Computer model of the atomic nucleus

Abstract:
The article presents the method of modelling the atomic structure of the nucleus of various elements. This way of modelling ensures that the modelled atoms behave similarly to real atoms. In nature, the vast majority of isotopes decay but some of them, due to the properties of protons and neutrons, remain stable.

Table of Contents

Introduction - Basics of atomic nucleus structure

To build the atomic nucleus model, it is necessary to adopt initial assumptions. These initial assumptions must result from the current knowledge about the structure of atoms. But at the very beginning, this knowledge must be properly selected. The knowledge of atoms should be based on experimental facts and must be logical. Therefore, extensive, but not having anything to do with experimental facts, illogical inventions on the quarks that supposedly are components of protons and neutrons will not be used here. There will be presented here atomic nuclei the basic components of which are protons and neutrons. The structure of the atomic nucleus described herein is based on the following facts.

1. The basic cause of stable and permanent structure

Protons and neutrons are located in the nucleus at some distance from each other and form a stable structure. The physical basis for the stable position of these particles relative to each other are their mutual accelerations when each of them is located on the potential shell of the neighbouring particle.*1)

In the structure of atomic nuclei, the most durable connections between particles arise when they form a system of four particles that are located at the same distance from each other, as shown in Fig. KM1.

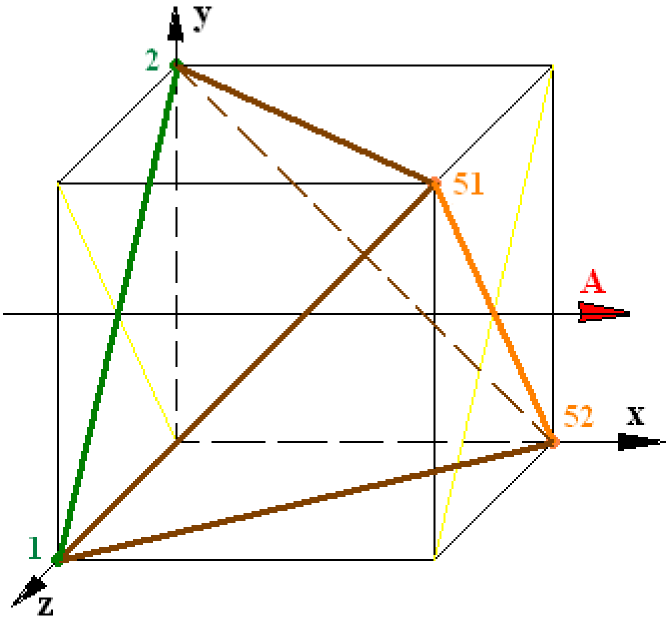


Fig. KM1. Acceleration direction of the ALPHA particle model - ALFA.ato work file in the AtomStand.exe modelling program
A - Axis of symmetry and direction of acceleration

In Fig. KM1 green dots symbolize the location of protons in the ALFA particle, and orange dots symbolize the position of neutrons. Protons and neutrons are positioned in relation to each other as if lying on opposite vertices on two opposite faces of the cube - protons at the ends of the diagonal of one face, and neutrons at the ends of the diagonal of the other face. Hereinafter, in order to simplify the description of the action of such ALFA particles, the diagonal connecting the protons will be called the diagonal P (with the possible addition of particle numbers, e.g. diagonal P, 1,2) and the diagonal connecting the neutrons will be called the diagonal N (with the possible addition of particle numbers e.g., diagonal N, 51,52). Thanks to this, you will be able to recognize it (in your mind), even if it is not marked as a line segment in the drawing.

The ALFA particles will be combined in different ways in complex structures, and individual protons or neutrons will be components of several ALFA particles joined together (i.e. adjacent).

Knowing of the position of protons and neutrons in the structure of the ALFA particle is important because on this basis it is possible to determine in which direction the resulting acceleration of this particle system is directed. When computer modelling of the behaviour of ALFA particles by means of the modelling program AtomStand.exe*2), there were assumed such initial parameters of protons and neutrons that the ALFA particle accelerated in the direction parallel to the X axis. That is, it accelerated in such way as shown in Fig. KM1, thus in the front there was the diagonal N, 51,52, and at the end the diagonal P,1,2.

2. Excluded and possible connections of protons and neutrons

Protons alone - without the participation of neutrons - and neutrons alone - without the participation of protons - cannot create a durable, stable structure. Stable structures of matter can only arise when in the immediate vicinity of two merging together particles of one type there are particles (or even one particle) of the other type. The simplest example of such a stable structural connection is the atomic nucleus of the ^{3}He helium isotope. Another example, but of a less stable connection, is the ^{3}H atom nucleus structure, called tritium. After a half-life amounting to 12.33 years, only half of the tritium atoms remain, because the rest decay. This fact could indicate the existence of a greater stabilizing capability of the neutron. Because one neutron permanently stabilizes the position of two protons, while one proton cannot always keep two neutrons in the structure. However, the list of elements in the Mendeleev's table shows that almost all kinds of atoms (of stable isotopes) have more neutrons in the nucleus than protons. And this indicates a greater stabilizing ability of protons.

3. The density of particles distributed in the structure

Based on the considerations about the structures that can be formed from ALFA particles, one can infer that in the construction of atomic nuclei, there are two types of structures - these types can be called: loose nucleus structure and tight nucleus structure. The difference between these two types of nuclei structures can be illustrated by the hypothetical atomic structures of lithium nuclei ^{7}Li and ^{6}Li.

