POSSIBLE EXPLANATION OF THE ANOMALOUS LOCALIZATION EFFECT OF THE NUCLEAR REACTION PRODUCTS STIMULATED BY CONTROLLED COLLAPSE AND THE PROBLEM OF STABLE SUPERHEAVY NUCLEI

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The model and method of creation and evolution of superheavy nuclear clusters with A>3000-5000 in the zone of controlled collapse action and in the volume of a remote accumulating screen is discussed. These phenomena were interpreted on the basis of the main common idea - formation of a self-organized and self-supported collapse of electronic-nuclei plasma under the action of the coherent driver up to a state close to a nuclear substance. The evolution of such clusters in a remote screen results the synthesis of isotopes with 1<A<500 and with anomalous spatial distribution.

Introduction

During experiments on superpressing solid density target to a collapse state by a special coherent driver [1] several anomalous phenomena were observed:

a) very intensive X-radiation with averaged energy about 35 KeV emitted from a point-like source situated in the collapse zone;

b) fusion of light, intermediate and heavy chemical elements and isotopes with $1 \le A \le 240$ and fusion of superheavy transuranium elements with $270 \le A \le 500$ in the area near the collapse zone;

c) unique spatial distribution of different chemical elements and isotopes with $1 \le A \le 240$ in the volume of an accumulating screen made of a chemically pure element remote from the collapse zone (all created elements and isotopes are situated in the same thin layer inside the screen);

d) all created elements and isotopes were stable (without radioactivity);

e) very slow quasi-neutral particles with very low coefficient of deceleration were observed in the remote accumulating screen.

These phenomena with a high probability can be interpreted on the basis of the main common idea - creation and evolution of a self-organized and self-supported collapse of electronic-nuclei plasma of initial solid-state density under the action of the coherent driver up to a state of electronic-nuclei clusters with density close to that of a nuclear substance. During the evolution of such collapse, the processes of fast fusion and creation of different isotopes (including trarnsuranium ones) take place. After the end of the collapse state the synthesized isotopes were detected near the collapse zone and both on the surface and in the volume of the remote accumulating screen.

It was also suggested that during evolution of this cluster the process of emission of superheavy neutral nuclei with A>3000-5000 takes place.

2. Formation of unique spatial distribution of created chemical elements

Let us consider in details the possible mechanisms of formation of a thin layer (containing different elements and isotopes with the same spatial distribution) in the volume of an accumulating screen made of a chemically pure element (e.g.,Cu) remote from the action zone of coherent driver. The scheme of formation of this layer in experiments [1] is presented on Figure 1.

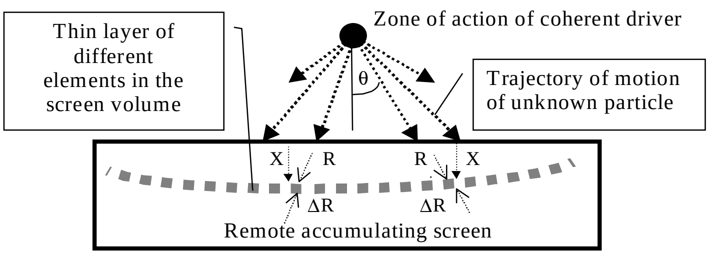

Figure 1.

The presented depth profile (see Figure 2) was typical for all experiments [1] and was obtained by ionic etching of a surface of the accumulating screen with ion microprobe analyzer IMS 4f (CAMECA, France).

It follows from Fig. 2 that different chemical elements (e.g., Au, Pr, La, I, Ce, W, unidentified element ^{156}A) are situated in the same thin layer with thickness $\Delta R/R \approx 0.25$ and distance $R = X\cos\theta$ from the surface into the depth of the accumulating screen in the direction from the collapse zone. The distance R and thickness ΔR are the same for the whole layer and all chemical elements for the single experiment. For different experiments the values of R and ΔR may be different but the ratio ΔR/R is the same. The typical value of R is $R \approx 0.3$-0.5 micron. In some experiments an additional thin layer of different elements at $R \approx 5$ micron was observed.

The synthesized elements and isotopes were distributed on the surface of the layer as separate clusters. In the center of the screen the clusters overlapped. The distribution of clusters of different elements (Al, B, Si, K) on the surface of the layer is presented on Figure 3. The distribution are the same in details! This result can be obtained only if all detected elements were born in each cluster during nuclear transmutation of unknown particles.

