

Systemic Theory of Particles and Atoms

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Abstract: New method, *systemic intuition*, has enabled us to discover the following:

(1) there are only two fundamental particles – virtual electron (electrino) and virtual positron (positrino) - with no physical properties; their interaction gives birth to virtual positronium characterized by energy; virtual positroniums exchange photons and acquire states, called complex positroniums or composiums;

(2) there exists ether, the primary physical medium, consisting of composiums;

(3) in ether there takes place spontaneous generation of mesons and neutrons; cosmic rays and microwave background are proper radiations of ether; experimental data on cosmic rays enabled us to evaluate correlation function of ether and dimensions of some particles; mean radius of real electron is about 0.01 fm;

(4) in respect to ether excitation, neutron is a linear system with continuously distributed parameters consistent spatially with ether;

(5) H-atom is a linear system with lumped parameters; its structural function is consistent in time with ether; H-atom consists of three quarks described by real symmetric matrices; agents of their processes correspond to so called gluons;

(6) essence of nuclear interaction is conservation of energy by alternate transformation of electric energy to magnetic one and vice versa, atom of deuterium (D-atom) being its fundamental case;

(7) excited by photons, atoms and neutrons respond with neutrinos;

(8) nuclear structure evolves by shells, D-atom being its basic element; there are seven shells: He-shell (2-shell), octahedral shell (8-shell), icosahedral shell (18-shell), double-icosahedral shell (36-shell) and three inverse shells of 18, 8 and 2 D-atoms; additional neutrons perform inter-shell interaction; electron shells are integral components of nuclear structure;

(9) every nuclear shell can be modeled by electric LCR-network, so that whole atom can be represented by matrix of impedances; atom with atomic number m consists of m D-atoms, is represented by network with m degrees of freedom and, when excited, emits m -neutrinos;

(10) stellar medium simulates conditions of ether, so that atoms produced in it become different models of ether, achieving their perfection in U-atom; its structure being actually realization and exposition of implicit structure of H-atom;

(11) whole theory is General System Theory in language of physics.

Key words: ether, origin of matter, theory of particles, nuclear interaction, nuclear structure, model of atom.

Preface

This article is a revised edition of my almost 30-year independent research in theoretical physics, "*A Theory of Ether, Particles and Atoms*". The research was published as a book privately in Britain, 2007; in 2008 it was registered at the Copyright Office of the Library of Congress; in 2009, after some correction, it was published with an Israel publishing company, and in 2010, after additional corrections, it was published with the Amazon self-publishing company "CreateSpace", ISBN 9781441478418 (the book is currently available online, with its text: <http://kvisit.com/S2uuZAO>, and cover: <https://kvisit.com/S2-uZAO>). In 2015, with the same company, I published another version of the book, titled "*Introduction to Theoretical Astrophysics*", designed as a textbook for

universities, ISBN 9781495220877 (the book is currently available online, with its text: <http://kvisit.it/SoPadAw>, and cover: <http://kvisit.com/SyYWeAw>).

I have since taken all possible measures to promote the publicity of my research but not a single serious response concerning its subject matter was received. The main reason for that utter neglect of my research was perhaps, beside my status of independent researcher, the challenge it presented to official science by questioning some of the most fundamental theories and programs of research. But such is the life of science.

So seeing no chance to break through that conspiracy about my research and understanding its fundamental importance for the destiny of modern science, I have decided to try and re-publish the whole work as an article with a new title in one of the most authoritative peer-review journals.

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Introduction

The crisis of modern science, caused mainly by the overestimation of the formal and experimental methods of research, manifests itself most blatantly perhaps in theoretical physics because of the fundamental character of its problems. The most urgent ones seem to be the following:

- ◆ the existence and the physical nature of ether*);
- ◆ the origin of matter in the universe;
- ◆ the theory of subatomic particles;
- ◆ the nuclear structure of the atom.

As we have ventured to start revising modern theories dealing with exactly these problems, let us consider briefly the reasons that necessitated such an enterprise.

The problem of ether

The existence of ether, a thin omnipresent substance, the physical medium supporting the propagation of light, was hypothesized as far back as by Aristotle and had been taken for granted by all physicists until the first decade of the 20th century. It is indeed difficult to imagine how it could have been otherwise, because Huygens' principles of wave construction and superposition, for example, the principles underlying the classic optics, would have made no sense without the conception of ether implied by them.

As to experimental investigations of ether, the famous experiment conducted by the American physicists Albert Michelson and Edward Morley (1887) failed to detect an ether and confirm the hypothesis. On top of that, the theory of relativity, developed by Albert Einstein (1905), though not refuting the conception of ether as such, managed to do without it, replacing it with the conception of field, after which the whole idea of ether came to seem obsolete and was almost abandoned by modern physics. That was certainly a kind of self-deception, because any field is merely an

excitation of the underlying physical medium and cannot exist without it.

As to the theory of relativity, it is usually misinterpreted now as a physical theory, but it is rather simply a method of mathematical physics designed for calculating relativistic effects. It is based on axioms that, from the philosophical point of view, are certainly not true just because they are axioms, arbitrary statements. From the physical point of view, their validity, for the subatomic world, at least, is also doubtful, because, in particular, they ignore the finite dimensions of real objects and their interaction with the frame of reference, on the one hand, and because the concept *the velocity of light* makes no sense in the subatomic world, on the other. Thus, as regards its implication to the theory of space, the theory of relativity just replaced the Newtonian abstract concepts of independent space and time by a new abstract concept *space-time*, showing no interest in its physical content.

It is therefore only natural that the further development of physics discovered vacuum to be no empty space but, on the contrary, an arena of intense physical processes. There have been observed such effects as vacuum polarization and vacuum fluctuations as well as the birth and vanish of virtual particles in it. All that proves vacuum to be indeed a physical medium, an ether. Thus ether has clearly manifested its reality and cannot be ignored any longer by theoretical physics.

Origin of matter

Modern cosmology is divided on this issue. The so-called super-dense *theory* asserts that the universe has evolved from one super-dense agglomeration of matter which suffered a cataclysmic explosion giving birth to all planets, stars, and galaxies. This theory is based on the assumption of the conservation of mass in the universe and, for that reason, seems untenable. Indeed, due to the possibility of mutual transformation of mass and energy, the above assumption should have been replaced by a more general one, that of the conservation of mass *and* energy. Now, as energy may be of opposite signs, as is the case, for example, with the energies of attraction and repulsion, it may be suggested that the universe has evolved from nothing. And, indeed, there are such hypotheses as well.

Another widely spread cosmological theory, the so-called *steady state theory*, postulates that the universe has always existed in a steady state, and the observable expansion of the universe is compensated by the continuous creation of matter, which is considered a property of space. Thus, whatever the origin of the universe, theoretical physics is facing now a definite challenge: to verify the hypothesis of matter being generated in space.

Subatomic particles

The subatomic particles – the electron, the mesons, the neutron and the proton – are the main constituents of the atom and should be studied first of all, if we want to conceive its origin. These particles, along with many other much less stable ones, are usually called elementary, but that has long been called into question, and this term has become to some extent ambiguous. So we shall use the term *subatomic particles*, excluding from this category the photon, because it is not an ordinary particle but rather a quantum of energy, an energy exchange agent.

At present, there is no satisfactory theory of subatomic particles. Modern theory investigates them largely from the point of view of their symmetry and, although is able to predict some experimental results and calculate some parameters, it does not present a logically consistent theory and cannot explain the nature and structure of these particles. For that reason, perhaps, there is a curious tendency now to make up the shortages of the theory by ever new experimental data and an increasingly esoteric terminology, but all that only emphasizes the necessity for the true theory.

Nuclear structure of the atom

The most fundamental problems of atomic physics are the nature of nuclear interaction and the nuclear structure of the atom. Despite a huge amount of experimental data and volumes of theoretical works, these cardinal questions are still actual.

Among the existing theories of nuclear interaction, the most respectable one seems to be the *meson theory of nuclear forces* advanced by Hideki Yukawa [1]. According to that theory, nuclear forces are produced by a meson field which is supposed to be similar in origin to the electromagnetic field, but is of much shorter range. The origin of nuclear forces is thus explained as a meson exchange interaction between protons and neutrons.

This empirical theory, although able to explain some experimental results, is too formal, because it involves arbitrarily such concepts as field, force, potential, charge, etc., and therefore is not able to explain the true nature of nuclear interaction. This theory needs, at least, a complementary one.

As to the nuclear structure of the atom, there have been proposed many different models. The so-called *shell model* seems to be most close to the results of our research. However it is based on the assumption of orbital motions of the constituent particles of the nucleus, neutrons and protons, and therefore is too formal to be the true one.

We do not need to consider other models because, in our view, they all omit a significant factor: they do not take into account the existence of ether and therefore cannot discover the true origin of the atom for which interaction with ether is an integral part of its nuclear process; besides, they model actually invalidated atoms arbitrary stripped of their electronic shells. For this reason, although able to predict some effects and calculate some experimental results, none of the proposed models could become a basis for the true theory of the atom.

Thus, despite its impressive achievements, modern theory has failed to understand the true nature of nuclear interaction and the true structure of the atom, and the present state of the theory does not seem much promising in this respect.

Method of research

The fragmentary character of modern theory of subatomic world, its increasing use of formal and experimental methods and half-empiric receipts, unable to achieve the logical integrity of the theory as a whole, show the necessity for the revision of both the basic principles of the theory and the very method of scientific cognition used by theoretical physics.

Philosophy is known to have found the true method of attaining scientific knowledge – *the dialectical logic*; it was substantiated most thoroughly in Hegel's philosophy works and was first applied in modern science by Karl Marx. According to it, the truth is neither a formula nor a statement, but *the process of self-affirmation*, and to prove the truth means *'to show how the object by itself and from itself makes itself what it is'* [2]. As regards physics, this means that a theory's evolution has to be a reflection of the research object's evolution from its simple forms to the complex ones, the reflection of its self-affirmation process.

The existing physical theories, however, are constructed, as a rule, mathematically: one formulates a set of axioms and deduces from it all the results possible. As axioms have no dialectical substantiation and are chosen according to 'common sense' - not scientifically - such an approach, although necessary at a certain stage of research, cannot provide the true solution. So we should try to revise from the dialectical point of view the main results of theoretical physics concerned with the above four problems.

The new method is called *systemic intuition*. With this method, every stage of research is a discovery rather than an intellectual work. According to Hegel's dictum, truth cannot be observed - it can only be thought; so the results of a dialectical research cannot be verified experimentally. On the other hand, the research based on this method takes into account all achievements of modern science, digests them, supplements them with new concepts, puts all concepts in a systemic order, finds their true meaning and, in this way, solves all systemic problems that are beyond the reach of modern science.

As to the dialectical logic proper, it being now far from thoroughly comprehended and ready to

use, its essence, in short, is known to be an alternation of analysis and synthesis, the aim of the analysis being the revelation of the contradictory sides of the object, while that of the synthesis being the revelation of the unity of those sides, which in turn produces a new object to be analyzed at the next stage.

In this work, as the reader will see, the mathematics is an inalienable part of this *self-developing*, as it were, logical investigation and is developing adequately, in our judgment, along with it.

References

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[2]. Hegel G. *The Logic. Translation from the Encyclopedia of the Philosophical Sciences*. Clarendon Press, Oxford, 1874, §83.

*) In this work, the terms *ether* and *vacuum* are used as synonyms.

Chapter 1. A non-formal theory of vacuum

Introduction

According to the above reasoning, the theory of subatomic world should start with the theory of vacuum, that is ether, because vacuum is supposedly the primary physical medium from which all the more complex forms of matter originate. At present, however, there is no satisfactory theory of vacuum. Modern quantum electrodynamics, based largely on Dirac's equation, cannot be considered such, because it starts with such *a priori* notions as space, time, energy, mass, momentum, charge, wave function, etc. [1,2], that themselves need substantiation and cannot be initial for the theory of vacuum. So we start with the very beginning making use of the new method, systemic intuition, mentioned above. This part was published first in [3] and is stated here with some correction.

1.1. Virtual positronium

A. We start our research with the study of the universe. It is the only possible object to begin with, because it exists for sure, because it is *something*. The universe is an integral system, it knows itself as such, it is what it knows about itself. The universe develops and has an *origin, a beginning*. The universe knows nothing about its origin, because otherwise it would have been natural to put the question about the origin of that its knowledge. So the origin of the universe is *nothing*, that is something on the one hand and nothing on the other, *something-nothing*, a fundamental contradiction.

Drawing on the well-known experimental results, general intuition and common sense, suggesting *the wave-corpusecular duality* to be the basic, fundamental contradiction in the physical subatomic world, we conclude that the origin of the universe is some elementary particle, a carrier of the wave-particle duality with no physical properties, *an electron*.

B. The electron described above is a *virtual* one, an abstraction unable to become a reality on its own. But the duality of the virtual electron implies the existence of its dual particle, *a virtual positron*. The latter is like the electron and likewise abstract. They differ in their primary feature: the electron being primarily *a wave*, while the positron *a corpusecular*; thus the virtual electron is *a wave-particle*, while the virtual positron is a *particle-wave*.

C. The above virtual electron and positron are the dual images of each other, can replace each other and do replace each other, producing a unity – *a virtual positronium*. The latter is *the primary*

interaction in which the virtual electron and positron merge and turn into each other. As such an interaction, with its intrinsic intensity, the virtual positronium is characterized by *energy* E and therefore is *real*.

Comments:

(1) The above particles should have been given new terms, '*electrino*' and '*positrino*', for example, because the terms 'virtual electron' and 'virtual positron' seem to be used now in a different sense; but as objection to these terms has not been expressed so far, we will use them tentatively throughout this research.

(2) It is noteworthy that it is due to the interaction of the virtual electron and positron that energy emerges here; therefore, these virtual particles taken separately have no energy of their own.

1.2. Complex positronium

A. The virtual positronium first is a *pair, corpuscular* interaction of the virtual electron and positron, the embodiment of their corpuscular properties; as such, this interaction is characterized by energy E_m which may be called *a corpuscular or a mass energy*.

B. The pair interaction of the electron and positron is the overcoming of their singularity, that is corpuscularity, and therefore the corpuscular interaction itself. As a result, the positronium spontaneously annihilates emitting *quanta* of energy, *photons*. The photon is primarily the manifestation of the virtual particles' wave properties. However, the photon inherits its ancestors' wave-corpuscular dualism and therefore has hidden corpuscular properties as well. Due to this, photons tend to turn into their opposition and do turn into it, colliding with each other and giving birth to electron-positron pairs. The latter generate likewise other pairs and the original pair, in particular. Thus the original pair is re-established as a result of photon exchange, or *the exchange interaction* of virtual positroniums. This interaction is the embodiment of the electron and positron's wave properties and is characterized by energy E_p which may be called *an exchange or a momentum energy*.

C. The pair and exchange interactions are inseparable and produce a unity which we shall call a *complex positronium, or composium*, for short. The latter comprises both the phase of pair interaction and that of exchange interaction and is an infinite alternation of these two phases. The composium is characterized by its *state* and its *full energy* E , its components E_m and E_p corresponding to the above dual phases. Mathematically, such a duality is expressed by complex numbers, so the full energy is

$$E = E_m \pm iE_p \quad (1.1)$$

where the signs '+' and '-' refer to the equally probable *conjugate states* with energies E and \tilde{E} , respectively.