The loose structure of the lithium nucleus ^{7}Li is shown in Fig. KM2 and the tight structure of the lithium nucleus ^{7}Li is shown in Fig. KM3. In a loose structure, the protons are located on the diagonals P,1,3 and P,2,3, while the neutrons lie on the diagonals N,51,52 and N,51,53. Neutron number 54 is distant to the diagonal length from protons 1, 2 and 3. In a tight structure, the distance between particles is in this sense varied, that is equal to the length of the diagonal or side of the cube face.

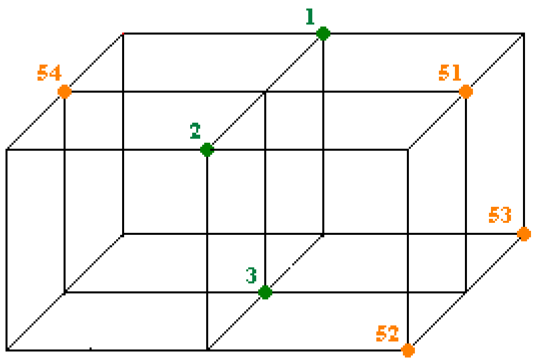


Fig. KM2
Location of protons and neutrons
in the atomic model of the ^{7}Li nucleus

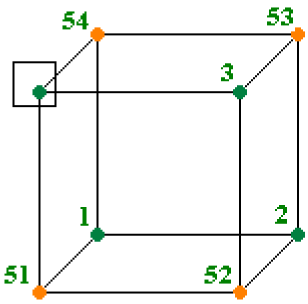


Fig. KM3
Location of protons and neutrons
in the atomic model of the ^{7}Li nucleus

In Fig. KM3, the "green dot in the square" symbolizes the placed additional proton, which of course does not exist in the nucleus of the lithium atom. Here in the figure, this additional proton is to help you understand which type of nucleus is naturally preferred in nature. It seems that the stable structure of the lithium nucleus can be presented both in one and the other form.

When one more neutron is removed from both structures shown in the drawings, then they will represent the structure of the nucleus of the stable ^{6}Li isotope. But the type of structure, which is shown in Fig. KM3, suggests that there are stable atomic nuclei with four protons and four neutrons. If such a structure really existed in nature and was supplemented with one neutron, it would be then the structure of the nucleus of the ^{9}Be beryllium isotope, which is the only stable isotope of this element.

It is known that in nature stable ^{8}Be beryllium isotope does not exist. On this basis, it can be concluded that the tight structure of the nucleus in atoms does not occur. There is only a loose structure. It can be assumed that protons and neutrons have only potential shells with such radii that ensure the formation of a loose nucleus structure. Tight structures could also form on the basis of these potential shells. And if they can not be formed, this indicates the presence in protons and neutrons of such anti-shell, which makes impossible the simultaneous keeping of the distance between these particles in the ratio of $2^{0.5}$:1 that is, the ratio that exists between lengths of diagonal and side of the cube face. It can, therefore, be assumed that in this way the possibility of creating a tight atomic structure of the nucleus is eliminated in nature. For this reason, the structure of the ^{9}Be beryllium nucleus has the shape shown in Fig. KM4 below.

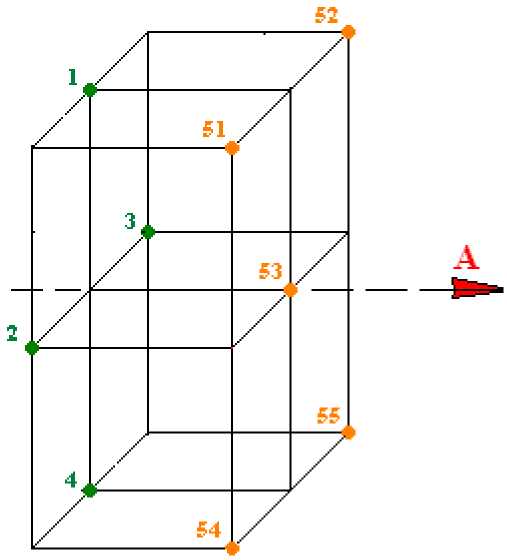


Fig. KM4
Location of protons and neutrons in the atomic model of the ^{9}Be nucleus
A - Axis of symmetry and direction of acceleration

When analysing the structural system of the ^{9}Be beryllium nucleus, four ALFA particles can be distinguished. These are particles, each of which has its own diagonal P, ie it is: the diagonal P,1,2, the diagonal P,1,3, the diagonal P,4,2 and the diagonal P,4,3. Opposite these diagonals P there are respectively diagonals: N,51,53, N,52,53, N,53,54 and N,53,55.

4. The importance of the symmetry of the structure.

The stability of the atomic nucleus structure and its accelerating abilities depend to the greatest extent on the symmetrical structure of the nucleus and on the number of its constituent particles. The most stable are the nuclei with the least number of components, such as the ALFA particle and the ^{9}Be beryllium nucleus. The lithium ^{6}Li nucleus does not belong to this group because there is no such axis of symmetry with which this structure system of the nucleus would be symmetrical.

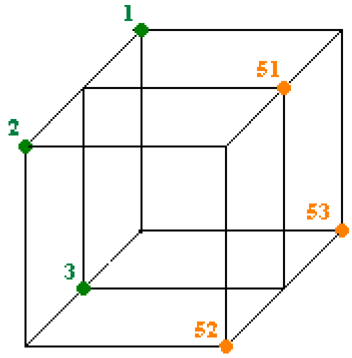


Fig. KM5
Location of protons and neutrons in the atomic model of the ^{6}Li nucleus

The symmetrical structure of the nucleus is expressed in the fact that particles of the same type are arranged symmetrically in the structure on opposite sides of the axis of symmetry. The process of accelerating such a structure takes place along a straight line, parallel to the axis of symmetry.