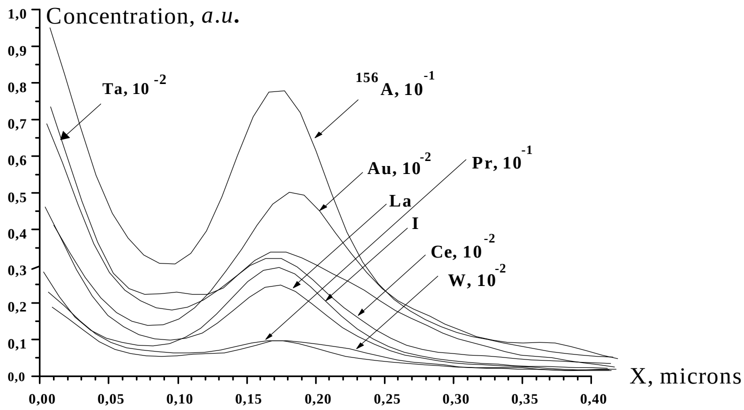

Figure 2. Depth profile of chemical elements in accumulating screen

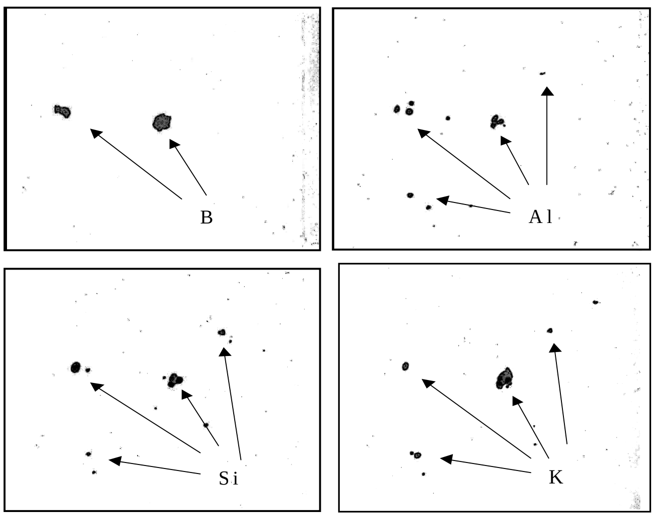

Figure 3. Distribution of clasters of chemical elements B, Al, Si, K on the same very small area on the surface of thin layer

It is easy to make sure that such distribution on surface and radius cannot be a result of the usual Coulomb deceleration process for different fast ions.

For such Coulomb deceleration the energy losses dE/dr and the ion deceleration distance R with mass M, charge Z and energy E are

$$dE/dr = -(2\pi n_e MZ^2e^4/m_eE)\, ln(4m_eE/MJ),\ R=\int_E^{E_{min}} dE/(dE/dx) \qquad (1)$$

Here, J is an averaged potential of ionization of screen atoms.

On the one hand, at the same distance of deceleration R = 0.3 micron in copper target for different ions the values of initial energies E are very different (e.g., for H^+ we need $E_H \approx 60$ KeV and for Pb^+ we need $E_{Pb} \approx 60$ MeV). The same dispersion of E_i will be for ions with different charges.

On the other hand, for different ions at the same energy E the ratio of deceleration distances R_i is also very high (e.g., for H^+ and Pb^+ we have $R_H/R_{Pb} > 20\text{-}30$).

The observed distribution of chemical elements (fixed values of ΔR and R for different particles in each single experiment) in the layer may appear only in the case of deceleration in the depth of the screen of identical particles with the same charge and energy. But such distribution is observed for different elements (from H to Pb)! So, we have a paradox here!

We suppose that such distribution of different chemical elements and isotopes is possible only if the following conditions are met:

1) all initial (decelerated and stopped) particles must be the same (identical);

2) for the stability of the charge of the particles, the velocity V of the particles must be low in relation to the velocity $v_0 = e^2/\hbar = 2.5.10^8$ cm/s of valence electrons;

3) for large distance of deceleration R at low velocity $V \ll v_0$ the mass M of an unknown particle must be very large;

4) different chemical elements and isotopes observed in the screen layer are created by nuclear transmutation of these identical particles after stopping at R.

What are the nature of these unknown surepheavy particles and the mechanism of fast nuclear transmutation to different final stable nuclei?

3. Deceleration of heavy particles by elastic scattering in the screen

We have investigated the possible mechanism of elastic deceleration of these unknown particles and have calculated their parameters.