Comments:

Expression (1.1) is actually the true definition of the term *energy*: the latter is *the measure of interaction*, and as such it is a complex number, with its real and imaginary parts being both algebraic numbers.

1.3. Vacuum

A. One composium suggests the existence of an unlimited number of composiums interacting with, and regenerating, each other. Because of their corpuscular nature, composiums are isolated,

that is, there takes place mutual *repulsion*. This results in every state being unique, corresponding to one composium only. The quantitative measure of the repulsion is the constant ϵ_o , the so-called *permittivity of a vacuum*.

B. Because of the composium's wave nature, all its states are identical and convertible to each other; therefore, there takes place mutual *attraction*. This results in every state being occupied. The quantitative measure of the attraction is the constant μ_o , the so-called *permeability of a vacuum*.

C. The repulsion and attraction of composiums are inseparable and produce a unity which is *vacuum*. The latter is an unlimited number of composiums, the primary physical medium, *ether*. characterized by the constant

$$c = \frac{1}{\sqrt{\epsilon_o \mu_o}} \quad (1.2)$$

actually the *connectivity* of ether, or, in modern terms, the *velocity of light in a vacuum*.

Comments:

(1) It is easy to notice the above definition of vacuum to be fairly close to Dirac's concept of it as a background of negative energy electrons occupying all the states possible [1].

(2) Making use of (1.2), let us introduce the quantities

$$m = -\frac{E_m}{c^2} \quad (1.3)$$

and

$$p = \frac{E_p}{c} \quad (1.4)$$

which, in accordance with modern terminology, should be called the *mass* and the *momentum* of the composium, respectively; the negative sign in (1.3) being accounted for by the fact that, as shown in Sec.1.4, here $E_m < 0$. Taking (1.3) and (1.4) into account, we present (1.1) as

$$E = -mc^2 \pm ipc \quad (1.5)$$

and then arrive at the formula

$$|E|^2 = m^2 c^4 + p^2 c^2 \quad (1.6)$$

which coincides with the known relativity theory formula for the energy $|E|$ of a material particle of mass m and momentum p .

The formulas (1.3) and (1.4) expose the physical meaning of such notions as mass and momentum. Indeed, as follows from (1.3), the mass of the composium emerges as a result of the pair interaction of the virtual electron and positron and is proportional to that interaction energy. Similarly, as follows from (1.4), the momentum of the composium emerges as a result of the photon exchange interaction and is proportional to the latter's energy. Therefore, neither electron nor positron, as virtual particles, have mass or momentum of their own.

1.4. Coherent multitude of composiums

A. Vacuum is a boundless and indefinite multitude of composiums. Due to the isolation and

mutual repulsion of composiums, that multitude is discrete; due to the identity and attraction of composiums, that multitude is continuous. As a sequence of transitions from one state of the composium to another, this multitude is *space* measured by *distance* r . As a sequence of the cycles of resurrection of states, which as such are identical to each other, this multitude is *time* t . However, the transition of the composium from one state to another is also the resurrection of its state, which means equivalency of time and space in vacuum and is described by the well-known identity

$$r = c t \quad (1.7)$$

Thus space and time in vacuum are identical and inseparable.

B. Like the whole multitude, each composium is also both discrete and continuous. It is discrete as one composium and continuous as identical to other composiums. As a discrete element of the multitude, the composium is characterized by the constant h , *Planck's constant*; as a continuous element, the composium is the center of some circle of composiums coherently close to it and is characterized by the constant π , the ratio of the circumference of the circle to its diameter. Therefore, the composium combines the features of both continuity and discreteness, and, with its energy E , is characterized by the number

$$\chi = \frac{2 \pi E}{h c} \quad (1.8)$$

which we shall call a *complex wave number*.

C. Due to the above continuity, the definiteness and discreteness of one state continuously transit to those of the contiguous states. Therefore, each composium is the center of some *coherent multitude* of composiums. The coherent multitude contains an unlimited number of composiums coherently connected with the given original composium. Thus the coherent multitude combines the features of both the whole multitude, vacuum, and its element, the composium. Since the coherency is a relative connection of two composiums, moving away from the center results in diminishing both the connection with the center and, to the same extent, the rate of this diminishing, too. Therefore, the coherent multitude is characterized by some fading exponential *function of coherency*,

$$\varphi_{\chi}(s) = e^{\chi s} \quad (1.9)$$

where s is a space ($s = r$) or time ($s = ct$) interval. Function (1.9) determines the degree of coherency of composiums separated in space or time.

Comments:

(1) This section displays the stage where vacuum exposes itself as a space-time medium, which makes it possible to specify the physical sense of such notions as space and time. These notions prove to be identical and inseparable in vacuum, because in the 'clear' vacuum there are neither independent 'landmarks' for identifying direction, nor a 'clock' for gauging time. Therefore, in vacuum space is time-like, that is half-dimensional, which is expressed by (1.7).

(2) Formula (1.8) is a natural generalization of the real wave numbers used in modern physics, while function (1.9) may be considered a generalization of the expression for the wave function of a particle in free space.

1.5. Bounded multitude of composiums

A. The coherent multitude first is a cumulative coherent amount of composiums, the amount

coherently connected with the center – the *coherent multitude proper*. As such, the coherent multitude is characterized by its *massiveness*, or its *internal measure* A_χ .

B. Each element of a given coherent multitude belongs also to all the other coherent multitudes, and each element of any other coherent multitude belongs to the given multitude, too. Thus the given coherent multitude correlates with the infinite number of other coherent multitudes as with its own *boundary* and, in this correlation, returns to itself, i.e. contains its boundary within itself. Therefore, the coherent multitude may be characterized by the *elasticity of the boundary*, or its *external measure* B_χ .

C. Any coherent multitude proper and its boundary condition, transit to, and complement each other and, as a result, produce a unity – a *bounded multitude* of composiums characterized by a *complex measure*

$$C_\chi = A_\chi \pm iB_\chi \quad (1.10)$$

The symmetry of conjugate states and that of conjugate coherent multitudes result in the same symmetry of the latter's complex measure, that is

$$C_{\tilde{\chi}} = \tilde{C}_\chi \quad (1.11)$$

1.6. Correlation domain

A. The bounded multitude, with its elastic boundary, is its own boundary, its center presented by the complex measure C_χ and coherently correlated with the center of another bounded multitude, distanced from the former by a space-time interval s , according to the function (1.9).

B. The center of the bounded multitude is also its own boundary, a singularity, a unity with its own boundary, *a movement along an infinitesimal circle* in the plane of the complex parameter χ , characterized by the relation

$$\oint \frac{1}{\chi} d\chi = 2\pi i, \quad (1.12)$$

the circle differing from its center by an infinitesimal quantity $d\tilde{c}$ and an infinitesimal measure dC_χ , the ratio of these quantities,

$$S(\chi) = \frac{dC_\chi}{d\chi}, \quad (1.13)$$

determining *the complex measure density*. The function $S(\chi)$ is the *complex energy spectrum* of composiums in vacuum; it determines the relative intensity of the respective bounded multitudes, thereby setting up a *spectral correlation* between them in the half-plane $\Re \chi < 0$ bounded by the half-plane $\Re \chi \geq 0$ – *the boundary of correlation*. As follows from (1.11) and (1.13),

$$S(\tilde{\chi}) = \tilde{S}(\chi) \quad (1.14)$$

C. The coherent correlation and the spectral correlation of bounded multitudes are formed by the same process of photon exchange and therefore fall into unity producing some pattern of correlation, a *correlation domain of vacuum*, characterized by the function

$$g(s) = \frac{1}{2\pi i} \int_L S(\chi) e^{\chi s} d\chi; \quad \Re \chi \geq 0 \quad (1.15)$$

which, due to the relation (1.14), is real. The curve L envelops the half-plane $\Re \chi < 0$ and may coincide with the axis $\Re \chi = 0$. The correlation domain embodies the unity of coherency and correlation, that is, the coherency of composiums in the bounded multitude and the correlation of bounded multitudes. The function $g(s)$ determines the correlation of processes separated by a space ($s = r$) or time ($s = c t$) interval, and may be called the *correlation function of vacuum*.

In the correlation domain, the definiteness inherent in bounded multitudes and their spectral relation vanish, and vacuum arrives at a simple relation towards itself, turning into a *correlative space-time* and thereby completing its development as a 'clear' vacuum. This completeness manifests itself in the realness of the function (1.15) which is a comprehensive, an essential characteristic of vacuum.

Comments:

(1) When reviewing the evolution the above concept of vacuum has undergone, we see that in the beginning vacuum, as an infinite number of composiums, is still a simple immediateness having no support in itself; but after conditioning itself by the coherent and bounded multitudes, vacuum turns into a self-supported immediateness, becomes identical to itself. Thus vacuum has been shown here in the process of its self-affirmation, which, as mentioned in the Introduction, is a necessary attribute of any respectable theory.

(2) Vacuum *per se*, a clear vacuum, is an *arithmetical* space and therefore differs drastically from its so-called 'electromagnetic' models advanced by modern theory and considered four-dimensional continua.

(3) Note that the transform inverse to (1.15),

$$S(\chi) = \int_0^{\infty} g(s) e^{-\chi s} ds, \quad (1.16)$$

is the Laplace transform of $g(s)$, which is known to be analytic in the half-plane $\Re \chi > 0$. Therefore, the expression (1.15) makes sense only if the curve L lies in the half-plane $\Re \chi \geq 0$, the motion along it being anti-clockwise. In case $\Re \chi = 0$, expression (1.15) still holds turning into the Fourier integral.

(4) The existence of ether is confirmed by the so-called Cosmic Microwave Background Radiation which is a natural thermal radiation of ether with its natural black body radiation spectrum.

Conclusion

The above part of the research provides at least a qualitative solution to the problem underlying theoretical physics, that of the existence, the composition, and the properties of ether, the medium to support the propagation of electromagnetic radiation in space. As shown here, this medium does exist and proves relativistic by its very nature. Thus this research settles the controversy between the physics of the 19th century, that stated the above problem and tried to solve it, and modern physics, that has almost abandoned that problem on the ground of the formal deductions of the theory of relativity.

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Chapter 2. Spontaneous generation of neutrons

Introduction

In this part of the research, published first in 2004 [1], a new theory of the so-called elementary particles is stated, the one lying outside the mainstream of modern theories based, as a rule, on the properties of symmetry of those particles (see, for example, [2,3]). The results obtained here suggest a new explanation of the origin of matter in the universe. Besides they shed light on the origin and the structure of the electron and the features of the mesons. This chapter is the continuation of Chapter 1 and is based on the same method.

2.1. A self-consistent cloud

A. The correlation domain of vacuum (see Sec.1.6), is a stable, self-consistent pattern of correlation, the indication of the *self-consistency* of vacuum itself, owing to which vacuum is a steady medium identical to itself. The correlation function $g(s)$ of vacuum determines connection between the processes in compositums separated by a space ($s = r$) or time ($s = ct$) interval. That connection is formed through photon exchange. In that process, one compositum emits a photon which is absorbed and re-emitted by another compositum. If the re-emitted photon retains the parameters of the original photon, there takes place *free propagation* of photons indicating correlation of the states of the respective compositums. Otherwise, there takes place *scattering* of photons indicating independence of the states of the compositums.

The second compositum, too, emits photons which are absorbed, in particular, by the first one. Therefore, the first compositum is correlated with the second to the same extent as the second with the first. Thus there takes place correlation of correlation, the *square of correlation*, which is depicted by the function $g^2(r)$. The latter determines the density of correlated compositums, *the density of correlation*, in the vicinity of some *center*.

The center suggests motion about it and therefore *division of space and time*; that division has actually happened above when we had to introduce opposite motions of photons, using, of necessity, the space symbol r instead of s . The center suggests localization of space about it and necessitates introduction of a spatial *frame of reference* with the center as its *origin*. So let us introduce the Cartesian frame of reference XYZ, in which spatial points we shall denote q , meaning the totality of their coordinates $\{x,y,z\}$; then the length of the radius-vector is

$$r = |q| = \sqrt{x^2 + y^2 + z^2} \quad (2.1)$$

and the element of space $dq = dx dy dz$.

B. After the division of space and time, with space localized about the center, the latter becomes the singular carrier of time, a *time gauge*, and as such is *the singularity* of vacuum. The form of the center is characterized by some *singularity distribution function* $\varphi_o(q)$, a continuous positive function satisfying the conditions

$$\varphi_o(q) = \varphi_o(|q|) \quad (2.2)$$

$$\int \varphi_o dq = 1 \quad (2.3)$$

where the integral is taken over all space. The function $\varphi_o(q)$ defines the *uncertainty sphere* of the center, *the density of singularity*.

C. The photons emitted by the center are absorbed by its vicinity distributed with the density $g^2(r)$. Although that distribution is continuous, the act of the absorption of photon at some point q_1 is singular and should be described by the density of singularity, which in this case takes the form $\varphi_o(q-q_1)$. Thus the singularity permeates the entire vicinity of the center, thereby making its every point similar to the center. As the motion about any point of singularity within the correlation domain should be correlated with that about the center, the entire vicinity of the center starts moving as a whole, that is, unites and merges with the center. This merging of self-consistency and singularity is the creation of a self-consistent singularity, a *self-consistent cloud*. The latter manifests *the re-unification of space and time*, represented by the functions g^2 and, φ_o , respectively; it is space localized and *rotating* as time about the center. The adequate mathematical expression for such merging of space and time, in which time unites with space at every point q_1 and therefore should be represented there by the function $\varphi_o(q-q_1)$, is the operation of *convolution* of the above two functions,

$$w(q) = g^2 \otimes \varphi_o = \int g^2(|q_1|) \varphi_o(q-q_1) dq_1 \quad (2.4)$$

As such a re-unification of space and time, the self-consistent cloud is a *material particle*, the function $w(q)$ being proportional to its *matter density*.

Comments:

The logical conclusion about matter being generated by some kind of convolution of space and time was made first by Hegel who stated, “*Space and time twist themselves into matter*” [5].

2.2. A balanced cloud

A. The function $w(q)$ defines the *inner boundary* of the self-consistent cloud dividing the domains of compositums correlated and non-correlated with the center. Therefore, the self-consistent cloud restricts the domain of free motion of photons, which results in that motion, as well as the states of the respective compositums, acquiring the nature of *reflection*, a standing wave. In that process, the opposite motions unite leading to the unity of conjugate states and the creation of *self-conjugate compositums*. The reflection is characterized by a *wave function*, $\psi(q,t)$, determining the distribution of reflection in space and its change in time, on the one hand, and by a *reflection energy*, E_{ref} , determining the intensity of reflection, on the other hand. Owing to the self-conjugation of compositum states in the reflection, E_{ref} is real. Taking into account that the linear transformation (2.4) is the most general description of processes in the self-consistent cloud, we should determine the relation between ψ and E_{ref} , most generally, in the form of a linear functional

$$E_{ref} = (\psi, \hat{E}_{ref} \psi) \quad (2.5)$$

where \hat{E}_{ref} is a linear operator,

$$(f_1, f_2) = \int \tilde{f}_1 f_2 dq \quad , \quad (2.6)$$

the *tilde* sign over the character is the symbol of complex conjugation.

