# Structure and Stability of Atomic Nuclei

Norbert Buchholz

Abstract

In the model of atomic nuclei presented here, we assume **cubic protons and neutrons**, with a classical structure of positrons and electrons. With this concept, stable nuclei can be constructed on a purely electrostatic basis, **without the postulate of a strong nuclear force nor quarks and gluons**, by assuming that the electrons are located on average 1/3 between neighboring nucleons, so that the $1/6 \ e^+$ of the neighboring positron charges are compensated and, in addition, stable electrostatic binding is generated. This also leads to the **neutron rule,** which states that 1/3 neutron must be available for each contact surface (inner surface). The structure of the nuclei is based on the simple principle of a modular system that consists only of the four basic building blocks D, T, He4, Be9 and single nucleons. When the basic building blocks are combined, new structures are created along the stacking direction, the mass defects of which are known or can be easily calculated. From this, the mass defects of the nuclides can be derived quite accurately. The relative errors of these calculations are smaller than those of the Bethe-Weizsäcker model by a factor of 10 and are excellent, especially in the range of smaller nuclei, where the droplet model only provides moderately good results. The basic building blocks mentioned above can be joined in different ways, which causes different structures along the stacking sequences and thus different mass defects. Our model thus leads to a **substructure of the isotopes**, which we have called **isomeric structural variants** or, more briefly, **structural isomers**. These differ by about $1 - 30 \ 10^{-30}$ kg. Their mass differences are thus smaller by a factor of $100 - 1000$ than those of the isotopes. Nevertheless, we assume that these structural isomers can be isolated and quantified, which would not only be extremely important for the verification of this model, but would also enable a very precise calculation of the isotope masses. Another very interesting point is that the composition of the isotopes with even and those with odd mass numbers follows **completely different structural lines**. The former all consist of stacked α particles and, where necessary, additional single nucleons. The latter isotopes are all derived from N15, which is formed by two intertwined Be9 rings. Adding two protons and neutrons produces the F19, a 3^3 cube with missing cornerstones, which can now be extended as desired by adding nucleons in pairs at the periphery, thus representing the core structure of all isotopes with an odd mass number.

I Basic concept of the new atomic model

Fig. 1 Classical model   Fig. 2 Quark-gluon model   Fig. 3 Neutron according to Ref 3
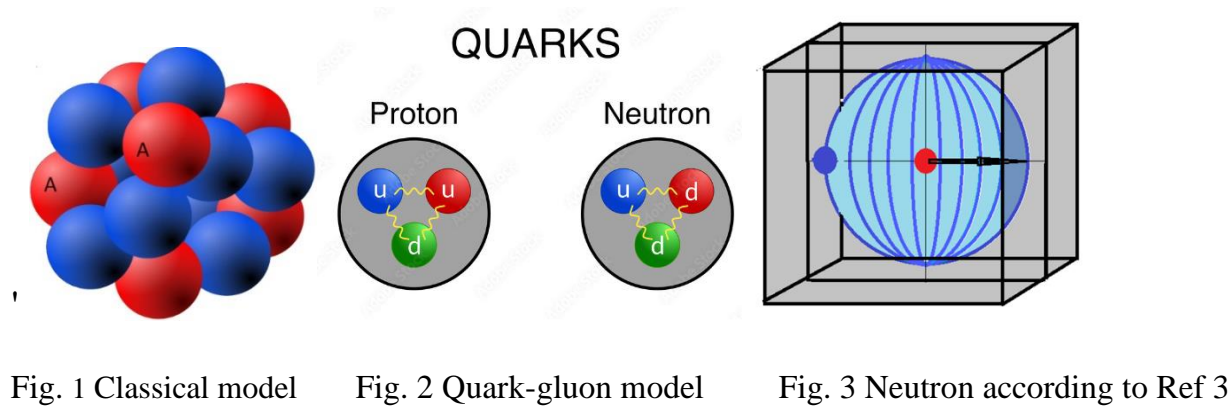
In textbooks and popular science magazines, atomic nuclei are still depicted as the densest spherical packings of protons and neutrons, as shown in Fig. 1. If one also assumes the idea of E. Fermi that neutrons are actually neutral, i.e. also internally without charge carriers, these merely cause a spatial "dilution", which hardly changes the enormous repulsive force of the protons among themselves and would lead to an almost explosive nucleus.

According to the quark-gluon theory currently favored by physicists (see Fig. 2), both the neutron and the proton consist of differently charged particles. The former consists of an up quark ($2/3e^+$) and two down quarks ($2 \times 1/3 \, e^-$), the latter of two up quarks and one down quark. In this model, a certain neutralization of the partial charges at the points where the nucleons come into contact is certainly possible. However, this has its limits. Since there are always gaps in a dense spherical packing, in which the space is only about 75% filled with nucleons (see Fig. 1, gap between the protons marked A), through which the repulsive proton charges can interact unhindered, the construction of a stable nucleus is ultimately impossible here too. This applies all the more to the droplet model developed by Gamow, Weizsäcker and Bethe from 1935 onwards[2], in which the nucleons, like water molecules in a drop of water, move freely in a spherical or droplet-shaped structure. There is therefore a positive excess charge in a very small space, a state that is untenable according to the laws of electrostatics. Physicists were faced with the dilemma that there are undoubtedly stable atomic nuclei but no model for them. As a way out of the dilemma, the strong nuclear force, later called the strong interaction, was finally introduced, whose properties, above all strength and range, were adapted to the requirements.

As I said, this new force with all its wonderful properties for explaining the stability of atomic nuclei was not discovered or even measured, but postulated, which means that its introduction was truly not a brilliant achievement, but an act of desperation.

In addition, this postulate has created another serious problem. According to the postulate, the strong nuclear force acts **independently of charge** at very short distances, i.e. between all neighboring nuclear building blocks. Thus, according to this theory, in addition to the existing deuterium (P-N), there should also be an N-N and, since this force is also significantly stronger than the Coulomb force, even a P-P as an elementary particle, which, however, does not

correspond to reality. According to our theory based on Coulomb forces, a P-P particle is of course an absurdity, but an N-N particle can also be ruled out. If a second neutron is added to the neutron shown in Fig. 3, it is immediately apparent that, apart from weak gravitational forces, there are no binding forces between these nucleons. However, the latter are overcompensated by the repulsive negative electrostatic forces of the electron sphere around the positrons. In the following, we will show that it is possible to develop a model for stable atomic nuclei without the postulate of a new force. *

From the projection theory we have developed, it inevitably follows that there must be a smallest length, which in turn inevitably implies a smallest volume. A decided interpretation of Planck's quantum of action[2] in combination with the formula developed in Ref. 1 for calculating the gravitational constant resulted in a formula which clearly shows that the mass of the proton can be assigned to this smallest volume, but only if a cubic volume is assumed. Rectangular bodies and, in the case of an isotropic space, cubic bodies as minimum volumes are also fundamentally required by our projection theory, as we understand these as the smallest resolved volumes, i.e. as spatial pixels, analogous to the surface pixels in electronic photography, which in turn are fundamentally represented as rectangular or square surfaces. We have already pointed out above that spheres cannot fill space even when densely packed. We can therefore take the size and cubic structure of the protons for granted This does not necessarily mean that neutrons also are rectangular. However, since it is certain that atomic nuclei are made up of protons and neutrons, a construct of spheres and cubes seems quite unlikely. In a recently published paper3 we developed the neutron model shown in Fig. 3.

It consists of a cubic basic body of approximately the size of the proton and a central positron, surrounded by a spherically symmetrical potential space (r = 0.6355 fm), which is statistically occupied by the electron (see Fig. 3). The change in position of the electron takes place via jumps in the minimum time t_{min} . With this model, we were able to calculate the mass and the β-decay curve of the neutron very accurately. In addition, we were able to determine some irregularities in the maximum of the decay curve of the neutron, which obviously have their cause in the clash between the spherical interior (potential space of the electron) and the cubic outer shell of the neutron, so that we can also derive an indication of its cubic form from the curve of the β-decay.

*In established physics, the non-existence of dineutrons and diprotons is explained – as it almost always is – by the spin and the Pauli exclusion principle in combination with the – in our opinion unproven – assertion that the strong nuclear force is significantly weaker with antiparallel spin (singlet state) than with parallel spin.

This allows the atomic nuclei to be constructed according to a simple "building block system", such as the tritium and helium illustrated below.

Fig. 4 Tritium   (T) *   Fig.5 He4*
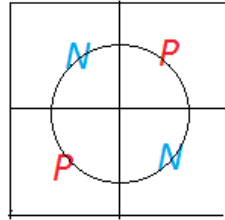
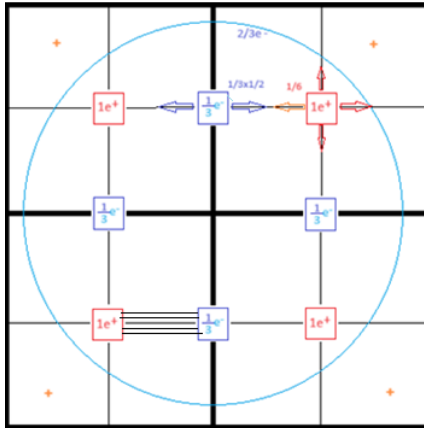The binding conditions in the nucleus can be demonstrated particularly well using the example of He4 (see Fig. 6)
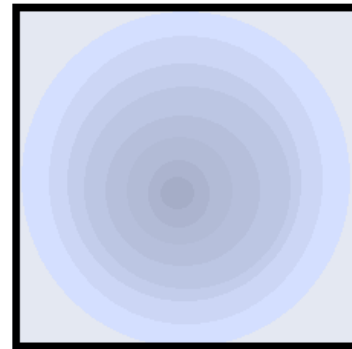

Fig. 6 Model of the binding conditions in   Fig. 7 Possible electron distribution in the area of
      the He4 nucleus   the contact surfaces

For the sake of simplicity and thus better understanding, we will start with two incorrect assumptions:

a) Positrons and electrons are cubic
b) The negative charge is present as partial charges with 1/3 of the elementary unit charge.

The 1/3 e⁻ charges each lie centrally on the boundary surfaces of neighboring nucleons and develop their electrostatic forces evenly in only two spatial directions.

In this work, the element symbols represent the respective atomic nuclei, with the number attached to the right indicating the number of nuclear building blocks. This adequately characterizes each nuclide nucleus (e.g. He3, He4, Be9 etc.).

The positrons are located in the center of the nucleons and act uniformly in all 6 spatial directions (see Fig. 6), so that $1/6$ e^- and $1/6$ e^+ are opposite each other, which leads to neutralization of the charges on the one hand and stable electrostatic bonds between opposing charge carriers on the other. This bond is present eightfold in He, which explains the high stability of this atomic nucleus. It may also be a ring-stabilized bond with delocalized electrons, as found in a similar form in the chemistry of aromatic compounds.

The strict alignment of the electrostatic forces therefore results in extensive neutralization in the central region, while the excess positive charge of each nucleus is predominantly located at the periphery (symbolized in Fig. 6 by + **signs** in the corners of the quadrants) and thus in close proximity to the negative atomic shell, which is of course very helpful for building stable atoms. Figure 6 also impressively demonstrates that protons and neutrons give up their identity in favor of an uniform charge distribution in the overall nucleus

On the one hand, this finding is important for understanding the symmetry and bonding relationships in the nucleus, On the other hand, however, the model also easily explains why the free neutron is unstable (β^--decay), while the neutron bound in the nucleus is stable, since, in our view, it no longer exists as an individual particle in the nucleus.

So-called mirror nuclei (isobaric nuclei with swapped proton and neutron numbers) also support our view outlined above that protons and neutrons lose their identity in the nuclear compound, as the following statement from Wikipedia shows:

Mirror nuclei impressively demonstrate that protons and neutrons, although they have different electric charges, otherwise behave very similarly: Energy levels as well as the corresponding spins and parities of mirror nuclei look confusingly similar; the main difference is the energy of the ground state due to differences in the Coulomb potential.[4]

The negative charge that is not required to shield the positive charges (here $2/3 e^-$) is referred to as the free charge Q_f, which is somehow distributed throughout the nucleus (symbolized by a blue circle in Fig. 4) and corresponds approximately to the Coulomb potential in the explanations above.
(To avoid misunderstandings, it is important to note that the atomic nucleus is of course positively charged according to the atomic number)

 If we discard the above-mentioned false assumptions of cubic electrons and positrons and of $1/3$ charge units, the positive charge no longer acts only on the centers of the boundary surfaces, i.e. for effective shielding we have to imagine the electrons distributed over the entire boundary surface. We can roughly adopt the binding models from chemistry with orbitals, which are to be understood as probability densities. In the nuclear compound the probability of the electrons being in the area of the boundary surfaces of two nucleons is $1/3$ of their total presence, so that even under these conditions, complete shielding of the positive charges of neighboring nucleons is guaranteed, i.e. the binding principle of the nuclei approximately reflects that of the atoms in their molecules on a much smaller scale. In the concept of projection theory, the binding in the nuclei has nothing to do with gluons and quarks, whatever their color and flavor, and a strong nuclear force is not required.

Fig. 7 presents a first rough model of an electron distribution on the contact surfaces of the nucleons. The aim of this work is not yet to calculate the exact binding forces or the shape of the orbitals, but only to show that stable nuclei can be formed with simple classical concepts.

According to our model, all elements are built from a few basic building blocks such as He4 or Be9 in combination with single nucleons. The **alpha particle model** postulated by Wefelmeier[5] as early as 1937, and quite wrongly forgotten, undergoes a certain renaissance here, but is integrated into a much larger framework that also includes other elements not built from α particles.

The shielding rule states that for every contact surface (inner surface), 1/3 neutron must be available. Since in the case of compact construction, i.e. the densest arrangement of nucleons, the number of inner surfaces in relation to the outer surfaces increases rapidly, the demand for neutrons also increases rapidly (**neutron rule**).

The number of neutrons required (N_{min}) is for cubic bodies such as

$2^3 = 8$
$3^3 = 27$
$4^3 = 64$
$5^3 = 125$

is easy to calculate:

$$N_{min} = n^3 - n^2$$

$2^3 = 8 - 4 = 4$		→	?
$3^3 = 27 - 9 = 18$	Al27	→	14
$4^3 = 64 - 16 = 48$	Ni64	→	36
$5^3 = 125 - 25 = 100$	Te125	→	73

However, the element with 8 nucleons (2 He4 nuclei) in particular, in which the rule with 4 neutrons would still be observed, is not actually realized - for whatever reason. For all other real elements, the number of neutrons is well below the target, i.e. real atoms cannot be densely packed bodies. In principle, ideally close-packed objects can only be realized for cubic numbers as listed above.

