Contribution ID : **127** Type : **Plenary/section talk**

Nucleosynthesis of Heavy Elements in Thermonuclear Explosions

Wednesday, 4 October 2017 15:30 (15)

Nucleosynthesis of Heavy Elements in Thermonuclear Explosions

Yu. S. Lutostansky1, V. I. Lyashuk2,1

1National Research Center "Kurchatov Institute", Moscow, 123182 Russia 2 Institute for Nuclear Research, Russian Academy of Science, Moscow, 117312 Russia

E-mail: Lutostansky@yandex.ru

The process of heavy elements production under the intensive pulsed neutron fluxes with a density of up to 1025 neutrons/cm2 is considered. The nature of neutron impulses can be both astrophysical and artificial origin. In astrophysical conditions, the formation of heavy nuclei occur at multiple neutron capturing process in rapid r-process [1], for example, at supernova explosions. In terrestrial conditions such processes are take places in nuclear/thermonuclear explosions [2]. The explosive process of artificial origin are differed from astrophysical ones by small duration time (t < 10-6 s), that allows to split it into two phases: the neutron capturing process and the following β-decays of N-rich nuclei [3]. Such a process can be called "prompt rapid" or pr-process and solution of the equations for calculating the concentration NA,Z(t) of formed nuclei is greatly simplified. Using the previously developed mathematical kinetic model describing the formation of heavy elements in the pulsed nucleosynthesis [4], adapted to the description of nuclear explosions - the adiabatic binary model (ABM) [5], it became able to calculate the concentrations of transuranium nuclei produced in thermonuclear explosions made in the USA ("Mike", "Par", "Barbel"). The results of our calculations using ABM are compared with the experimental date in all mass number region A = 239 – 257. As a result our standard rms deviation for "Mike" experiment is δE(ABM) = 91% is better than the first calculations of Dorn [6] with δE([6]) > 400%, or recent calculations [7] with δE([7]) = 180 %. For "Par" experiment we had obtained δE(ABM) = 33% and for Dorn and Hoff [8] δE([8]) = 76 %. For "Barbel" experiment δE(ABM) = 33% and compare to Bell [2] δE([2]) = 54%. So it is possible to conclude that the authors ABM-model [5] allows to obtain better results in simulations of transuranium isotopes under conditions of nuclear explosions. 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. Thus, it was 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 of very neutron-rich uranium isotopes. The work is supported by the Russian RFBR grant 16-02-00228 and RSF project 16-12-10161.

1. B. M. Burbridge, G. Burbridge, W. Fowler, P. Hoyle. Rev. Mod. Phys. 29, 547 (1957).
2. G. I. Bell. Phys. Rev. B 139, 1207 (1965).
3. Yu. S. Lutostansky, V. I. Lyashuk, I. V. Panov. Bull. Russ. Acad. Sci. Phys. 74, 504 (2010).
4. Yu. S. Lyutostanskii, et al. Yad. Fiz. 42, 215 (1985) [Sov. J.Nucl. Phys. 42, 136 (1985)].
5. Yu. S. Lutostansky, V. I. Lyashuk, I. V. Panov. Bull. Russ. Acad. Sci. Phys. 75, 533 (2011).
6. D. W. Dorn. Phys. Rev. 126, 693 (1962).
7. V. I. Zagrebaev, A. V. Karpov, I. N. Mishustin, and W. Greiner. Phys. Rev. C 84, 044617 (2011).
8. D. W. Dorn and R. W. Hoff. Phys. Rev. Lett., 14, 440 (1965).

Primary author(s) : Prof. LUTOSTANSKY, Yuri (Kurchatov Institute)

Presenter(s) : Prof. LUTOSTANSKY, Yuri (Kurchatov Institute)

Session Classification : Nuclear Physics - 2

Track Classification : Nuclear physics