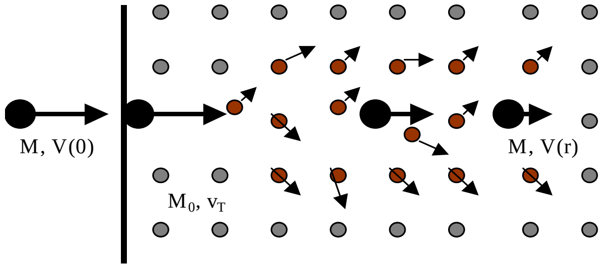

Figure 4. The scheme of elastic deceleration of unknown heavy particles in the depth of accumulating screen

The equation of motion of unknown uncharged particles with mass M in the depth of the screen (see Figure 4) is the following:

$$M\, dV/dt = F = -\,(2M_0V^2\sigma n) \qquad (2)$$

Here, $F \equiv \Delta p/\Delta t = -\,(2M_0V^2\sigma n)$ is the average force of elastic deceleration of an unknown heavy particle in the screen,

$\Delta p = -\,\delta p\ (\Delta t/\delta t) = -\,(2M_0V^2\sigma n)\,\Delta t$ is the decelerating impulse of a particle at $\Delta t >> \delta t$ (during $\Delta N=\Delta t/\delta t$ single collisions with ions of target with mass M_0),

$\delta t = l_1/V = 1/\sigma nV$, $l_1 = 1/\sigma n$ is interval between the two nearest collisions of unknown heavy particle with ions of a target,

$\delta p \approx 2M_0V(t)$ is the decelerating impulse of a particle at a single collision.

The solution of Eq.(2) is

$$V(t) = V(0)/[1+2M_0\sigma nV(0)t/M] \qquad (3)$$

Deceleration ends at a time $t=\tau$ when the kinetic energy of the particle $MV(\tau)^2/2$ is equal to thermal energy $M_0v_T^2/2$ of atoms (ions) of the screen.

The duration of deceleration equals

$$\tau = [(V(0)\sqrt{M})/(v_T\sqrt{M_0}) - 1]\ M/2M_0\sigma nV(0) \qquad (4)$$

The distance of deceleration is

$$R(\tau)=\int_0^\tau V(t)dt = \frac{M}{2M_0\sigma n}\ln\left(\frac{V(0)\sqrt{M}}{v_T\sqrt{M_0}}\right) = \frac{M}{M_0\sigma n}\ln(T/T_0) \qquad (5)$$

The mass of the unknown particle is

$$M = 4R(\tau)M_0n\sigma / \mathit{ln}(T/T_0) \qquad (6)$$

Here, $T = E(0) = MV(0)^2/3$ is the initial energy of the unknown particle after leaving the zone of the coherent driver action,

$T_0 = M_0 v_T^2/3$ is the temperature of the screen.

Let us make numerical estimations. For a screen made of chemically pure cooper ($A_0 \approx 64$), the concentration and cross-section of elastic scattering are $n_i \approx 8.10^{22}$ cm^{-3}, $\sigma \approx 10^{-16}$ cm^2. At experimental value of the distance of deceleration $R(\tau) \approx 0.4$ micron and at T_0=300 K = 0.025 eV, T = 35 KeV we have very large mass of the unknown particle: $M \approx 91\ M_0$, $A \approx 91A_0 \approx 5700$.

The initial velocity of these superheavy particles was low in relation to the velocity of valence electrons $v_0 = e^2/\hbar$ =2.5.10^8 cm/s and equaled

$V(0) = (3T/M)^{1/2} \approx 3.7.10^6$ cm/s.

The total duration of deceleration of the particles equals $\tau \approx 0{,}8.10^{-9}$ s.

For different case (for layer situated at different distance of deceleration $R(\tau) \approx 5$ micron) we have $M \approx 1100M_0$, $A \approx 1100A_0 \approx 73000$.

The obtained parameters correspond to requirements 1)-3).