B. Propagating free in the domain of compositums correlated with the center, photons penetrate into the domain of non-correlated compositums and undergo scattering. The latter leads to the *degradation of reflection* and the respective time change of the wave function. The degradation of reflection depends on the density of non-correlated compositums and therefore should be proportional to the function

$$W(q) = w_{max} - w(q) \quad (2.7)$$

determining the extent of non-correlation; it being evident that $W \geq 0$.

As the time change of the reflection is characterized by the function $\frac{\partial \psi}{\partial t}$, the intensity of reflection degradation is proportional to the functional

$$P = \frac{1}{c} \left(\frac{\partial \psi}{\partial t}, W \frac{\partial \psi}{\partial t} \right) \quad (2.8)$$

The scattering of photons provides *exchange interaction* of the self-consistent cloud with vacuum, the value P being proportional to the *power* of that interaction.

C. The inner boundary of the self-consistent cloud divides the domains of reflection and scattering, the latter providing the exchange interaction with vacuum. That boundary is self-conjugate in a sense: not only does it scatter centrifugal photons, but, due to the exchange interaction with vacuum, produces, with the same probability, centripetal photons, thereby creating the effect of photon reflection from the boundary. Therefore, the reflection in the self-consistent cloud exists due to the exchange interaction with vacuum. In its turn, the exchange interaction with vacuum exists due to the above reflection which, degrading through the scattering of photons, gives rise to the above interaction. Thus the reflection of compositiums in the self-consistent cloud and its exchange interaction with vacuum depend on, and turn into, each other, due to which they fall into unity and produce a balance of reflection and exchange interaction, creating a *balanced cloud*. In the latter, the power of exchange interaction with vacuum is brought into balance with the rate of the reflection degradation energy, which, taking into account (2.5) and (2.8), corresponds to the relation

$$\frac{\partial(\psi, \hat{E}_{ref} \psi)}{\partial t} = -\frac{1}{c} \left(\frac{\partial \psi}{\partial t}, W \frac{\partial \psi}{\partial t} \right) \quad (2.9)$$

2.3. A self-controlled cloud

A. The reflection of compositiums in the balanced cloud first, as suggested by (1.3), is the reflection of pair interaction – the formation of the mass of the self-conjugate compositiums; it is a coordinate pair interaction of virtual electrons and positrons in two bound conjugate states of compositiums, some closed in itself, cyclic, time-forming process – *time reflection*. As it is the change of the wave function in time that is essential for the time reflection, the latter's energy, to within a constant factor, is

$$E_t = \frac{1}{2c^2} \left(\frac{\partial \psi}{\partial t}, \frac{\partial \psi}{\partial t} \right) \quad (2.10)$$

where c is the velocity of light in a vacuum.

B. The reflection of compositiums is also the reflection of exchange interaction inside the balanced cloud – the formation of the pair of momenta of the self-conjugate compositiums; it is a co-ordinate exchange interaction in two bound conjugate states of compositiums – *space reflection*. As it is the change of the wave function in space that is essential for the space reflection, the latter's energy, taking into account the proportionality between time and space intervals in the free propagation of photons, to within the same constant factor as in (2.10), is

$$E_s = -\frac{1}{2} (\psi, \Delta \psi) \quad (2.11)$$

where

$$\Delta = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} \quad (2.12)$$

C. The pair interaction of virtual electrons and positrons results in their spontaneous annihilation and radiation of photons, thus contributing to the exchange interaction by means of photon exchange. In its turn, the exchange interaction, due to the spontaneous generation of virtual electrons and positrons in that process, turns into the pair interaction. However, that connection is not immediate but mediated by the exchange interaction with vacuum. In that process, a change of the time reflection gives rise to the respective change of the space reflection and the penetration of that change through the boundary; but the latter *bounds* that change, that is, leads to such a change of the exchange interaction with vacuum, and that of the degradation of reflection, which seek to restore the original reflection intensity, unless its change was too large. Thus there arises the effect of *self-control*.

The balanced cloud in which the time and space reflections form a united self-controlled space-time reflection is *a self-controlled cloud*. In the latter, the process of self-control is described by the equality $E_{ref} = E_s + E_t$, which, taking into account (2.8), (2.10) and (2.11), takes the form

$$\partial \left\{ \frac{1}{c^2} \left(\frac{\partial \psi}{\partial t}, \frac{\partial \psi}{\partial t} \right) - (\psi, \Delta \psi) \right\} / \partial t = -\frac{2}{c} \left(\frac{\partial \psi}{\partial t}, W \frac{\partial \psi}{\partial t} \right) \quad (2.13)$$

It is easy to show that

$$\frac{\partial}{\partial t} \left(\frac{\partial \psi}{\partial t}, \frac{\partial \psi}{\partial t} \right) = 2 \left(\frac{\partial \psi}{\partial t}, \frac{\partial^2 \psi}{\partial t^2} \right) \quad (2.13')$$

and

$$\frac{\partial}{\partial t} (\psi, \Delta \psi) = 2 \left(\frac{\partial \psi}{\partial t}, \Delta \psi \right) \quad (2.13'')$$

in which case (2.13) is equivalent to the equation

$$\frac{1}{c^2} \frac{\partial^2 \psi}{\partial t^2} - \Delta \psi + \frac{W}{c} \frac{\partial \psi}{\partial t} = 0 \quad (2.14)$$

The latter seems to be known as the equation of *the full internal reflection*.

2.4. A self-conjugate cloud

A. The effect of self-control in the self-controlled cloud gives rise to the preferential forms of reflection and therefore leads to the discretization of the previously continuous spectrum of states. To determine these discrete states, it is necessary to solve the equation (2.14). To this end, let us represent (2.14) as

$$\frac{\partial u}{\partial t} + H u = 0 \quad (2.15)$$

where $u = u(q, t)$ is a two-component wave function,

$$u = \begin{pmatrix} \frac{\partial \psi}{\partial t} \\ \psi \end{pmatrix} \quad (2.16)$$

H is the matrix operator,

$$H = \begin{pmatrix} cW & -c^2\Delta \\ -I & 0 \end{pmatrix} \quad (2.17)$$

I is the unit operator.

The partial solution of (2.15) is known to be

$$u = U e^{\lambda t}, \quad (2.18)$$

where $U = U(q)$ is a two-component spatial wave function satisfying the equation

$$\lambda U + H U = 0 \quad (2.19)$$

The solution of (2.19) is a set of complex-conjugate numbers $\{\lambda_k\}, \{\tilde{\lambda}_k\}$ and the corresponding wave functions $\{U_k\}, \{\tilde{U}_k\}$. These wave functions determine *bound* states satisfying the condition $(U, U) < \infty$. The equation (2.19) has a finite number of bound solutions. Indeed, substituting (2.18) into (2.15) and assuming $|\lambda_k| \rightarrow \infty$, we arrive at the equation

$$\lambda^2 U - c^2 \Delta U = 0 \quad (2.20)$$

which has no bound solutions in the open space. Therefore, one must assume that $|\lambda_k| < \infty$ and $k < \infty$. However, the solutions of (2.19) are abstract because they depend on the indefinite quantity

$$A = \int g^2 dq \quad (2.21)$$

B. As the reflection intensity grows in the bound states, it achieves its extreme value. The extreme state separates the domain of bound states from that of free states and therefore is both bound and free, a bound state of free conjugate composites, a *free self-conjugate state, the state of rest*. In the latter, the reflection is determined only by the self-conjugation and concentrated in the minimal sphere corresponding to the uncertainty sphere determined by the function ϕ_o . In the state of rest, therefore, it is necessary to put $w = w_o$, $w_o = B\phi_o$. Under this condition, the wave function of the state of rest satisfies the equation

$$\lambda U + H_o U = 0, \quad (2.22)$$

where $H \rightarrow H_o$ when $w \rightarrow w_o$.

As a bound state, the state of rest is a stable state; and as a free state, it is a single state isolated from other bound states, the most stable single state. Therefore, when solving (2.22), it is necessary to choose the value B in such a way that would ensure the existence of the most stable single bound solution. To this end, changing B from zero up, one should find values B_1 and B_2 corresponding to the emergence of the first and the second bound solutions, respectively. So the value B is selected between B_1 and B_2 and admits some variation. When selected, it would correspond to a definite critical value of $\lambda = \lambda_o$. So solving simultaneously equations (2.19) and (2.22) with a slight variation of numbers A and B , it would be possible to achieve both a stable solution for the state of rest and the set of solutions for bound states of self-conjugate composites within the self-

controlled cloud satisfying the condition

$$\lambda_n = \lambda_o. \quad (2.23)$$

Thus, the two different characteristics of vacuum, represented by the functions g and φ_o , prove agreed with each other.

C. In their evolution, the bound states have turned into a free self-conjugate state, but the latter has also proved to be bound. That mutual transition of boundness and free self-conjugation suggests the existence of their unity – a multitude of *free and bound* self-conjugate states, corresponding, apparently, to the joint solution of (2.19) and (2.22). Physically, this means that in the self-controlled cloud conjugate states unite into *bound self-conjugate* states thus making themselves free within the cloud. Formally, we have the multitude of complex-conjugate numbers $\{\lambda_k\}, \{\tilde{\lambda}_k\}$ and the corresponding wave functions $\{U_k\}, \{\tilde{U}_k\}$, $k = 1, 2, \dots, n$, which, unlike the previous solutions, are definite, not abstract.

As the time factor of (2.18) coincides with the function of coherency of vacuum (see Chapter 1), it should be assumed that

$$\lambda = \frac{E}{\hbar}, \quad \hbar = \frac{h}{2\pi} \quad (2.24)$$

Then the energy of the self-conjugate composium in the k -state is determined by the pair of the complex-conjugate numbers

$$\begin{aligned} E_k &= -m_k c^2 + i p_k c \\ \tilde{E}_k &= -m_k c^2 - i p_k c \end{aligned} \quad (2.25)$$

where $E_k = \hbar \lambda_k$, that is

$$m_k = \frac{\hbar}{c^2} |\Re \lambda_k| \quad (2.26)$$

$$p_k = \frac{\hbar}{c} \Im \lambda_k \quad (2.27)$$

m_k being its mass and $\{p_k, -p_k\}$ its pair of momenta.

The creation of free and bound self-conjugate states completes the formation of self-conjugate composiums, which, as shown in Sec.2.2, started as far back as in the self-consistent cloud. On completing the formation of self-conjugate composiums the self-controlled cloud turns into a *self-conjugate cloud*. The latter is characterized by a set of self-conjugate wave functions

$$u_k(q, t) = U_k e^{\lambda_k t} + \tilde{U}_k e^{\tilde{\lambda}_k t}, \quad k = 1, 2, \dots, n \quad (2.28)$$

2.5. A consistent cloud

A. Having acquired definiteness in the self-conjugate cloud, the reflection of composiums, defined by functions (2.28), establishes, within each particular state of reflection, its proper, *particular correlation* of processes, and that of the rate of those processes, at different points of the vicinity of the center. However, the above reflection is mediated by the exchange interaction with vacuum where the correlation of processes is different.

B. In vacuum, the correlation of processes is characterized by its correlation function $g(r)$; the latter characterizing also the correlation of the rate of those processes. Thus we have a *two-*

component correlation function of vacuum for the processes and their rates.

$$G = \begin{pmatrix} \mathfrak{g} \\ \mathfrak{g} \end{pmatrix} \quad (2.29)$$

C. Under the influence of exchange interaction with vacuum, its mode of correlation penetrates the self-conjugate cloud, impelling it to conform its totality of independent particular modes of correlation with that of vacuum. As a result, the whole totality of reflections in the self-conjugate cloud undergoes the process of organization, during which there forms a collective, *organized reflection*, represented by a *linear combination* of spatial wave functions,

$$F = \sum_{k=1}^n C_k U_k + \tilde{C}_k \tilde{U}_k \quad (2.30)$$

approximating the function G ; the coefficients $\{C_k\}$ being naturally formed according to the expressions

$$C_k = \frac{(V_k, G)}{(V_k, U_k)}, \quad \tilde{C}_k = \frac{(\tilde{V}_k, G)}{(\tilde{V}_k, \tilde{U}_k)} \quad (2.31)$$

where the functions $\{V_k\}$ are the solutions of the equation

$$\lambda V + \bar{H} V = 0 \quad (2.32)$$

\bar{H} being the matrix transposed to H ; the relationship of orthogonality,

$$(V_i, U_j) = 0, \quad i \neq j \quad (2.33)$$

taking place [4].

Thus a spatial consistency with vacuum is achieved, which results in the self-conjugate cloud turning into a *consistent cloud*. The latter has an organized totality of modes of reflection characterized by a 4n-component self-conjugate function,

$$f(q, t) = \sum_{k=1}^n C_k U_k e^{\lambda_k t} + \tilde{C}_k \tilde{U}_k e^{\tilde{\lambda}_k t} \quad (2.34)$$

which describes the correlation of processes in the consistent cloud and therefore can be called its *correlation function*.

2.6. Discussion of the results

1. As follows from the above development, the first four creatures – the self-consistent, the balanced, the self-controlled, and the self-conjugate clouds – depend on the correlation function of vacuum, which has been introduced from outside and is alien to them. Contrary to them, the consistent cloud itself models that function and therefore stands, as it were, on its own feet, affirms itself, which suggests that it is much more stable. This means that the consistent cloud is the *neutron*; while the above earlier creatures, not consistent with vacuum, correspond to the much less stable types of the so-called elementary particles – *the muon*, *the π -meson*, *the K -meson*, and *the η -meson*, respectively; these particles prove to be the intermediate stages of the synthesis of the neutron and, clearly, are not elementary. Thus in vacuum there takes place spontaneous generation of mesons and neutrons because this process, as shown above, is logical and therefore inevitable.

2. The inherent logic of the above particles and their mathematical description suggest the following features of their structure:

(a) the muon is a primitive material particle having no structure and characterized by its matter density proportional to the function (2.4);

(b) the π -meson is a particle with a primitive *inarticulate structure* described by the wave function $\psi(q,t)$ satisfying the equation (2.9);

(c) the K-meson is a particle with a primitive *discrete structure* characterized by a number of states satisfying the equation (2.14);

(d) the η -meson is a particle with a *self-conjugate structure* characterized by a number of self-conjugate wave functions (2.28);

(e) the neutron is a particle with a *consistent structure* characterized by its correlation function (2.34).

3. The above result confirms the well-known dialectical thesis that “*the essence must appear*” (see [6], §131). The essence of vacuum is the correlation of compositums in its correlation domain, defined by the correlation function. The birth of neutrons in vacuum is the materialization, or the 'existence' of that essence, because the neutron is a discrete model of the above correlation domain. Thus the aspiration for evolution and self-expression, common for the nature in general, is inherent in vacuum as well.

4. The conclusion about the process of spontaneous generation of mesons and neutrons in vacuum is confirmed by the existence in outer space of cosmic rays and hydrogen gas, in particular, being created supposedly during, and as a result of, the above process. Thus this result enables us to give a new explanation of the origin of matter in the universe.

