Exploration of Mass Defect, Preons and Relic Neutron

Victor Chibisov[1]
st.4p@mail.ru

[1] Independent researcher, Novosibirsk, Russia

Categories: nucl-th, hep-ph, astro-ph.CO

ABSTRACT

This article was originally prepared in anticipation of the launch of the James Webb Space Telescope (JWST) by NASA on December 24, 2021. JWST, in accordance with its program of work, is expected to peer into the first galaxies beyond the redshift corresponding to the time interval of 100-250 million years after the Big Bang. explosion. The article presents the rationale for the prediction of the detection of metals in the gaseous environment of the first galaxies at this point even before the explosion of the first supernovae. To substantiate this forecast, the article considers a variant of the preon structure of nucleons, which allows us to take a fresh look at the mechanism of the occurrence of a mass defect, and the ensuing consequences about the existence of relic neutrons of increased mass in the early Universe, and the implementation of primary nucleosynthesis according to Gamow's scheme from relic neutrons of increased mass. This article is of a discussion nature and is intended to familiarize the scientific community with the proposed concept, which, in our opinion, does not contradict the ideas of modern physics about the structure of matter, but refines this structure taking into account previously put forward and unreasonably rejected hypotheses.

TAGS: nuclear physics, astrophysics, theoretical physics, cosmology.

MASS DEFECT

According to the Standard Model, the masses of all protons and neutrons are considered stable and have their reference values of 938.27208816(29) and 939.56542052(54) MeV, respectively (hereinafter we use the abbreviated form of the MeV unit of mass measurement, adopted in nuclear physics and physics elementary particles, instead of the full writing MeV/s2). At the same time, when protons and neutrons combine into atomic nuclei, a so-called nuclear mass defect arises, which can be calculated. The nuclei of the isotopes 56Fe, 58Fe, 62Ni have the highest value of mass defect per nucleon, in which the average mass of one nucleon is approximately 930.0915 MeV, which is less than both the reference proton mass and the reference mass of the neutron. On Fig. 1. is a graph of calculating the average mass of one nucleon for stable isotopes, depending on the number of nucleons in the nucleus. The mass of particles in this article is given in accordance with [1], and the mass of isotopes in accordance with [2].

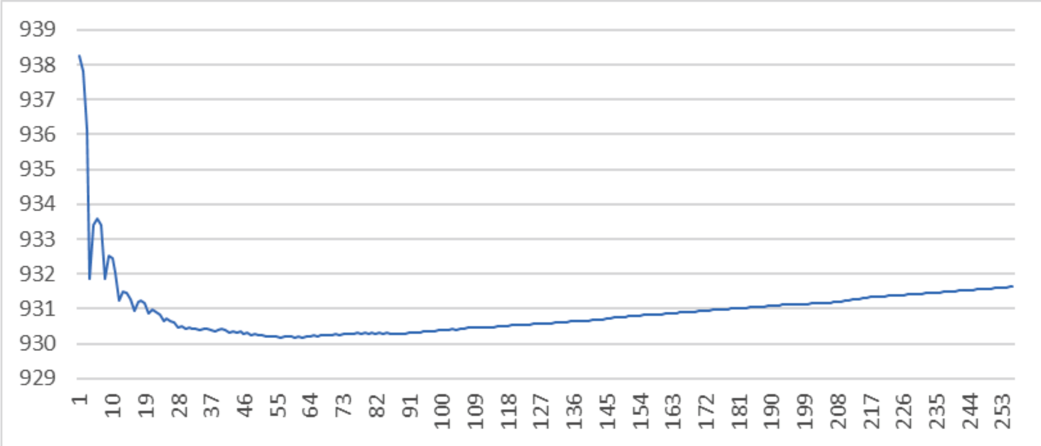


Fig. 1. Average mass of one nucleon from the number of nucleons in the isotope nucleus (for isotopes of the valley of stability).

As we can see, the maximum average mass of nucleons in isotope nuclei is equal to the mass of the reference proton in the 1H isotope nucleus. In the nuclei of subsequent isotopes, the average mass of one nucleon is much less.

It is believed that the missing mass of protons and neutrons is converted into the binding energy of nucleons in the compound nuclei of isotopes. But is it? Indeed, when protons and neutrons combine into nuclei, other particles are additionally formed - electrons, photons, neutrinos, which also carry away part of the mass and energy of nucleons, and it is this circumstance that plays a decisive role in reducing the mass of nucleons, which is reflected in the form of this graph. What does this mean? This means that part of the mass of nucleons in compound nuclei is missing, and the nucleons have a mass less than the reference one, regardless of the value of the binding energy. At the same time, we absolutely do not question the laws of conservation and transformation of mass and energy. But we assume that, within the framework of these laws, the mass of nucleons in all nuclear reactions constantly decreases, and it is this decrease in the mass of nucleons (nucleon mass defect) that explains the defect in the mass of isotope nuclei, and ensures the formation of new particles, and the energy results of these reactions (external and internal).

Our assumption about the decrease in the mass of nucleons during nuclear reactions can be confirmed by the graph (see Fig. 2) of the dependence of the total defect in the mass of isotope nuclei on the number of nucleons in the nuclei.

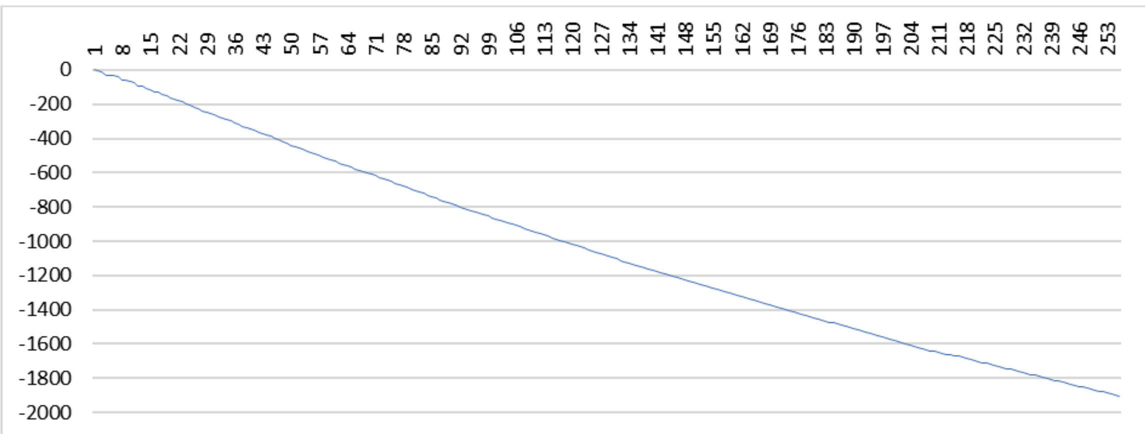
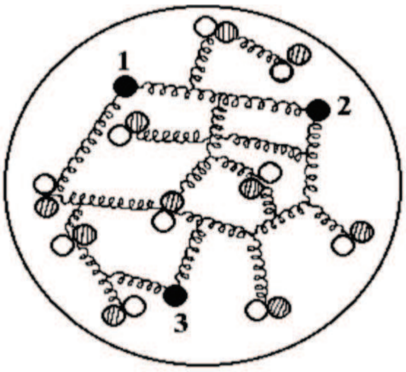


Fig. 2. The total defect in the mass of nuclei of isotopes on the number of nucleons in nuclei (MeV).