Fig. 8 shows the relative proportion of neutrons required for the densest packing for atomic weights up to 8000, which is already approx. 95% for the latter. It can be seen that the graph approaches 1 (100%) asymptotically. Formations with almost 100% neutrons are realized as **neutron stars** with gigantic nuclear masses in the order of magnitude of solar masses in the cosmos.
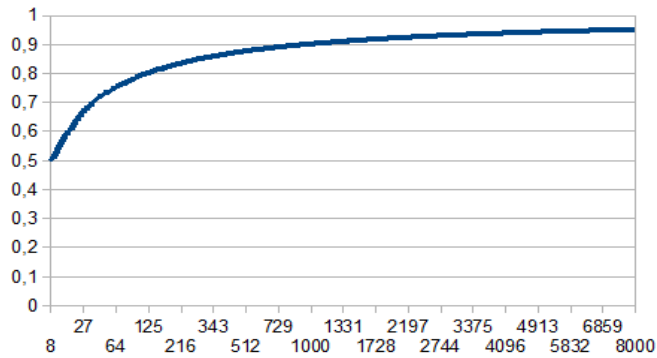
Fig. 8 Relative proportion of neutrons required according to the neutron rule
　　as a function of the nuclear mass

The elementary particle density (see Ref. 1, section 'Fundamentals of Projective Representation')
is 7.24 10^{17} kg/m^3, whereas the density of atomic nuclei, on the other hand, is only about 2.8 10^{17}
kg/m^3. This, in addition to the lack of neutrons, is further evidence that atoms are not objects with
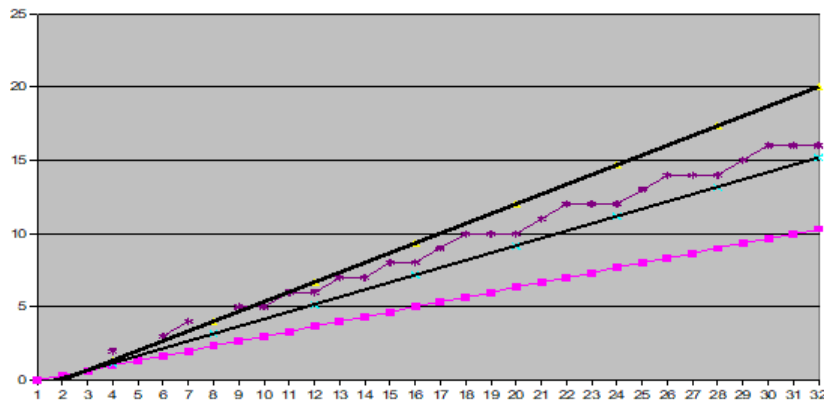maximum density.

Fig. 9 Neutron distribution

Abscissa: relative atomic masses
Ordinate: number of neutrons
light violet line: number of neutrons required in a linear arrangement
　　　　　　　　(lowest number of contact surfaces)
top black line:　number of neutrons in a compact arrangement
　　　　　　　　(maximum number of contact surfaces)
second black line: arithmetic mean of the maximum and minimum values,
dark purple line:　actual neutron number in the elements up to Sulphur

The free charge Q_f obviously has an influence on the stability of a nucleus, as the comparison of
He3 and T or C14 and N14, which each have a difference of 1 N, i.e. 3/3 e⁻, shows:

7

Element	$^*\Delta m$	Q_f
T	15,12	4/3
He3	13,785	1/3
T - He3	1,362	(+9,8%)
C14	187,68	8/3
N14	186,57	5/3
C14 – N14	1,11	(+0,6%)

For smaller nuclei (e.g. Li6), this effect must be taken into account when calculating the mass balance, but as the percentages show, it quickly loses significance in relation to the total mass balance.

II Basic elements and design principles of the new atomic model

1. Basic elements

Analogous to the molecular level, the mesomeric effect, i.e. the energy gain through the delocalization of electrons, which we know from the organic chemistry of double bond systems, can obviously also be seen in the bonding system of the nuclei that we have postulated.
If we consider the first two multi-nuclear elements in our periodic table, deuterium and tritium, the binding energy (mass loss) is not doubled by the additional bond (contact area), but almost quadrupled. The additional energy gain through **ring formation**, which is well known in the molecular range from the chemistry of aromatic hydrocarbons, is also realized on a nuclear scale. If we assume a hypothetical linear trans-tritium with 4 nucleons, calculate the mass loss of this particle using equation AK1 (see Table 1, tT4) and, in a second step, take into account the additional energy gains due to the increase the contact surfaces from 3 to 4 when a ring is formed, we obtain a mass loss of about 34. However, the actual mass loss of the He4 nucleus is 50.44. Consequently, there is an enormous ring stabilization and thus a very stable particle.
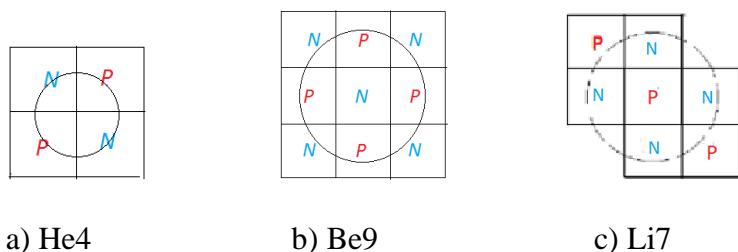

a) He4   b) Be9   c) Li7

Fig. 10 Ring-stabilized basic elements

---

* *All mass data in this work, unless provided with concrete specifications or other information, must be supplemented by the power 10^{-30} and the unit kg. The NIST table was used for all isotope masses, in accordance with Ref. 7.*

With the Be9, consisting of a 3x3 arrangement of 5 neutrons and 4 protons, or of a ring of eight alternating protons and neutrons and a central neutron, there is another particle stabilized by ring mesomerism.

The Li7 nucleus can be described as a defective Be9 nucleus and is also energetically located between the linear and ring-shaped structures. Ultimately, it only plays a decisive role in the C13 nucleus.

According to the calculations so far, all elements are built from the above-mentioned basic building blocks, whereby, according to the current state of knowledge, all elements with an even mass number are based on He4 and almost all elements with an odd mass number on Be9 as the characteristic structural element. (Exceptions such as Li7 or B11 and C13 will be discussed in detail at the appropriate point).

The elements are constructed from the above-mentioned basic building blocks and, if necessary, additional protons (P) and neutrons (N). This results in new linear structural elements (StE) for these constructs **along the stacking sequence** such as D, T, He3, tT4, tT5 to tT10, with the last seven, the linear trans-tritium elements with 4 -10 building blocks, which are not realized in isolated form. The stability of the tTx building blocks can be calculated using a simple rule of thumb, whereby the mass defects of the element symbols in the equation (AK.1) must be used. The resulting values give the specific mass differences for the respective structural element, which are referred to as specific masses (spM) in the following text.

$$\left(\frac{T-D}{D2^n}+1\right)tT_{n+1} = tT_{n+2}$$

(AK.1)

$n = 2, 3, 4.....$

StE		spM [2]	
D_{lit}	=	3,965	n=2
$He3_{lit}$	=	13,785	
T_{li}	=	15,12	
$tT4_{calc}$	=	25,75	
$tT5_{calc}$	=	34,80	
$tT6_{calc}$	=	40,92	
$tT7_{calc}$	=	44,52	
$tT8_{calc}$	=	46,48	
$tT9_{calc}$	=	47,50	
$tT10_{calc}$	=	48,02	

StE Structural element
spM Specific masses   (Mass equivalent of atomic binding energy)
D Deuterium   T
Tritium
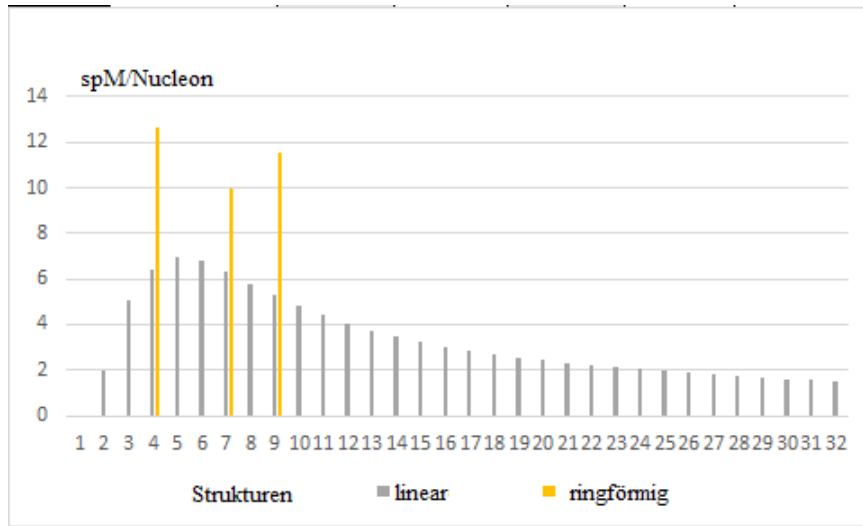tTn_i trans-tritium element with n_i nuclei

Fig. 11 Binding efficiency of the elementary building blocks

Fig. 11 shows the binding efficiency, i.e. the mass loss per nucleon, for the linear and ring-shaped basic structures. It can be seen that

  a) the tT5 in the linear structures represents the maximum of an initially steeply
     rising and then flatly fading curve and therefore - as we will see below - plays
     a major role in the construction of particularly stable structural isomers and
  b) the ring-shaped basic elements He4, Li7 and Be9 occupy an outstanding
     energetic position.

2. Design principles

The constructive procedure for building up isotopes from the above-mentioned basic building blocks is demonstrated using the elements C12 and N14 with even and N15 and F19 with odd mass numbers.
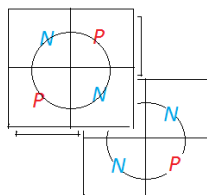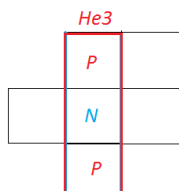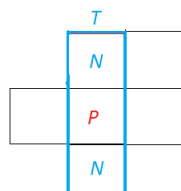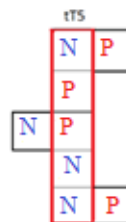
C12 Top view   C12 Side views C12   N14 Side view

Fig. 12 a   b   c   d
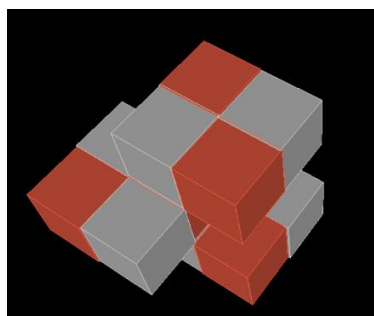

Fig. 13 3D representation of the C12

C12 consists of three He4 units stacked over a corner (see Fig. 12 a). Along the connecting axis, depending on the stacking sequence, this results in a He3 or a T as linear linking elements (see Fig.12 b and c), which occur statistically with the same frequency and are not far apart in terms of energy, so that we include the arithmetic mean of these structural elements in the calculation:

C12   3He4 + (T+He3)/2 → 165.76 (measured value: 164.29)
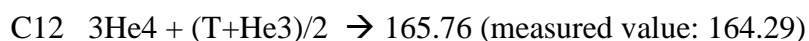
The N14 has a very similar structure, except that the He4 units are not linked directly, but each via an additional proton or neutron. This results in a linear unit of five particles along the linkage axis. Fig.12d shows only one of the possible stacking sequences. Analogous to the chemistry of conjugated double bonds, the individual permutations in this stack are only to be understood as boundary structures of the actual mesomeric structure. It has already been pointed out earlier that the protons and neutrons give up their individuality in the nuclear compound in favor of a new combined particle.

Since, in contrast to the triple stack in C12 with the boundary structures He3 and T for the tT5 unit, no measured values are available for individual boundary structures, we must assume that the value calculated from Eq. (AK.1) for the tT5 approximately reflects the mass balance of all possible stacking sequences correctly. As a large number of calculations have shown, this is approximately the case. However, an average value of 34.4 +- 0.2 could be calculated from a large number of larger nuclei containing this structural element. For smaller nuclei, the value calculated using Eq. (AK.1) appears to be correct. We thus obtain

N14   3He4 + tT5 → 186.12 (measured value: 186.57)
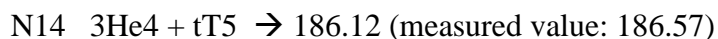
All isotopes with an **odd** mass number from atomic mass 15 (N15) can be derived from Be9 as the basic structural element**.**
**There are therefore two completely separate structural lines for the isotope series with an odd mass number on one side and the one with an even mass number on the other.**
The elements with odd masses before N15 are discussed separately below.

The N15 consists of two Be9 units that are perpendicular to each other, i.e. the two rings are linked via a bridge proton, a bridge neutron and the central neutron of the Be9 units. This results in the following nucleon constellation:

2 Be9 = 10 N + 8 P separated
2 Be9 = 10 - 2 N = 8 N   8P - 1 P = 7 P   8N + 7P → N15 linked
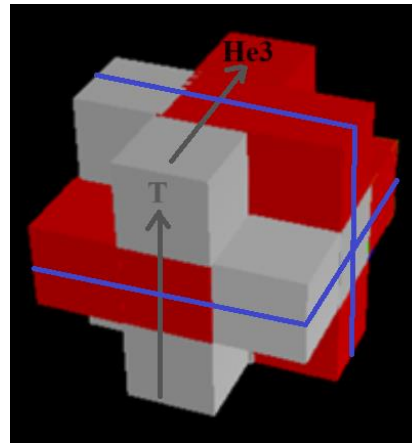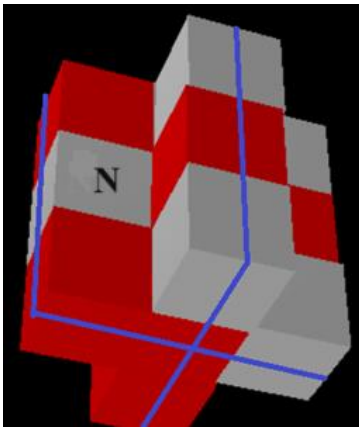
*Fig. 14 3D representation of the N15   Fig. 15 3D representation of the F19

If a nucleon is added to the position marked N in Fig. 14 and the point symmetrically opposite, the result is O17, and by repeating this process at the mirror-symmetrically opposite positions, F19. Formally, there are now three perpendicular, interwoven rings of the basic element Be9 (see Fig. 15).
In fact, however, the third ring does not correspond to a stable Be9 ring structure, since otherwise a mass loss of >300 would be expected (measured value 263), i.e. a completely delocalized electron structure as in Be9 can no longer form in the third ring. The added nucleons must therefore be included in the mass balance as He3 or T units, which, for example, leads to a very good agreement between the calculated and measured values for O17.

N15 2 Be9   →   207,36 (measured value: 205,99)
O17 N15 + He3 + T   →   234,89 (measured value: 234,88)
F19 N15 + 2He3 + 2T   →   263,78 (measured value: 263,47)

The blue bands illustrate the Be9 rings.

Even the first connection of the two Be9 rings to the N15 obviously causes a slight mutual interference of the isolated rings, so that the measured value for the N15 is significantly below the sum of the individual elements (see above).

F19 in the form shown above can also be described very simply as a 3^3 cube without corner building blocks. It is of enormous importance as it forms the basis of all isotopes with an odd mass number, which will be discussed in detail in the section "The trans fluorine elements".

III Isotopes with even mass number based on He4 units

1. General notes and explanations on the illustrations

The atomic model presented here is based on a modular principle, i.e. ever larger and more complex nuclei are built up from a few basic building blocks. The basic principle has already been presented in the previous section.