The structural durability of modelled nuclei structure was tested using the computer modelling program AtomStand.exe and working files ato format.*2) The greatest stability of the structure in the modelled processes was demonstrated by the ALFA particle, i.e. the helium nucleus ^{4}He. The structure of the ^{9}Be beryllium nucleus was less stable and after some time (after some number of computational iterations made) underwent decay into individual particles and less complex structures. However, before the decay of this nucleus occurred, there appeared curvature of the trajectory of its accelerated motion.

The distribution of protons and neutrons in the structure of the nucleus and their mutual acceleration results in a complex form of the vibratory motion of the constituent particles. In the ^{4}He helium nucleus, the vibrations of the constituent protons and neutrons have a similarly symmetrical character; as the structure of this nucleus. The nature of these vibrations contributes to the fact that the acceleration of the nucleus as a whole is incessantly rectilinear and directed along the axis of symmetry. In the ^{9}Be beryllium nucleus, the situation is similar but there is a difference. Because the beryllium nucleus has more spatially spaced protons and neutrons. This causes that during accelerated motion each of these component particles performs more complex vibrations than in the ^{4}He nucleus. This greater complexity of vibrations in the symmetric structure of the nucleus in appropriate conditions contributes to the loss of the symmetrical nature of particle vibrations in the nucleus. The thing is that in nature this destabilizing factor may be the influence of other non-contiguous particles, and in the computer, the destabilization in the modelled process is influenced by the approximate character of calculations of subsequent positions of particles during each computational iteration. Destabilizing factors in the first place contribute to the curvature of the path followed by the nucleus and then to the decay of the nucleus.

In nature, in addition to destabilizing factors, there are conditions that positively affect the stabilization of the atomic structure of the nucleus. Such a factor is the existence of the protoelectron medium, which is commonly called a physical vacuum. Near the central points of protons and neutrons, when they occur in a free state, or when they form part of the structure, there is a large concentration of protoelectrons. Accelerating proton and neutron capabilities that accelerate other particles towards their central points contribute to this concentration. A computer program usually has limited capabilities, so it is difficult to model this situation and present it on the screen. In the natural world, these concentrations of protonelectrons accompanying the protons and neutrons constitute a ballast, which limits their vibrations and the resultant accelerations of the composed of them structures.

5. The importance of structure configuration

In the atomic structure of the nucleus, its component ALFA particles can be combined in various configurations. Such different combinations, despite the same amount of protons and neutrons in the nucleus, resulting in different motility and various other properties of the nucleus. In one case, the nucleus may have the ability to self-accelerate and in the absence of obstacles develop an increasing speed of movement, and in other cases, the resultant acceleration of the nucleus will be zero. An example of this is the model of the hypothetical nucleus of the ^{12}C carbon atom. Below are presented five versions of the structure of the ^{12}C carbon atom.

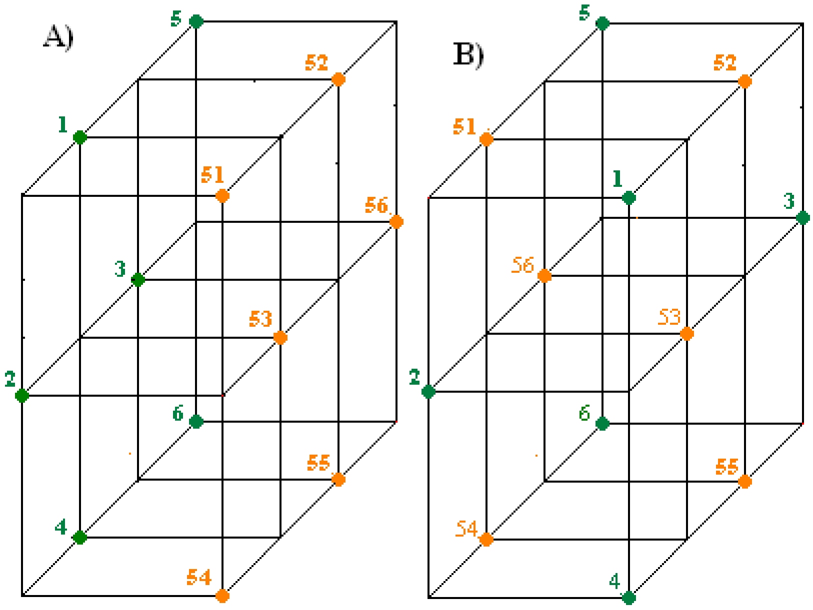


Fig. KM5a
Location of protons and neutrons
in the atomic model of the ^{12}C nucleus

The nucleus of the carbon atom of version A) has the greatest acceleration ability. Accelerates in the direction parallel to the X axis, and thanks to the ever-increasing speed it has more and more chances of damage during a collision with other nuclei. It can be assumed that achieving an increasing speed is more typical for gas nuclei than for solid bodies.