As we see, the total defect in the mass of isotope nuclei always increases and never decreases with increasing number of nucleons in the nucleus. From this we make the assumption that in the process of all nuclear reactions, some of the components of the nucleon structure are destroyed, while some of these nucleon components are transformed into the above particles and leave the nucleons, reducing their mass. In accordance with this scheme, the mass of nucleons in all nuclear reactions only decreases and can never increase, and the resulting mass of nucleons participating in reactions is always less than the reference mass of protons and neutrons, with the exception of the reference proton in the 1H isotope, and the reference neutron in isotope 2H. Below we consider the mechanism of this decrease in nucleon masses.

NUCLEON STRUCTURE

The question about the mechanism of occurrence of a nucleon mass defect in isotope nuclei cannot be answered without analyzing the internal structure of nucleons. This issue has been studied in great detail over the past 50-70 years. The most widely accepted model is that protons and neutrons are composite particles consisting of three valence quarks and a sea of virtual quark-antiquark pairs connected by chains of gluons (see Fig. 3).



Rice. 3. Quark-gluon model of nucleons.

But at the same time, this model of nucleons does not answer another interrelated question - how, for example, are electrons formed from these components of a given nucleon structure? In the indicated structure of nucleons, only quarks and gluons are present, but all quarks have a mass greater than the mass of electrons, and gluons are massless particles and can only be transformed into quarks. As a result, we have to hypothetically assume that quarks are also composite particles from smaller components, from which electrons and other particles are formed during nuclear reactions. This hypothesis was quite popular in the 70s and 80s of the 20th century and was called the Preon theory of the structure of quarks and leptons. But the concept of String Theory, which appeared in the late 80s, pushed the concept of Preon theories far into the background. However, at the end of the 90s, the first crisis in String Theories was outlined, and the concept of Preon theories was revived again. In 1997, a new preon theory, Preon Trinity, appeared [3]. If you now click on the word preon on the arxiv website, a list of hundreds of articles on various preon theories of our 21st century will open.

Let us immediately note that preons have not currently been experimentally detected (as well as individual quarks and gluons) and are purely hypothetical particles. However, in our further analysis we will use precisely this hypothesis of the preon structure of quarks and leptons, and the process of reducing the masses of nucleons in the course of all nuclear reactions will be considered as the destruction of part of the sea quark-antiquark pairs into preons, with the subsequent formation of new particles from these preons, leaving nucleons.

In accordance with this hypothesis, the process of decreasing nucleon masses should be discrete in nature, in which the discrete decrease in nucleon mass is one decaying sea quark-antiquark pair, which can conventionally be called a quasiparticle - a defecton. I would like to note the following. The quark nucleon model balances well the charges of nucleons, valence quarks, and sea quark-antiquark pairs. The balance of these charges has been confirmed experimentally. At the same time, the reference values of the masses of valence quarks are purely calculated based on the corresponding mathematical models, and have not been experimentally confirmed. Also, the identity of sea quarks with valence quarks is accepted based on the principle of Occam's razor, and has also not yet been confirmed experimentally. We will take these circumstances into account in our assessments.

It is believed that the quark composition of different sea quark-antiquark pairs may differ, but this has not yet been confirmed experimentally. Our article is purely evaluative, so for these purposes we will consider the mass of all sea quark-antiquark pairs (defectons) to be on average the same, and consisting not of a quark-antiquark pair, but of a preon-antipreon pair. In this article, we set the task, based on the hypothesis we set out and the available data, to determine the mass of an average defecton, the mass and charge of preons* (halves of a defecton), the preon composition of valence quarks, electrons and positrons, and to analyze some of the consequences arising from this preon structure of matter.

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* In [3], the authors propose a model of the preon structure of quarks and leptons, which includes three types of preons. We have a variant of the preon structure of leptons, quarks, and nucleons, the basis of which is a set of five preons. But in this article, we set a limited task - to justify the discrete decrease in the mass of nucleons in the course of all nuclear reactions, to determine the size of this discrete, and the consequences arising from this. For these purposes, it is enough for us to operate with preons of average mass. We will return to the issue of the detailed preon structure of elementary particles and nucleons, taking into account a more complete nomenclature of preons, in the next article.

DETERMINATION OF ESTIMATE PARAMETERS OF DEFECTON AND PREON

To determine the mass of a defecton, let us turn to the graph of the mass defect of isotope nuclei versus the number of nucleons. The minimum absolute value of the mass defect falls on the nucleus of the 2H isotope formed during the first nucleosynthesis reaction:

$$p + n \rightarrow D + \gamma \qquad (1)$$

where D is a deuteron, the nucleus of the 2H isotope,

γ is a photon.

The deuteron mass defect arising during this reaction is equal to:

p + n – D = 938.27208816 + 939.56542052 - 1875.61283176 = 2.2246769 MeV.

For other isotopes, the value of the mass defect of their nuclei is greater (see graph 2). To begin with, let us note that the mass defect of the 2H isotope nucleus (2.2246769 MeV) falls within the range of the u-quark reference mass (2.3 ± 0.7 MeV). Based on this, it could be assumed that during this reaction one u-quark is destroyed, and the mass balance would be maintained. However, this option must be rejected due to the occurrence of an imbalance of electrical charge before and after the reaction. That is why we made the assumption that during all nuclear reactions, sea quark-antiquark pairs with a total zero electric charge, which we called defectons, are always destroyed.

It should also be noted that during this reaction, a proton and a neutron combine into a nucleus without changing the composition of their valence quarks. This means that the entire deuteron mass defect was formed only due to the destruction of defectons (sea quark-antiquark pairs).

We know the significance of this mass defect, but we do not know the number of defectons destroyed. Now we will compile a table number 1 possible options for the number of destroyed defectons, and the corresponding masses of one defecton, and their halves (sea quarks). At the same time, taking into account the appearance in the calculations of mass values that do not correspond to the reference masses of valence quarks, we will use the term we previously stated - preons. In the future, we will use the following terminology - we will call destroyed sea quark-antiquark pairs defectons, and we will call one sea quark of this pair (of defecton) a preon, the mass of which, according to our calculations, may differ from the mass of valence quarks. Thus, in our terminology, one defecton consists of two preons with opposite equal electric charges. We do not consider the remaining parameters of preons (except for mass and electric charge) here.

number of defectons destroyed	mass of one defecton	mass of one preon in defecton
1	2,2246769	1,1123385
2	1,1123385	0,5561692
3	0,7415590	0,3707795
4	0,5561692	0,2780846
5	0,4449354	0,2224677
6	0,3707795	0,1853897
7	0,3178110	0,1589055
8	0,2780846	0,1390423
9	0,2471863	0,1235932
10	0,2224677	0,1112338
11	0,2022434	0,1011217
12	0,1853897	0,0926949
13	0,1711290	0,0855645

Table 1. Calculation of variants of masses of defectons and preons.

To determine the specific variant of the defecton and preon masses, we will additionally analyze the charge balance of particles participating in nuclear reactions. To do this, we will use another nuclear reaction of the decay of a free neutron, which in general has the following formula:

$$n \rightarrow p + e- + \underline{\nu} + \gamma \qquad (2)$$

where $\underline{\nu}$ is the electron antineutrino

Note that during this reaction, not only the destruction of a certain number of neutral defectons in the neutron, and the formation of neutral particles (antineutrino and photon), but also the formation of a negatively charged electron (with charge -1), and the confinement of valence quarks with the replacement of d -quark (with charge -1/3) to u-quark (with charge +2/3). According to our concept, this happens as follows.

In the neutron, the valence d-quark and the Nth number of defectons are destroyed into preons with the formation of a cloud of preon plasma. Next, an electron is formed from the resulting preons, and some preons with opposite charges are annihilated to form a photon and an electron antineutrino; all three of these particles leave the nucleon. After this, only preons of one positive charge remain in the nucleon, from which a valence u-quark is formed.