An ensemble of identical building blocks always corresponds to a specific isotope, but can be assembled in different ways. As demonstrated in Fig. 10 using the example of three He4 units, the corner-linked construct in Fig. 10 a contrasts with the edge-linked construct in Fig. 10 b.. Both are made up of the same number of identical base elements. They are therefore isomeric, but differ in their spatial arrangement, i.e. in their structure. An exact nomenclature for this would be **isomeric structure variants**. In the following, however, they are referred to somewhat simplified and more concisely as **structural isomers**.

Fig. 16 Structural isomers

corner-linked   edge-linked

3He4 + (He3 + T)/2→ 165.8   3 He4 + He3 + T→ 180.2
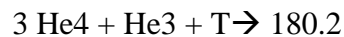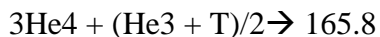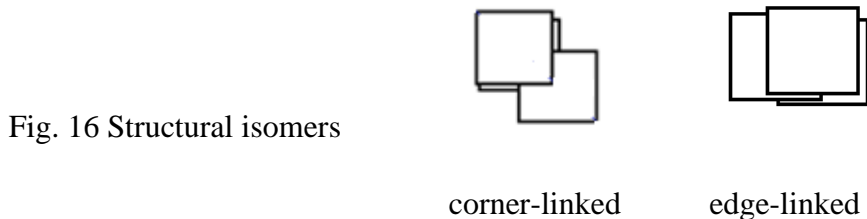
As demonstrated in the example above, the majority of structural isomers have a different mass balance. In addition, there are structural isomers that do not differ in their mass loss despite their sometimes significantly different structure (see e.g. Fig. 13 B and B'). These can be described as **isobaric** structural variants. For the construction of the structural isomers of an isotope, minimum **symmetry** requirements must be met. The constructs must either have at least 2 mirror planes (m1 and m2) or an inversion center I (rotational mirroring). This can be easily demonstrated using the He4 elements.

All elements with an odd number of He4 units stacked over a corner or an edge fulfill the first requirement (see Fig. 11 a - f) and all elements with an even number of elementary building blocks in the same stacking sequence fulfill the second requirement (see Fig. 11 g - j). This minimum symmetry requirement ensures that 3 mutually perpendicular axes can be constructed, which intersect at the center of mass of the construct and thus enable rotation of the nuclide without imbalance in all spatial directions.

Corner linking   Edge linking

a   b   c   d   e   f

mirror symmetrical

g   h   i   j   k
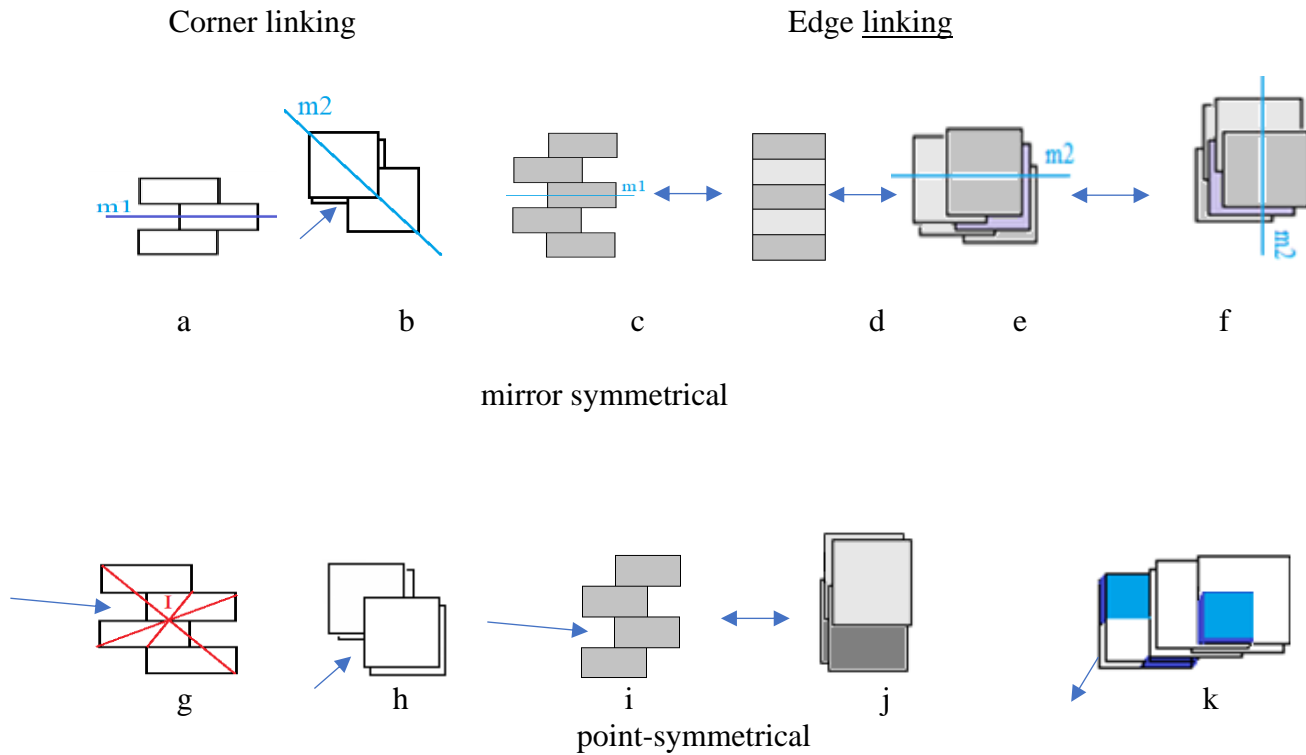
point-symmetrical

Fig. 17 Demonstration of the forms of representation of the structural isomers

The side view of the corner-linked units is always viewed from the mirror plane m2, i.e. from the surface diagonals of the building blocks (see arrow in Fig. 17b). The horizontal extension of the individual building blocks is therefore stretched by a factor of $\sqrt{2}$ compared to the vertical extension, although this is not true to scale in the illustrations, but is indicated by a slight elongation of the base lengths. In the case of edge-linked isomers, the side view is of the edges themselves. It is therefore not necessary to correct the base edge lengths. The edge-linked He4 units were colored gray to better distinguish them from the corner-linked units (see Fig. 17 c - f and i, j). The stacking sequence of the edge-linked structures can be displayed either with a view to the mirror plane m2 (see Fig. 17 c and d) or along it (see Fig. 17 e and f).
This structural system is based solely on the structural elements N, P and He4. These elements can therefore only touch each other in a stacking plane via corners, not via edges, as otherwise new base elements would be created (P + N→ D). The gap marked with arrow in Fig. 17 g can

therefore be **easily** filled with a single nucleon in the **corner-linked** form**, but not** in the **edge-linked** form (Fig. 17 i).

The short blue arrow, as shown in Fig. 17 k, indicates that the structural elements shown above must be extended in the direction of the arrow into the depth below the paper planes in such a way that, overall, a centrosymmetric construct is obtained
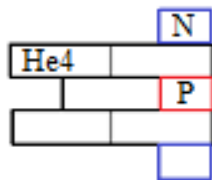
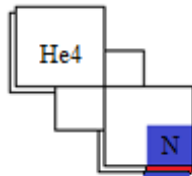Side view   Top view

Fig. 18 Color coding of the nucleons

The neutrons are shown in blue and the protons in red (see Fig. 12). However, this color coding only serves to better identify the isomer shown. For the symmetry considerations, both nucleons are always to be regarded as equivalent.

Due to the exponential function in the denominator of equation AK1, the specific masses very quickly approach the limit value 48.553 and consequently the mass differences of neighboring links approach the value 0. It follows that elongated structures such as A in Fig. 18 become energetically inefficient with increasing chain length. But not only energetically but also sterically very elongated structures are to be classified as less favorable. Although we do not achieve an ideal spherical shape in this model as in the droplet model of Bethe and Weizsäcker, which will be discussed in detail at the end of this paper, an approximation to a state that is as compact as possible is also aimed for in this system.

.

As the depth of the structures to be compared is generally identical, the front surface of the isomers, which should ideally form a square, plays the decisive role.

As selection criteria for the realization of a certain structural isomer, not only its energy balance but also its geometry, which is determined by the geometric factor f_g , which reflects the ratio of height and width of the front surface, must be taken into account. For better comparability, the ratio of height to width was always chosen so that the resulting value is >1, i.e. the quotient f_g represents both the ratio h/b and b/h.

In the following, this factor is added in brackets after the Latin capital letters with which structural isomers are identified in the further course.

$$A(1,88) \; h/b = 8/3\sqrt{2} \qquad B\,(1,13)\; b/h = 4\sqrt{2}/5 \qquad C\,(2,83)\; b/h = 6\cdot\sqrt{2}/3$$

h (Height)

b (Width)

Δm   450,0   473,12   464,0
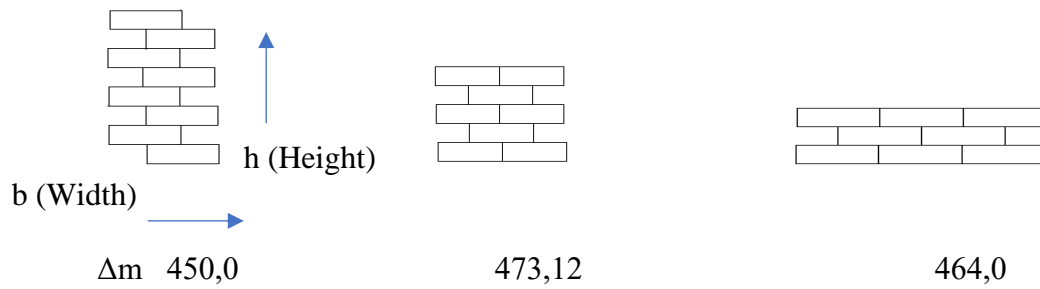
Fig. 19 Illustration of the basis for calculating the geometric factor fg

In the example in Fig. 13, the situation is quite simple. The two structural isomers A and C are significantly less favourable than B in terms of geometry **and** energy balance and are consequently not realized.

2. Representation of the structural isomers and calculation of the mass defects of the He4 isotopes

All isotopes whose mass is divisible by 4 and which have the same number of protons and neutrons are composed **exclusively** of the **structural unit He4 (α-particles).** Since the relative proportion of neutrons must increase with increasing nucleus size and thus increasing number of contact surfaces (neutron rule), the second condition is no longer met for elements above Ca, so that Ca40 is the last element in which this structural principle is realized.

This structural principle also plausibly explains the particularly high energies for the separation of a neutron measured precisely for this group of elements (see Fig. 20), since ultimately the neutron must be removed from a very stable He4 unit in all these elements, irrespective of their overall structure. Of course, with increasing nucleus size, the loss of a neutron from a larger ensemble of neutrons (e.g. 20 for Ca40) is less severe and therefore involves less energy expenditure than for the He4 nucleus itself with only two neutrons, so that a gradual decrease in the separation energy towards heavier elements is to be expected and also is observed.
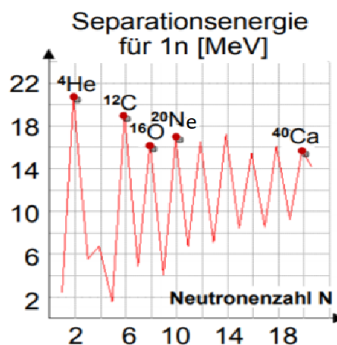
Fig. 20 Separation energy for 1 neutron in the He4 elements[5]

It is somewhat surprising that Be8 is missing as the second member in this homologous series, although the mass balance resulting from the linking of two He nuclei via a corner is greater than that measured for Be9.

Be8   2 He4 + D $\Delta m = 104,85$
Be9 $\Delta m = 103,68$

Structural isomers of C12

     A (1,41)   B (1,88)   B´ (2,82)   C (1,0)

                                                          Top view   Side view*
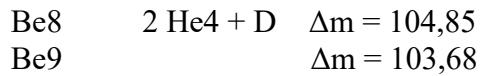
Fig. 20 Schematic representation of the structural isomers of C12

Calculation of the mass defects for the isomers shown above

3He4 + (T + He3)/2   165.75 A
3He4 + 2D   159.25 B/B'
3He4 + He3+T   180.2   C

Mean value **   165.75 (A)
Measured value   164.29
Δm_{rel} $8.9 \; 10^{-3}$

A gray frame has been placed around the side view of this structure to make the square front view clearer.

**The structural isomers relevant for the mass balance are listed in brackets after the numerical mean. The term mean is retained even if the result was derived from only one isomer.*

Structural isomers of O16

A (1,06)   B (1,88)   C (1,76)   D (1,33)   E (1,33)   B´(1,0)*

Fig.21 Schematic representation of the structural isomers of O16
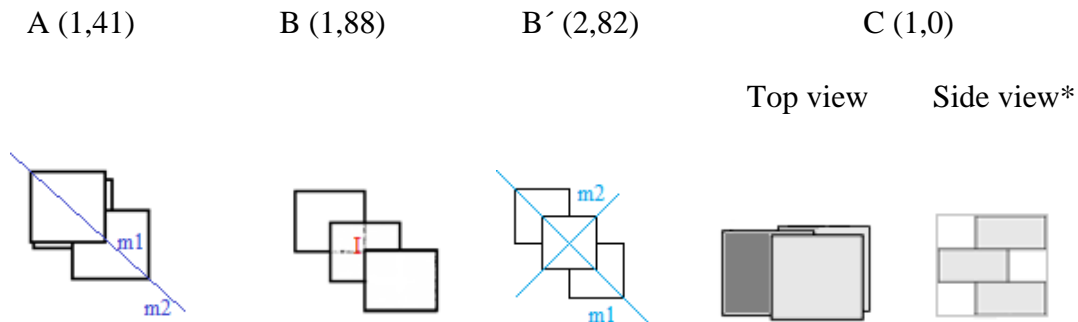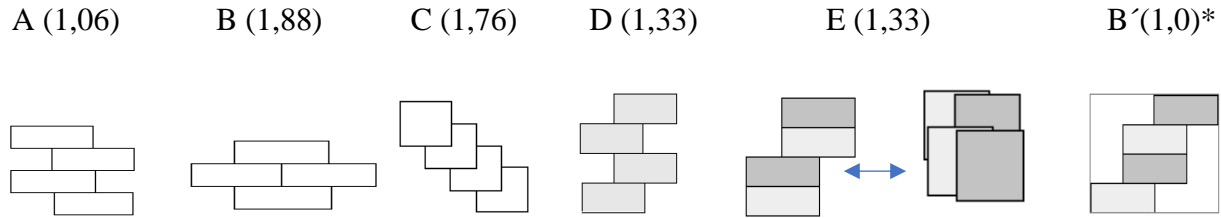
Calculation of the mass defects for the isomers shown above

4He4 + tT4   **227,51 A**
4He4 + 2T   232,0   B
4He4 + 3D   213,66 C
4He4 + 2tT4   253,26 D
4He + tT4 + 2D   235,44 E

Mean value   227.51 (A)
Measured value   227.51
Δm_{rel} $< 10^{-5}$

Both C12 (Fig.15 C) and O16 (Fig.16 B') have edge-linked structural isomers with optimal geometry ($f_g = 1$) and high mass balance, which should definitely be taken into account when realizing these isotopes according to our criteria developed above. As the comparison with the measured values shows, this is not the case. The further calculations showed that **edge-linked structures** are not realized for isotopes below 7 to 8 He4 units (also depending on the number of neutrons) **- for whatever reason -** i.e. they are obviously not stable. They are therefore no longer considered in the following isotopes in this section. For significantly larger masses, however, they are then absolutely necessary in order to obtain any agreement at all between calculated and measured mass defects. **This is another important point that needs to be clarified in future work.**

The agreement between calculated and measured values for C12 is only moderately good compared to results for other isotopes such as O16. It is possible that a smaller proportion (approx. 22%) of the form B is present in addition to A, but this is highly speculative. A precise mass spectrometric investigation of the substructure of the isotopes would be useful and of essential importance here.
In the case of O16, on the other hand, the agreement between the calculated and measured mass balance is impressively good.