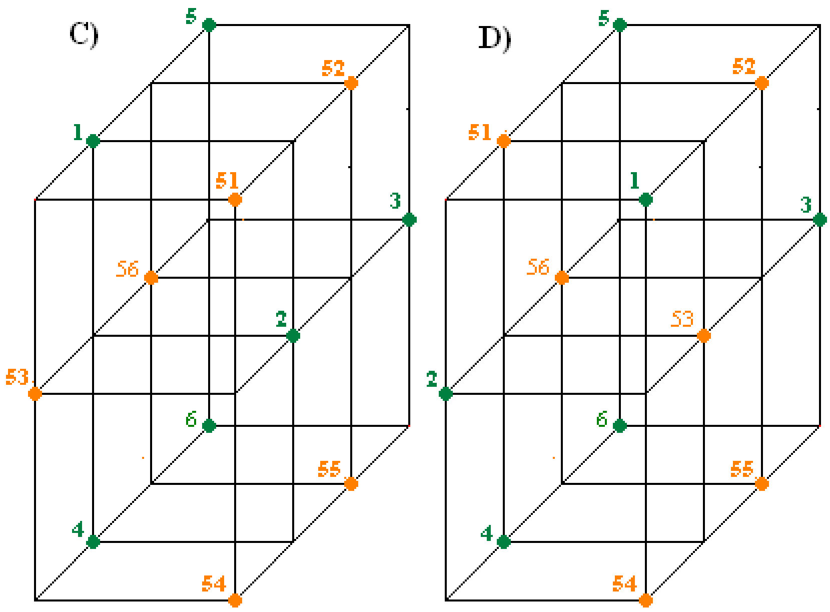


Fig. KM5b
Location of protons and neutrons
in the atomic model of the ^{12}C nucleus

The model of the carbon atom of version C) accelerates to a lesser extent. The direction of this acceleration is parallel to the Z axis. In contrast, the model version D) moves in a more complex way, because it accelerates and simultaneously rotates. The nucleus model version B) does not show the ability to accelerate and it can be assumed that this is the structure of real carbon nuclei that exist in nature. This is indicated by the known properties of carbon atoms, and above all, the ease with which they form molecules with atoms of other elements and the widespread occurrence of this element in many chemical compounds, especially organic ones. The ease of creating molecules with atoms of other chemical elements is related to low mobility of atom, and the mobility of the atom depends primarily on the mobility of its nucleus.

The nucleus model of the B) version has another feature, which constitutes its disadvantage. It is characterized by accelerated rotary motion. This structure rotates around the Y axis, it reaches an increasing rotational speed and eventually breaks.

Similar features as the nucleus of version B) is characterised by the nucleus model of the version B1). The difference is that model B1) rotates around the Y axis in the opposite direction.

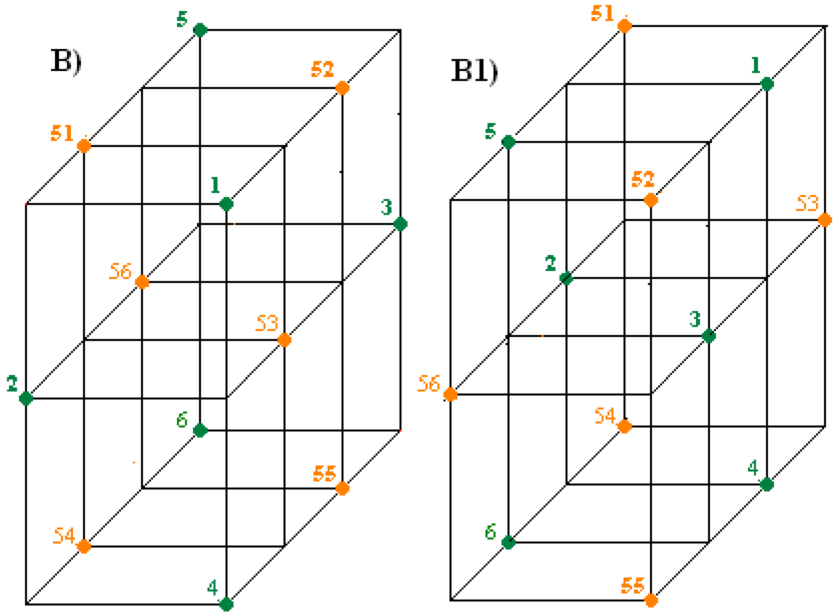


Fig. KM5c
Location of protons and neutrons in the atomic model of the ^{12}C nucleus

The presented versions of the atomic nucleus ^{12}C have different ability to self-relocate. Some accelerate approximately linearly, while others as a result of their acceleration get faster and faster, which leads to the decay of the nucleus.

6. The formation of nuclear structures

The different versions of the ^{12}C carbon nucleus presented in the previous chapter have similar chances to arise and exist for a certain time under appropriate conditions. Their duration in a stable form depends on many factors. Above all, their formation is a very complex process. Because this process takes place in the very dense matter in the nuclei of stars, where nuclear reactions take place.

There is a mixture of protons and neutrons in the nuclei of stars, and the distances between their central points are of the same order as the size of their nuclear potential shells. This mixture is located in a very dense protoelectron medium, which strongly limits the movement speed of protons and neutrons.

In this matter, there are no atoms capable of creating molecules. Because the radii of the molecular potentials of protons and neutrons are much, larger than the radii of their nuclear shells. There exist there only isolated particles - protons and neutrons - and their aggregates in the form of nuclei of various atoms. These particles can come into being as atoms and be able to create molecules only when their rareness is considerable. And this can happen after the starburst and after the matter is dispersed into space. Only then will the conditions arise in which molecular potential shells will be used to create stable connections between atoms. Then atoms can combine with each other and create molecules; they can also form much larger clusters.

After such a rareness of the stellar protoelectron medium disappears its very high inhibitory effect on the proton and neutron movements in the atomic nuclei. After such a rareness of matter, the conditions are created in which the atomic decay of many previously stable atomic nuclei occurs.