We do not yet know the number of preons in the resulting cloud of preon plasma and their final distribution among the resulting particles. To determine this amount, let's make a table of possible options for the number and masses of negative preons from which the electron was formed:

electron mass	number of preons in an electron	preon mass
0,51099891	1	0,51099891
0,51099891	2	0,255499455
0,51099891	3	0,17033297
0,51099891	4	0,127749728
0,51099891	5	0,102199782
0,51099891	6	0,085166485
0,51099891	7	0,072999844
0,51099891	8	0,063874864
0,51099891	9	0,056777657
0,51099891	10	0,051099891

Table 2. Calculation of options for the number of preons in an electron.

Let's compare the two tables we calculated. The closest preon masses to each other are the values 0.0855645 and 0.085166485 MeV (marked in yellow in the tables). The difference between these values is less than 0.5%.

But more importantly. At a given preon mass value, their number in an electron is 6, which means that the electric charge of preons is 1/6 of the electron charge. This is an absolutely multiple of the quark charges +2/3 and -1/3. Such a coincidence of both masses and charges cannot be accidental.

As a result of this calculation, we take the estimated value of the defecton mass to be equal to 0.171129 MeV, and the estimated value of the mass of one averaged preon to be equal to 0.0855645 MeV (see Table 1), and the value of the electric charge of preons to be equal to +1/6 or -1/ 6 electron charges.

As for the mass of valence quarks, it was not involved in the calculations and can remain unchanged (for reference). Their charges are determined: for the u-quark by the presence in its composition of 4 unpaired preons with a charge of +1/6 each, and for the d-quark by the presence in its composition of 2 unpaired preons with a charge of -1/6 each. The missing amount of mass of valence quarks in addition to the mass of these unpaired preons, which determine the charge of valence quarks, can be supplied by the corresponding amount of neutral preon-antipreon pairs, additionally included in the structure of valence quarks.

Concluding this section of calculating the masses of defecton and preon, we note that during the nucleosynthesis reaction of the deuterium nucleus (2H), 13 defectons were destroyed (see Table 1). We cannot say now definitely which part of these defectons was destroyed in the proton, and which part in the neutron. This issue requires additional study of the preon structure (form factor) of nucleons.

RELIC NEUTRON

PRIMARY NUCLEOSYNTHESIS ACCORDING TO THE GAMOW SCHEME

The concept we have put forward of the destruction of a certain number of defectons during all nuclear reactions and the corresponding reduction in the mass of nucleons participating in these nuclear reactions allows us to give a new answer to a number of questions that do not have convincing answers in modern physics at the present time.

In particular, it becomes clear how, during the β+_decay reaction, a proton (having a lower reference mass) is transformed into a neutron (having a larger reference mass). In accordance with our concept, in this reaction, a certain number of defectons in the initial proton are destroyed, and a neutron is formed, which has a mass less than the mass of the initial proton. It is in this way that during a series of nuclear reactions of nucleosynthesis of nuclei of the isotopes 56Fe, 58Fe, 62Ni, protons and neutrons with an average mass of one nucleon equal to 930.2 MeV are formed in their nuclei.

Now, from the reactions of nucleosynthesis and decay of neutrons, let us return in reverse chronological order to the era of the formation of nucleons and electrons. Here, too, there is one fundamental question to which modern physics does not have a convincing answer. This is a question of the ratio in the Universe of the resulting number of protons and electrons, which are completely equal to each other, up to one particle. The question is that the processes of formation of protons and electrons according to the Standard Cosmological Model are considered independent of each other, then it is not clear how these quantities of protons and electrons formed are completely equal to each other?

Our proposed concept of the destruction of defectons during all nuclear reactions provides a very logical and the only possible answer to this question. We only need to apply our concept of defecton destruction to these subnuclear processes retrospectively. Namely, we conclude that in the era of the formation of nucleons and electrons, at first there was an advanced formation of only relict neutrons (n_r), having a mass slightly greater than the mass of the reference neutron by a certain number of defectons. And the formation of protons and electrons in absolutely equal quantities occurred through the decay of relic neutrons.

But more importantly, this consequence of the advanced formation of relict neutrons of increased mass breathes new life into the model of primary nucleosynthesis according to Gamow's scheme [4, 5, 6]. The increased mass of relic neutrons makes it possible to solve those problematic issues due to which the model of primary nucleosynthesis according to Gamow's scheme was rejected more than 70 years ago, in particular, the problem of the synthesis of unstable nuclei consisting of 5 nucleons, which we will consider below.

We do not yet know by how many defectons the mass of the relic neutron is greater than the mass of the reference neutron. But the question of calculating the specific mass of the relic neutron does not pose any fundamental problems. Table 3 shows the calculation of possible options for the mass values of the relic neutron, exceeding the mass of the reference neutron by the number of additional defectons from 1 to 10 pieces. The minimum possible mass of a relic neutron, corresponding to one additional defecton compared to the mass of a reference neutron, is marked in yellow:

$n_{r(min)}$ = 939.56542052 + 0.171129 = 939.7365495 MeV

Let us immediately note that all the masses of the relic neutron given in the table are estimates, because The masses of defecton and preons given above and used in these calculations are also estimates.

The number of additional defectons in the relic neutron in comparison with the reference neutron	mass of relict neutron
1	939,7365495
2	939,9076785
3	940,0788075
4	940,2499365
5	940,4210654
6	940,5921944
7	940,7633234
8	940,9344524
9	941,1055814
10	941,2767104

Table 3. Calculation of options for the mass of the relict neutron

Next, we need to carry out a sequential calculation of the reactions of primary nucleosynthesis of the entire cloud of isotopes according to Gamow's scheme for all presented variants of the relic neutron masses. The option with the minimum mass of the relic neutron, for which reactions of primary nucleosynthesis are realized according to Gamow's scheme for all isotopes, will determine the true mass of the relic neutron (at least its minimum value).

But before carrying out such a calculation, let us remember the problems for which the model of primary nucleosynthesis according to Gamow's scheme was rejected more than 70 years ago. These problems concerned mainly isotopes consisting of 5 nucleons, and were as follows.

Firstly, there is a group of isotopes of 5 nucleons, during the synthesis of which according to Gamow's scheme, the increase in the mass of the isotope exceeds the mass of the reference neutron, i.e. the resulting mass defect (binding energy) turns out to be negative. Such a synthesis was considered impossible, and Gamow's scheme for primordial nucleosynthesis was rejected. The introduction of relic neutrons with increased mass into circulation solves this problem.

Secondly, all isotopes of 5 nucleons are unstable. For all these isotopes (5H, 5He, 5Li, 5Be), the half-life is about 10-22 seconds. Carrying out the synthesis reaction of subsequent isotopes consisting of 6 nucleons in such a short period of time is completely unrealistic. As a result, the process of primary nucleosynthesis according to Gamow's scheme on these isotopes should be interrupted, and these isotopes themselves should very quickly disappear. Let's look at this problem in more detail.

In nuclear physics, the pattern of neutron pairing inside nuclei is well known and experimentally studied. Figure 4 illustrates this phenomenon using the example of the dependence of the neutron separation energy (B_n) on the number of neutrons N in the isotopes Ca, Sn, and Pb. These experimental data are taken from [7, 8].