Structural isomers of Ne20

A (1.17)   B (1.41)   C (1.88)   D (2.82)   D' (1.69)

Fig. 22 Schematic representation of the structural isomers of Ne20

Calculation of the mass defects for the isomers shown above

5He4 + tT5	**286,60**	**A**
5He4 + T + 2D	275,25	B
5He4 + 2T	282,44	C
5He4 +4D	268,10	D / D´

Mean val	286,60 (A)
Measured value	286,37
Δm_{rel}	8,1 10^{-4}

Structural isomers of Mg24

A (1,41)   **B (1,13)**   **C (1,13)**   D (1,76)   E/E´ (2,35/2,82)

E´

Fig. 23 Schematic representation of the relevant structural isomers of Mg24

Calculation of the mass defects for the isomers shown above

6He4 + tT6	343,56	A
6 He4 + 2tT4	**354,15**	**B**
6 He4 + tT5 + T	**352,25**	**C**
6He4 + tT4 + 2T	358,62	D
6 He + 3 T	348,00	E
6He +2T + 2D	340,81	E´

Mean value	**353,20 (B/C)**
Measured value	353,42
Δm_{rel}	6,2 10^{-4}

Structural isomers of Si28

*A (1,65)   B (1,24)   **C (1,13)**   D (1,41)
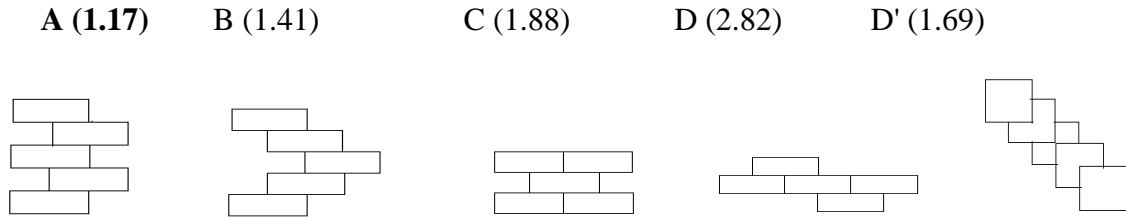

E (1,13)   F(1,69)   G (2,82)

Fig. 24 Schematic representation of the relevant structural isomers of Si28

Calculation of the mass defects for the isomers shown above

7He4 + tT7	397,60	A
7He4 + 2tT4	404,58	B
7He + 2tT5	**421,88**	**C**
7He4 + T + 4D	384,06	D
7He4 + tT5 + 2D	395,31	E
7He + 2T + 2D	391,25	F
7He4 + 4T	413,56	G

Mean value	421,88 **(C)**
Measured value	421,67
Δm_{rel}	$5,0 \; 10^{-4}$

Structural isomers of S32

A (1.88)   B (1.23)   C (1.01)   D (1.13)

By moving the units marked with arrows, further isomers can be constructed, which, however, are energetically in the same range as A and therefore do not make any new contribution to the overall view.

E (1.41)   F (1.69)   G (1.69)   H (2.82)
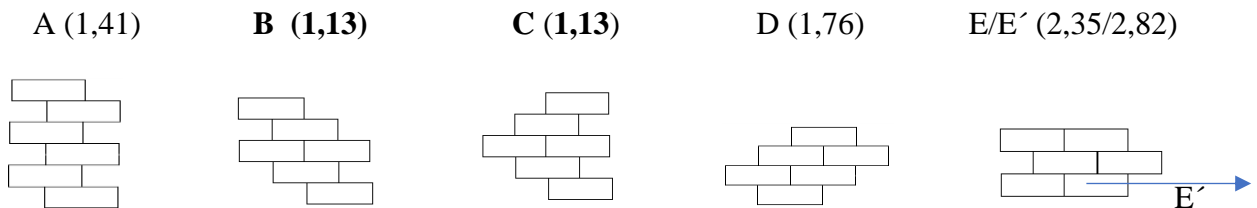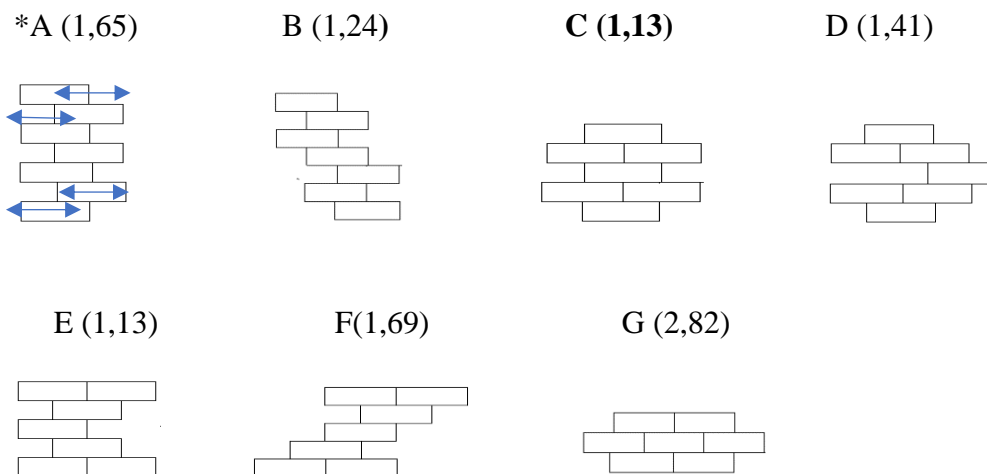

Fig.25 Schematic representation of the relevant structural isomers of S32

Calculation of the mass defects for the isomers shown above

8 He4 + tT8	450.0	A
8 He4 + tT7 + T	463,21	B
8 He4 + tT5 +T + 2 D	460,87	C
8He4 + 2 tT5	**473,12**	**D**
8 He4 +2 tT5 + T	**488,24**	**E**
8He4 + 2tT4 + 2T	**485,26**	**F**
8He4 +2tT4 + 2D	462,95	G
8He4 + 4T	464,00	H

Mean value	482,21 **(D/E/F)**
Measured value	483,49
Δm_{rel}	2,7 10

Structural isomers of Ar36

A/A' (1.69)   B (1.23)

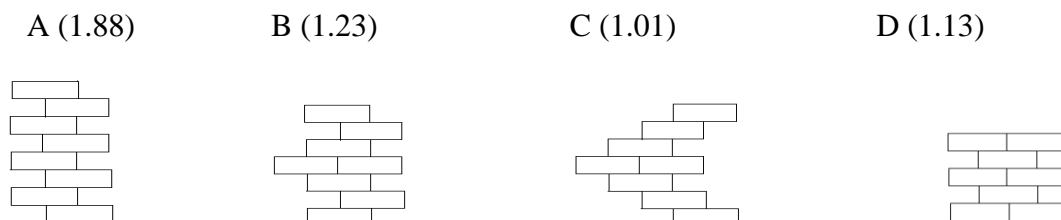
Fig. 26 Schematic representation of the relevant structural isomers of Ar36

Calculation of the mass defects for the isomers shown above

9He4 + 2tT5 + 2T	553.0	A (mirror symmetrical)
9He4 + 2tT4 + 2T	535.7	A' (centrosymmetrical)
9He4 +2 tT6	535.8	B (centrosymmetrical)

Mean value	544.35 (A/A')
Mean value	544.4 (A/B)
Mean value	541.0 (A/A'B)
Measured value	546.77
Δm_{rel}	4.4 10^{-3}

Structural isomers of Ca40
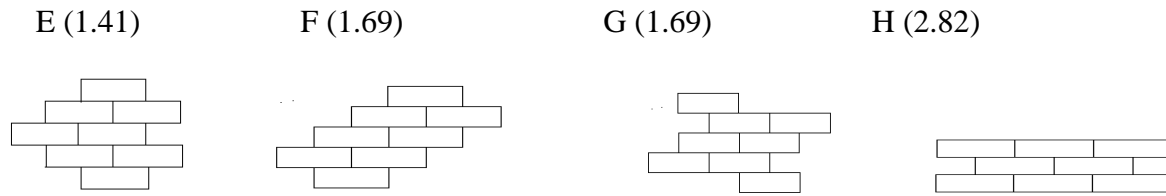
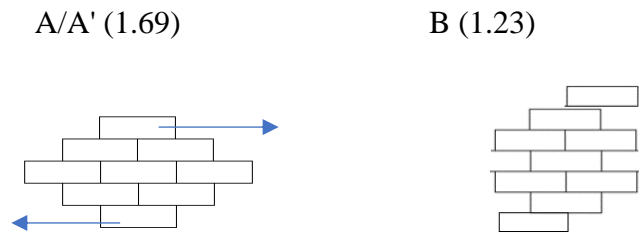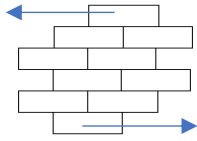A/A/(1.17)   B (2.47)
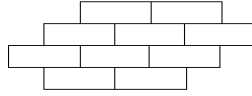
Fig. 27 Schematic representation of the relevant structural isomers of Ca40

Calculation of the mass defects for the isomers shown above

10He4 + tT6 + 2tT5   614.92 A (point-symmetrical)
10He4 + 2tT5 + tT4   598.95 A' (point-symmetrical)
10He4 + 3tT4 + 2T   611.83 B (point-symmetrical)

Mean value   608.57 (A/A'/B)
Measured value   609.77
Δm_{rel} 1.9 10^{-3}

3. Structural isomers: a new substructure of the elements

At this point, we would like to note the remarkable fact that a new substructure appears in our new atomic model.
This results in the following simple system for the nuclides:

Nuclide   Substructure

Element   Isotopes (Z const)

Isotope   Structural Isomers (Z and N const)
                 (isomeric structure variants)

These structural isomers are responsible for the exact mass or mass loss of the isotopes compared to the sum of their basic building blocks.
Important criteria for the preferred occurrence of individual structural variants were

  a) Stability (loss of mass compared to the individual components) *
  b) Compactness (as explained above, measured by the geometric factor f $_g$)

  *A_I = Mass of isotope (NIST)   N= number of neutrons   Z= number of Protons or Elektrons
  $\Delta m = Z \times m_e + Z \times m_P + N \times m_N - A_i$

22

The criteria mentioned are completely sufficient for some nuclei. In the case of Ne20 and Si28, for example, only the two isomers with by far the greatest compactness and greatest stability are realized and lead to excellent agreement with the measured values. The situation is less clear for most isotopes. As demonstrated above with the example of Ar36 (see above), we do not obtain a satisfactory result for any of their combinations, assuming equal proportions of the A, A' and B variants. If, for example, we only take A and B, we obtain the correct measurement result with a proportion of 2/3 A and 1/3 B. This gives us a similarly arbitrary percentage composition as we know from the isotopic composition of the elements and which is listed for Ni in the following table. This element makes it particularly clear that there is obviously no significant correlation between abundance and stability of the respective isotope. It is known that the isotopic composition of some elements even varies depending on their geographical origin.

Isotopes	$\Delta m/N$	stability-ranking	share %	ranking
Ni58	15,5664625	5	68	1
Ni60	15,6533176	2	26	2
Ni61	15,6252342	4	1,2	4
Ni62	15,6778698	1	3,6	3
Ni64	15,6474129	3	0,9	5

In contrast, the correlation between stability and the quantitative presence of a structural isomer appears to be more likely for the substructure of the isotopes. However, the qualitative analysis carried out above is not sufficient to precisely calculate more complex mixtures, whereby the exact influence of the energetic ratios would have to be determined and, above all, the very rough geometric factor f_g would have to be replaced by a precise calculation of the moments of inertia for the three axes of rotation. So far, however, there is no plausible model for calculating the amount of an isomer, so that an important prerequisite for calculating the exact mass balances of the Isotopes missing.

As a consequence of the findings of this work, it would therefore be an urgent experimental task to find these substructures experimentally, which occur frequently in the isotopes with even mass numbers but much less frequently in the isotopes with odd mass numbers, in order to obtain reliable facts for a calculation formula, but also as an "Experimentum Crucis" to verify the nuclear structure model presented here and thus also to verify the entire projection theory.

The absolute mass differences between the structural isomers are generally 2 - 20 10^{-30} kg, i.e. a mass spectrometer with a resolution 100 - 1000 times higher than that required for isotope separation ($\Delta m \sim x \cdot 1.6 \ 10^{-27}$) is required for detection. In our opinion, the following isotopes with the following structural isomers and their respective masses would be particularly suitable for an initial investigation:

Structural isomers (atomic weight x10^{-27} kg)

*Oα18   29.902097
Oβ18   29.886357
Oγ18   29.884277
Oδ18   29,879787

Sα34   56,409619
Sβ34   56,400599

Niα58   96.218584
Niβ58   96.216545
Niγ58   96.177475

Table 4 Structural isomers of O, S and Ni

Isomers are already known in nuclear physics as metastable excited states in decay processes. The extent to which these are consistent with the isomer concept developed here remains the subject of further research.

All atomic nuclei with at least four nucleons can exist in excited states as well as in the ground state. These normally have very short lifetimes of 10^{-22} to 10^{-14} seconds, which are measured via the line width of the emitted radiation (e.g. gamma radiation). Isomers are longer-lived (metastable) excited states with lifetimes from around 10^{-9} seconds. These longer lifetimes are due to the fact that transitions to lower states are not impossible, but are orders of magnitude less likely than under normal conditions [6]
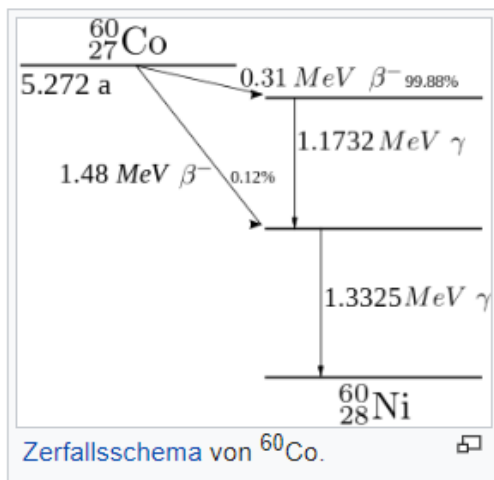

Fig. 28 Decay diagram of Co60

The structural isomers are labeled with lower-case Greek letters in this work. To avoid confusion with the crystal modifications of the respective elements, these are placed between the element symbol and the atomic mass.