4. The model of evolution of superheavy neutralized nuclei

We assume that these superheavy particles are similar to abnormal superheavy neutralized nuclei that were proposed by A. Migdal about 20 years ago [2]. Migdal obtained the important result - the energy E/A of nuclear substance has two minimums (first "usual" at $A \approx 60$ and second "abnormal" at $A_{max} \geq 2.10^5$). Migdal suggested that the presence of the second "abnormal" minimum of energy E/A was the result of Fermi-condensation of pions in the volume of superheavy nucleus (e.g., during the shocking action). These minimums are separated with a high potential barrier at $Z_0 \approx (\hbar c/e^2)^{3/2} \approx 1600$. The mechanism of suppression of the action of that barrier will be discussed below. If this hypothesis is correct, than superheavy neutralized nuclei created in the active zone of the coherent driver can absorb environmental "usual" nuclei of the target (screen). This transmutation leads to growth of these superheavy neutralized nuclei by nuclear fusion up to A_{max}.

Very few electrons are outside the volume of these nucleus in a thin skin with thickness about 10^{-12} cm. The probability of such synthesis is very high due to the high transparency of the Coulomb barrier. During such fusion energy is released. There are different channels for the release of the excessive energy (gamma-emission, neutrons emission, nuclear fragments emission). One of the channels is connected with the creation of different "normal" nuclei and emission of these nuclei from the volume of the growing superheavy nucleus. E.g., after the absorption in a short time of several target nuclei with $A_T \approx$ 50-200, high binding energy can lead to emission of several light nuclei with $A_L < A_T$ or one heavy nucleus with $A_H \approx 300\text{-}500 > A_T$ (see Figure 5).

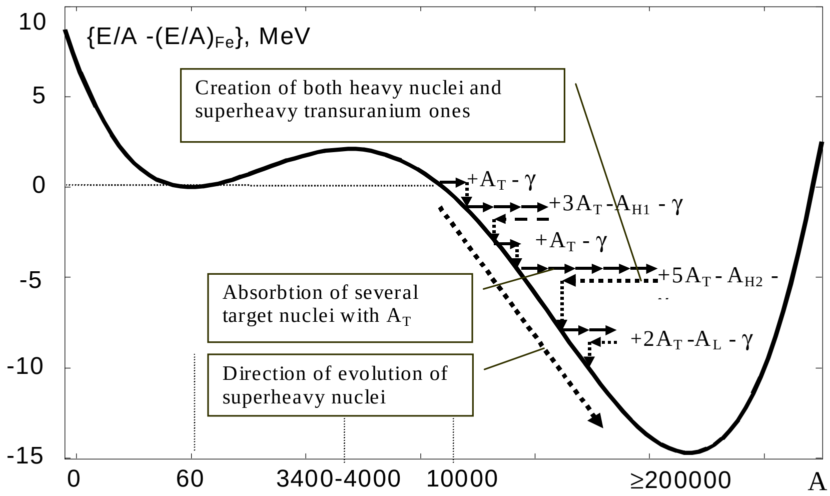

Figure 5. Evolution of superheavy nucleus - absorbtion of target nuclei and creation of different nuclei (from H up to stable transuranium nuclei)

The process of nucleus emission is competing with the other ways of nuclear substance cooling. In this case, usual even-even nuclei (like alpha-particle and C^{12},O^{16},..., Pb^{208}) that already exist in the volume of a superheavy nucleus are more likely to emerge and be emitted. In fact, every superheavy nucleus is a "specific microreactor" for transmutation of "usual" target nuclei to different nucleons configurations. In this microreactor the process of transmutation comes to an end after the utilization of all target nuclei or after the evolution of a superheavy nucleus to the final stable state with A_{max}.

What is the way of creation of these superheavy nuclei?

We have carried out the analysis of evolution of nuclei in the action zone of the coherent driver. It follows from our calculation that for some usual (not superheavy) but "critical" nuclei (e.g., at $Z>Z_{cr} \approx 92$) at special parameters of the coherent driver, the process of fast and self-controlled change (decrease) of energy of nucleons (increase of the energy of binding) takes place. The value Z_{cr} depends on the driver's parameters. It also follows that the minimum of this energy changes in time from the initial (usual) value at $A_{opt} \approx 60$ to $A_{opt} \geq 10^4$. All "subcritical" nuclei with $Z< Z_{cr}$ have the stable minimum of energy at $A_{opt} \approx 60$. This effect is connected with self-similar processes in superdense degenerated electron-nucleon plasma with suppressed influence of Coulomb interaction between protons in the volume of superheavy nucleus.

The coherent driver is to start this self-amplified process of nuclear transformation for "critical" nuclei.