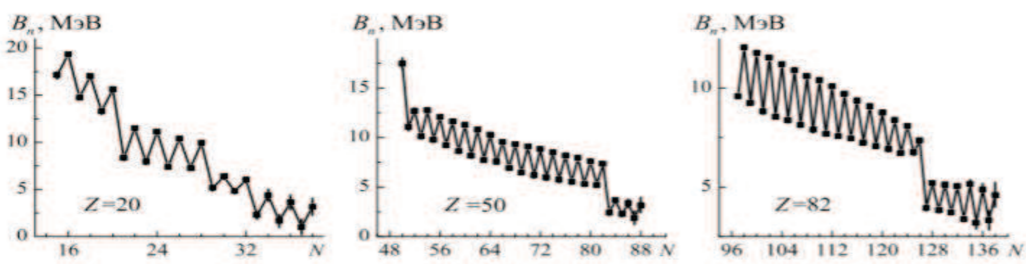

Fig. 4. Dependence of the neutron separation energy Bn on the number of neutrons N in the isotopes Ca, Sn, and Pb

The graphs show an increased change in the neutron separation energy at N = 20, 28, 50, 82, 126, which are also called the magic numbers of nucleons, but we will not touch on this issue now.

The obvious pattern of pairwise alternation of increasing and decreasing neutron binding energy has its own quantum mechanical justification [9]. Without considering the details that explain this pattern, we only note this feature of neutrons being grouped in pairs. It is possible that not only neutrons in nuclei, but also free neutrons have this ability to pair. Moreover, according to our hypothesis, when such a pair of free neutrons is formed, a certain number of defectons are destroyed in each neutron and a stable connection is established between them, stabilizing the lifetime of such a pair of neutrons.

Considering this ability of neutrons to pair, it is possible that primary nucleosynthesis according to Gamow's scheme after the synthesis of the 4He isotope proceeds by the addition of both single relic neutrons and by the addition of two paired relic neutrons with the immediate formation of a stable isotope of 6 nucleons (6Li). Thus, in the model of nucleosynthesis according to Gamow's scheme, the problem of instability of isotopes containing 5 nucleons, which prevents the synthesis of isotopes from 6 nucleons, can be overcome.

In connection with the ability of neutrons to form pairs, one can also assume the ability of neutrons to form fours, sixes, eights, etc., which can, in other words, be interpreted as the ability of neutrons to oscillate. Experimental searches for tetra-neutrons have been going on for a long time. Recent experiments at the Technical University of Munich (TUM) accelerator laboratory at the Garching research campus show that a particle consisting of four bound neutrons may well exist, with a confidence of more than 99.7%, or 3 sigma [10].

Taking this into account, it is possible that primary nucleosynthesis can proceed by adding both single relic neutrons and by adding blocks of twos, fours, and other even numbers of relic neutrons, with some of the neutrons turning into intranuclear protons, and some into intranuclear neutrons.

CALCULATION OF THE MASS OF THE RELIC NEUTRON

Let us now move on to calculating the mass of the relic neutron, which solves the first problem of the negative mass defect during nucleosynthesis according to Gamow's scheme when adding a reference neutron. In general, we need to calculate for the entire cloud of isotopes the maximum difference in the masses of neighboring isotopes participating in the primary nucleosynthesis reaction according to Gamow's scheme. This maximum difference in the masses of isotopes will correspond to the minimum value of the mass of the relict neutron, the variants of which we calculated in Table. 3.

Considering that the relic neutron has no charge, the process of primary nucleosynthesis according to Gamow's scheme is electrically neutral, without the expenditure of external energy to overcome the Coulomb barrier. In general, the equation of primary nucleosynthesis from relic neutrons according to Gamow's scheme with a certain degree of convention (taking into account the future recombination of electrons and the insignificant mass-energy of antineutrinos) can be written as follows:

$$M_{i-1} + n_r \rightarrow M_i + \gamma \qquad (3)$$

M_{i-1} is the mass of the previously formed isotope,

n_r is the mass of the relic neutron,

M_i is the mass of the isotope formed at this step of nucleosynthesis,

γ is a photon produced when the excitation of a nucleus is removed as a result of the capture of a relict neutron.

Then, the difference in the masses of the isotopes before and after the n_r_nucleosynthesis reaction is equal to the mass of the relic neutron minus the energy of the photon, and the mass of the relic neutron is equal to the difference in the masses of the isotopes plus the energy of the photon that left the isotope:

$$\Delta M_i = M_i - M_{i-1} = n_r - \gamma \qquad (4)$$

$$n_r = \Delta M_i + \gamma \qquad (5)$$

In this equation, we operate not with the masses of isotope nuclei that actually participated in nucleosynthesis reactions, but with the masses of isotopes as a whole, which include the mass of electrons, and changes in the mass of the triad of valence quarks during confinement. This was done purely for the convenience of using the table of reference isotope masses [2]. The mass of the isotope already includes the mass of the electron formed, the change in the mass of the triad of valence quarks, the change in the binding energy of electrons with the nucleus, and the change in the binding energy of nucleons among themselves in the isotope nucleus that occurs during nucleosynthesis reactions. Moving on to operating with isotope masses, we simply move away from detailed calculations of these components without disturbing the mass-energy balance as a whole.

It is not difficult to calculate the difference in the masses of neighboring isotopes participating in the primary nucleosynthesis reaction according to Gamow's scheme and select the maximum value from them. It should be borne in mind that nucleosynthesis reactions according to Gamow's scheme are divided into two types. The first type is a reaction during which the added relic neutron is transformed into an intranuclear neutron. The second type is a reaction during which the added relic neutron is transformed into an intranuclear proton. It is in the second type of reactions that the additional difficulties that we noted arise in taking into account the constituent elements of the reaction associated with the formation of an electron and the change in the mass of the triad of valence quarks as a result of confinement. In the first type of reaction this does not happen, and the equation we use quite accurately reflects the essence of the nucleosynthesis reaction. Therefore, we first calculate the maximum difference in isotope masses specifically for reactions of the first type:

ΔM_i = 13Be - 12Be = 12142.667816 - 11203.005484 = 939.662332 (MeV)

Let us now find the maximum difference in isotope masses for reactions of the second type with the transformation of a relict neutron into an intranuclear proton:

ΔM_i = 12O – 11N = 11209.976785 - 10270.737351 = 939.239434 (MeV)

In accordance with table. 3, both of these results fit into the minimum value of the mass of the relic neutron (939.7365495 MeV), which exceeds the mass of the reference neutron by the mass of one defecton.

In accordance with formula (5), we additionally need to estimate and add the energy value of the resulting photon, the energy of which is equal to the excitation energy of the nucleus upon absorption of a relict neutron. It is the photon radiation that removes this excitation. Considering that primary nucleosynthesis occurs in a cloud of cooled primary plasma even before its collapse into stars, the kinetic energy of relict neutrons can be compared with the energy of slow neutrons having an energy of no more than 100 keV. This value of external excitation, taking into account the maximum mass defect we calculated, is completely covered by the minimum mass of the relic neutron calculated by us. The real energy of the emitted photons can be much higher, but this is already the result of the transition into radiation of the emerging mass defect as a result of the destruction of defectons, in accordance with our hypothesis.

Thus, we have determined the estimated mass of the relic neutron to be equal to 939.7365495 MeV, and now we can proceed to a verification calculation of the reactions of primary nucleosynthesis using the Gamow scheme. The purpose of this calculation is to make sure that with the mass of the relic neutron calculated by us, primary nucleosynthesis according to Gamow's scheme of all isotopes, including the heaviest ones, is possible in a single cycle in the cloud of primordial plasma even before the era of recombination and the formation of the first stars.

To calculate the mass of the relic neutron, we used formula (5). In general, this formula takes the following form:

$n_r = \Delta M_i + \gamma = \Delta M_i + N_i * ð$ where (6)

N_i is the number of destroyed defectons at each step of nucleosynthesis reactions,

ð – mass of one defecton.