24

IV The isotopes with odd mass numbers

1. General Remarks

As the continuous white line in Fig. 29 shows, the odd-mass nuclei derived from N15 by adding further nucleon pairs form the backbone of the stable nuclides on the map shown below. The vertical steps each show the incorporation of an isotope. It is immediately apparent how important the occasional incorporation of isotopes is, as in the case of Cu63/Cu65, for example, as otherwise a linear continuation of the series would quickly lead to a region of unstable nuclides (see yellow line in Fig. 29 right).

The first three members of this series have already been discussed in detail. The F19 can then be described as a 3^3 -cube with missing corner stones, which has 30 internal faces (IF) and 10 neutrons (N) and therefore no free charge.

$Q_f = 10 N \times 3/3e - 30 IF \times 1/3e = 0$

Fig. 29 Nuclide map of isotopes up to Zr
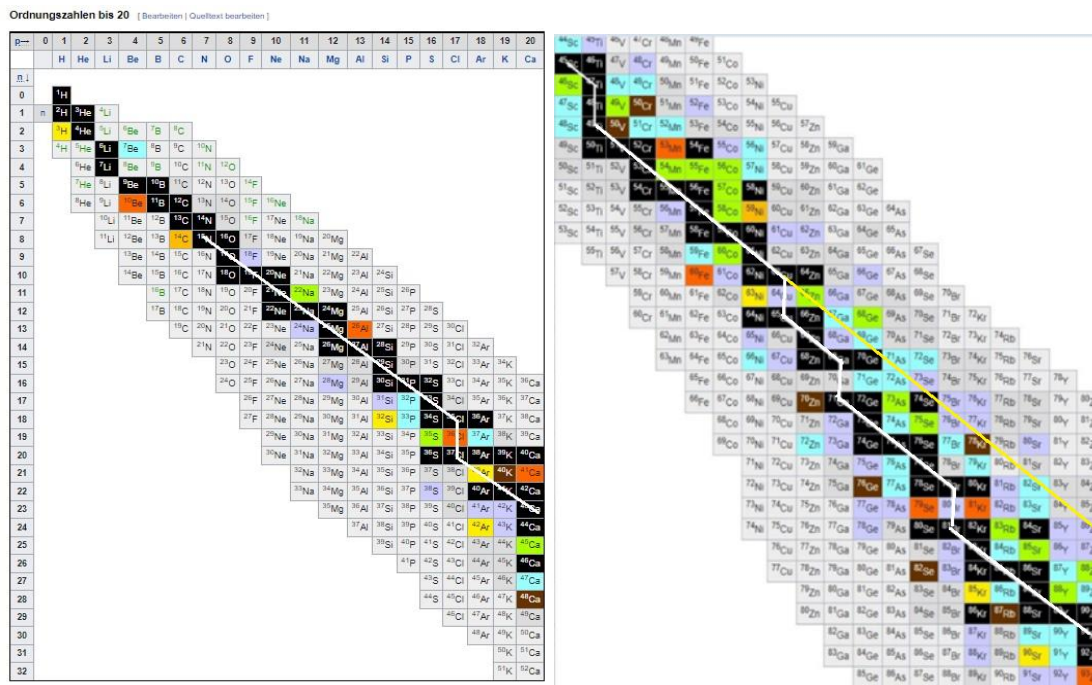
The free charge Q_f is of enormous importance for the following considerations. It can never be less than 0, because then the neutron rule would be violated and thus unstable structures would arise. For the following steps, it should be noted that adding an N/P pair or N/N pair to the surface of the cube produces an excess charge of 1/3 or 4/3, respectively, while inserting an N/P

pair into the corner positions requires an excess charge of 3/3e. Since there is no excess free charge in the initial position described above and three inner surfaces are created when filling a corner position, we can only occupy these with neutrons or, in other words, we could only produce neutron-rich fluorine isotopes at this point, but no new elements. The path to new elements, which is schematically shown in Figures 30-32, must therefore be different.

2. Deviation of isotopes with odd mass number from F19

a) Determination of a homologous series

If it is assumed that a homologous series is to be expected from a certain isotope (base isotope), i.e. a series that is created by the multiple addition of the same structural element, this can be easily checked using the procedure described below.

F19	263,78	n		Base isotope
Ne21	297,92	1	34,95	
Na23	332,36	2	34,55	
Mg25	366,79	3	34,34	
Al27	401,24	4	34,38	
Si29	435,68	5	34,51	
P31	469,34	6	34,2	
			34,49	Mean value
Table 5			0,24	Standard Deviation

The mass difference of the base isotope (here F19) is subtracted from the mass differences of the subsequent isotopes and divided by the number of expected structural elements n.
In this case, the result confirms our assumption of a homologous series, with the mean mass difference indicating the structural element tT5 with a theoretical mass of 34.8 (see Table 1).

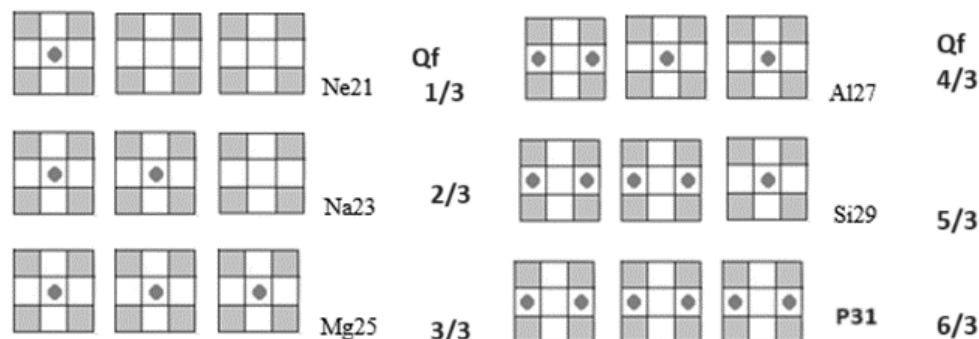b) Schematic representation and calculation of the mass defects for Ne21 to P31

Fig. 30 The dark gray squares represent the unoccupied corner points and the light areas the surface of the 3^3 cube. The dots correspond to the single nucleons (N/P) on three cube faces, whose respective mirror-symmetrical back sides are not shown.

First, the central points of the cube surface on the front and back sides are assigned N/P pairs, whereby the tT5 units, which have already been calculated, arise in the connecting line between these nucleons (s. Fig. 30 left side) Then, for reasons of symmetry, the central units have to be split and move to the outer edges. In this way, we can generate six new elements and arrive at P31 (see Fig. 30 right side).

Isotope	model	Δm according to model	Δm measured	$\Delta\ m_{abs}$	Q_f	Δ_{rel}
F19	N15+2T2He3	263,78	263,47	0,31	0	0,001176605
Ne21	F19+1tT5	297,85	298,42	-0,561	1/3	0,001879901
Na23	F19+2tT5	332,24	332,58	-0,332	2/3	0,000998256
Mg25	F19+3tT5	366,63	366,49	0,147	3/3	0,000401102
Al27	F19 + 4tT5	401,02	401,01	0,016	4/3	3,98993E-05
Si29	F19 + 5tT5	435,41	436,05	-0,635	5/3	0,001456255
P31	F19 + 6tT5	469,80	468,7	1,104	6/3	0,002355451

Table 6

c) Schematic representation and calculation of the mass defects for S33 to Sc45

However, it is no longer possible to occupy the centers of the surfaces to continue the elementary series, as occupying these positions, just as with the corner positions, creates three inner surfaces that can only be occupied by neutrons. This means that the direct path to a further occupation of the cube surface up to a quadruple occupation of each surface is also not possible.
However, according to the equation below, we have generated a free charge of 6/3e via the 6 elements generated so far.

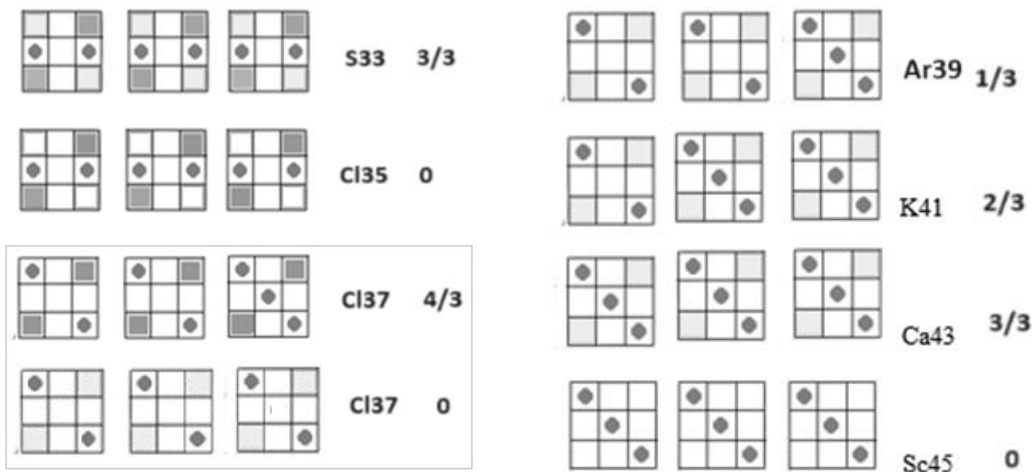$Q_f = 1\ N\ 3/3e - 2\ IF\ 1/3e = 1/3\ F \qquad x6 \rightarrow 6/3\ Q_f$

Fig. 31 The light gray areas represent the half-occupied corner positions.

In the first step, we can now insert an N and P at two corners connected by the spatial diagonal (point symmetry) and, in a second step, fill the positions above and below with nucleons so that we have completely occupied four corner points. However, each of the two actions consumes 3/3e, so that after occupying the four corner points, i.e. when Cl35 is reached, the surplus charge of 6/3e generated above is completely used up. Since we are adding an isotope with Cl37, we now have two equally valid options for continuing the series. Either we place the two neutrons on the central position of the cube and generate an excess charge of 4/3e- or we fill up two corner positions, whereby the charge 0 of Cl35 is retained. Starting from alternative 1, two corner positions and from option 2 two central position are now filled. The result is identical for Ar39 in both cases.

Adding further nucleons to the surface of the cube at K41 and Ca43 results in a free charge of 3/3 e-, so that in the next step we can also occupy the last two corner positions and finally arrive at Sc45 with $Q_f = 0$, which can also be described as a cube with the "number 3" on all sides (see Fig. 31).

S33	F19 +6tT5 + 2T	500,04	499,9	0,144	3/3	0,000287975
Cl35	F19 + 6tT5 + 4T	530,28	531,61	1,326	0	0,002500547
Cl37	F19 +6tT5 + 6T	564,67	565,29	0,617	0	0,001092668
Ar39	F19 + 7tT5 + 6T	594,91	595,31	0,397	1/3	0,000667324
K41	F19 + 8tT5 + 6T	629,30	626,82	2,482	2/3	0,003944052
Ca43	F19 + 9T5 + 6T	663,69	659,28	4,411	3/3	0,006646165
Sc45	F19 + 9tT5 +8T	693,93	691,41	2,521	0	0,003632926
				Mean relative error		**2,7 10^{-3}**

Table 7

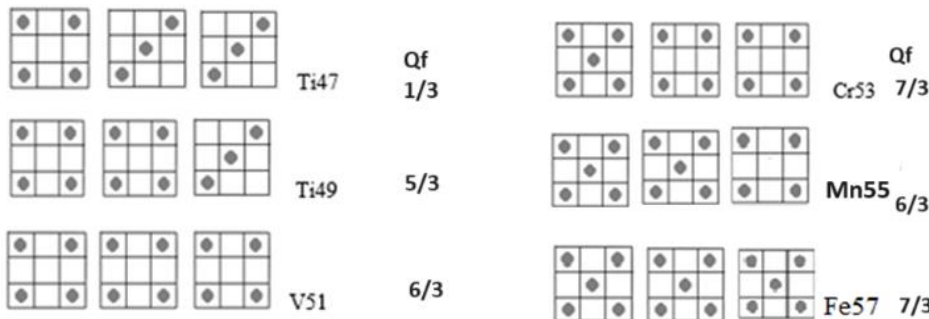d) Schematic representation and calculation of the mass defects for Ti47 to Fe57

Fig. 32

The series is now continued from Sc45 by adding nucleon pairs on the surface up to Fe57.

Ti47	Sc45 +1tT5	725,8	725,7	0,1	1/3	0,00013642
Ti49	Sc45 +2tT5	760,2	760,9	-0,7	5/3	0,000975123
V51	Sc45 +3tT5	794,6	794,8	-0,2	6/3	0,000280574
Cr53	Sc45 +4tT5	829,0	827,9	1,1	7/3	0,001287595
Mn55	Sc45 +5tT5	863,4	859,4	4,0	8/3	0,000202472
Fe57	Sc45 +6tT5	897,8	891,2	6,6	9/3	0,002726752
Table 8						**9,3 10-4**

However, the high absolute errors for Mn and Fe (see Table 8) suggest that the series is not as simple as shown above. In the case of Mn55, instead of the central position C (see Fig. 33), the position E between the nucleons standing on the surface is obviously filled, resulting in an angled T-unit. This process must of course be repeated on the opposite side to maintain point symmetry. In the case of Feβ57, point C is then occupied again in continuation of the previous series. However, it is also possible to occupy another angular position starting from Mnβ55, which leads to Feγ57.