5. The equation (2.14) is not so-called relativistically invariant, as it should have been to conform with modern theory. What is the matter? The answer is that one should distinguish between a mathematical approach and a physical one. Mathematically, it is admissible to choose arbitrarily any frames of reference moving relative to each other at any velocity. Physically, it is, strictly speaking, inadmissible, because in physics any frame of reference is some material body which interacts with the object investigated and should be united with it into a single system. It is such an interaction with the frame of reference that is essential for the above theory.

6. As (2.18) suggests, the self-conjugate compositum in the n-state is the basis of the *real electron* to be created after the neutron decay; the pair of momenta transforming into the *spin* of the electron; the real and imaginary parts of the factors C_n and \bar{C}_n transforming into the *electric charge* and the *magnetic moment* of the electron, respectively.

7. The above theory enables us to explain some peculiarities of the muon. Thus the extremely weak interaction of the latter with matter can be explained as follows. The muon is the simplest self-consistent group of compositums and, as mentioned above, has no material structure. But any material particle is also, first of all, a self-consistent creature, that is, contains the self-consistent cloud as its basis. Therefore, the muon interacts with the nuclei of matter not as with anything alien, but as with its like. For that reason, the interaction of the muon with matter takes the form of successive replacements of the self-consistent clouds underlying the nuclei by the self-consistent cloud of the muon, with the last replaced cloud, due to the conservation laws, leaving the matter with parameters close to those of the original muon.

The fact that one of the products of the muon decay is the electron is accounted for by the result that it is in the self-consistent cloud, that is, the muon, that the formation of the self-conjugate compositums starts; one of them, that in the extreme state, completes, supposedly, its formation and transformation into the electron during the muon decay.

Conclusion

There have been obtained new results introducing a drastic change to the existing theories concerning the nature and the adequate way of description of the so-called elementary particles, and

the origin of matter in the universe.

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Chapter 3. The neutron becoming the atom

Introduction

In modern physics the neutron decay is considered a kind of so-called weak interaction and there is a lot of works based on such an approach, for example, [1,2]. In our view, such an approach is based on abstract assumptions and inadequate to the problem. Our above investigation of the nature and the structure of the neutron makes it possible to develop quite a different approach to, and interpretation of, the above process. This part of the research was published first in [3] and is stated here with some correction.

3.1. The consistent cloud

A. The consistent cloud, that is the neutron, as shown in Chapter 2, is an organized system of reflection consistent with vacuum; it is characterized by its $4n$ -component correlation function,

$$f(q, t) = \sum_{k=-n}^n C_k U_k e^{\lambda_k t} \quad (3.1)$$

$$a_{-k} = \tilde{a}_k, \quad C_0 = 0.$$

Function (3.1) consists of n terms such as

$$f_k(q, t) = C_k U_k e^{\lambda_k t} + \tilde{C}_k \tilde{U}_k e^{\tilde{\lambda}_k t}, \quad (3.2)$$

where the spacial functions $U_k(q)$ and $\tilde{U}_k(q)$ describe the form of reflection, a *standing wave*. In this reflection, every element of space dq carries oscillation with the infinitesimal amplitude $C_k U_k dq$ and the complex frequency λ_k . Thus function (3.2) describes oscillation of a damped harmonic oscillator with *continuously distributed parameters*; its mode of oscillation defined by the function $e^{\lambda_k t}$.

The functions $U_k(q)$ and $\tilde{U}_k(q)$ are solutions of equation (2.19) with the operator H

described by the matrix (2.17). This operator is of a strange kind: it is not a completely structured and articulated matrix operator. Therefore, the structure of the consistent cloud is, in a sense, underdeveloped.

B. As to the mode of oscillation, $\varphi_k(t) = e^{\lambda_k t}$, it has a definite frequency λ_k and, taken directly, corresponds to the oscillation of a damped harmonic oscillator with *lumped parameters* described by the equation

$$\alpha_k \frac{d^2 \varphi_k}{dt^2} + \beta_k \frac{d\varphi_k}{dt} + \gamma_k \varphi_k = 0, \quad (3.3)$$

where $\alpha_k, \beta_k, \gamma_k$ are positive coefficients.

As a whole, there is a set of n oscillation modes $\{e^{\lambda_k t}\}$ corresponding, as it were, to the set of n independent oscillators with lumped parameters. However, their independence is abstract, because their frequencies are intimately connected and organized by the whole structure of the consistent cloud determined by the operator H .

3.2. An organized cloud

C. (1) As follows from the above reasoning, the consistent cloud is, on the one hand, a linear system with continuously distributed parameters, and, on the other hand, as it were, a set of independent oscillators with lumped parameters constituting no integral system. Thus the structure of the consistent cloud is internally contradictory: the continuous spacial distribution of its parameters contradicts the discrete character of its oscillation modes. At the same time, as we have seen, these contradictory features mutually suggest, and are intimately connected with, each other, which implies the existence of their unity with the above contradiction settled.

(2) Indeed, under the influence of the above contradiction, on the one hand, and the exchange interaction with vacuum, on the other hand, the structure of the consistent cloud undergoes re-structuring: there takes place the process of concentrating the continuously distributed parameters into lumped parameters, like churning milk into grains of butter. As a result, the consistent cloud completes its process of self-organization and becomes an organized system of interdependent oscillators with lumped parameters, an *organized cloud*. The latter is, apparently, the hydrogen atom (H-atom), the simplest and most spread one in the universe. The orbiting electron is exactly the manifestation of the discrete character of the atom's internal structure.

Through the exchange interaction with vacuum, the organized cloud continuously reproduces itself and therefore retains the traces of all the previous entities – the muon, the mesons, and the neutron – being the completion of their evolution, on the one hand, and the most perfect discrete model of vacuum, on the other. For that reason, the organized cloud is immune to the destructive influence of vacuum and hence absolutely stable.

With the identity of space and time in vacuum and the space-time symmetry of its correlation function, the transformation of the neutron into the H-atom, with the spatially distributed parameters of the former turning into the lumped parameters of the latter, means the transformation of the space consistency of the neutron into the time consistency of the H-atom.

(3) The process of the organized cloud is described by a system of linear differential equations

$$\begin{aligned} \delta_{11} \varphi_1 + \delta_{12} \varphi_2 + \dots + \delta_{1n} \varphi_n &= 0 \\ \delta_{21} \varphi_1 + \delta_{22} \varphi_2 + \dots + \delta_{2n} \varphi_n &= 0 \\ \text{-----} \\ \delta_{n1} \varphi_1 + \delta_{n2} \varphi_2 + \dots + \delta_{nn} \varphi_n &= 0 \end{aligned} \quad (3.4)$$

where

$$\delta_{ik} = \alpha_{ik} \frac{d^2}{dt^2} + \beta_{ik} \frac{d}{dt} + \gamma_{ik}, \quad (3.5)$$

$\alpha_{ik}, \beta_{ik}, \gamma_{ik}$ are real constants. Making use of the matrices,

$$A = (a_{ik}) = \begin{pmatrix} \alpha_{11} & \alpha_{12} & \dots & \alpha_{1n} \\ \alpha_{21} & \alpha_{22} & \dots & \alpha_{2n} \\ \dots & \dots & \dots & \dots \\ \alpha_{n1} & \alpha_{n2} & \dots & \alpha_{nn} \end{pmatrix}, \quad B = (\beta_{ik}), \Gamma = (\gamma_{ik}) \quad (3.6)$$

and the n -vector function

$$\Phi = \begin{pmatrix} \varphi_1 \\ \varphi_2 \\ \dots \\ \varphi_n \end{pmatrix} \quad (3.7)$$

we rewrite (3.4) as

$$A \frac{d^2 \Phi}{dt^2} + B \frac{d \Phi}{dt} + \Gamma \Phi = 0 \quad (3.8)$$

or

$$\frac{d \mathbf{u}}{dt} + \hat{H} \mathbf{u} = 0, \quad (3.9)$$

where

$$\mathbf{u} = \begin{pmatrix} \frac{d \Phi}{dt} \\ \Phi \end{pmatrix} \quad (3.11)$$

$$\hat{H} = \begin{pmatrix} A^{-1} B & A^{-1} \Gamma \\ -I & 0 \end{pmatrix} \quad (3.10)$$

The partial solution of (3.8) is known to be

$$\mathbf{u} = U e^{\lambda t} \quad (3.12)$$

where U is a $4n$ -eigenvector satisfying the equation

$$\lambda U + \hat{H} U = 0 \quad (3.13)$$

where the complex eigenfrequency λ is determined by the characteristic equation

$$\det |\lambda I + \hat{H}| = 0 \quad (3.14)$$

and is supposedly close to the respective frequency of the consistent cloud.

Supposing the solutions of (3.13) to be simple and complex-conjugate – otherwise they would make no physical sense – we arrive at the general solution of (3.8),

$$\mathbf{u}(t) = \sum_{k=-n}^n T_k \mathbf{U}_k e^{\lambda_k t}, \quad a_{-k} = \tilde{a}_k \quad (3.15)$$

where the complex coefficients $\{T_k\}$ are, in general, different from the coefficients $\{C_k\}$ in (2.31) determined by the consistency of the consistent cloud with vacuum.

The vector function $\mathbf{u}(t)$ characterizes the structure of the organized cloud and may be called its *structural function*. Its k -th term,

$$\mathbf{u}_k(t) = T_k \mathbf{U}_k e^{\lambda_k t} + \tilde{T}_k \tilde{\mathbf{U}}_k e^{\tilde{\lambda}_k t}, \quad (3.16)$$

is a vector describing the oscillation with the complex frequency λ_k ; the vectors

$$\mathbf{U}_k = \begin{pmatrix} U_{k1} \\ U_{k2} \\ \dots \\ U_{kn} \end{pmatrix}, \quad \tilde{\mathbf{U}}_k = \begin{pmatrix} \tilde{U}_{k1} \\ \tilde{U}_{k2} \\ \dots \\ \tilde{U}_{kn} \end{pmatrix}, \quad (3.17)$$

defining the form of that oscillation: all their components, $\{U_{ki}\}$ and $\{\tilde{U}_{ki}\}$, oscillate with the same complex frequency λ_k , but have different amplitudes and initial phases.

3.3. Atomic subsystems

The organized cloud has a completely developed organization of its internal and external processes, that is, the pair and the exchange interactions of virtual electrons and positrons inside the cloud, and its exchange interaction with vacuum. The organization of these processes has achieved the level of three *autonomous subsystems* implementing these processes, on the one hand, and the appropriate *agents* for them, on the other hand. This conclusion is confirmed by the possibility of describing the organized cloud with the equation (3.8), where the real, symmetric matrices A, B, Γ correspond, apparently, to the above subsystems, while the vectors $\frac{d^2 \Phi}{dt^2}, \frac{d \Phi}{dt}, \Phi$ correspond to their respective agents. These subsystems and agents may be called, in a generalized sense, those of *inertia, dissipation, and elasticity*, respectively. The existence in the hydrogen atom of such subsystems and their agents, called quarks and gluons, respectively, has been established experimentally.

The neutron, which is also an organized system, should also have similar subsystems and agents, which, indeed, has been confirmed experimentally; however, they are not developed to the same extent as in the atom and cannot be described by matrices and vectors, except only symbolically.

Quarks and gluons have also been found inside the π -meson, the K -meson, and the η -meson, two quarks in each; these quarks being described as relative combinations of the quarks found in the nucleons (see, for example, [4,5]). In the context of the above theory, this fact may be commented as follows. The structures of the above mesons are much less developed than those of the neutron and the hydrogen atom and, unlike them, are not consistent with vacuum. For that reason, their *internal organs* are not developed to the level of three autonomous subsystems, but only to the level

of their two relative combinations, which may be symbolically described by the ratios of the above three matrices: A/B , A/Γ , B/A , B/Γ , Γ/A , Γ/B . These quarks implement the simplest operations, those of the conservation of energy and exchange interaction with vacuum, and may be called, accordingly, *the quarks of conservation and exchange*.

Conclusion

There have been obtained new results concerning the structure and the adequate way of description of the hydrogen atom, which introduces a useful and promising supplement to modern theories.

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Chapter 4. Parameters and characteristics of ether

Introduction

In this part of the research, published first in [1], we show that the above theoretical conclusions are confirmed by available experimental data on cosmic rays, making it possible to evaluate the essential parameters and characteristics of ether. In particular, there have been evaluated the normalized energy spectrum of ether and its correlation function, which enabled us to evaluate also the dimensions of subatomic particles and the electron.

4.1. The normalized energy spectrum of ether

4.1.1. Experimental data on cosmic rays

Now that the existence of ether has been confirmed and elucidated by the above theoretical analysis, it is necessary to evaluate its characteristics. To begin with, we should try and evaluate the spectrum of photons in ether, making use of the available data on cosmic rays. So let us consider the experimental data on the spectrum of cosmic rays stated in [2], and reproduced in rough in Fig.4.1.

Analyzing the spectra of different particles (electrons, positrons, protons and α -particles) depicted there, we notice that they have approximately the same cut-off energy (about $10^{8.5} eV$) and the same steepness of their slopes (about 2.7) for energies beyond the cut-off up to about $10^{12} eV$. This implies that the spectrum of the primary cosmic particles beyond $10^{8.5} eV$ does not depend on the nature of the particles and is determined only by the properties of ether. Therefore, the primary cosmic photons, which cannot perhaps be detected directly, but are nevertheless present in cosmic rays, should have the same spectrum, too. To evaluate the latter, let us consider the

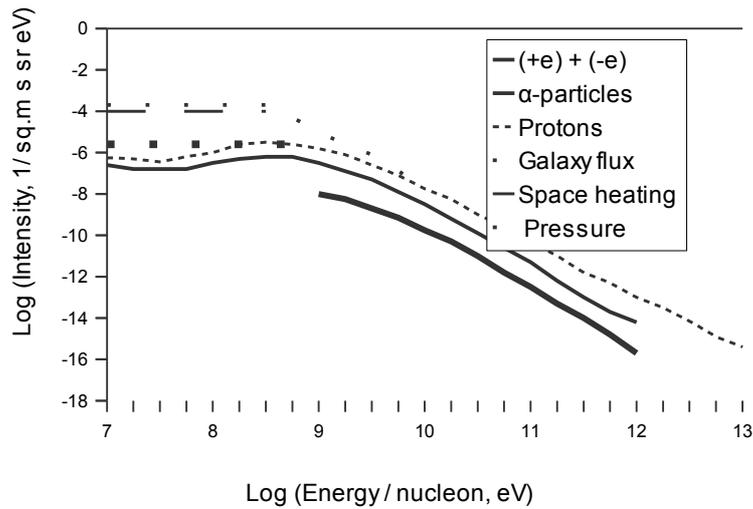


Fig.4.1 Spectrum of cosmic rays

spectrum of cosmic rays electrons that should be more characteristic of the spectrum of photons.