Our verification calculation will consist of determining the number of defectons destroyed at each step of the nucleosynthesis reactions according to Gamow's scheme:

$N_i = (n_r - \Delta M_i) / ð$ (7)

The numerator of this formula must always be positive. In this case, we will round up the number of destroyed defectons, assuming that the difference between the whole and fractional number of defectons is spent on rearranging the gluon structure of nucleons, which affects the change in the binding energy of nucleons in the nucleus. This issue will be discussed further below.

Considering that we do not know the initial number of defectons either in the reference neutron or in the relic neutron, and we also do not know how the number of destroyed defectons is distributed among the nucleons of the formed nucleus, therefore we cannot count the number of defectons for each nucleon, and we will calculate the average the number of destroyed defectons per one nucleon of the isotope nucleus. Initially, we performed calculations only for a number of stable isotopes (main stream). In Fig. 5, 6 show the results of this calculation depending on the parameter A (the number of nucleons in the isotope).

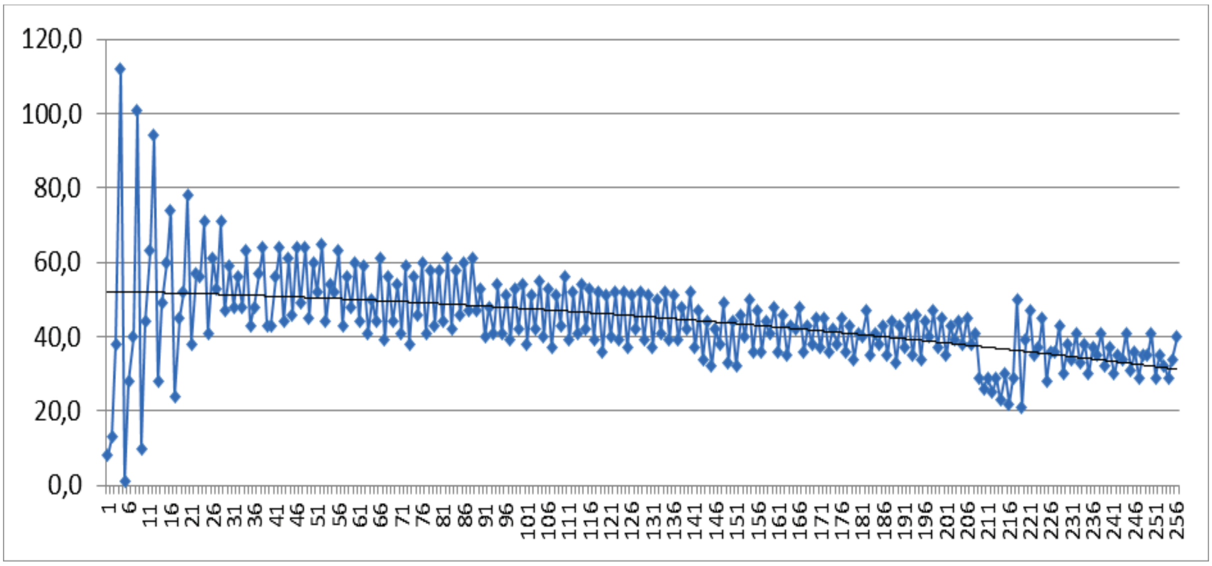

Fig. 5. The number of destroyed defectons at each step of the primary nucleosynthesis of stable isotopes with a polynomial trend line (main stream).

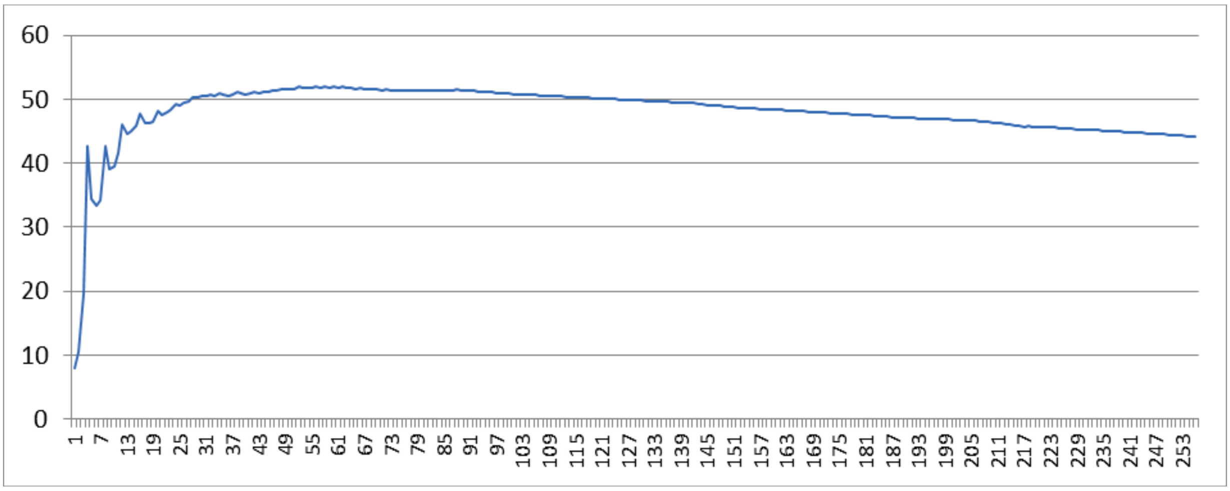

Fig. 6. Average number of destroyed defectons per nucleon.

Graph in Fig. 6 in its appearance actually repeats the well-known graph of the binding energy of nucleons in isotope nuclei, and is a mirror copy of the graph of the average mass of one nucleon of an isotope in Fig. 1. From this we can conclude that the process of destruction of defectons correlates with a change in the binding energy of nucleons in the nuclei of isotopes. This conclusion is confirmed by the graph data in Fig. 5. In its initial part up to the 28th isotope, the scatter in the number of destructed defectons is very large, which also affects the scatter in the binding energy of nucleons, with the formation of peaks and dips corresponding to thermonuclear reactions of subsequent stellar thermonuclear fusion of elements.

Our proposed concept of reducing the mass of nucleons in the course of all nuclear reactions as a result of the destruction of defectons acquires additional physical meaning of binding energy. When defectons are destroyed, peculiar “holes” are formed in their place in the nucleons, which are filled with chains of gluons and increase the energy of the strong interaction of nucleons (binding energy). With a further decrease in the specific number of destroyed defectons per nucleon in the region of heavy isotopes, the specific number of “holes” per nucleon also decreases, and the binding energy of nucleons in the nucleus decreases accordingly, which affects the growth of spontaneous decay reactions in the nuclei of heavy isotopes. It can be assumed that “holes” from destroyed defectons are real objects inside nucleons, and are the main “shareholders” of the binding energy of nucleons in isotope nuclei, acting as channels for gluon chains. In this case, the preons of destroyed defectons are the building material for electrons, positrons, neutrinos and antineutrinos (leaving from nucleons), and the restructuring of the preon structure of the triad of valence quarks, the annihilation of the remaining unused extra preons with opposite parameters with the formation of radiant energy of photons, and the formation of additional chains of gluons, passing through new communication channels (“holes”), i.e. changes in nucleon binding energy.

Let us now move on to calculating the nucleosynthesis of the entire cloud of isotopes. Primary nucleosynthesis could not proceed only along the channel of stable isotopes, otherwise the diversity of isotopes of elements would be limited only to stable isotopes, and not to the entire diversity of isotopes. Primary nucleosynthesis according to Gamow's scheme makes possible such diversity. The essence of this possibility is that at each step of nucleosynthesis, the added relic neutron can be transformed into both an intranuclear proton and an intranuclear neutron. We will not now analyze in detail the reasons for this different transformation; this is probably due to the peculiarities of the specific encounter of a relict neutron with a specific nucleus. We would rather check all these possible options for the transformation of relic neutrons at each step of nucleosynthesis. See the initial part of this process in Figure 7 (the symbol d indicates an additional possible transition along the diagonal by attaching the formed pair of relic neutrons).