However, before such a starburst occurs, atomic nuclei synthesis processes take place. The simplest process is the combination of proton and neutron. These molecules reach the nuclear potential shell of their neighbours and in this way, they bond with each other. Their binding shells have similar radii, so the nucleus of hydrogen isotope – deuterium is formed, that has the ability to self-accelerate. In the protoelectronic medium, which is the inside of the star, the ability to accelerate such a deuterium nucleus is effectively inhibited. There are other similarly combined pairs of particles nearby, so they can easily connect to each other and form the helium nucleus ^{4}He, as shown in Fig. KM1.

In the protoelectron centre of the star interior, arise atomic nuclei, which in other conditions easily undergo decay. Here, the decay of such nuclei into components is protected by the inhibitory effect of the medium and the high density of other complex particles and their components - protons and neutrons. Hence, atomic nuclei of hydrogen - tritium, consisting of one proton and two neutrons, are easily formed. In Fig. KM6a these nuclei are schematically depicted on the plan of two cubes - these are particles marked as 2, 53 and 54 and 1, 51 and 52. From these two nuclei after they are joined together, the nucleus of the ^{6}He helium isotope forms.

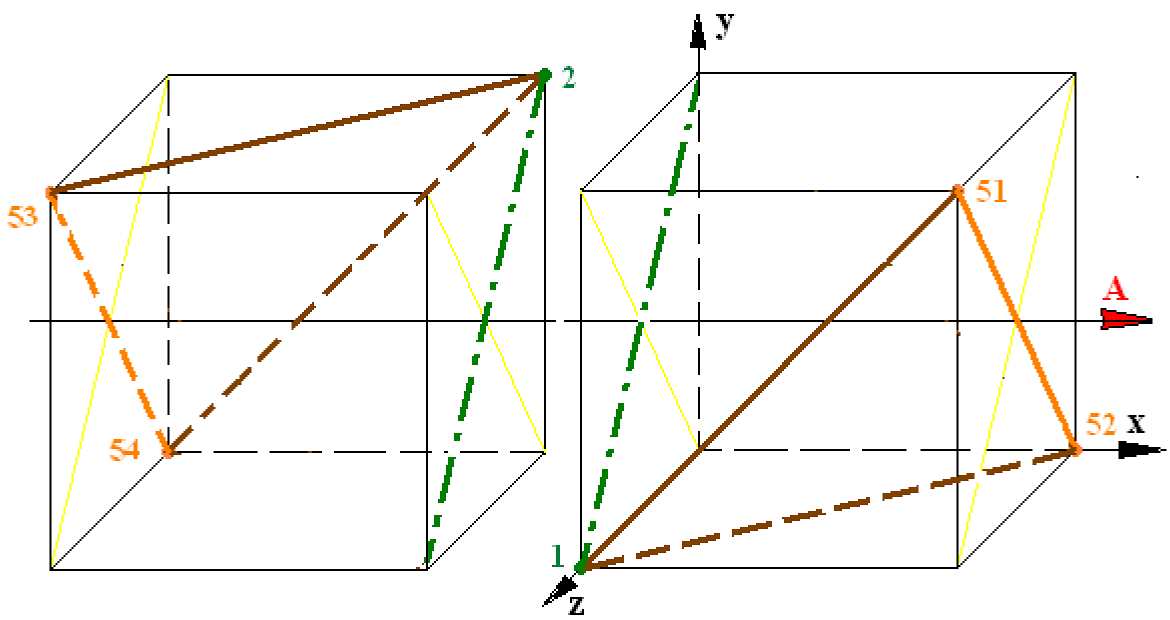


Fig. KM6a. Two nuclei of ^{3}H tritium atoms before the formation of the helium atom ^{6}He

The nucleus of the ^{6}He helium isotope can be formed in the form of various structural systems. Below are diagrams of two, in a sense, ideal structural systems. Fig. KM6b presents a symmetrical version of the ^{6}He helium nucleus structure. In this version you can see the connection of two ^{4}He nuclei, with the diagonal P,1,2 being common for both these systems.