A detailed information on the spectrum of cosmic rays electrons is stated, for example, in [4], and is reproduced in rough in Fig.4.2. The spectrum depicted there consists of two parts, the main one which corresponds to energies above 10^8 eV and is ready to approximation, and the lower one which corresponds to energies below 10^8 eV and is distorted thoroughly by solar activity. The curve seems to have a plateau and is quite monotonous, as compared with the spectra of protons and α -particles

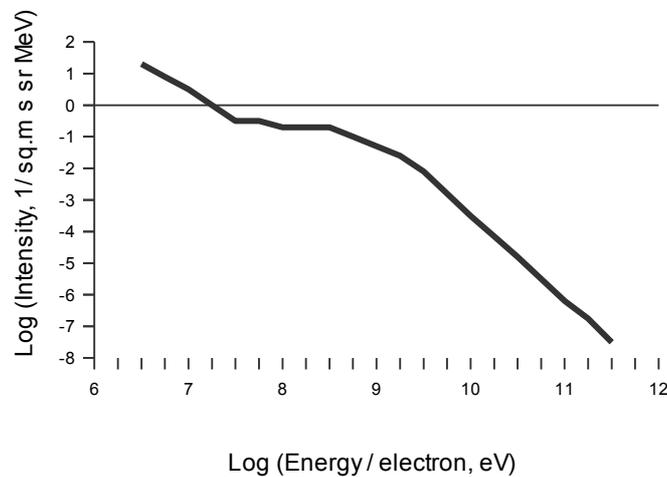


Fig.4.2 Spectrum of cosmic rays electrons

(Fig.4.1), with their distinct extrema. Because of the small mass of electrons and their probable direct transformation to photons via collision with positrons, the spectrum of cosmic photons should be closer to that of electrons, rather than to those of α -particles and protons, and therefore should have the same plateau as well. Additional considerations impel us to make a much stronger assumption: the spectrum of cosmic photons is likely to have a plateau from $10^{8.5}$ eV down to the zero energy.

4.1.2. The spectrum of cosmic rays photons

To substantiate the above assumption, let us return to Fig.4.1, to its dotted, dashed, and bold-dotted lines. As indicated in [3], the first corresponds to the estimated galactic flux, as interpreted from satellite measurements; the second is the spectrum required for interstellar cloud heating, and the third is that required for pressure support of the galactic disk. Thus different authors, from different points of view, have arrived at the same conclusion, i.e. the spectrum of the galactic flux,

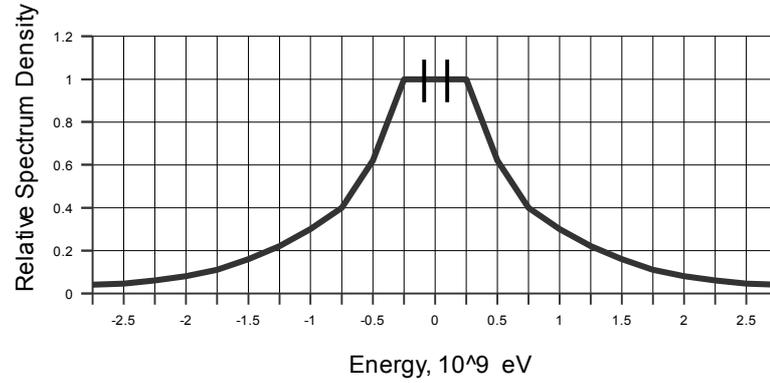


Fig. 4.3 Spectrum of cosmic rays photons

and therefore of cosmic photons as well, should have a plateau from about $10^{8.5}$ eV down perhaps to the zero energy.

To be more confident with the above assumption, let us consider now three additional arguments of our own. The first one is that the spectrum of cosmic photons, being supposedly the Fourier transform of the correlation function, or its like, which is a positive one, should have a positive zero-energy component.

The second argument is that the electromagnetic properties of ether have been experimentally found to be constant from extremely low frequencies to, at least, X-rays.

The third argument is that in depicting the spectrum of cosmic rays we should not ignore their isotropy. Indeed, as the momentum of a cosmic rays particle is a 3-vector, the three-dimensional spectrum of momentum of cosmic rays, given their isotropy, is a function spherically symmetrical about the center of coordinates, the latter corresponding to the zero energy. In a one-dimensional representation, this spectrum is an even function, and the problem of hypothesizing the missing part of the spectrum of electrons and therefore photons is thus reduced to that of the interpolation of the even function in a close vicinity of its zero abscissa, as shown on a linear scale in Fig.4.3 for the spectrum of photons.

The most natural form of the above-mentioned interpolation is, graphically, a straight line connecting two symmetrical points at $\pm 10^8$ eV indicated in curve of Fig.4.3 by two vertical dashed lines. Consequently, applying a piecewise linear approximation to the rest of the curve, we obtain the following evaluation of the *normalized* energy spectrum (the relative intensity, P) of ether:

$$\log P(E_{eV}) = \begin{cases} 0; & 0 \leq \log E \leq 8.5 \\ 8.5 - \log E; & 8.5 \leq \log E \leq 9.0 \\ 15.7 - 1.8 \log E; & 9.0 \leq \log E \leq 9.5 \\ 24.06 - 2.68 \log E; & 9.5 \leq \log E \end{cases} \quad (4.1)$$

4.2. Correlation function of ether

4.2.1. Formulas for computation

To evaluate the correlation function of ether (CFE), we should observe that the above evaluation of the spectrum of photons in ether (SPHE) deals with the relative probabilities of particles, which are associated with the second power of their wave functions, while the CFE, being a superposition of partial functions, is associated with the first power of wave functions. Therefore, on a linear scale, the first power of the absolute value of the SPHE is

$$SPHE(E) = 10^{0.5 \log P(E)} \quad (4.2)$$

As shown in Chapter 1, see (1.15), the CFE is determined by the formula

$$g(r) = \frac{1}{2\pi i} \int_L S(z) e^{zr} dz; \quad z = x + iy; \quad x \geq 0; \quad (4.3)$$

where the infinite curve L envelops the half-plane $\Re z < 0$ and where the function $S(z)$, the complex spectrum of compositums in ether, is analytic in the half-plane $\Re z > 0$. Representing $S(z)$ in the polar form as

$$S(z) = F(x, y) e^{i\varphi(x, y)}, \quad (4.4)$$

where

$$F(x, y) > 0; \quad -\pi < \varphi(x, y) \leq \pi; \quad \varphi(x, -y) = -\varphi(x, y); \quad (4.4')$$

and taking natural logarithm of both sides, we get the function

$$\ln S(z) = \ln F(x, y) + i\varphi(x, y), \quad (4.5)$$

which is also analytic under the above restrictions. Being conjugate parts of an analytic function, the functions $f(x, y) = \ln F(x, y)$ and $\varphi(x, y)$ satisfy the Cauchy-Riemann conditions

$$\frac{\partial f}{\partial x} = \frac{\partial \varphi}{\partial y}, \quad \frac{\partial f}{\partial y} = -\frac{\partial \varphi}{\partial x}. \quad (4.6)$$

Being therefore harmonic, these functions are connected with their boundary values by Poisson's formula, which for the function $f(x, y)$ in the half-plane $\Re z \geq 0$ takes the form

$$f(x_0, y_0) = \frac{x_0}{\pi} \int_{-\infty}^{\infty} \frac{f(0, y) dy}{(y - y_0)^2 + x_0^2}. \quad (4.7)$$

Now, taking into account that $f(0, y) = \ln SPHE(y)$ and $SPHE(0) > 0$, we are in a position to determine the functions $S(z)$ and $g(r)$ by the known function $SPHE(y)$. To that end, we should determine first the function $f(x, y)$ by the formula (4.7), then, using relations (4.6), find the function $\varphi(x, y)$, for example, by the integral

$$\varphi(x, y) = \int_{y_1=0}^y \frac{\partial f(x, y_1)}{\partial x} dy_1, \quad (4.8)$$

and, finally, find the functions $S(z)$ and $g(r)$ through the formulas (4.4) and (4.3), respectively.

4.2.2. Computation

A simplified block-program for computing the CFE according to the above algorithm is stated in Fig.4.4, with D being a space step, L the number of energy steps, M the number of space steps, G the resulting space function, and $A(I)$ the samples of the experimental data.

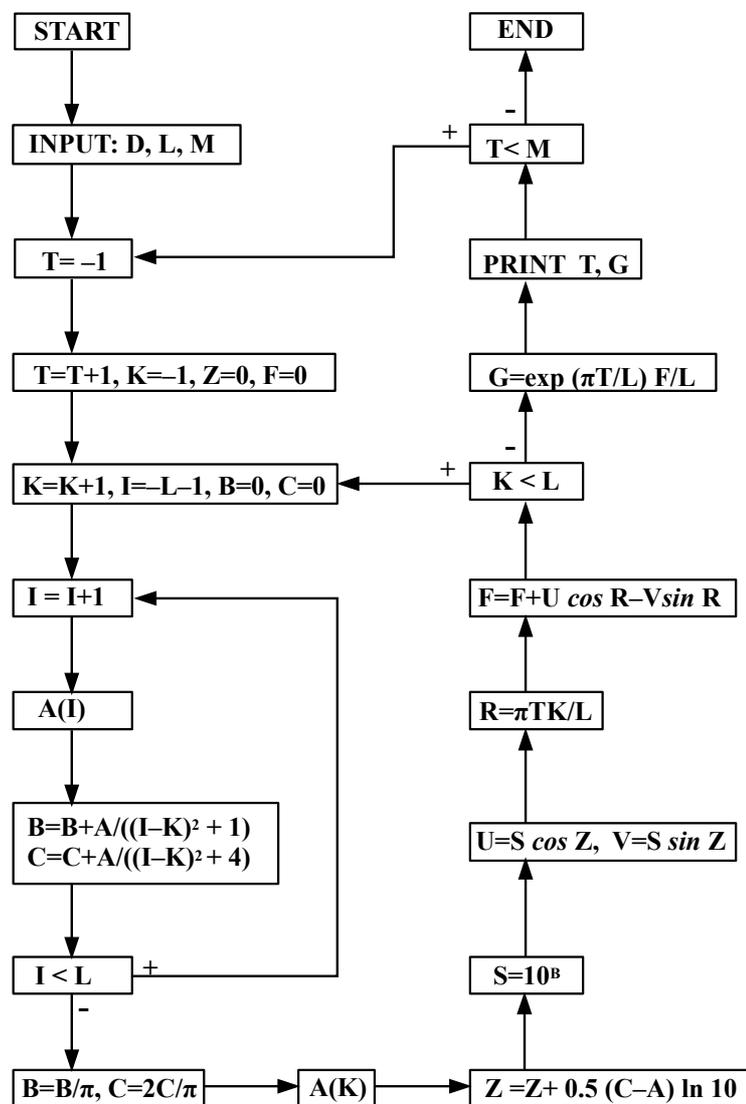


Fig.4.4 Block-program of computation

The computation was implemented with a programmable calculator for three cases: $D=0.05\text{ fm}$, $D=0.025\text{ fm}$ and $D=0.01\text{ fm}$, corresponding to three different ranges of energy: $1.26 \times 10^{10}\text{ eV}$, $2.52 \times 10^{10}\text{ eV}$ and $6.3 \times 10^{10}\text{ eV}$, respectively. The results of computation on a linear scale are shown in Fig.4.5 and Fig.4.6. The full program is stated in the Appendix.

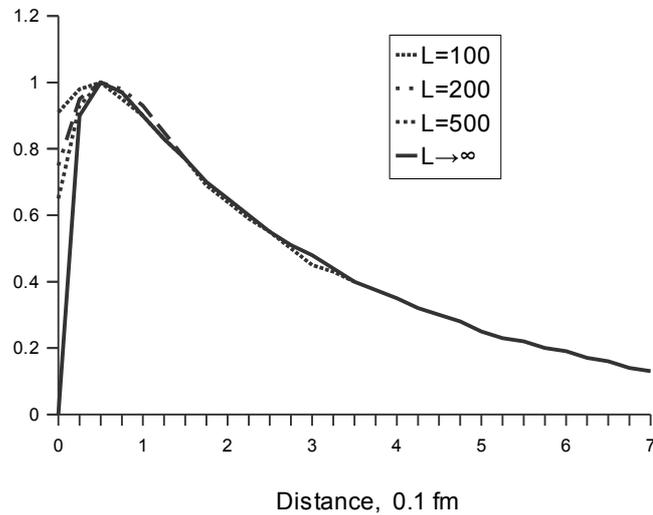


Fig. 4.5. Correlation function of ether

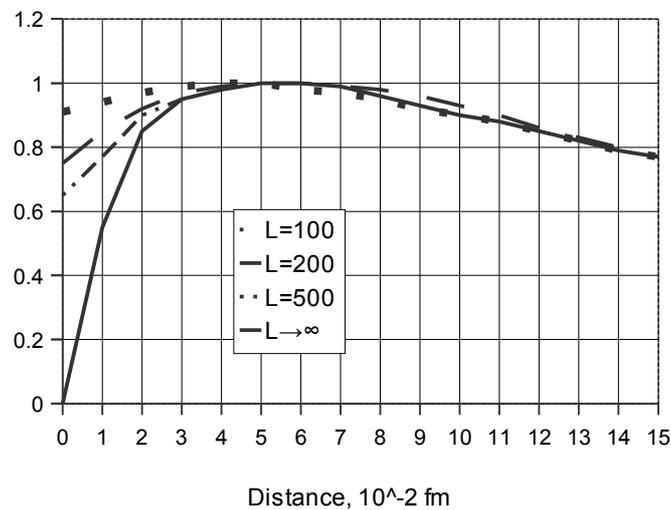


Fig. 4.6. Correlation function of ether. Detail

4.2.3. Analysis of the results

As seen in Fig.4.5, the computed curves consist of two parts, ascending and descending, meeting approximately at the distance $r_{et} \sim 0.052\text{ fm}$. (*et* stands for ether). The first part depends strongly on the high energy components involved in the analysis. The second part follows almost a strict

exponential law.

The above results seem to be quite comprehensible from the physical point of view. Indeed, the CFE starts with an excitation at $r=0$ which gives birth to a pair of virtual electron and positron, with their corpuscular interaction to follow. The latter cannot be concentrated in the infinitesimal region of the point $r=0$ and, to develop, must spread over a finite region, about r_{et} wide. Thus the first part of the curves ($r < r_{et}$) corresponds to the region of corpuscular interaction, this region being therefore the zone of uncertainty, the distance r_{et} the minimal interval discernible in ether, the *radius of uncertainty*. Within this zone, the concept of *correlation* between compositums makes no sense, which explains the ascending character of the CFE at $r < r_{et}$.

The second part of the curves ($r > r_{et}$) corresponds to the process of photon exchange. The intensity of this process, quite predictably, with a sufficiently wide range of energy involved in the analysis, declines exponentially with distance. The very fact that the above computation has exposed this intrinsic exponential character proves the above approximation of the experimental data, as well as the subsequent evaluation of the energy spectrum of ether, to be sufficiently accurate.

Taking into account both the calculation results and the above reasoning, we can describe the CFE, to a constant factor, by the expression

$$g(r) \propto \exp(-\alpha_{et}r) - \exp(-\beta_{et}r) \quad (4.11)$$

where

$$\alpha_{et} = 3.18 \text{ fm}^{-1}; \quad \beta_{et} = 56.81 \text{ fm}^{-1}; \quad (4.11')$$

the parameters α_{et} and β_{et} characterize the rate of degradation with distance of the processes of photon exchange and corpuscular interaction, respectively; accordingly, these parameters may be called the *rate of exchange interaction* and the *rate of pair (corpuscular) interaction*, respectively. The function (4.11), as shown in Fig.4.5 (the solid curve), seems to provide a good approximation of the computed curves at $L \rightarrow \infty$.

