EXPERIMENTS ON THE SYNTHESIS OF SUPERHEAVY ELEMENTS IN DUBNA

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The constraints on the existence of nuclei, according to the microscopic models, are determined totally by their shell structure. For nuclei located in the vicinity of the closed shells with Z = 108, N = 162 (deformed nuclei) and Z =114 (and perhaps 120), N=184 (spherical nuclei), a considerable stability to different decay modes is predicted. Thus as a result of the shell effect "islands of stability" of superheavy elements emerge, and during the last years these have become the subject of numerous theoretical and experimental investigations.

The experimental verification of this hypothesis requires the investigation of neutron-rich nuclei, the closer they are to the N = 184 shell – the better. For this reason, for the synthesis of superheavy nuclides we use fusion reactions involving the neutron-rich isotopes ^{238}U, ^{242,244}Pu, ^{243}Am, ^{245,248}Cm, ^{249}Cf and ^{48}Ca.

During 5 years (from 1999 to 2004) we obtained 17 new isotopes of elements with Z = 112 - 118 and studied their decay properties. In the sequential α–decay chains of the new nuclides, also new formerly unknown neutron-rich isotopes of the lighter elements with Z = 104 – 111 were produced. All decay chains of the superheavy nuclei terminate by spontaneous fission with high average fission fragment kinetic energy (TKE ~ 220-250 MeV).

This report gives a short account of the experimental technique used and of the decay characteristics of 29 new nuclides. The deduced properties agree in general with the calculations of the microscopic models for nuclei in the region of the predicted "islands of stability" of superheavy elements. The fusion mechanism, leading to the formation of compound nuclei with Z = 112 - 114 and N = 169 – 180, is discussed on the basis of the experimental cross sections and excitation functions for xn-evaporation channels in the ^{233,238}U, ^{242,244}Pu + ^{48}Ca reactions.

The experiments were carried out at the heavy ion accelerator of the Flerov Laboratory of Nuclear Reactions (JINR, Dubna) with the Dubna Gas-filled Fragment Separator (DGFRS) in collaboration with colleagues from the Analytical and Nuclear Chemistry Division (LLNL, Livermore).