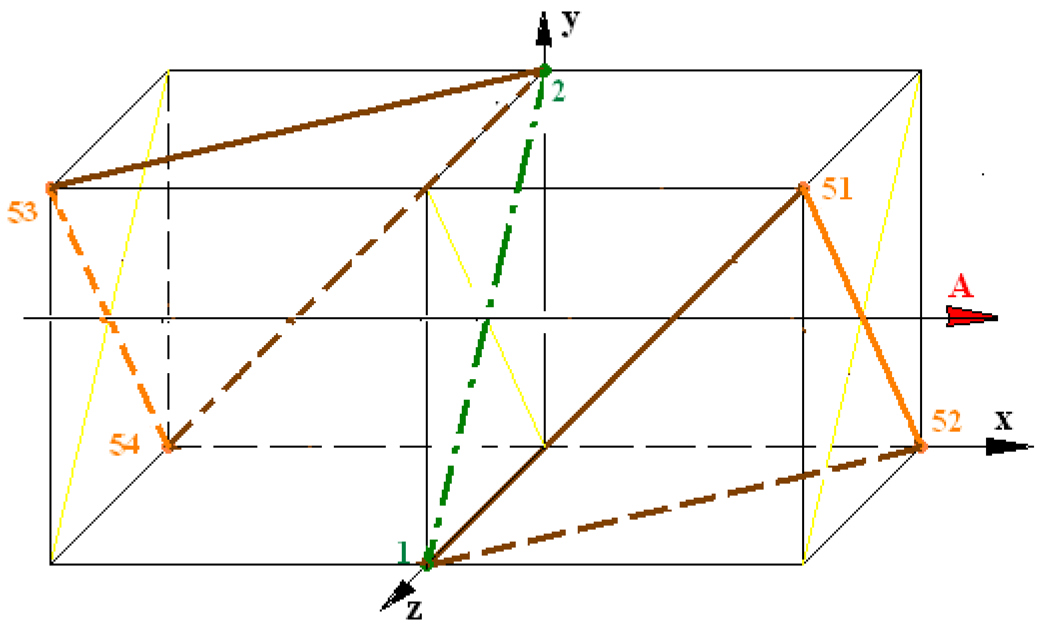


Fig. KM6b. Formation of ^{6}He atom nucleus from two nuclei of hydrogen atoms - tritium ^{3}H - symmetrical version

It may seem that such a structural system should have high stability. But in reality, it is not. Such a system is stable in the interior of the star, but in the thin matter, the instability caused by the too large number of neutrons in the structure is manifested, followed by the nuclear decay of ^{6}He. It should be noted that by looking at this structural system one can guess that neutrons probably do not have a nuclear potential shell with a radius that would bind neutrons with each other at the distance that exists between neutrons 51 - 53 and 52 - 54. This means that in such a system the binding of protons and neutrons together is not stable enough.

In Fig. KM6c, one of many possible asymmetric structural ^{6}He nuclei systems is depicted. This system is however characterized by the particular feature that neutrons 52 and 54 are spaced apart from each other as components in the ALPHA particle. It might seem that this system is also stable under different conditions than inside the star, but it is not.

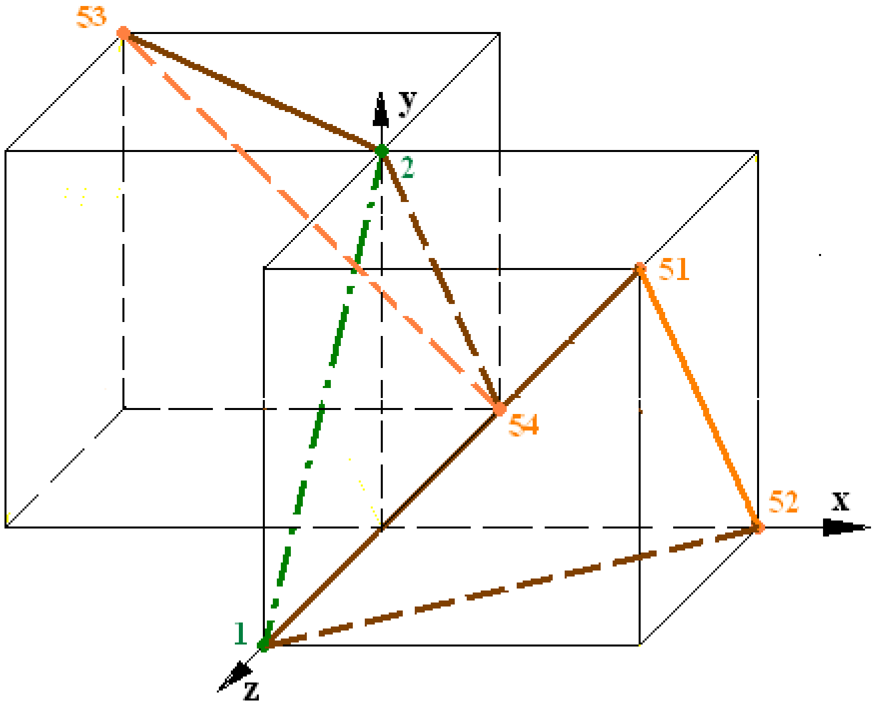


Fig. KM6c. Formation of ^{6}He atom nucleus from two nuclei of hydrogen atoms - tritium ^{3}H - asymmetrical version

Stable systems arise when the number of neutrons and protons is congruent. This is particularly so when the total number of atomic nucleus components is not large. With a small number of components in the nucleus of the atom, some kind of deviation occurs, as for example, the ^{5}He helium atom with the surplus of one neutron is then unstable.

Considering the number of isotopes in particular elements, it is difficult to notice any regularity. Below is a list of stable isotopes in elements with an atomic number from 1 to 54.

1. hydrogen ^{1}H, ^{2}H,	2. helium ^{3}He, ^{4}He,
3. lithium ^{6}Li, ^{7}Li,	11. sodium ^{23}Na,
4. beryllium ^{9}Be,	12. manganese ^{24}Mn, ^{25}Mn, ^{26}Mn,
5. boron ^{10}B, ^{11}B,	13. aluminium ^{27}Al
6. carbon ^{12}C, ^{13}C,	14. silicon ^{28}Si, ^{29}Si, ^{30}Si,
7. nitrogen ^{14}N, ^{15}N,	15. phosphorus ^{31}P,
8. oxygen ^{16}O, ^{17}O, ^{18}O,	16. sulfur ^{32}S, ^{33}S, ^{34}S,
9. fluorine ^{19}F,	17. chlorine ^{35}Cl, ^{37}Cl,
10. neon ^{20}Ne, ^{21}Ne, ^{22}Ne,	18. argon ^{36}Ar, ^{38}Ar, ^{40}Ar,

Stable isotopes of elements with an atomic number from 1 to 18 are on pages from http://chemistry-reference.com/q_elements.asp?language=pl&Symbol=H to http://chemistry-reference.com/q_elements.asp?language=pl&Symbol=Ar