We have calculated energy change per nucleon (E/A) for different relations of electron and proton concentration for "critical" nuclei at $10<A<2.10^5$. During the initial phase of the process (at the shift of minimum of nucleon energy E/A to $A_{opt} \approx 5000$-10000) the role of pionic condensation is low but becomes critical at $A_{opt} \geq. 10^5$. The degenerated electron-nucleus plasma initially includes the mixture of all nuclei (usual stable nuclei and growing superheavy ones) and electrons and is prevented from decay due to the action (pressure) of the coherent driver. The description of such processes will be presented in the nearest publications.

During such change of E/A ratio for superheavy nuclei, the process of fusion of target nuclei (absorption of target nuclei with "subcritical charge" $Z < Z_{cr}$ and growth of "critical" nuclei with $Z >Z_{cr}$) in the zone of action of the coherent driver becomes possible (see Figure 6). This fusion leads to the fast growth of initial "critical" nuclei up to $A \approx 10^4$-10^5 during the time of action of the coherent driver (about $\Delta t_d \leq 100$ ns) with velocity $(dA/dt)_{collapse} \approx A/\Delta t_d \approx 10^{12}$ - 10^{13} s^{-1}. This velocity is proportional to the target nuclei concentration. This process may lead to the creation of nuclei with $1< A < 300$-500. The scheme of creation of these nuclei and the scheme reviewed above during the analysis of the processes taking place in the accumulating screen are the same.

After the end of the compressing action of the coherent driver the process of decay of degenerated electron-nucleus plasma, that after the nuclear reactions included the mixture of all nuclei (usual stable nuclei of the target, growing superheavy nuclei and created nuclei), takes place. Some of these superheavy nuclei hit the remote accumulating screen and are decelerated there.

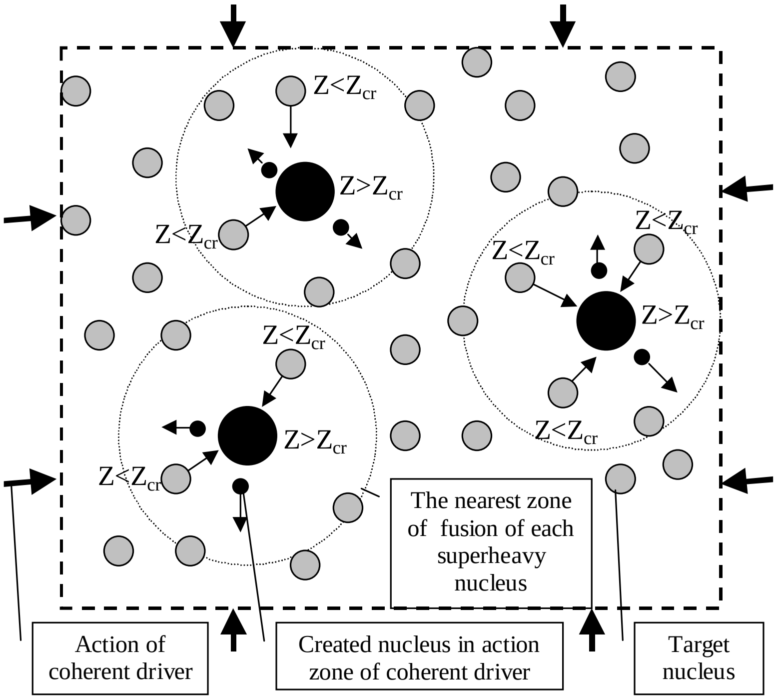

Figure 6. Tramsmutation of target nuclei ($Z<Z_{cr}$) to different nuclei ($1<A<500$) in zone of collapse

The velocity of growth of these nuclei in the volume of solid state density accumulating screen is proportional to the nuclei concentration n_{screen} and equals $(dA/dt)_{screen} \approx (n_{screen}/n_{collapse})\ (dA/dt)_{collapse} \approx 10^8\ s^{-1}$. After the deceleration of these superheavy nuclei in the screen during $\tau \approx 10^{-9}$ s the process of growth continued for a period $T \approx A_{max}/(\ dA/dt)_{screen}\ \geq 10^{-3}$ s

We suppose that above scenario gives rather a full explanation of all the abnormal results a) - e) obtained in course of experiments [1].

References

1. A.V. Adamenko, A.S.Adamenko //International Symposium "New Projects and Lines of Research in Nuclear Physics", Messina, Italy, October 2002, Abstracts of contributed papers, p.19.

2. A.V.Migdal, D.N. Voskresenskii, E.K. Sapershtain and M.A.Troitskii. Pionic degrees of freedom in a nuclear substance, Moscow, 1991 (in Russian).