THE SYNTHESIS AND DECAY PROPERTIES OF SUPER-HEAVY NUCLEI

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The report deals with problem of existence of hypotetical superheavy elements for which theoretical models predict high stability against different types of radioactive decay.

The reactions of synthesis of superheavy nuclei, their formation cross sections and decay properties are considered.

This paper presents results of the experiments aimed at producing long-lived superheavy elements located near the spherical shell closures with Z more 110 and N more 162 in the Pu-242, 244, Am-243, and Cm-245, 248 plus Ca-48 reactins. The large measured alpha-particles energies of the newly observed nuclei, together with the long decay times and spontaneous fission terminating the chains, offer evidence of the decay of nuclei with high atomic numbers. The decay properties of the synthesizes nuclei are consisted with the consecutive alpha-decay originating from the parent nuclides with Z =114, Z=115, and Z=116, produced in the 3n and 4n-evaporation channels with cross sections of about a picobarn.

The results of an attempt aimed at the synthesis of element 118 in reaction Cf-249 plus Ca-48 are reported. The alpha-particle energies and the half-lives of the new activities are compared with the values calculated using various theoretical models.

The present observation can be considered an experimental evidence of the existence of the "island of stability" of superheavy elements.

The experiments were performed employing the Dubna Gas-Filled Recoil Separator and the U-400 cyclotron at FLNR (JINR, DUBNA).

TO QUESTION OF NPP POWER REACTOR CHOICE FOR KAZAKHSTAN

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The requirements to NPP power reactors that will be under construction in Kazakhstan are proved and given in the report.

A comparative analysis of the most advanced projects of power reactors with light and heavy water under pressure of large, medium and low power is carried out. Different reactors have been considered as follows:

1. Reactors with high-power (700 MW(el) and up) such as EPR, French - German reactor; CANDU-9, Canadian heavy-water reactor; System 80+, developed by ABB Combustion Engineering company, USA; KNGR, Korean reactor of the next generation; APWR, Japanese advanced reactor; WWER-1000 (V-392) - development of Atomenergoproect /Gydropress, Russian Federation; EP 1000, European passive reactor.
2. Reactors with medium power (300 MW 9el) - 700 MW (el): AP-600, passive PWR of the Westinghouse company; CANDU-6, Canadian heavy-water reactor; AC-600, Chinese passive PWR; WWER-640, Russian passive reactor; MS-600 Japanese reactor of Mitsubishi Company; KSNP-600, South Korean reactor.
3. Reactors with low power (a few MW (el)- 300 MW(el)): IRIS, reactor of IV generation, developed by the International Corporation of 13 organizations from 7 countries, SMART, South Korean integrated reactor; CAREM, Argentina integrated reactor; MRX, Japanese integrated reactor; "UNITERM", Russian NPP with integrated reactor, development of NIKIET; AHEC-80, Russian NPP, developed by OKBM.

A comparison of the projects of the above-mentioned power reactors was carried out with respect to 15 criteria of nuclear, radiating, ecological safety and economic competitiveness, developed especially for this case.

Data on a condition and prospects of power production and power consumption, stations and networks in Kazakhstan necessary for the choice of projects of NPP reactors for Kazakhstan are given. According to the data a balance of power production and power consumption as a whole in the country was received at the level of 59 milliard kW/h. However, strong disbalance in the regions of Republic of Kazakhstan occurs. Southern and western regions import electric power and capacity because of undeveloped circuit of networks. Moreover, power intensity of an industrial-agrarian complex of the country is limited transmission capacity of lines is insufficient; plenty of small consumers are removed from power supply lines. Thus, nuclear stations of medium and low power are the most acceptable for construction in Kazakhstan.

Recommendations for the choice of maximum safe, reliable and economically competitive reactors for Kazakhstan have been made in result of the carried out projects' comparison of the power reactors according to 15 criteria of safety and economic competitiveness, with respect to condition and perspectives of Kazakhstan power complex development:

Recommended power reactors of medium capacity:

- AP-600 - passive PWR, developed of the Westinghouse company, USA;
- CANDU-6, developed by Atomic Energy of Canada, Limited (AECL), Canada.
- MS-600 - Mitsubishi Company, Japan.

Recommended reactors of low power:

- IRIS - reactor of IV generation developed by the international corporation of 13 organizations from 7 countries;
- NPP "UNITERM" - development NIKIET, Moscow, Russia;

- MRX - the Project of sea reactor MRX for civil applications, is developed by the Japanese Research Institute of Atomic Energy (JAERI);

The most important advantages of recommended medium and low power reactors are given.

REARRANGMENT OF THE EXPERIMENTAL DATA FOR LOW LYING COLLECTIVE STATES IN EVEN-EVEN NUCLEI

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Nature of low lying 0^+ states bands in deformed nuclei remains a mystery under debate. The improvements in technology have remedied the situation by enabling spectroscopy, reactions, and life-time measurements of a large number of 0^+ bands that were previously inaccessible in nuclei. In many deformed even-even nuclei there are several number of excited states and we investigate the variation in collectivity amongst 0^+, 2^+, 4^+, 6^+ and 8^+ bands in the same nucleus in very broad isotopic region. Small vibrations of nuclear shapes around equilibrium can give rise to physical states at low to moderate excitation energies. Our analysis based on phenomenological collective Hamiltonian [1] and also on the Hamiltonian of Interacting Vector Boson Model (IVBM) [2] have shown that the experimental energies of low lying excited 0^+ states in every even-even nucleus can be rearranged in a manner in which the energies of these states are distributed by number of collective excitations with parabolic distribution function. Again, low lying excited states with the values of spin different from zero can also be distributed with great accuracy by collective classification parameter – number of collective excitations building corresponding excited state. Large amount of nuclear excited 0^+, 2^+, 4^+, 6^+ and 8^+ states are analyzed, their energies distributed by number of bosons and comparison with experiment are presented. Using this classification and in the framework of IVBM we describe simultaneously the rotational ground, octupole and γ – bands energies in some even-even rare-earth and actinide nuclei. New experimental data for ^{160}Dy nucleus obtained in DLNP JINR, Dubna [3] are presented and discussed together with the data for ^{158}Gd recently achieved by S.R. Lesher, A. Aprahamian et al. [4]. The successful reproduction of the experimental energies and their odd-even staggering was obtained as a result of the consideration as yrast energies in respect to the number of phonon excitation N that built the collective states.

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