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TERMONUCLEAR EXPLOSIONS AND NUCLEOSYNTHESIS OF HEAVY ELEMENTS

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The artificial r-(rapid)-process of nucleosynthesis goes under high neutron flux densities: the obtained neutron fluencies in the irradiated volume of thermo-nuclear devices reach ˜1025 neutrons/cm2 during the time interval ˜10-6 s. Under (thermo) nuclear explosions the obtained conditions in neutron flux and temperature (˜ 108 °K) reach extreme values. The creation of transuranium nuclides under pulsed neutron fluxes of thermonuclear explosions is investigated by means of dynamical model (as in the kinetic model of the astrophysical rapid r-process) taking into account the time dependence of the external parameters and the processes accompanying the beta decays of neutron-rich nuclei. Time dependent neutron fluxes in the interval ˜ 10-6 s (prompt rapid pr-process) were simulated within the framework of the developed adiabatic binary model (ABM) [1]. The results of calculation on the base of the ABM model are compared with the experimental date for all mass numbers in the region A = 239 –257.

Calculations of transuranium nuclides yields Y(A) are made for six large scale explosion USA experiments (”Mike”, “Anacostia”, “Par”, “Barbel” “Vulcan” and “Kankakee”and it were obtained good or satisfied agreement. The corresponding root-mean-square deviations (r.m.s.) of the model yields compare to the experimental data are: 91% (for “Mike”); 70% (”Anacostia”); 33% (”Par”); 29% (”Barbel”); and 45% (”Vulcan”). The beta-delayed processes are taken into account for isotope yields correction after the pulse neutron wave. The calculations include the processes of delayed fission (DF) and the emission of delayed neutrons (DN), which determine the “losing factor” –the total loss of isotope concentration in the isobaric chains. The DF and DN probabilities were calculated in the microscopic theory of finite Fermi systems [2]. Thus, it is possible to describe the even-odd anomaly in the distribution of concentrations N(A) in the mass number region A = 251 –257. It is shown qualitatively also that the odd-even anomaly may be explained mainly by DF and DN processes in very neutron-rich uranium isotopes.

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1. Yu.S. Lutostansky, V.I. Lyashuk // JETP Letters, 2018. V. 107. No. 2. P. 79.
2. A.B. Migdal. Theory of Finite Fermi Systems and Applications to Atomic Nuclei. (1983) Nauka Moscow; 1967 Inter-Sci. New York).

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