The function $\exp(-\beta_{et}r)$, characterizing the zone of uncertainty, enables us to determine the singularity distribution function, SDF (see Sec. 2.1 B). Indeed, it is the process of pair interaction that is responsible for the formation of the zone of uncertainty and is itself formed by that zone. Therefore, the function $\exp(-\beta_{et}r)$ characterizes the SDF. Now, as the function $g(r)$ has been treated above like a wave function, so should we treat its part, the function $\exp(-\beta_{et}r)$. To convert a wave function into the density function, we should square it. After normalization, we arrive at the following form of the SDF :

$$\varphi_o(q) = \frac{2\beta_{et}^3}{\pi^2} \exp(-2\beta_{et}|q|) \quad (4.12)$$

with the mean $q=0$ and the variance $\overline{q^2} = \frac{1}{2\beta_{et}^2}$.

4.3. Dimensions of particles

The above results enable us to evaluate the real dimensions of the electron and the muon. Indeed, as the results of Chapter 2 imply, in the state of rest, the real electron is a cyclic interaction of two conjugate compositums with a direct photon exchange between them, a cyclic corpuscular interaction. Therefore, in the state of rest the electron is localized within the zone of uncertainty, being actually its realization and manifestation. Thus function (4.12) may be considered the density

function of the mass of the electron in the state of rest. This conclusion enables us to evaluate the mean radius of the electron

$$\overline{R}_e = \frac{1}{2\beta_{et}} \approx 0.88 \times 10^{-2} \text{ fm} \quad ; \quad (4.13)$$

and its mean square-root radius

$$\sqrt{\overline{R}_e^2} = \frac{1}{\sqrt{2}\beta_{et}} \approx 1.24 \times 10^{-2} \text{ fm} \quad . \quad (4.14)$$

These values are over two hundred times less than the so-called electronic radius, $r_e \approx 2.82 \text{ fm}$, suggested by modern physics. This difference is accounted for by the unsuitability of the classical model of the electron on the basis of which the value r_e was calculated.

As to the dimensions of subatomic particles, let us consider first those of the muon, Its matter density function, as suggested in Chapter 2, is proportional to function (2.4). Taking into account the formula (4.11) and the inequality $\alpha_{et} \ll \beta_{et}$ we may reduce (2.4), similarly to (4.12), as

$$w(q) \propto \exp(-2\alpha_{et}|q|) \quad (4.15)$$

This function covers both the zone of correlation and that of uncertainty, that is the whole volume of the muon. Although the zone of uncertainty does not contribute to the mass of the correlated composites, it is the birth place of the electron and therefore does contribute to the total mass of the muon. This reasoning, apart from the implications of formula (2.4), suggests expression (4.15) to be the exact representation of the muon density, which gives the following estimation of the mean radius of the muon,

$$\overline{r}_m = \frac{1}{2\alpha_{et}} \approx 0.16 \text{ fm}. \quad (4.16)$$

and its mean square-root radius,

$$\sqrt{\overline{r}_m^2} = \frac{1}{\sqrt{2}\alpha_{et}} \approx 0.22 \text{ fm}. \quad (4.17)$$

To evaluate the dimensions of the neutron, let us take into account that the relation of the masses of neutron and muon is about 8.89. Assuming the same matter density in both particles, we arrive at the following estimation of the mean square-root radius of the neutron

$$r_n \approx r_m \times 8.89^{1/3} = 0.459 \text{ fm} \quad (4.18)$$

To compare this figure with the existing evaluations, let us consider the values given, for example, in [4]. Analyzing electric and magnetic models of nucleons, the authors arrived at the following evaluations of the mean square-root radii of the neutron: 0.86 fm for the magnetic model and about 0.1 fm for the electric model. Additional data received in electron-scattering experiments and revealing distributions of charge within individual protons and neutrons, [5, 6], suggest that the mean radius of the neutron is between 0.3 fm and 0.5 fm . All that means that our above evaluations, though obtained from quite a different approach, seem to match well with the range of existing evaluations.

Conclusion

This part of the research confirms the theory developed in the previous chapters, concerning the existence of ether, its composition and properties, and, complementing it with a quantitative analysis based on the well-known experimental data, seems to put an end to this most cardinal and puzzling problem of modern physics.

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Chapter 5. Introduction to the electric model of the atom

Introduction

This chapter deals with such fundamental problems of modern physics as the nature of nuclear interaction and the nuclear structure of the two most fundamental atoms, the atoms of deuterium (D-atom) and helium (He-atom). In modern theory (see, for example, [1, 2]) the D-atom is considered simply a hydrogen isotope, with its nucleus consisting of a proton and a neutron bound by some unclear binding force. In this chapter, using our new method of research, we discover the nature of that binding force and introduce an evolutionary theory of the nuclear structure based on the electric model of the atom.

5.1. The H-atom

5.1.1. Interaction with vacuum

As shown in Chapter 3, the process of the H-atom (the organized cloud) is characterized by the $4n$ -component structural vector-function of time,

$$\mathbf{f}(t) = \sum_{k=-n}^n T_k \mathbf{U}_k \exp(\lambda_k t), \quad a_{-k} = \tilde{a}_k \quad (5.1)$$

This function looks like a response of the atom to some standard excitation, an excitation by a photon, a pulse excitation. Judging by this function, the H-atom is a linear system with n degrees of freedom. So let us now investigate what kind of system it is.

It seems from (5.1) that the structure of the H-atom consists of two major parts: a deterministic part corresponding to the set of vectors $\{\mathbf{U}_k\}$ and a stochastic part corresponding to the set of coefficients $\{T_k\}$. The latter are formed through the process of the neutron (the consistent cloud) which is therefore implicitly present in the process of the H-atom. This structural duality manifests itself in the H-atom consisting explicitly of two parts: a *proton* and an *electron*, the first being a

deterministic part, the second a stochastic one, the agent of interaction with vacuum.

Owing to its dual structure, the H-atom responds to vacuum excitations in two ways: by scattering incident photons, and by absorbing and assimilating them thus reproducing its own structure and rejecting the surplus of energy, in accordance with its own organized structure, in the form of organized groups of photons – *neutrinos*; the latter may be called *electric neutrinos*, as shown below.

5.1.2. The rough model

The structure of the H-atom is expressed by function (5.1) only implicitly and cannot be modeled directly from it. Thus the H-atom, with such an abstract structure, is a *thing-in-itself*, still to be determined and exposed, a *purpose-in-itself*. As such a purposeful system, the H-atom is also a means for its own realization, an *electric device* consisting explicitly of a positively charged nucleus and a negatively charged stochastic shell, a storage of electric energy, an *electric capacitor* of some capacitance C_o . The process of its interaction with vacuum, that is the process of receiving and radiating electromagnetic waves, can simply be represented by some *wave impedance* R_o .

The above reasoning suggests that the H-atom can be represented by an electric RC-circuit as shown in Fig.5.1, where $e(t)$ is a generator of electromotive force (emf) modeling electric excitations generated by ether.

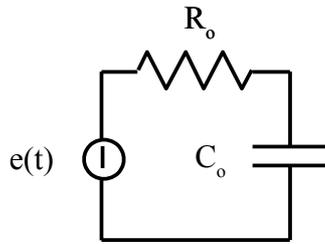


Fig.5.1 The rough model of the H-atom

With this representation, the process of the H-atom is characterized by the time change of the charge $q(t)$ of the capacitor, which satisfies the equation

$$R_o \frac{dq(t)}{dt} + \frac{1}{C_o} q(t) = e(t) \quad (5.2)$$

Assuming zero initial conditions and $e(t) = \delta(t)$, where $\delta(t)$ is the delta-function, and taking the Laplace transform, $L\{ \}$, of both sides in (5.2), we obtain the equation

$$pR_o Q(p) + \frac{1}{C_o} Q(p) = 1 \quad (5.3)$$

where

$$Q(p) = L\{q(t)\} = \int_0^{\infty} q(t) \exp(-pt) dt \quad (5.4)$$

which gives

$$Q(p) = \frac{C_o}{p\tau_c + 1}, \quad \tau_c = R_o C_o \quad (5.5)$$

and, up to a constant factor,

$$q(t) = L^{-1}\{Q(p)\} \propto \exp\left(-\frac{t}{\tau_c}\right) \quad (5.6)$$

Function (5.6) determines correlation between two states of the atom separated by time t and may be called its *correlation function*, the time constant τ_c being the mean interval between excitation and emission.

To analyze function (5.6) from the spectral point of view, let us put $p = i\omega$ in (5.5) and consider the square of its absolute value. Up to a constant factor, we have

$$|Q(i\omega)|^2 \propto \frac{1}{1+x^2} \quad (5.7)$$

where $x = \omega \tau_c$. This function is a normalized energy spectrum of the H-atom radiation and is evaluated below.

5.1.3. The exact model

In the above model of the H-atom, its response (5.6) to an excitation turns up immediately, which cannot occur in reality, because it takes some time for the excitation to be processed by the atom. To amend this defect of the rough model, we should take into account the magnetic properties of the atom. Indeed, due to its own magnetic moment, the H-atom presents also a *magnetic inductor* of some *inductance* L_1 , which, for the above reason, should be connected in series with R_o and C_o . With this addition, the model of the H-atom looks as shown in Fig.5.2.

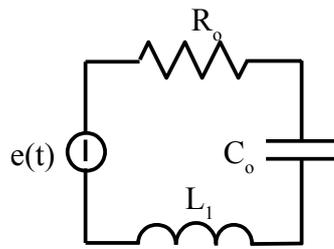


Fig. 5.2 The exact model of the H-atom

This is the exact model of the H-atom interacting with ether. Its process is depicted by the equation

$$L_1 \frac{d^2 q}{dt^2} + R_o \frac{dq}{dt} + \frac{q}{C_o} = e(t) \quad (5.8)$$

Repeating the above procedure, with $e(t) = \delta(t)$, we find

$$Q(p) = \frac{1}{L_1(p-p_1)(p-p_2)} \quad (5.9)$$

where

$$p_{1,2} = -\frac{R_o}{2L_l} \pm \sqrt{\frac{R_o^2}{4L_l^2} - \frac{1}{L_l C_o}} \quad (5.10)$$

Up to a constant factor,

$$Q(p) \propto \left(\frac{1}{p-p_1} - \frac{1}{p-p_2} \right) \quad (5.11)$$

which gives

$$q(t) \propto \exp(p_1 t) - \exp(p_2 t) \quad (5.12)$$

This is the exact pulse response, the correlation function of the H-atom, its initial value $q(0) = 0$.

Substituting $p = i\omega$ in (5.11) and finding the square of its absolute value, we have

$$|Q(i\omega)|^2 \propto \frac{1}{(\omega^2 + p_1^2)(\omega^2 + p_2^2)} \quad (5.13)$$

which is the normalized energy spectrum of the H-atom in its exact representation.

5.1.4. Magnetic deficiency

The H-atom stores energy primarily in the form of electric field and therefore cannot respond adequately to the dual electromagnetic excitations generated by ether. With this magnetic deficiency, under the pressure of vacuum excitations, the H-atom tends to develop its magnetic capability and transform its structure accordingly.

5.2. The Neutron

5.2.1. Interaction with vacuum

The neutron, as shown in Chapter 2, is characterized by the $4n$ -component space-time function,

$$f(q, t) = \sum_{k=-n}^n C_k U_k(q) \exp(\lambda_k t) \quad (5.14)$$

Its continuously distributed structure manifests itself by its intrinsic magnetic field generated by some internal currents. It is through its magnetic field and magnetic perceptivity protruding far outside its structure that the neutron interacts with vacuum. In that interaction, it scatters, absorbs and assimilates incident photons and ejects the surplus of energy in the form of neutrinos which, unlike the above-mentioned electric neutrinos, may be called *magnetic neutrinos*.

5.2.2. The rough model

Taken directly, the neutron is a storage of magnetic energy, an elementary *electric inductor* of some inductance L_o . Owing to the mutual correspondence of the structures of the H-atom and the neutron and their dual consistency with ether, the interaction of the neutron with ether should be

represented by the same wave impedance R_o . Accordingly, the neutron can be represented in rough by an electric circuit shown in Fig.5.3 and consisting of inductor L_o and resistor R_o . The circuit is excited by a generator of electric current $i(t)$ modeling the magnetic field excitation supplied by ether. The parallel structure of the circuit is exactly due to the magnetic character of the interaction.

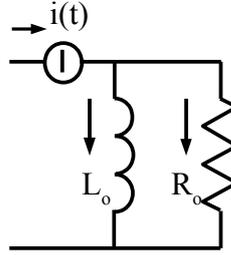


Fig. 5.3 The rough model of the neutron

In this model, the process of the neutron is characterized by the time change of the current $i_L(t)$ in the inductor in accordance with the equation

$$\tau_L \frac{di_L}{dt} + i_L = i(t) \quad (5.15)$$

where $\tau_L = L_o/R_o$; this equation is similar to (5.2).

Assuming zero initial conditions, substituting $i(t) = \delta(t)$ and finding the Laplace transform of (5.15), we have

$$I_L(p) = \frac{1}{1 + p \tau_L} \quad (5.16)$$

which, up to a constant factor, gives

$$i_L(t) \propto \exp\left(-\frac{t}{\tau_L}\right) \quad (5.17)$$

Function (5.17) determines correlation of processes in states separated by the time t , the time constant τ_L being the mean interval between excitation and emission. Owing to the kinship and the interdependency of the H-structure and the n-structure, $\tau_L = \tau_C$. Due to the identity of functions (5.6) and (5.17), the normalized energy spectrum of the neutron is similar to that of the H-atom.

Comments:

Taking into account their origin, the above mentioned electric and magnetic neutrinos seem to correspond in modern terms to the electronic and muonic neutrinos, ν_e and ν_μ , respectively.

5.2.3. The exact model

The above analysis suggests that the H-atom and the neutron have dual structures with a thoroughly developed duality owing to the dual electromagnetic excitations supplied by vacuum. Therefore, similar to the H-atom which has major electric properties and minor magnetic properties, we should assume that the neutron, apart from its major magnetic properties, has also minor electric properties. Indeed, the existence of such properties has been established experimentally (see, for

example, [2]). These minor electric properties of the neutron can be simply represented by a capacitor of some capacitance C_1 . With this amendment, the process of the neutron interacting with vacuum can be modeled by the electric circuit in Fig.5.4.