19. potassium ^{39}K, ^{41}K,
20. calcium ^{40}Ca, ^{42}Ca, ^{43}Ca, ^{44}Ca, ^{46}Ca,
21. scandium ^{45}Sc,
22. titanium ^{46}Ti, ^{47}Ti, ^{48}Ti, ^{49}Ti, ^{50}Ti,
23. vanadium ^{51}V,
24. chromium ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr,
25. manganese ^{55}Mn,
26. iron ^{54}Fe, ^{56}Fe, ^{57}Fe, ^{58}Fe,
27. cobalt ^{59}Co,
28. nickel ^{58}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni, ^{64}Ni,
29. copper ^{63}Cu, ^{65}Cu,
30. zinc ^{64}Zn, ^{66}Zn, ^{67}Zn, ^{68}Zn, ^{70}Zn,
31. gallium ^{69}Ga, ^{71}Ga,
32. germanium ^{70}Ge, ^{72}Ge, ^{73}Ge, ^{74}Ge,
33. arsenic ^{75}As,
34. selenium ^{74}Se, ^{76}Se, ^{77}Se, ^{78}Se, ^{80}Se,
35. bromine ^{79}Br, ^{81}Br,
36. krypton ^{78}Kr, ^{80}Kr, ^{82}Kr, ^{83}Kr, ^{84}Kr, ^{86}Kr,

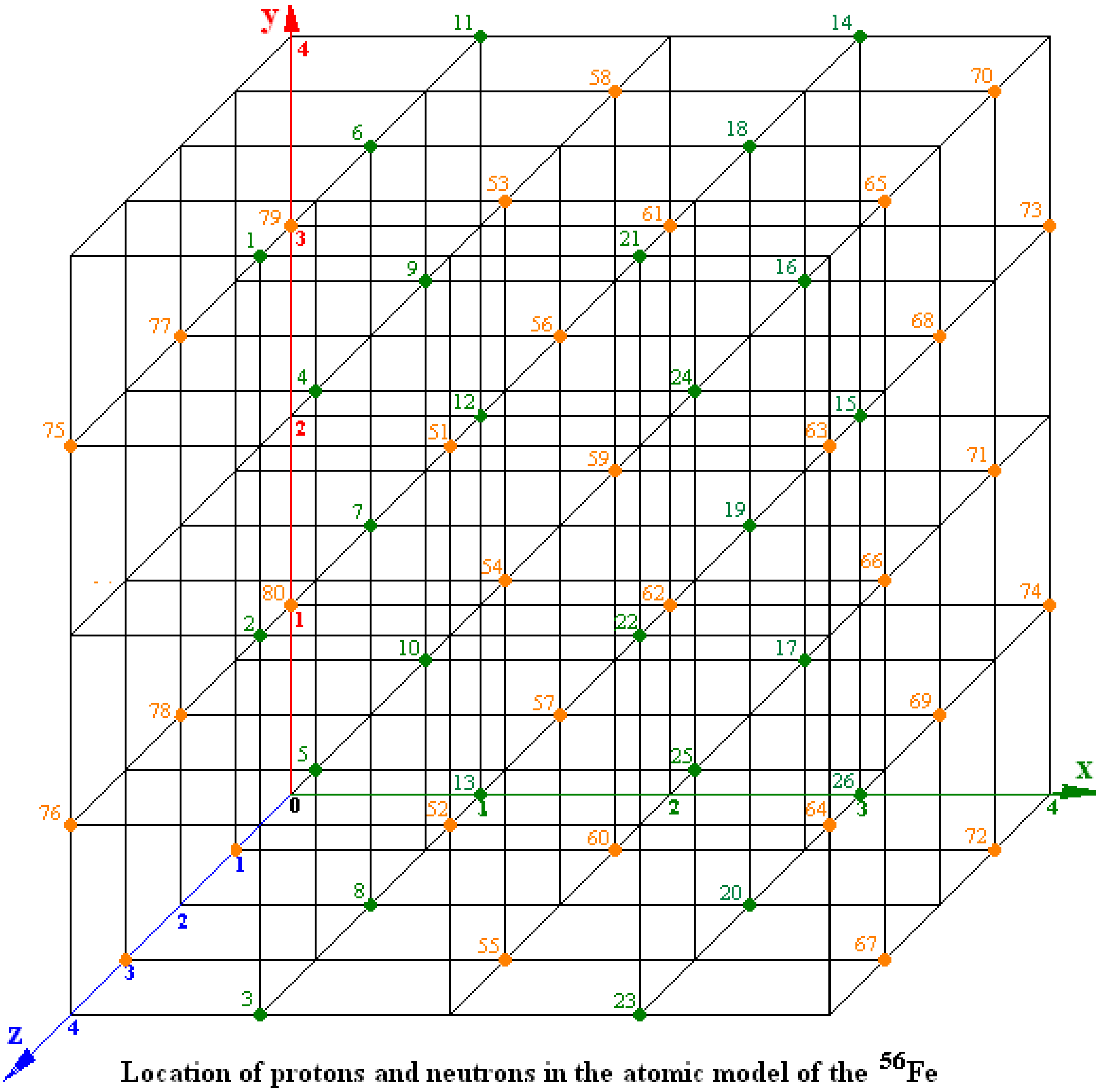
Stable isotopes of elements with an atomic number from 19 to 36 are on pages from http://chemistry-reference.com/q_elements.asp?language=pl&Symbol=K to http://chemistry-reference.com/q_elements.asp?language=pl&Symbol=Kr