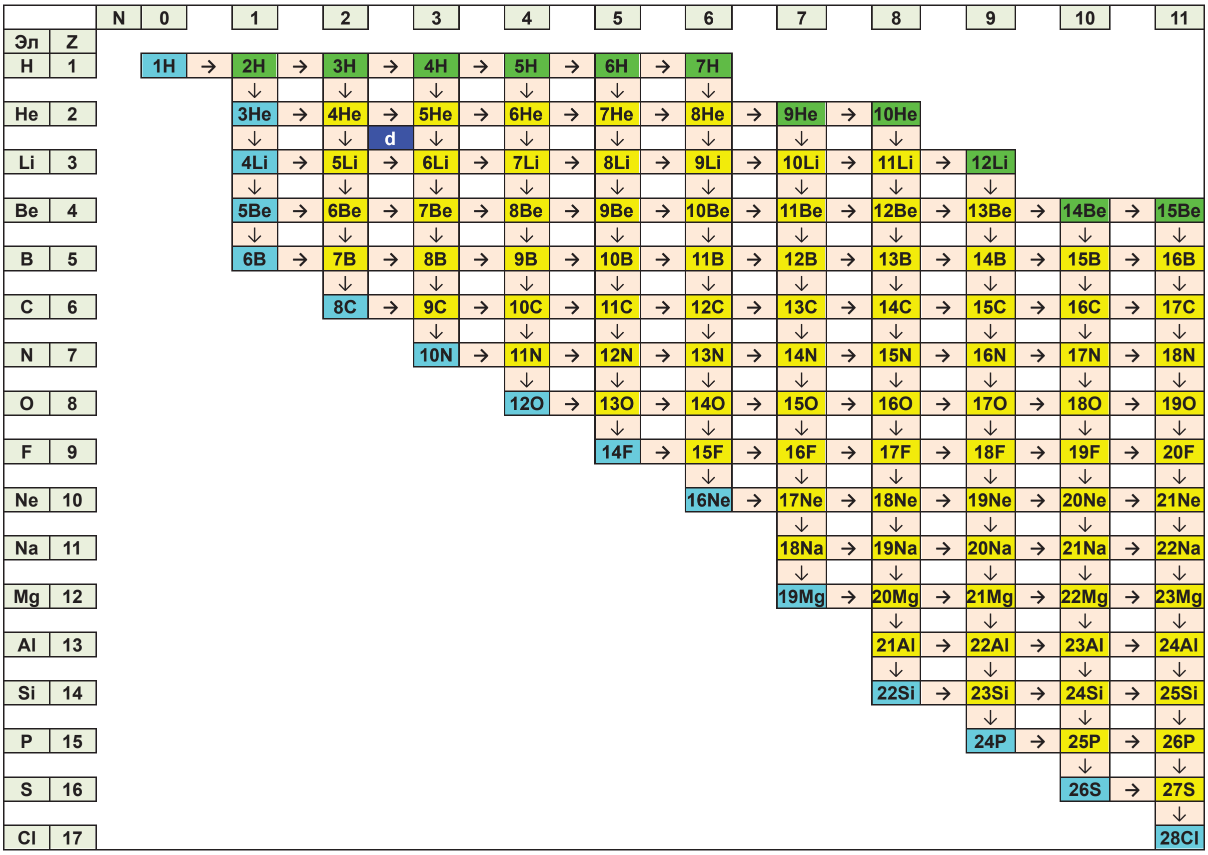

Fig. 7. The process of primary nucleosynthesis of an isotope cloud according to the Gamow scheme

The calculation results are presented in Fig. 8, 9, 10. For greater clarity, the graphs 8 and 9 are presented in three-dimensional form, where we unfold the arguments of the graph Z and N (the number of protons and the number of neutrons in the isotope nucleus) along two axes of the horizontal plane. And the vertical axis shows not the number of destroyed defectons, but the number of remaining intact defectons per one nucleon of the nucleus for each isotope. In this case, the base (beginning of the scale) is taken to be a certain still unknown to us value of the number of defectons remaining intact, corresponding to the 56Fe isotope (the bottom point of the graph, for clarity of the shape of the graph, taken equal to 9). Taking into account the specific shape of the resulting chart, we call it a rook.

For clarity, Figure 10 additionally shows a graph of the cross section of the rook along the height of the “deck”, corresponding to the minimum values of defectons remaining in the isotope per one nucleon for each series of data (chemical element).

As you can see, this graph 10 is completely equivalent to graph 1, reflecting the average mass of nucleons in stable isotopes. This, of course, is not surprising, because for both calculations, the initial data are the reference isotope masses. However, we were able to show that the mass spectrum of isotopes as a whole, as well as the masses and charges of isotope nuclei, individual nucleons, sea quarks, and electrons with positrons, are discrete in nature, indicating the presence in the structure all these particles of single objects - previously known as preons, with an estimated average mass of 0.085166485 MeV and an electric charge equal to +1/6 or -1/6 of the electron charge.

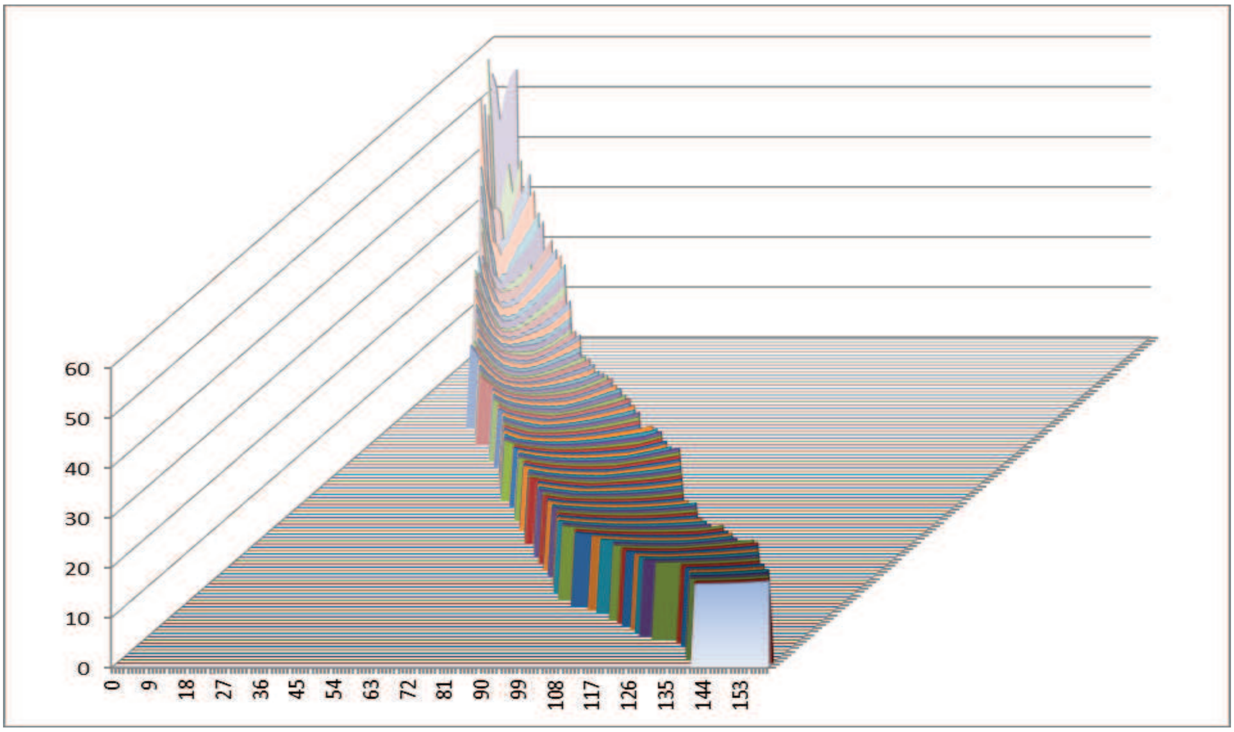

Fig. 8. The number of remaining defectons averaged per nucleon in the primary nucleosynthesis of a cloud of isotopes from relic neutrons according to the Gamow scheme (rook - rear view).