Mnα55	Sc45 +5tT5	863,4
Mnβ55	Sc45 +4tT5+ 2T	859,1
	Measured value	859,4

Feα57	Sc45 +6tT5	897,8	
Feβ57	Sc45 +5tT5 +2T	893,6	6/3
Feγ57	Sc45 +4tT5 +4T	889,5	
Fe57	Mean value β/γ	891,5	
	Measured value	891,2	

For Mn, only the β version seems to be realized, for Fe the β and γ version. If both of these are included in the calculation with equal weighting, the result is excellent agreement with the measured value.
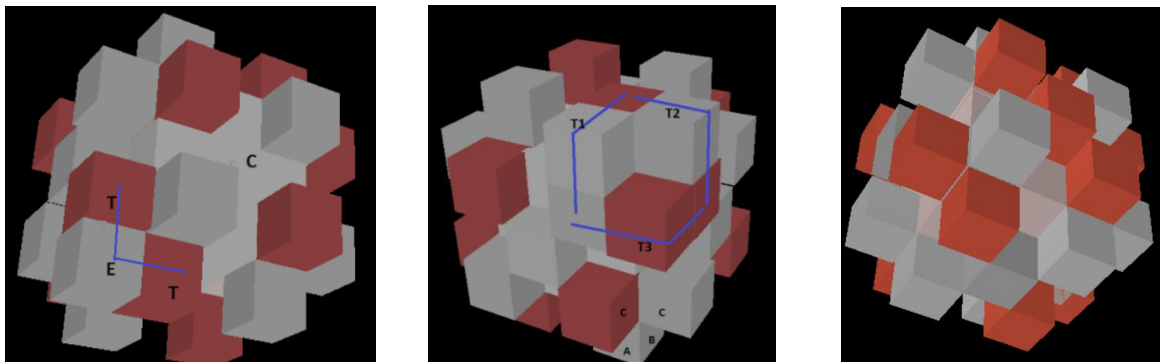

Fig. 33 3D representation of the Mn55   34 3D representation of the Ni61   35 3D representation of the Feα57

Although the Feα57 is surprisingly (probably) not realized according to the above explanations, it was included in the above image gallery because of its highly symmetrical aesthetics.
For the following isotopes, we start from Feβ57 by filling all possible angular positions, i.e., 8 x 3 positions. We have to take into account that two of these positions are already occupied in Feβ57, so that we have to add 2 to the number of T-units listed in Table 9 (+2). We therefore have a total of 6 T-units at Ni61, 3 of which are shown in Fig. 34, and the remaining 3 are located centrosymmetric on the (invisible) opposite corner position. After 11 isotopes, i.e. at Br79, we have occupied all angular positions.

e) Calculation of the mass defects for Co59 to M097

Isotop	Construction model	Δm cal	Δm me	Δ m rel x10-3	Q_f
Co59	Fe57 + 2T (+2)	921,63	922,07	0,5	6/3
Ni61	Fe57 + 4T	952,09	953,14	1,1	5/3
Cu63	Fe57 + 6T	982,55	982,94	0,4	4/3
Cu65	Fe57 + 8T	1013,01	1014,42	1,3	6/3
Zn67	Fe57 + 10T	1043,47	1043,21	0,25	5/3
Ga69	Fe57 + 12T	1073,93	1073,17	0,7	4/3
Ga71	Fe57 + 14T	1104,39	1103,39	0,9	6/3
Ge73	Fe57 + 16T	1134,85	1132,84	1,7	5/3
As75	Fe57 + 18T	1165,31	1163,32	1,7	4/3
Se77	Fe57 + 20T	1195,77	1193,48	1,9	3/3
Br79	Fe57 + 22T	1226,23	1223,49	2,2	2/3
Br81	Fe57 + 22T +2Tl	1256,47	1255,66	0,65	6/3
Kr83	Fe57+ 22T +4Tl	1286,71	1286,66	0,04	7/3
Rb85	Fe57 + 22T +6Tl	1316,95	1317,99	0,79	8/3
Sr87	Fe57 + tT5+22T + 6Tl	1351,35	1350,99	0,27	9/3
Y89	Fe57 + tT5+22T + 8Tl	1381,59	1382,55	0,69	10/3
Zr91	Y89 + 2TE	1409,09	1410,27	0,83	7/31
Nb93	Y89 + 4TE	1436,59	1436,43	0,11	4/3
M095	Y89 + 6TE	1464,09	1464,7	0,42	1/3
M097	Y89 + 8TE	1491,59	1493,18	1,06	1/3

Table 9   Mean value   0,88

Isotop	$\Delta m\ n_2 - n_1$	Struktur
Br81	32,16	2Tl
Kr83	31,33	2Tl
Rb85	31,49	2Tl
Sr87	33,41	tT5
Y89	31,56	2Tl
Zr91	27,72	2He3
Nb93	26,16	2He3
MO95	28,27	2He3
MO97	28,48	2He3
Mittelwert	27,66	27,52 theor. 2He3

Tabelle 10

Table 10 shows the mass differences between an isotope and its predecessor isotope from Br81 to Mo97. A clear tripartite division can be recognized. Four values at approx. 31.5, four at approx. 27.5 and a relatively high value of 33.4 for Sr87.

We therefore assume that the last central position (see Fig. 33 C) is occupied by Sr87, resulting in a tT5 unit (34.4).

We assign the values at 31.5 to two linear tritium units (30.24), which are formed by the docking of nucleons to the satellite cubes (see Fig. 35).

The last group, with a mean value of 27.66, corresponds quite exactly to 2 He3 units (27.52). We therefore assume that when the cornerstones of the satellite cubes are occupied, no T units but only He3 units can be formed and therefore assign the last four isotopes to this structural element.
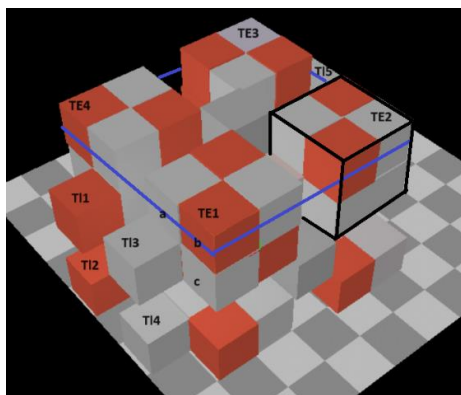

Fig. 36 3-D model of the Mo97

- The upper level framed in blue must be added below the floor level
- Fig. 36 shows only one of the possible arrangements for the Tl units. Tl3 can also be located at positions a, b or c. If you move Tl3 to position C, you immediately recognize that it is a linear tritium unit.
- This model is provisional

V The isotopes from D to Ca40

1. Table of isotopes D to Ca40

Isotope	structure model	Mass defect cal	ref. 7	$\Delta\ m_{rel}\ x10^{-3}$
D			3,965	
T			15,12	
He3			13,758	
He4			50,44	
Li6*	He4 +2D	57,01	57,03	0,4
Li7			69,96	
Be9			103,68	
B10***		116,18	115,42	
B11**	2He+tT5	135,68	135,85	1,70
C12	3He+1/2T+1/2He3	165,76	164,29	8,95
C13*	Be9+Li7	173,64	173,11	3,06
N14	3He+tT5	186,12	186,57	2,41
N15	2Be9	207,36	205,99	6,65
O16	4He4+tT4	227,51	227,51	0,00
O17	N15+He3+T	234,89	234,88	0,04
O18***		249,4	249,25	0,60
F19	N15+2He3+2T	263,78	263,47	1,18
Ne20	5He4+tT5	286,69	286,37	1,12
Ne21	F19+tT5	297,92	298,42	1,68
Ne22***		317,71	316,91	2,50
Na23	F19+2tT5	332,27	332,58	0,93
Mg24	6He+2tT4	354,12	353,42	1,98
Mg25	F19+3tT5	366,79	366,49	0,82
Mg26***		385,87	386,26	1,01
Al27	F19+4tT5	401,24	401,01	0,57
Si28	7He+2tT5	421,96	421,66	0,71
Si29	F19+5tT5	435,68	436,05	0,85
Si30	7He+3tT5	456,58	455,68	1,98
P31	F19+6tT5	469,34	468,67	1,43
S32***		482,26	483,49	2,55
S33	F19+6tT5+2T	500,35	499,89	0,92
S34****		520,11	520,25	0,27
Cl35	F19+6tT5+4T	530,59	531,61	1,92
Ar36***		544,75	546,77	3,67
Cl37	F19+7tT5+4T	565,08	565,28	0,35
Ar38****		583,30	583,55	0,42
K39	F19 + 7tT5 6T	594,37	594,92	0,92
Ca40***		608,57	609,77	1,97
				2,0 *10-3

Table 11

- All isotopes shown in red are derived from the He4
- all isotopes shown in blue from the Be9 and
- the isotope shown in green is derived from Li7 as the basic building block
- all isotopes highlighted in yellow consist exclusively of He4 units (α particles)
- In addition to the linear structural elements listed in Table 1, all the elements shown in black are the basic structural elements from which this system is built.

* With the same number of inner surfaces, T has 3/3 e more freely available charge Q compared to He3 due to the additional neutron, which leads to an increased mass loss (stability gain) of 1.368. This effect must also be taken into account for other small nuclei, such as the Li6.

We have mentally divided the Li6 into one He4 and two D units, which have a total excess charge of 6/3 e- . The Li6 itself only has an excess charge of 3/3e- (3 neutrons - 6 inner surfaces → 9/3-6/3), i.e. we have the same difference in Q_f as for T and He3, from which one could conclude that this difference in stability could also play a role for the Li. If we correct our calculation in this sense, we obtain excellent agreement between the calculated and measured values.

$\Delta mLi6_{kor} = 58{,}37 - 1{,}368 = 57{,}01$ (ref 7: 57,03) $\Delta m_{rel} = 0{,}4 \cdot 10^{-3}$

However, this effect seams to play an increasingly smaller role with increasing overall size and thus the total number of neutrons in the nuclei.

** B11 occupies a special position. Like all other "odd" elements, it could be derived from Be9 in the form of two structural isomers with the mass balances $\Delta m = 118.8$ and (Be9+T) or $\Delta m = 111.6$ (Be9+2D), but this contradicts the actual mass balance of $\Delta m = 135.85$, which can only be reconciled with a structure consisting of He4 units. According to previous findings, B11 is therefore the only element with an odd mass number that can be structurally assigned to elements with even mass numbers.

*** If no structural model is given in the table, the isotopes are derived from two or more structural isomers. In these cases, the relevant models and further explanations of these isotopes can be found in the respective descriptive text passages

  **** The same applies to these isotopes as to those marked with three stars, with the difference that, as a novelty, edge-linked structural elements arise here.

* Li7 and C13 posed a problem for a long time. They could not be derived either structurally or energetically from the previously postulated basic building blocks. Only the assumption that Li7 has its own basic structure (see Fig. 10c), which can be understood as a defective Be9 structure, and which therefore also lies energetically between the very stable ring structures and the less stable linear structures, was expedient. This new basic element also solved the C13 problem, because just as two Be9 units can be

"fused" together to form N15, a Be9 and a Li7 unit can be linked via a common bridge proton or neutron and the central neutron.

Be9 + Li7 = 9N + 7P   separated
Be9 + Li7 = 9-2N+7-1P = 7N +6P = C13   linked

As the table shows, the agreement between the measured and calculated mass defect for C13 is excellent, so that these two "problem elements" ultimately also fit very well into the overall concept presented here.

2. Structure and mass defects of the previously undiscussed isotopes from Table 11 (B10, B11, Ne22, Mg26, Si30, S34, Ar38)

Structural isomers of B10

A(1.41)/A'(2.83)   B (1.33)

Fig. 37 Schematic representation of the structural isomers of B10

Calculation of the mass defects for the isomers shown above

2He+3D   112.7 A /A'
2He +tT4   126.6 B

Mean value: 117.3 (A/A'/B)
Measured value: 115.42 B10
Δm_{rel} 6.5 10^{-3}

In fact, we assume that A' is not realized at all due to its unfavorable geometry and that the components A and B are present in a ratio of 4:1. However, as this is quite speculative, B10 is not included in the error statistics.
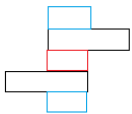
Structural isomer of B11 (see notes above under **)

Fig. 38 Schematic representation of the structural isomer of B11

Calculation of the mass defect for the isomer shown above

2He+tT5   135.62

Measured value :   135.85
Δm_{rel} $1.7 \cdot 10^{-3}$

Structural isomers of O18

A (1.41)   A'(1.41)   B (1.06)   C (1.06)

D (1.13)   E (1.13)   F (1.88)   G (1.88)
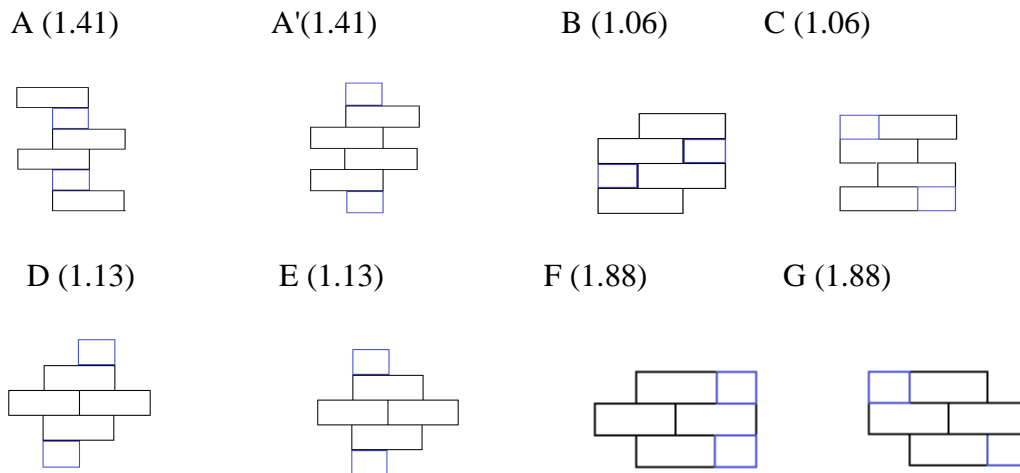
Fig. 39 Schematic representation of the corner-linked structural isomers
of O18

Calculation of the mass defects for the isomers shown above

4He4 + tT6	242,68	A / A´
4He4 + tT4 + 2 T	**257,75**	**B**
4He4 + tT4 + 2D	**235,44**	**C**
4He4 + 2tT4	**253,26**	**D**
4He4 + tT5 + T	**251,18**	**E**
4He4 + 3T	247,12	F
4He4 + 2t + 2D	239,93	G

Mean value   249.40 B/C/D/E
Measured value   249.25
Δm_{rel} $0.6 \cdot 10^{-3}$

Structural isomers of Ne22

The mass balance of Ne22 can be derived very simply from the two structural isomers A and C
used for the calculation of Ne20,

A   C

Fig. 40 Schematic representation of the corner-linked structural isomers of Ne20

by filling the gaps marked with arrows above with neutrons. The following constellations are obtained:

5He4 +2 tT5	321.0 A
5He4 +4T	312.68 C

Mean value	316.84 A/C
Measured value	316.91
Δm_{rel}	0.22 10^{-3}

As the comparison of mean value and measured value shows, the two structural isomers are obviously present in a 1:1 ratio

Structural isomers of Mg26

The mass balance of Mg26 can be derived very simply from the two structural isomers B and C used for the calculation of Mg24,

B (1.13) C (1.13)

Fig. 41   2 Structural isomers of Mg24

by filling the gaps marked with arrows above with neutrons. The following constellations are obtained:

6He4 + 2tT4 + 2T	384.38 B
6He4 + 2tT5 + T	387.36 C

Mean value	385.87 (B/C)
Measured value	386.26
Δm_{rel}	1.0 10^{-3}

Structural isomer of Si30

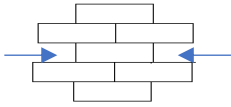The structure and mass balance of Si 30 can be easily derived from the structure C of Si28,

Fig. 42 Structural isomer of Si28

by inserting the two neutrons into the gaps marked with arrows.
The following constellation is obtained:

7He4 + 2tT5 + 2T   452.92

Measured value   455.68
Δm_{rel} $6.0 \, 10^{-3}$

In this case, the error is quite high, presumably because there maybe one more isomer that is already edge-linked (see below).

Structural isomers of S34

From this isotope onwards, the observed mass defects for the nuclides from He units +2 neutrons discussed here can only be calculated using structural elements linked via edges. For the structures with 2n He units, the structure is derived from the basic structure shown in Fig. 43a.
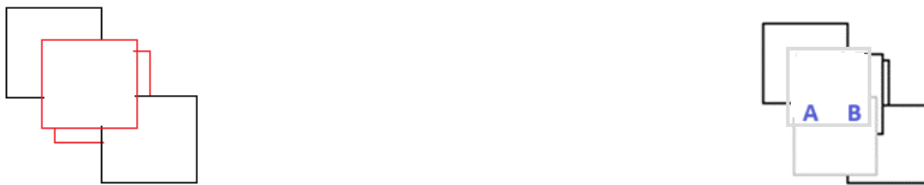
Fig. 43 a) Basic unit linked via corners b) Supplement linked via edges

The addition linked via edges must be continued on the opposite side (under the paper plane) in such a way that a centrosymmetric structure is formed. The additional neutrons can be placed at positions A/A' or B/B' (A'/B' below the paper plane), resulting in the structural isomers listed below, which are obviously present in equal amounts, as the comparison with the measured value shows.