37. rubidium ^{85}Rb,
38. strontium ^{84}Sr, ^{86}Sr, ^{87}Sr, ^{88}Sr,
39. yttrium ^{89}Y,
40. zirconium ^{90}Zr, ^{91}Zr, ^{92}Zr, ^{94}Zr,
41. niobium ^{93}Nb,
42. molybdenum ^{92}Mo, ^{94}Mo, ^{95}Mo, ^{96}Mo, ^{97}Mo, ^{98}Mo,
43. technetium ---
44. ruthenium ^{96}Ru, ^{98}Ru, ^{99}Ru, ^{100}Ru, ^{101}Ru, ^{102}Ru, ^{104}Ru,
45. rhodium ^{103}Rh,
46. palladium ^{102}Pd, ^{104}Pd, ^{105}Pd, ^{106}Pd, ^{108}Pd, ^{110}Pd,
47. silver ^{107}Ag, ^{109}Ag,
48. cadmium ^{106}Cd, ^{108}Cd, ^{110}Cd, ^{111}Cd, ^{112}Cd, ^{114}Cd,
49. indium ^{113}In,
50. tin ^{112}Sn, ^{114}Sn, ^{115}Sn, ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{119}Sn, ^{120}Sn, ^{122}Sn, ^{124}Sn,
51. antimony ^{121}Sb, ^{123}Sb,
52. tellurium ^{120}Te, ^{122}Te, ^{124}Te, ^{125}Te, ^{126}Te,
53. iodine ^{127}I,
54. xenon ^{124}Xe, ^{126}Xe, ^{128}Xe, ^{129}Xe, ^{130}Xe, ^{131}Xe, ^{132}Xe, ^{134}Xe, ^{136}Xe,

Stable isotopes of elements with an atomic number from 37 to 54 are on pages from http://chemistry-reference.com/q_elements.asp?language=pl&Symbol=Rb to http://chemistry-reference.com/q_elements.asp?language=pl&Symbol=Xe

If there any regularity occurs, it is difficult to see. Probably deciphering of the regularity could be done by a properly constructed computer program. This article may serve as a kind of basis and introduction for someone who will be interested in the subject in the future. The most important thing to note is that in the case of elements with a small atomic number, those isotopes that have the same number of protons and neutrons or have a slightly higher number of neutrons than protons are stable. There are very few such situations in the elements with a large atomic number.

The construction of atomic nuclei of elements with a large atomic number is quite complex and such nuclei for a given element can exist in several versions. In the structure of the nuclei, one can state the existence of the basic building stuff in the form of the ALFA particle structure. But such structural ALFA systems in the outer regions of the nucleus can be connected in different ways. Below is one of the versions of the ^{56}Fe iron nucleus model.



Location of protons and neutrons in the atomic model of the ^{56}Fe

This is one of the many versions of one of the four stable isotopes of this element.

Conclusion - Information for future researchers

In order to see the physical processes that occur in the atomic nucleus, to see the structure of the nucleus, you can only apply the principle of logical inference. It is in this way that the author tries to show the way to those who are interested in the structure of atoms. In the process of understanding the structure of atoms, building of models using a computer program, for example, AtomStand.exe*2) can help. Using the computer program, you can arrange protons and neutrons models in three-dimensional space. Using the created structure, you can study its behaviour.

The behaviour of the atomic models being constructed contradicts one of the fundamental physical laws - the law of conservation of energy. For more than two hundred years, physicists have learned that this physical law is inviolable. However, logic indicates that this law has a limited scope of activity. This law would be right only one hundred percent if protons and neutrons gave acceleration to other particles, which when changing the distance would change in the same way, that is, it would be described by the same mathematical function. But then protons and neutrons would not be different from each other however such a situation in nature does not exist. Because protons and neutrons differ from each other precisely because they accelerate the neighbouring particles in a different way. On the other hand, when they form together a durable, stable structural system, for example in the form of the ^{4}He helium atom, then such a system is capable of automatic accelerating and achieving ever higher speeds of motion.

By examining the acceleration of the models of various atoms, one can state the occurrence of a certain dependence. Namely, the ability to self-accelerate structural systems is also the reason for the decay of many of these systems. This is one of the reasons why only a small number of stable isotopes of each element occurs. The acceleration of the system, which is composed of a large number of particles, is the cause of increasing the speed, but also the reason for the formation of very complex vibrations of the component particles in relation to each other. For this reason, atoms with a high atomic number achieve relatively low velocities, because then during the process a part of the automatically generated energy, instead of the linear acceleration of the entire system, is converted into the energy of vibrations of the component particles of this system.

---

*1) Details on the potential shells and the principles on which the mutual accelerations of the constituents of atomic particles are based, are presented in Pinopa's paper "Constructive field theory - briefly and step by step" on http://pinopa.narod.ru/KTP_uk.pdf.

*2) The modelling program AtomStand.exe along with working ato files can be copied on http://pinopa.narod.ru/AtomStand.zip . The ato work files related to the topic of the article can be found there in the Akcleracja.zip collective file. There are there examples of building the structure of several atoms and their isotopes. In these examples, the initial parameters of particles - components of structural systems are recorded. After starting the process of interaction of particles with each other, you can stop the process at any time and create a new file, thus fixing the new locations of particles in space. There are also stored speeds that these systems achieve after the computer has completed 1000 computational iterations. These parameters are shown there in the name of the working files, for example, Ferrum_56Fe_T1000_V5,3.ato.

Bogdan Szenkaryk "Pinopa"
Poland, Legnica, 2018.08.04.