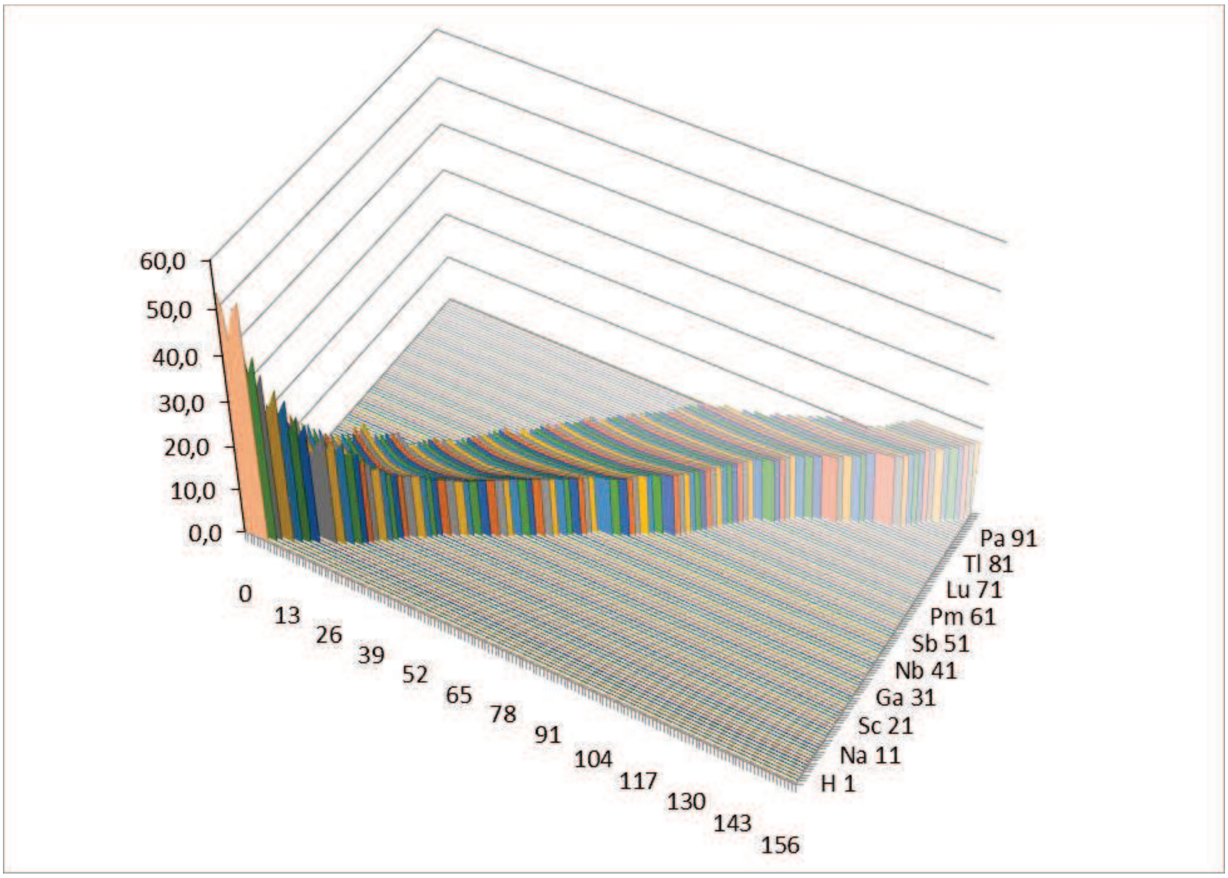

Fig. 9. The number of remaining defectons averaged per nucleon in the primary nucleosynthesis of a cloud of isotopes from relic neutrons according to the Gamow scheme (rook - side view).

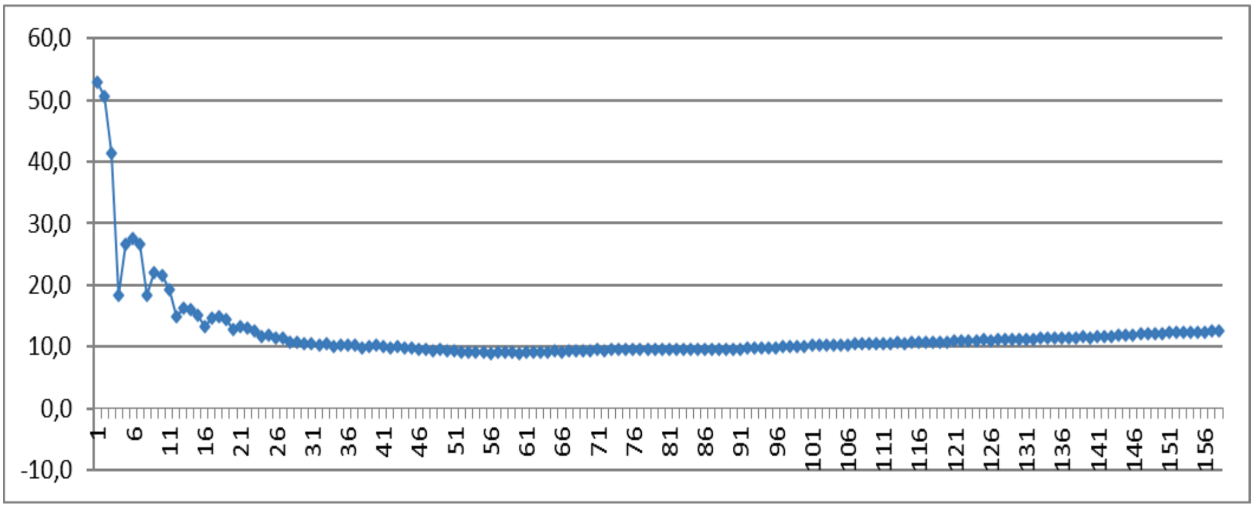

Fig. 10. The minimum value of the number of defectons remaining in the isotope, averaged per one nucleon, for each row of isotopes (stable isotopes of a chemical element).

Our calculations have shown that the process of primary nucleosynthesis according to Gamow's scheme from relic neutrons of increased mass makes it possible in a single cycle to synthesize the entire spectrum of all known isotopes, with a total number of more than 3000 pieces, including all problematic isotopes consisting of 5 nucleons, and all the so-called metals and heavy isotopes. In this case, the number of destroyed defectons per nucleon falls within the range from 1 pc. (when transforming a relic neutron into a reference neutron of the 2H isotope), up to 52 pcs. (at the completion of the process of transformation of relic neutrons into intranuclear protons and neutrons of the 56Fe isotope).

Primary nucleosynthesis ends with the end of the supply of relic neutrons as a result of two parallel processes: (1) – decay of free relic neutrons into a proton, electron, photon and antineutrino; (2) – participation of relic neutrons in the process of primary nucleosynthesis according to Gamow's scheme. The issue of determining the concentration of various isotopes formed as a result of these two processes requires a separate additional study, and is not considered in this article.