8He4 + 2tT6 + 2T   515.60 B
8He4 + 2tT5 + 2tT4   524.62 A

Mean value   520.11 (A/B)
Measured value   520.25
Δm_{rel} $0.3 \cdot 10^{-3}$

Structural isomers of Ar38

In the structures with 2n+1 He units, the structure is derived from the corner-linked basic structure shown in Fig. 40a.

Fig. 44 a) Basic unit linked via corners b) Supplement linked via edges

Moving the upper three layers (light grey) to the lower edge of the basic structure results in two further structures, the most stable of which appears to have been realized.

9He + 2tT6 + 2tT4   587,3   A
9He + 4tT5   591,56   B
9He + 2tT5 + 2tT4 +2D   582,19   C/C´
9He + 2tT5 + 2tT4   574,26   D

Mean value   583.5 A/B/C/C'/D
Measured value   583.55

However, it is still completely unclear why edge-linked structures are **not realized** in the smaller nuclei, but **are indispensable** for larger complex nuclei in order to be able to reproduce the high binding energies computationally.

VI Comparison of the droplet model according to Bethe/Weizsäcker with the concept of isomeric structural variants in this work
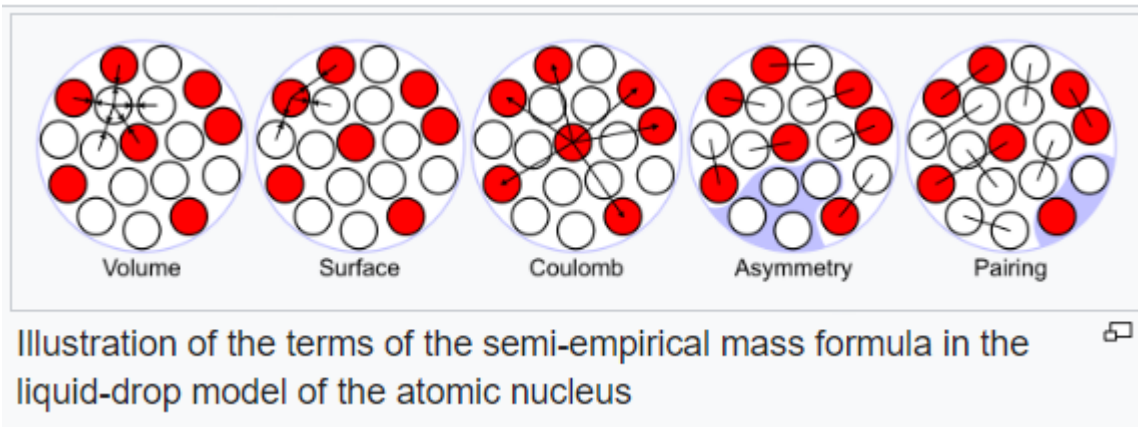
1. Basics of the droplet model

The droplet model will not be explained in detail here. For more information, please refer to the relevant specialist literature[2]. First of all, it should be noted that it is a semi-empirical mass formula, i.e. the values for the parameters a_V, a_S, a_C, a_A, a_P are determined experimentally by

adapting the mass formulas to the binding energies of at least five nuclei using a "least square" error calculation. Depending on the choice of these nuclei, the exact values in the literature vary. This is because the parameters were optimized for different mass ranges.

For our calculations, however, we only need the mass defects of the two smallest linear structures D and T, from which the higher linear homologs can be calculated using formula AK1, as well as the ring-stabilized structural elements He4 and Be9. The illustrations and parameters listed below for the calculations carried out in this section according to Bethe/Weizsäcker were taken from Wikipedia (German version / as of 6/24).

The total binding energy of an atomic nucleus consists of five contributions:

| Volume | Surface | Coulomb | Asymmetry | Pairing |

Illustration of the terms of the semi-empirical mass formula in the liquid-drop model of the atomic nucleus

$$E_{\mathrm{B}} = a_{\mathrm{V}} A - a_{\mathrm{S}} A^{2/3} - a_{\mathrm{C}} \frac{Z(Z-1)}{A^{1/3}} - a_{\mathrm{A}} \frac{(N-Z)^2}{A} \pm \delta(N, Z).$$

$$\delta(A, Z) = \begin{cases} +\delta_0 & \text{for even } Z, N \text{ (even } A), \\ 0 & \text{for odd } A, \\ -\delta_0 & \text{for odd } Z, N \text{ (even } A), \end{cases}$$

$a_{\mathrm{V}} \cdot A$ $\qquad\qquad\qquad a_{\mathrm{V}} \approx 15{,}67 \text{ MeV}$

$-a_{\mathrm{S}} \cdot A^{\frac{2}{3}}$ $\qquad\qquad\qquad a_{\mathrm{S}} \approx 17{,}23 \text{ MeV}$

$-a_{\mathrm{C}} \cdot Z \cdot (Z-1) \cdot A^{-\frac{1}{3}}$ $\qquad a_{\mathrm{C}} \approx 0{,}714 \text{ MeV}$

$-a_{\mathrm{A}} \cdot \dfrac{(N-Z)^2}{4A}$ $\qquad\qquad a_{\mathrm{A}} \approx 93{,}15 \text{ MeV}$

$\qquad\qquad\qquad\qquad\qquad a_{\mathrm{P}} \approx 11{,}2 \text{ MeV}$

2. Calculations of the binding energies in mass units for all elements with odd mass number from B11 to Mo97

	A	B	Δm abs	Δmrel x10-3	C	Δm abs	Δmrel x10-3
B11	135,85	140,06	4,21	30,99	135,68	-0,17	1,25
C13	173,11	173,81	0,7	4,04	173,64	0,53	3,06
N15	205,99	207,66	1,67	8,11	207,36	1,37	6,65
O17	234,88	241,54	6,66	28,35	234,89	0,01	0,04
F19	263,47	275,4	11,93	45,28	263,78	0,31	1,18
Ne21	298,42	309,2	10,78	36,12	297,79	-0,63	2,11
Na23	332,58	342,89	10,31	31,00	332,1	-0,48	1,44
Mg25	366,49	376,47	9,98	27,23	366,41	-0,08	0,22
Al27	401,01	409,9	8,89	22,17	400,72	-0,29	0,72
Si29	436,05	443,16	7,11	16,31	435,03	-1,02	2,34
P31	468,7	476,24	7,54	16,09	469,34	0,64	1,37
S33	499,9	509,13	9,23	18,46	499,58	-0,32	0,64
Cl35	531,61	541,81	10,2	19,19	529,82	-1,79	3,37
Cl37	565,29	578,29	13	23,00	564,13	-1,16	2,05
K39	594,92	606,53	11,61	19,52	594,37	-0,55	0,92
K41	626,82	644,49	17,67	28,19	628,68	1,86	2,97
Ca43	659,28	677,17	17,89	27,14	658,92	-0,36	0,55
Sc45	691,41	709,13	17,72	25,63	693,59	2,18	3,15
Ti47	725,7	742,38	16,68	22,98	727,9	2,2	3,03
Ti49	760,93	775,31	14,38	18,90	762,21	1,28	1,68
V51	794,8	807,9	13,1	16,48	796,52	1,72	2,16
Cr53	827,9	840,18	12,28	14,83	830,83	2,93	3,54
Mn55	859,38	872,14	12,76	14,85	865,14	5,76	6,70
Fe57	891,17	903,8	12,63	14,17	899,45	8,28	9,29
Co59	922,07	935,15	13,08	14,19	921,63	-0,44	0,48
Ni61	953,14	966,2	13,06	13,70	952,09	-1,05	1,10
Cu63	982,94	996,95	14,01	14,25	982,55	-0,39	0,40
Cu65	1014,42	1030,43	16,01	15,78	1013,01	-1,41	1,39
Zn67	1043,21	1061,5	18,29	17,53	1043,47	0,26	0,25
Ga69	1073,17	1092,24	19,07	17,77	1073,93	0,76	0,71
Ga71	1103,39	1123,01	19,62	17,78	1104,39	1	0,91
Ge73	1132,84	1154,08	21,24	18,75	1134,85	2,01	1,77
As75	1163,32	1184,8	21,48	18,46	1165,31	1,99	1,71
Se77	1193,48	1215,19	21,71	18,19	1195,77	2,29	1,92
Br79	1223,49	1245,25	21,76	17,79	1226,23	2,74	2,24
Br81	1255,66	1275,08	19,42	15,47	1256,69	1,03	0,82
Kr83	1286,66	1305,41	18,75	14,57	1287,38	0,72	0,56
Rb85	1317,99	1335,41	17,42	13,22	1319,11	1,12	0,85
Sr87	1350,12	1365,06	14,94	11,07	1350,83	0,71	0,53

Y89	1382,55	1394,94	12,39	8,96	1382,56	0,01	0,01
Zr91	1410,27	1423,96	13,69	9,71	1409,09	-1,18	0,84
Nb93	1436,43	1452,66	16,22	11,30	1436,59	0,16	0,11
M095	1464,7	1481,04	16,33	11,15	1464,09	-0,61	0,42
M097	1493,18	1511,83	18,65	12,49	1491,59	-1,59	1,06

Table 11		AV **ΔrelB**	18,66		AV Δrel **C**	1,78

A Mass defects calculated from isotope masses (NIST) and the underlying
nucleon masses
B Mass defects calculated using the droplet model (Bethe/Weizsäcker)
C Mass defects calculated using the model of structural isomeres

As can be seen from Table 11, the relative error in the calculation using the structure model is smaller overall by a factor of 10 than in the droplet model. In addition, our system shows an astonishingly high precision, especially in the lowest area of the nuclide chart, where the Bethe-Weizsäcker model is hardly applicable.
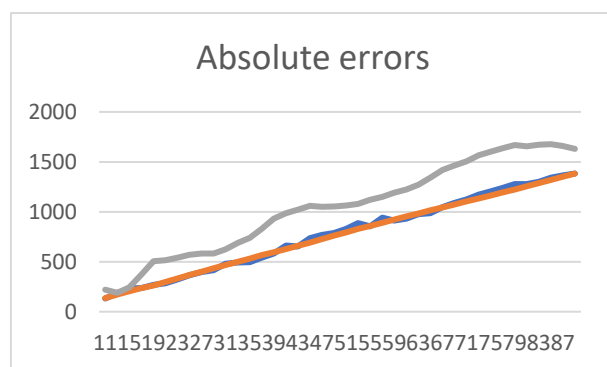

Fig. 37 Comparative illustration of the absolute errors (see text)

For a simple visualization, the absolute errors in the calculation of the mass defects of the isotopes with odd masses from B11 to Y89

    a) according to the droplet model (see Fig. 37 gray line) and
    b) using the method presented in this paper (see Fig. 37 blue line)

enlarged by **a factor of 20** and superimposed on the measurement curve (red line). The quality of both methods is immediately evident here without further explanation.
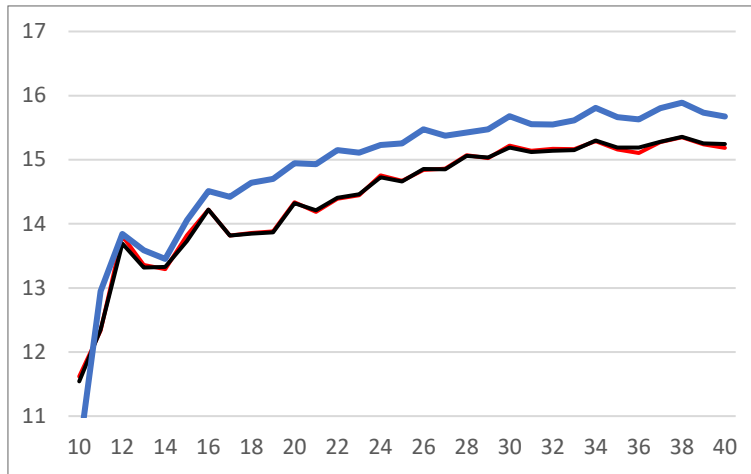
Fig. 38 Binding efficiency Δm/N of the isotopes from B10 to Ca40

blue: Bethe/Weizsäcker
black: from NIST values
red: our calculations

A comparative analysis of the binding efficiencies for the isotopes listed in Fig. 38 also shows excellent agreement with the theoretical curve for the method used here, while the calculations according to Bethe/Weizsäcker are clearly too high in wide areas and the peaks and troughs only follow the theoretical curve to some extent from Si28 onwards.

Only the elements with odd mass numbers were used for the comparison of the above methods, as the even isotopes form a large number of structural isomers with increasing atomic number (>40). As long as it is not known according to which criteria the exact proportions of the individual structural isomers are to be calculated, the calculation of the isotope mass from the random combination of numerous individual masses is quite arbitrary and unsuitable for a comparative evaluation

V Representation of hypothetical structural isomers for isotopes with odd mass numbers based on α-particles

In this section, we will examine whether isotopes with an odd mass number can also be constructed from He4 units and single nucleons.
In principle, it is difficult and at first glance seems almost impossible to add an unpaired number of single nucleons to constructs that are subject to double mirror image symmetry or point symmetry. However, there are actually two positions that allow the insertion of single nucleons.

However, a distinction must be made between the two fundamentally different constellations that have already played an important role in the construction of the structural isomers presented above, namely the constellation

1.) even or 2.) odd number of He4 units.

1. 2n He4 units n = 1,2,3....

As discussed in detail above, the structural isomers made up of an even number of He4 units are always centrosymmetric, which makes it possible to place a single nucleon in the center of symmetry, i.e. the inserted nucleon represents the center of symmetry (see Fig. 39 a and b). The additional nucleon now even makes it possible to convert the construct into a mirror-symmetric version (see Fig. c). Inserting an odd number of nucleons >1 is also no problem, since after inserting a nucleon in the center, the remaining even-numbered nucleons can be arranged in any mirror or centrosymmetric way (see Fig. d and e)
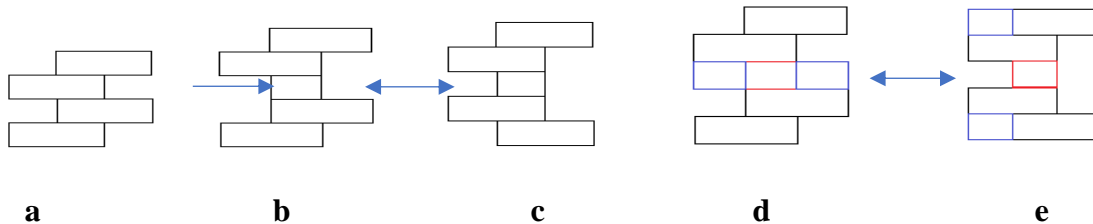

a   b   c   d   e

Fig. 39 Structure of structural isomers consisting of 4 He4 units and 1 or 3 single nucleons
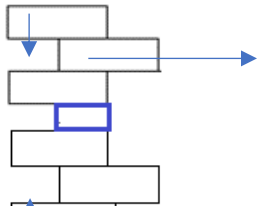
Examples

Hypothetical structural isomers of F19

A   B

Fig. 40

4 He4 + tT7	246.28 A
4 He + 3 T	244.08 B
*Be9 system	263.78
Measured value	263.47

This information refers to the calculation with Be9 as the base element, which was carried out above for all elements with an odd mass number from N15 to Mo97.

