles.

After a brief historical report we present the macroscopic-microscopic method with an example of PES for 282Cn. Then we describe our theoretical approach of alpha decay (ASAF, UNIV, and semFIS models), cluster decay (ASAF and UNIV), and spontaneous fission dynamics with cranking inertia. UNIV means the universal curve, and semFIS the fission based semi-empirical formula.

The latest evaluation of the experimental atomic masses [3] are very useful to update the Q-values. Within ASAF, UNIV, and semFIS models the deviations for 512 (88 %), 527 (91 %), and 555 (96 %) alpha emitters out of the total of 580, are under one order of magnitude.
Similarly, ASAF and UNIV may reproduce 23 (85 %), and 24 (89 %) experimental data from the total of 27 cluster emissions with deviations under one order of magnitude. All measured half-lives [4] on 14C, 20O, 23F, 22,24-26Ne, 28,30Mg, 32,34Si radioactivities are in
agreement with predicted values within ASAF model. The daughter is mainly the doubly magic 208Pb.

Calculations of half-lives of superheavy nuclei (SH) show an unexpected result [5]: for some of them cluster radioactivity (CR) dominates over alpha decay — the main decay mode of the majority of recently discovered SHs. We changed the concept of CR in order to allow emitted particles with Ze > 28 from parents with Z > 110 and daughters around 208Pb. From a typical example the trend of increasing branching ratio Ba for heavier nuclei may be clearly seen. Ba = Ta/Tc.

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