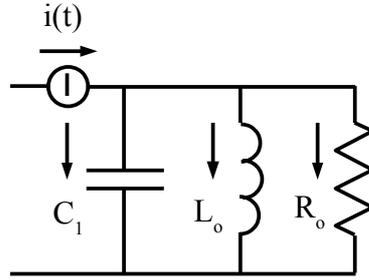


Fig.5.4 The exact model of the neutron

According to Kirchhoff's law,

$$i_L + i_R + i_C = i(t) \quad (5.18)$$

Making use of the Laplace transforms of the respective currents, $I_L(p)$, $I_R(p)$, $I_C(p)$ and $I(p)$, with $i(t) = \delta(t)$, and assuming zero initial conditions, (5.18) is replaced by

$$I_L + I_R + I_C = I \quad (5.18')$$

which gives the following:

$$I_L = \frac{R_o}{pL_o} I_R, \quad I_C = pR_o C_1 I_R \quad (5.19)$$

$$I_R(p) = \frac{pL_o}{p^2 R_o L_o C_1 + pL_o + R_o} \quad (5.20)$$

While for the H-atom, the storage of mainly electric energy, it was essential to find its response in the form of the electric charge on the capacitor C_o , for the neutron, the storage of mainly magnetic energy, it is essential to find its response in the form of the electric current in the inductor L_o . Thus, substituting (5.20) in (5.19), we have

$$I_L(p) \propto \frac{1}{p^2 R_o L_o C_1 + pL_o + R_o} \quad (5.21)$$

Now, following the principle of dual symmetry of the H-structure and the n-structure, and taking into account their mutual consistency and consistency with ether, we should assume the following identities:

$$\frac{L_o}{C_o} = \frac{L_1}{C_1} = R_o^2 \quad (5.22)$$

With this assumption, (5.21) becomes identical, up to a constant factor, to (5.11). Thus the H-atom and the neutron have identical pulse responses to electric and magnetic excitations, respectively.

5.2.4. Electric deficiency

The neutron stores energy primarily in the form of magnetic field and therefore cannot respond adequately to the dual electromagnetic excitations generated by ether. With this electric deficiency, under the pressure of vacuum excitations, the neutron tends to develop its electric capability and transform its structure correspondingly.

5.3. The D-atom

5.3.1. Nuclear interaction

The eventual transformation of the neutron into the H-atom, accompanied by the transformation of its magnetic energy into electric energy, implies the possibility of their reverse transformation. Moreover, the duality of their above models, with electric deficiency on the one side and magnetic deficiency on the other, suggests the neutron and the H-atom to be dual parts of some integral electromagnetic entity. So it is natural that in stars, where there exist proper conditions, neutrons and H-atoms are drawn to each other and unite into the atoms of deuterium, D-atoms. The D-atom is the simplest case of *nuclear interaction*, its bare manifestation, *the embryo of the atom*.

5.3.2. The rough model

Following the above development, the process of the D-atom should be represented by the synthesis of the above H- and n-models. In the rough representation of the D-atom by electric circuit, we allow only for the major parameters of its constituents, that is R_o and C_o for the H-atom and R_o and L_o for the neutron. Their synthesis may be of two kinds, shown in Fig.5.5a and Fig.5.5b, corresponding to electric and magnetic excitations, respectively.

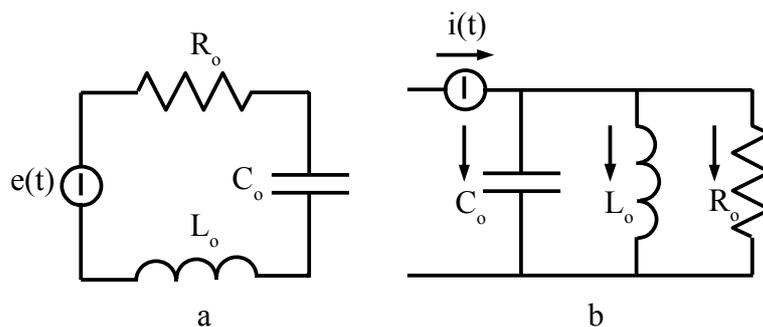


Fig.5.5 The rough models of the D-atom:
(a) electric excitation, (b) magnetic excitation

This means that the process of the D-atom exists only in one phase, either electric or magnetic, corresponding to the respective types of excitation. Noteworthy, these models contain only three components each, instead of four components in total in the separate models of the H-atom and the neutron, which implies a higher structural efficiency of the D-atom, as compared with that of its constituents.

Before defining the characteristics of these models, we should determine first what type of characteristics (the charge in the capacitor, the current in the inductor or the potential difference of the resistor) is essential for these models. The answer is suggested by the models themselves: it is

the common current $i(t)$ for the series circuit in Fig.5.5a and the common potential difference $V(t)$ for the parallel circuit in Fig.5.5b. The fact that the above circuits, when excited by *emf* or current, respectively, respond with current and potential difference, respectively, means that the D-atom converts the type of field from electric to magnetic and vice versa – the effect of *field conversion*.

5.3.3. Characteristics

(a) The pulse response. Making use of the procedures stated above, we find the Laplace transform of the current $i(t)$ in Fig.5.5a and the common potential difference $V(t)$ in Fig.5.5b, as follows:

$$I(p) = \frac{pC_o}{p^2 L_o C_o + pR_o C_o + 1} \quad (5.23)$$

$$V(p) = \frac{pL_o}{p^2 L_o C_o + pL_o R_o^{-1} + 1} \quad (5.24)$$

Taking into account equality (5.22), we find the above characteristics to be identical up to a constant factor. After simple operations, we can rewrite (5.23) as

$$I(p) = \frac{pC_o}{(p-p_1)(p-p_2)} \quad (5.25)$$

where

$$\begin{aligned} p_{1,2} &= -\alpha \pm i\omega_1; \quad \alpha = \frac{R_o}{2L_o} \\ \omega_1 &= \sqrt{\omega_o^2 - \alpha^2}; \quad \omega_o^2 = \frac{1}{L_o C_o} \end{aligned} \quad (5.25')$$

that is $\omega_o = 2\alpha$. Expressing (5.25) in terms of partial functions, we have

$$I(p) = pC_o \left(\frac{A}{p-p_1} + \frac{B}{p-p_2} \right) \quad (5.26)$$

where $A = \frac{p_1}{p_1 - p_2}$, $B = -\frac{p_2}{p_1 - p_2}$, which, up to a constant factor, gives

$$i(t) \propto e^{-\alpha t} \left(\cos \sqrt{3}\alpha t - \frac{1}{\sqrt{3}} \sin \sqrt{3}\alpha t \right) \quad (5.27)$$

Remarkably, the damping exponent factor, $\alpha = \frac{R_o}{2L_o}$, in (5.27) is half those for the separate H-

atom and neutron, $\frac{1}{R_o C_o}$ and $\frac{R_o}{L_o}$ in (5.6) and (5.17), respectively, which implies a more

efficient mode of energy conservation in the D-atom as compared with its constituents. Thus it is this already mentioned structural efficiency of the D-atom that prompts the H-atom and the neutron to unite.

(b) The normalized energy spectrum. Assuming $p=i\omega$ in (5.26), we find

$$|I(i\omega)|^2 = \frac{C_o^2 \omega^2}{[\alpha^2 + (\omega - \sqrt{3}\alpha)^2][\alpha^2 + (\omega + \sqrt{3}\alpha)^2]} \tag{5.28}$$

After some rearrangement, with $x = \frac{\omega}{\omega_o}$, we have

$$|I(i\omega)|^2 \propto \frac{x^2}{x^4 - x^2 + 1} \tag{5.29}$$

This is the normalized energy spectrum of the D-atom.

5.3.4. The exact model

In the exact representation, we should allow also for the minor parameters of the above models, that is L_1 for the H-model and C_1 for the n-model. Then the models for the electric and magnetic phases of the D-atom look as shown in Fig.5.6a and Fig.5.6b, respectively.

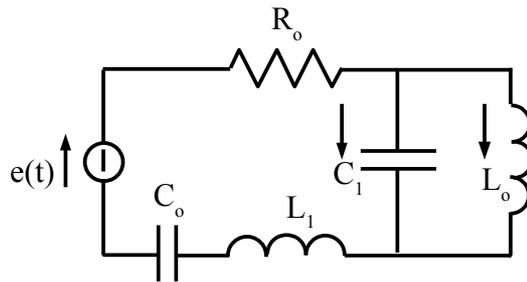


Fig.5.6a The exact model of the D-atom for electric excitation

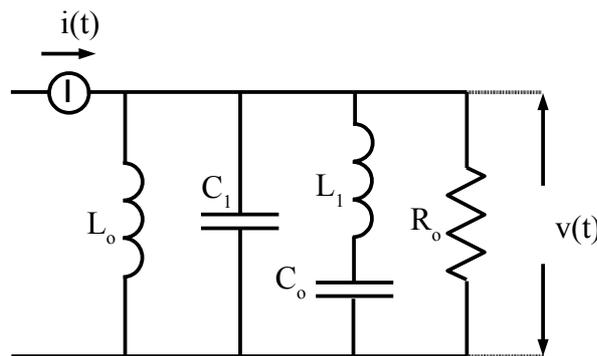


Fig. 5.6b The exact model of the D-atom for magnetic excitation

Although the mathematical analysis of these circuits is simple, in principle, it is rather cumbersome, and we shall confine ourselves in this work to the above analysis of the rough models of the D-atom.

5.3.5. Interaction with vacuum

The D-atom is thus a kind of electromagnetic resonator generated by ether, consistent with it, and *living* in it. Excited sporadically by vacuum photons and neutrinos, it absorbs and assimilates them, thus reproducing its own structure. In doing so, it transforms its internal energy alternately from electric form to magnetic one and vice versa, while radiating the surplus of energy in the form of neutrinos. When excited by photons, the D-atom responds with electric or magnetic neutrinos, depending on the kind of excitation. When excited by neutrinos, the D-atom, in accordance with its internal logic, transforms electric neutrinos to magnetic ones and vice versa.

5.4. The He-atom

5.4.1. From the D-atom to the He-atom

The above electromagnetic models of the D-atom suggest that the state of the gas of D-atoms cannot be stable indefinitely. Indeed, according to those models, the process of the D-atom is one-sided: it is either in the electric phase or in the magnetic one, which contradicts the electromagnetic duality of ether. Besides, owing to the above-mentioned effect of field conversion, separate D-atoms, unlike ether, are not transparent. So separate D-atoms cannot adequately respond to excitations and are prompted to unite. As a result, under proper conditions, D-atoms collide and unite in pairs giving birth to the He-atoms.

Because of its dual structure, the He-atom responds adequately to the dual electromagnetic excitations supplied by vacuum. In particular, when excited by neutrinos, the He-atom converts them first into their dual types (electric neutrinos to magnetic ones and vice versa) and then returns them to their original types. This makes the He-atom transparent, to a significant extent, to both photon and neutrino excitations and therefore more consistent with ether. This explains the great abundance of the He-atom, as compared with that of the D-atom, and its role as the foundation in all the more complex atoms.

5.4.2. The rough model

In the above context, the He-atom should be represented by two united LCR-circuits. This unification may be either magnetic, with a double inductance, as shown in Fig.5.7a, or electric, with a double capacitance, as shown in Fig.5.7b.

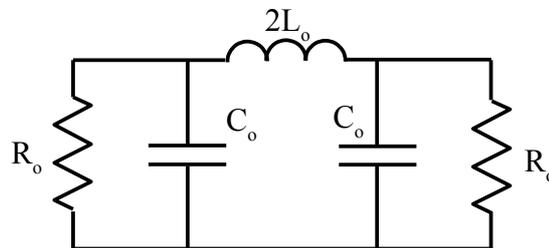


Fig. 5.7a The model of the magnetic unification of two D-atoms

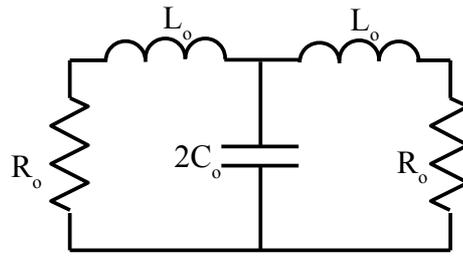


Fig.5.7b The model of the electric unification of two D-atoms

The second version seems to be more probable, because it contains only two meshes and therefore is more simple, and, what is more important, it has a distributed magnetic structure and a concentrated electric one, which is more consistent with the nature of its components – neutrons, with their distributed magnetic structure, and H-atoms, with their concentrated electric one. So we take the circuit in Fig.5.7b as the rough model of the He-atom.

As compared with its constituents, D-atoms, the model of the He-atom, a T-shape low-pass filter, has an important feature of symmetry which imparts it the above-mentioned property of transparency, making it a rough physical model of ether. To calculate the characteristics of this model, we should include in it the generator of *emf* (as shown in Fig.5.8) or current modeling excitations supplied by ether.

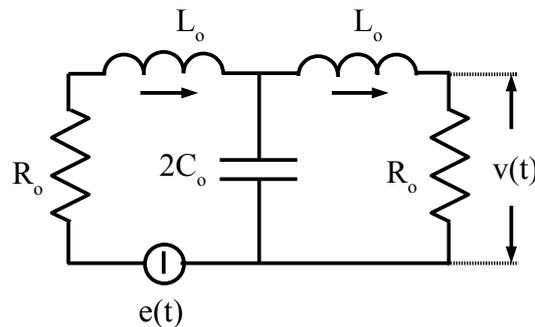


Fig. 5.8 Rough model of the He-atom

Making use of the above-mentioned operational method based on the Laplace transformation, assuming $L\{e(t)\}=1$ and zero initial conditions, we write Kirchhoff's equations for the circuit as follows:

$$\begin{aligned} Z I_1 - Z_{12} I_2 &= 1 \\ -Z_{12} I_1 + Z I_2 &= 0 \end{aligned} \tag{5.30}$$

where ,

$$Z = pL_o + Z_{12} + R_o, \quad Z_{12} = \frac{1}{2pC_o} \tag{5.30'}$$

I_1 and I_2 are the transforms of the loop currents in the left and right meshes, respectively.

5.4.3. The pulse response

From equations (5.30) we find the following expression for the transform of the potential difference $v(t)$:

$$V(p) = I_2 R = \frac{RZ_{12}}{Z^2 - Z_{12}^2} \quad (5.31)$$

Replacing Z and Z_{12} in (5.31) by their above expressions, making use of the relations (5.22) and (5.25'), we find:

$$V(p) = \frac{\omega_o^3}{2(p + \omega_o)(p^2 + p\omega_o + \omega_o^2)} \quad (5.32)$$

This function has three poles:

$$p_1 = -\omega_o, \quad p_{2,3} = -\frac{\omega_o}{2} \pm \frac{i\sqrt{3}\omega_o}{2} \quad (5.33)$$

and its inverse Laplace transform, up to a constant factor, is

$$v(t) \propto e^{-2\alpha t} + e^{-\alpha t} \left(\frac{1}{\sqrt{3}} \sin \sqrt{3}\alpha t - \cos \sqrt{3}\alpha t \right) \quad (5.34)$$

where $\alpha = \frac{\omega_o}{2}$. This is *the correlation function of the He-atom*.

5.4.4. The spectral transparency

To analyze the process of the He-atom from the spectral point of view, let us put $p = i\omega$ in (5.32), then, introducing $x = \omega/\omega_o$, we have

$$V(i\omega_o x) = \frac{1}{2(1 + ix)(1 - x^2 + ix)} \quad (5.35)$$

from which we find, up to a constant factor,

$$|V(i\omega_o x)|^2 \propto \frac{1}{1 + x^6} \quad (5.36)$$

Function (5.36) may be called the *spectral transparency* of the He-atom.

5.4.5. The exact model

To upgrade the rough model of the He-atom to the exact model, we should allow for the minor parameters: the capacitors C_1 shunting the inductors L_o and the inductors L_1 connecting the main capacitance with the resistors R_o , as shown in Fig.5.9. As the mathematical analysis of this circuit would be cumbersome, we confine ourselves here to the above analysis of the rough model.