Hypothetical structural isomers of Mg25

A

C   B Fig.41

6 He + tT7   347.16 A
6 He + tT5 + 2D   344.97 B/C

* Be9 system   366.79
Measured value   366.49
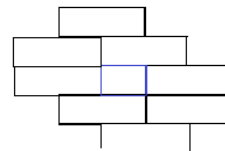
Hypothetical structural isomers of S33

A   B   C   D
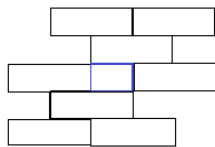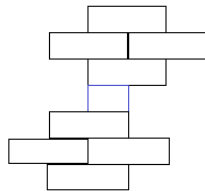

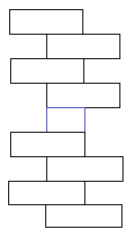Fig.42

8He + tT9   451.02 A
8He + tT7 + 2T   478.26 B
8He + tT5 + 2T   478.26 C
8He + tT5 + 2tT4   484.42 D

Be9 system   500.02
Measured value   499.98

44

1. 2n+1 He4 units n = 1,2,3 ....

In this constellation, the stacks are always in a mirror-symmetric form and it is not possible, as above, to convert a single nucleon into the center of a centrosymmetric construct. The only way to insert a single nucleon without violating symmetry is a position in which the nucleon lies on both mirror planes m1 and m2 (see Fig. a - c). However, this fixes the mirror symmetry. It can no longer be converted into a centrosymmetric configuration by adding further structural elements. Such a position does not exist in purely edge-linked structures, since a mirror plane always lies between the nucleons (see Fig. d)

Fig. 43 a   C13   b   c Ne21
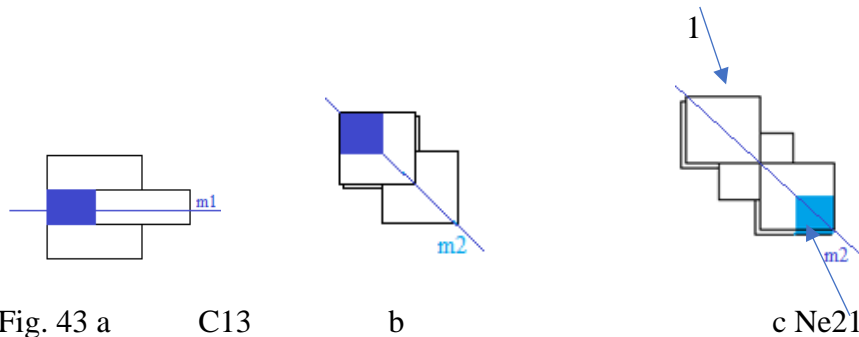
If, for example, an edge-linked He4 unit is added to position 1 below or position 2 above the plane of observation in the Ne21 shown in Fig. 43 c, all mirror symmetry is removed and centrosymmetric is established, although this is removed by the single neutron between the He4 units (blue square).

To summarize briefly, it can be said that the double mirror symmetry of a corner-linked basic structure is the prerequisite for the insertion of a single nucleon in this structure group and that this always changes to centrosymmetric when edge-linked He4 units are added, which in turn is incompatible with the extension by single nucleons. Since we have established in the previous sections that for the structure of larger nuclides from about 7 - 8 He4 units at least partial edge linkage is indispensable in order to be able to calculate even approximately correct mass balances with the constructed models, it can therefore be concluded from purely symmetry-theoretical considerations that a not inconsiderable proportion of unpaired isotopes **cannot be composed of He4 units**.

Nevertheless, a small selection of these isotopes will be checked for this statement below by calculating the mass balances of all its possible structural isomers.

Examples

Hypothetical structural isomer of C13

The hypothetical structure of C13 based on He4 is shown in Fig. 43 a and b.

Calculation of Δm for the isomer shown above

3 He + 2T   **181.56**

Be9/Li7 system   173.64
Measured value   173.11

Hypothetical structural isomers of N15

    A/A'   B Side view   B Top view
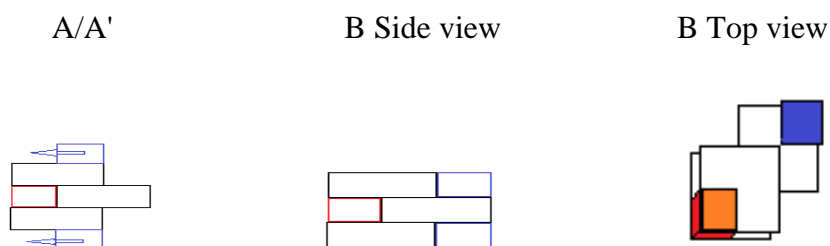
Fig. 44

3 He + tT5 + T   **200.74 A/A'**
3 He + 3 T   196.68 B

Be9 system   207.36
Measured value   206.0

Hypothetical structural isomers of the Ne21

          A   B

Fig. 45

5 He4 + tT5 + T   301.62 A
5 He + 3 T   297.56 B

Be9 system   297.92
Measured value   298.42
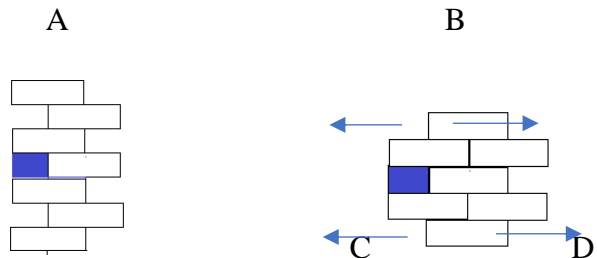
Hypothetical structural isomers of Si29

A   B

Fig.46

7He + tT7 +T	412.72	A
7He + 2tT5 +T	437.0	B
7He + tT5 +2T	417.72	C
7He +3T + 2D	406.37	D

Be9 system	436.05
Measured value	435.68

Hypothetical structural isomers of P31

A   B   C   D

B'   E   F

Base structure of B'/E/F
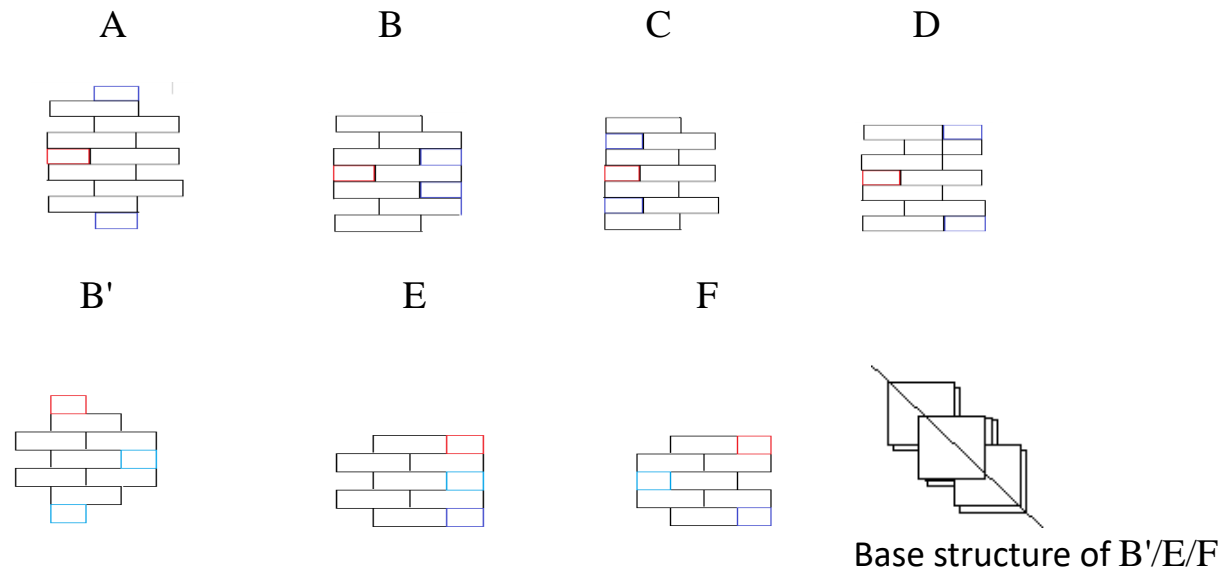
Fig.47

7 He + tT9 + T	415,7	A
7 He + tT7 + tT5 + T	447,07	B
7 He + 2 tT7	442,22	C

7 He + tT7 + T + 2 D	420,7	D
7 He4 + tT7 + tT5 + T	447,07	B´
7 He4 + 3 tT5	**457,48**	**E**
7 He4 + 2 tT5 +T + 2 D	444,78	F

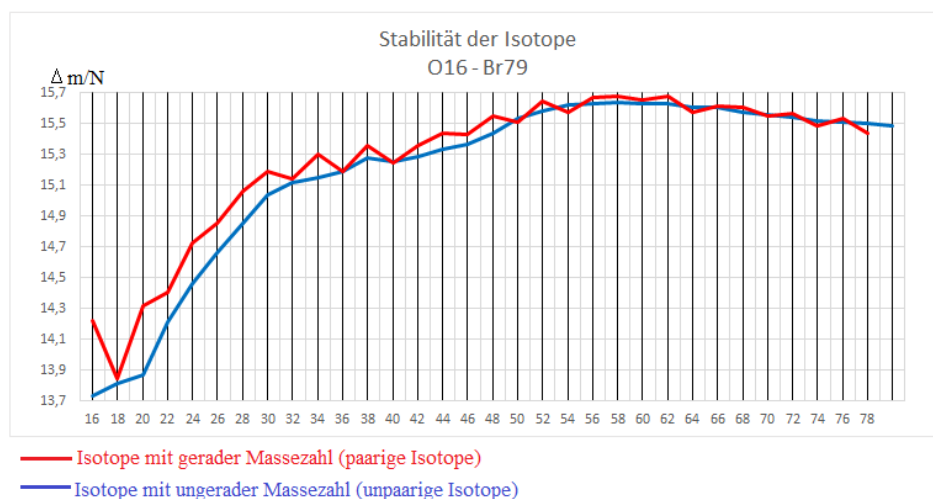|	
Be9 system	469.34
Measured value	468.67

VI Summary of the properties of the nuclides

Fig. 48 Mass efficiencies of the isotopes O16 - Br79

o-nuclei isotopes e-nuclei isotopes→ ee (He4-based)→ eo (Be9-based)

9F19	1	8O	3	16/18	17
11Na23	1	10Ne	3	20/22	21
13Al27	1	12Mg	3	24/26	25
15P31	1	14Si	3	28/30	29
17 Cl 35/37	2	16S	4	32/34/36	33
19 K 39/41	2	18Ar	3	36/38/40	(39)
21Sc45	1	20Ca	6	40/42/44/46/48	43

23V51	1	22Ti	5	46/48/50	47/49
25Mn55	1	24Cr	4	50/52/54	53
27Co59	1	26Fe	3	54/56/58	57
29Cu63/65	2	28Ni	5	58/60/62/64	61
31Ga69/71	2	30Zn	5	64/66/68/70	67
33As75	1	32Ge	5	70/72/74/76	73
35Br79/81	2	34Se	6	74/76/78/80/82	77
37Rb85/87	2	36Kr	6	78/80/82/84/86	83
39Y89	1	38Sr	4	84/86/88	87
	1,373/E		4,25/E		

Table 13

Fig. 48 shows that the isotopes with an even mass number have significantly higher binding energies than the unpaired isotopes, especially in the lower range up to about mass number 52. In addition, this curve is very uneven with numerous energy jumps, whereas the blue curve of the unpaired isotopes is quite uniform.

The table 13 shows that the isotopes with an even mass number are significantly more common than those with an odd mass number (for the above elements approx. 1.4 : 4.3)

All these phenomena can be explained very well with the model presented here, since
for the paired and unpaired isotopes structurally completely different development lines
are available.
Both the oe and the eo nuclei (with the exception of B11 and C13) are derived from 2 Be9 rings
as the basic building block, whereby two of these units are initially linked to form an intertwined
double ring, the N15, and then continuously supplemented by nucleon pairs.
In this way, each further step is a logical consequence of the previous ones and a
stringent, homologous series that leaves no room for arbitrary isotopes.
The initial double ring of the N15 forms compact, centrosymmetric
nuclei and since nucleons can only be attached to their periphery,
two nucleons are required for each expansion step to maintain symmetry,
which consequently generate a consistent sequence of eo and oe nuclei.
There is a simple reason why eo or oe and not oo and ee nuclei are formed,
that the basic building block of this series, the Be9 itself, already has a neutron excess,
which runs consistently through this entire isotope series.
If we were to remove the central neutron when merging the two Be9 units (apart from the energetic
consequences here), the result would not be the N15, but the oo nucleus N14 and, in the entire continuation
of the series, consequently alternating oo and ee nuclei, so that the entire isotope map would not show any

oe or oe nuclei. (We assume that the advocates of a droplet model would also find a valid, presumably quantum mechanical reason for the fact that oe/eo nuclides cannot exist).

The isotopes with **an even numbered mass** are derived from He4 as the basic building block. A special group in this series are the elements C12, O16, Ne20, Mg24, Si28, S32, Ar36 and Ca40,
which consist exclusively of stacked He4 units (α-particle nuclides).
The almost consistently higher stability of the paired compared to the unpaired isotopes
(see Fig. 48) is not due to an ominous pairing energy, as postulated in the droplet model, but to the considerably higher binding efficiency of the He4 unit as the basic building block of this isotope series compared to that of Be9 and the linear structures (see Table 7), from which the unpaired isotopes are formed. In addition, the paired isotopes (α-particle nuclides) are composed exclusively or for the most part of the very stable He4 units, while the unpaired isotopes contain the Be9 units only in the core and their binding strength results essentially from linear structures.

Especially for heavier elements with a large number of He4 units as building blocks
in combination with additional single nucleons creates combinatorial diversity,
the presence of numerous isotopes and their large fluctuations in terms of them
stability (mass loss per nucleon) in this structural series.

The homologous structure of the **unpaired nuclides** results in a uniformly developing energy balance and thus a continuous curve of the binding efficiency (see Fig. 48, blue curve). Starting from a compact cube without cornerstones (F19), two nucleons are progressively added, whereby a compromise is sought between the most compact structure possible and the smallest possible number of additional neutrons. As already explained using the nuclide map (Fig. 29), it is easy to see from this when the addition of additional neutrons (isotopes) is necessary, as otherwise, i.e. if the series is continued consistently without taking the necessary isotope into account, one quickly advances into the area of unstable nuclides.
The few isotopes in this series are therefore absolutely necessary to guarantee the shielding rules inside the nucleus (neutron rule).

Referencies

1 viXra: 2104.0093

2 Wikipedia Semi-empirical mass formula

  Bethe–Weizsäcker formula

 last editied 6. Nov 2024

3 viXra:2402.0122

4 Wikipedia Spiegelkerne

  last edited on 17. Juni 2024

5 Wefelmeier, W. Ein geometrisches Modell des Atomkerns. *Z. Physik* 107, 332−346 (1937).

6 viXra:2301.0137

7 https://physics.nist.gov/cgi-bin/Compositions/stand_alone.pl?ele=