LABORATORY OPTION FOR TESTING THE CONCEPT OF THE PREON MODEL OF PARTICLES

The preon model of the structure of matter provides a new explanation for the observed defect in the masses of isotope nuclei that occurs during all nuclear reactions, which consists in a real decrease in the masses of nucleons due to the destruction of defectons, which are marine preon-antipreon pairs, and the formation of new particles leaving the isotope. According to this concept, protons with a reference mass are protons in 1H isotopes, and neutrons with a reference mass are neutrons in 2H isotopes. All other protons and neutrons in the nuclei of other isotopes have masses less than the reference ones. This concept allows us to naturally explain the result of intranuclear reactions of transformation of protons into neutrons (β+_decay reactions), by a real decrease in the mass of the resulting neutron less than the mass of the original proton.

These conclusions can be verified and confirmed by precision measurements of the mass of protons, neutrons, and α-particles leaving the nuclei of radioactive isotopes during the corresponding p-, n-, and α-decay reactions. In accordance with the calculations of the number of destroyed defectons, the masses of these protons and neutrons should be less than their reference masses by up to 1%, and the mass of α-particles by up to 0.2% compared to the mass of the nucleus of the 4He isotope (reference α-particle).

WHAT WILL JWST SHOW?

Compared to traditional models of thermonuclear fusion, the model of primary nucleosynthesis of a cloud of isotopes according to the Gamow scheme from relict neutrons of increased mass does not require external energy costs to overcome the Coulomb barrier. This processe are replaced by an electrically neutral process of attachment of an electrically neutral relict neutron to a proton or a previously formed nucleus, transforming it into an intranuclear proton or intranuclear neutron. This process can continue until the supply of relic neutrons is completely used up, and as a result of this process, nuclei of all isotopes, including the heaviest ones, can be sequentially synthesized in a single cycle.

The concentration of heavy isotopes after primary nucleosynthesis according to Gamow's scheme from relic neutrons is, of course, very low, because their formation occurs only at the very end of this process, when the relic neutrons are already running out. But this does not mean that they can be "neglected". One of the main conclusions of the concept we proposed is precisely that it gives the "right to life" in the gas clouds of the first galaxies formed in the Universe to the entire spectrum of isotopes (elements), including the heaviest. This explains the regular instrumental detection of metal spectra in the filaments and gas clouds of the first galaxies up to the turn of 13.4 billion light years (galaxies GN-z11 and UDFj-39546284). We predict that the James Webb Telescope (JWST), which, in accordance with its work program [11], should look beyond the redshift corresponding to the time interval of 100–250 million years after the Big Bang, will be able to detect metals at this point in the spectra of the first galaxies, even before the explosion of the first supernovae. This will decisively confirm the proposed model of the advanced formation of relic neutrons, and the model of primary nucleosynthesis from relic neutrons according to Gamow's scheme.

This finding is not predicted by any other model. We expect that the results of the JWST work will confirm our conclusions about the existence of relic neutrons and will rehabilitate the model of primordial nucleosynthesis according to Gamow's scheme.

CONCLUSIONS AND OUTLOOK

1. The work proposes a new explanation for the observed defect in the masses of isotope nuclei that occurs during all nuclear reactions, which consists in a real decrease in the masses of nucleons due to the destruction of defectons, which are marine preon-antipreon pairs. According to this concept, protons with a reference mass are protons in the 1H isotope, and neutrons with a reference mass are neutrons in the 2H isotope. All other protons and neutrons in the nuclei of other isotopes have masses less than the reference ones. This concept allows us to naturally explain the result of intranuclear reactions of transformation of protons into neutrons (β+_decay reactions), by a real decrease in the mass of the resulting neutron less than the mass of the original proton.

2. From this concept, a retrospective consequence follows about the advanced formation of relict neutrons of increased mass in the cosmological era of the formation of nucleons and leptons. This consequence allows us to unambiguously explain the absolute equality of the number of protons and electrons in the Universe, as a result of the decay of relict neutrons.

3. The conclusion about the advanced formation of relict neutrons of increased mass allows us to update the model of primary nucleosynthesis of the entire cloud of isotopes according to Gamow's scheme in a single cycle even before the recombination era. The calculated estimated masses of the relic neutron, defecton and preons make it possible to resolve previously arising problems of primary nucleosynthesis according to Gamow's scheme from reference neutrons.

4. Updating the model of primary nucleosynthesis according to Gamow's scheme allows us to interpret in a new way the known facts of the detection of metals in filaments and early galaxies, as well as make a prediction about the presence of metals in the first galaxies even before the

explosion of the first supernovae, which JWST should presumably confirm. This result, if obtained, will decisively confirm the concept of the preon structure of quarks and leptons, the decrease in the mass of nucleons in the course of all nuclear reactions as a result of the restructuring of their preon structure, the model of the advanced formation of relict neutrons of increased mass, and the model of primary nucleosynthesis from relict neutrons according to the scheme Gamov.

5. It should be noted that these conclusions can be further verified and confirmed by precision measurements of the mass of protons, neutrons, and α-particles leaving the nuclei of radioactive isotopes during the corresponding reactions of spontaneous p-, n-, and α-decay. In accordance with the proposed concept, the masses of these protons and neutrons should be less than their reference masses by up to 1%, and the mass of α-particles by up to 0.2% compared to the mass of the 4He isotope nucleus. This option of testing the put preon concept of the structure of matter and the conclusions drawn becomes more relevant in connection with the problems that have arisen with the MIRI interferometer of the JWST space telescope [12]. It was this interferometer that was supposed to make the most accurate measurement of the spectra of the most distant (first) galaxies, checking them for the presence of metals in these galaxies even before the explosions of the first supernovae.

6. It should also be noted that if primary nucleosynthesis according to Gamow's scheme is confirmed, the question of clarifying the parameters of temperature and pressure in the relict cloud of primordial plasma during the era of baryogenesis and primary nucleosynthesis may become relevant.

All of these conclusions indicate a discrete structure from preons of all considered particles of matter. We note once again that our calculations of the masses of the averaged preon, defecton, and relic neutron are of an estimated nature. More accurate calculations of their masses with the proposal of detailed preon models of elementary particles and nucleons are presented in [13].

REFERENCES

1. CODATA Recommended Values: neutron mass energy equivalent in MeV.
2. isotopic_WikipediA-2016.
3. J.-J. Dugne, S. Fredriksson and J. Hansson. Preon Trinity — A Schematic Model of Leptons, Quarks and Heavy Vector Bosons // Europhysics Letters. — 2002. — T. 60, № 2. — C. 188—194.
4. Gamov G. Expanding Universe and the Origin of Elements // Physical Review. 1946. N 70. P. 572–573.
5. Alpher R. A. A Neutron-Capture Theory of the Formation and Relative Abundance of the Elements // Physical Review. 1948. N 74. P. 1577–1589.
6. Alpher R. A., Bethe H., and Gamov G. The Origin of the Chemical Elements // Physical Review. 1948. N 73. P. 803–804.
7. Audi G. et al. // Chin. Phys. 2012. C36(12). P. 1287.
8. M. Wang et al. // Chin. Phys. 2012. C36(12). P. 1603.
9. B. S. Ishkhanov, M. E. Stepanov, T.Yu. Tretyakov. Nucleon pairing in atomic nuclei. VMU. Series 3. PHYSICS. ASTRONOMY. 2014. No. 1.
10. T. Faestermann, A. Bergmaier, R. Gernhäuser et al, Indications for a bound tetraneutron, Physics Letters B 824 136799.
11. General Observer Programs in Cycle 1 with JWST, https://www.stsci.edu/jwst/science-execution/approved-programs/cycle-1-go
12. JWST's MIRI instrument is having problems again, Nancy Atkinson, Universe Today.
13. viXra:1802.0218 S_theory (electromagnetic model of the universe).