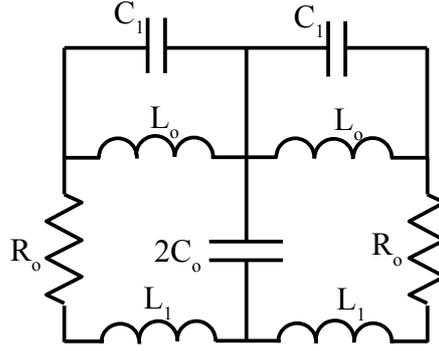


Fig. 5.9 The exact model of the He-atom

5.5. Evaluation of the electric parameters

Let us now evaluate the parameters of the above electric models. First of all, taking into account the wave nature of the D-atom interaction with vacuum and the common origin of its parameters generated and maintained in the process of that interaction, we should confirm the above-assumed relation (5.22), which is characteristic in general of such electromagnetic devices as antennas, waveguides, electromagnetic lines, etc. Now, taking into account the intrinsic consistency of the D-atom with vacuum, we should assume also the equality

$$R_o^2 = \frac{\mu_o}{\epsilon_o} \quad (5.37)$$

because the value $\sqrt{\frac{\mu_o}{\epsilon_o}} \approx 120\pi$ is known to be exactly the wave impedance of space. Thus we conclude:

$$R_o \approx 120\pi = 376.7\Omega. \quad (5.38)$$

Now let us evaluate the fundamental frequency f_o of the D-atom. As the mass of the atom is approximately proportional to the third power of its mean radius, we may assume the relation

$$\frac{m_H}{m_D} = \frac{r_H^3}{r_D^3} \quad (5.39)$$

held between the masses and the mean radii of the H-atom and the D-atom. Assuming the equality $m_D = 2m_H$, we find

$$r_D = r_H \sqrt[3]{2} \quad (5.40)$$

To evaluate the mean radius of the H-atom, we take into account that the subatomic particles are formed under the direct influence of the correlation function of ether and, therefore, their dimensions are closely connected with the parameters of that function. Assuming the equality

$r_H = r_n$, where n stands for neutron, we may approximately admit

$$r_H \approx \alpha_{et}^{-1} \quad (5.41)$$

where $\alpha_{et} = 3.18 \times 10^{15} m^{-1}$; it is the rate of exchange interaction in ether, used in the approximation of its correlation function,

$$g(r) \propto \exp(-\alpha_{et} r) - \exp(-\beta_{et} r) \quad (5.42)$$

offered in Chapter 4, where $\beta_{et} = 56.81 \times 10^{15} m^{-1}$ is the rate of corpuscular (pair) interaction in ether. Now we may assume r_D equal to quarter of the wave-length of the fundamental frequency f_o , which yields

$$f_o = \frac{c\alpha_{et}}{4\sqrt[3]{2}} \quad (5.43)$$

where c is the velocity of light; calculating, we find

$$f_o = 1.89 \times 10^{23} Hz \quad (5.43')$$

The comparison in Fig.5.10 of the correlation function of ether with that of the H-atom in its rough representation (5.6), with $\tau_c = 1/2\pi f_o$, shows their identity for $t > r_{et}/c$. This is understandable because the H-atom is dominant in ether and their characteristics should indeed be largely identical. This enables us to do more plausible evaluations. To this end, taking into account the identity of the expressions (5.12) and (5.42) for the correlation functions of the H-atom and ether, respectively, we conclude:

$$p_1 = -\alpha_{et} c, \quad p_2 = -\beta_{et} c \quad (5.44)$$

which gives the following formulas:

$$\begin{aligned} C_o &= \frac{|\alpha_{et} + \beta_{et}|}{cR_o \alpha_{et} \beta_{et}}, \quad L_o = C_o R_o^2, \\ L_1 &= \frac{R_o}{c|\alpha_{et} + \beta_{et}|}, \quad C_1 = \frac{L_1}{R_o^2} \end{aligned} \quad (5.45)$$

Calculating, we obtain the following values:

$$\begin{aligned} L_o &= 4.17 \times 10^{-22} H, \quad C_o = 2.94 \times 10^{-27} F, \\ L_1 &= 2.09 \times 10^{-23} H, \quad C_1 = 1.48 \times 10^{-28} F. \end{aligned} \quad (5.46)$$

The above amendment gives a more exact evaluation of the fundamental frequency of the D-atom

$$f_o = \frac{1}{2\pi \sqrt{L_o C_o}} = 1.44 \times 10^{23} Hz \quad (5.47)$$

which corresponds to quantum energy

$$E = hf_o \approx 9.54 \times 10^{-11} J \approx 5.95 \times 10^8 eV. \quad (5.47')$$

5.6. Discussion of the results

5.6.1. Ether and the atoms

Let us compare the correlation and the spectral functions of the H-atom, D-atom and He-atom with those of ether, as shown in Fig.5.10 and Fig.5.11. Taking into account the identity $r = ct$ and the evaluations $\alpha = \pi f_0 = 4.52 \times 10^{23}$ rad/s; $\alpha_{et} c = 2.11 \alpha$; $\beta_{et} c = 37.71 \alpha$, we rewrite (5.42) as

$$g_{et}(ct) \propto \exp(-2.11\alpha t) - \exp(-37.71\alpha t) \tag{5.48}$$

which enables us to use common frames for all objects.

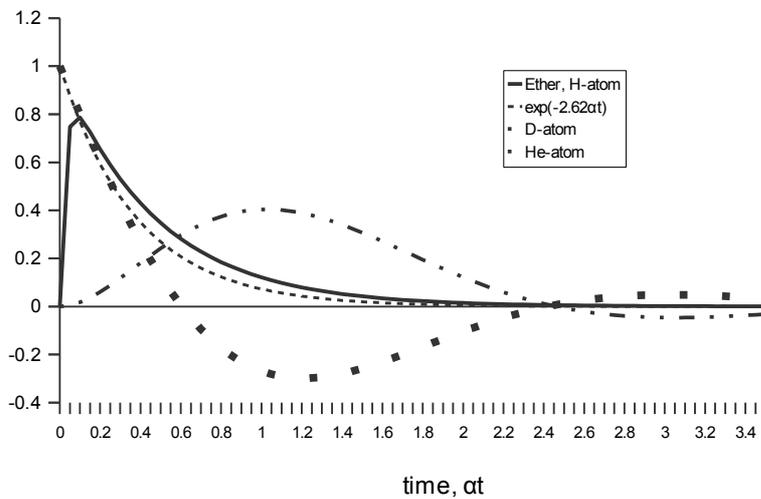


Fig. 5.10 Correlation functions of the atoms

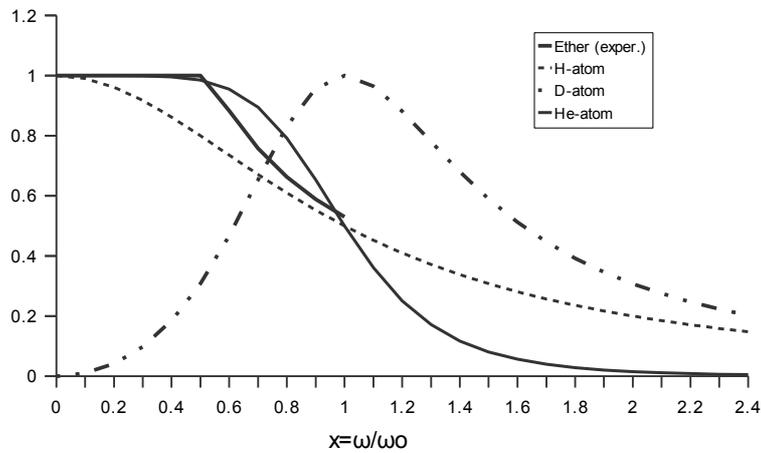


Fig.5.11 Spectral functions of the atoms

Note that Fig.5.10 shows the characteristics in an early-time presentation corresponding to the high-energy region, while Fig.5.11 presents the characteristics in a low-energy region. For this reason, the low-energy cut-off region of the ether spectrum is neglected in Fig.5.10, while it is prominent in Fig.5.11.

5.6.2. The H-atom

Examining Fig.5.10, we note that the fine-dashed curve, $\exp(-2.62 at)$, corresponding to the correlation function of the H-atom in its rough representation and the preliminary estimation of f_o in (5.43) is sufficiently close to the correlation function of ether at $t > r_{et}/c$, which justifies the foregoing correction of the former to conform the latter. So the correlation function of the H-atom corresponding to its exact representation and the improved estimation of f_o in (5.47) is essentially identical to that of ether (the bold curve), because, as mentioned above, the cut-off region of the latter is neglected here. Thus, as found in Sec.5.5, the correlation function of the H-atom, in its exact representation (5.12), follows closely the correlation function of ether (5.48). This, along with the above analysis, confirms our preliminary supposition that the H-atom is a latent model of ether. The H-atom cannot be considered a physical model of ether, because of its one-sidedness: it responds only to electrical excitations and presents a scattering obstacle to magnetic excitations; therefore, unlike ether, the H-atom is not transparent.

The energy spectrum of the H-atom, Fig.5.11, differs a little, within the band $0.1 < X < 0.9$, from our above estimation of the ether spectrum, with its plateau extending from the zero energy to the cut-off energy (see Chapter 4). This difference, neglected by the approximation (5.48), as shown below, is most likely due to the cosmic abundance of the atoms of helium and other elements, as shown below. So, comparing the square of the difference area with that of the H-spectrum, we find this abundance to be about five per cent. To compare this figure with the existing estimation, we can only refer to [3] stating that elements other than hydrogen *and* helium constitute about two per cent of the interstellar gas mass; this figure seems to harmonize with our above estimation.

5.6.3. The D-atom

The correlation function and the energy spectrum of the D-atom, as seen from the above graphs, are thoroughly different from those of ether. So, taking into account the above-mentioned effect of field conversion, this atom is not transparent and cannot be considered a physical model of ether either.

5.6.4. The He-atom

Although the correlation function of the He-atom in Fig.5.10 looks like a very rough approximation of the correlation function of ether, their likeness is more prominent on the energy scale, as shown in the comparison of the spectra of the H-atom, the He-atom and ether suggests the abundance of the He-atom to be indeed responsible, to a significant extent, for the formation of the cut-off region of the ether spectrum, as was supposed above. All this warrants our preliminary treatment of the He-atom, with its partial transparency, as a rough physical model of ether accounting for its high stability and its role as the foundation of all the more complex atoms.

5.6.5. The essence of nuclear interaction

As follows from the above, the essence of nuclear interaction is the conservation of energy by means of alternate transformation of electric energy to magnetic one and vice versa in the D-atom. There is another important aspect of this process: with the neutron embodying space consistency with ether and the H-atom implying time consistency, space and time are separated, and it is only through nuclear interaction that the space-time reunification is achieved.

Conclusion

This part of the work discovers the essence of nuclear interaction and paves the way to the electromagnetic model of the nuclear structure of the atom, thus solving one of the most cardinal problems of modern physics and opening new horizons and methods of research.

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- [2]. Ohanian, Hans C. *Modern Physics. Second Edition.* Prentice-Hall, 1995.
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Chapter 6. Evolution of the nuclear structure

Introduction

As we mentioned earlier, there exists at present a firm belief in a shell nuclear structure (see, for example, [1, 2]). However, the existing shell theories are not satisfactory, because they lack the understanding of the true nature of nuclear interaction. In this chapter, we develop an evolutionary theory of the nuclear structure of complex atoms based on the electromagnetic models of their shells.

6.1. The center

The He-atom is a system of two bound D-atoms rotating about their common center and creating in space a simple system of *central symmetry*, a *center*; it is a space-time center, the center of space and the origin of time, *beginning, here and now*. With its primitive transparency, it is the most simple and fundamental physical model of ether and makes the center (a 2-shell) of the nuclear structure in general.

The shortage of this simplest model of ether is that, while the D-atom consists mainly of three *nuclear quarks*, represented by the components L, C, and R, interaction between two D-atoms in the He-atom, represented in Fig.5.8, is performed only through the C-quark.. So, under the pressure of the stellar environment, the He-atom tends to upgrade itself to a more sophisticated structure containing, to begin with, a *tetrahedral shell* of four D-atoms (4-shell).

6.2. The tetrahedral shell

This type of shell is realized in the atom of carbon and accounts for its great abundance and unique properties. The process of nuclear interaction in the 4-shell can be represented by an electric LCR-circuit consisting, in the rough representation, of six components located along the ridges of a tetrahedron and connected at its vertices, as shown in Fig.6.1; each of its four meshes adjoins the other three, so that all the D-atoms represented by these meshes interact with each other. Composing Kirchhoff's equations for this network and making use of Laplace transforms, we obtain the following matrix for the 4-shell

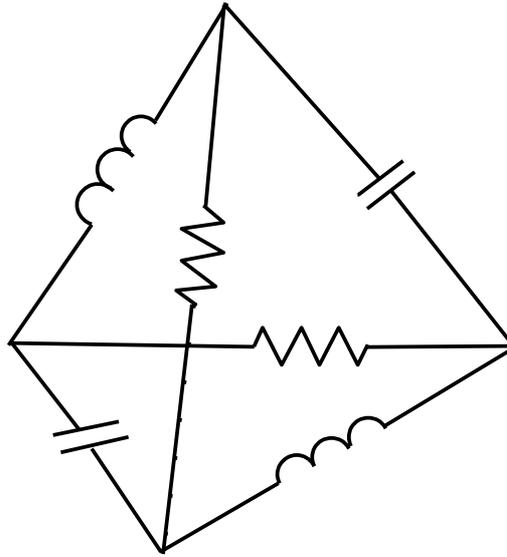


Fig.6.1 The model of the tetrahedral shell

$$(Z_{4 \times 4}) = \begin{pmatrix} Z & -R & -Z_C & -Z_L \\ -R & Z & -Z_L & -Z_C \\ -Z_C & -Z_L & Z & -R \\ -Z_L & -Z_C & -R & Z \end{pmatrix} \quad (6.1)$$

where $Z_L = pL$, $Z_C = \frac{1}{pC}$, $Z = Z_L + Z_C + R$, p is the variable of the Laplace transform.

For the exact representation of the atom, it is necessary to take into account also the minor parameters of the D-atom, its minor inductances and capacitance. To this end, in every mesh of the electric model, the minor inductance should be connected in series with the resistance, while the minor capacitance should be connected in parallel with the major inductance, as shown, for example, in Fig.5.9.

The atom of carbon is an integral whole and its two shells cannot be independent. However, the symmetries of these two shells are incompatible, and their interaction deprives the C-atom of its central symmetry, thereby prompting it to develop into a more complex structure. So, under proper conditions, the tetrahedral shell rises to an *octahedral shell* (8-shell).

6.3. The octahedral shell

The octahedral shell is realized first in the Ne-atom, with its outer shell consisting of eight D-atoms. The symmetry of this 8-shell is compatible with that of the central shell and together they open the *internal space* of the atom.

In a rough representation, nuclear interaction in the 8-shell is represented by an octahedral electric network with its 12 components placed along the ridges of an octahedron and connected at its vertices, as shown in Fig.6.2.

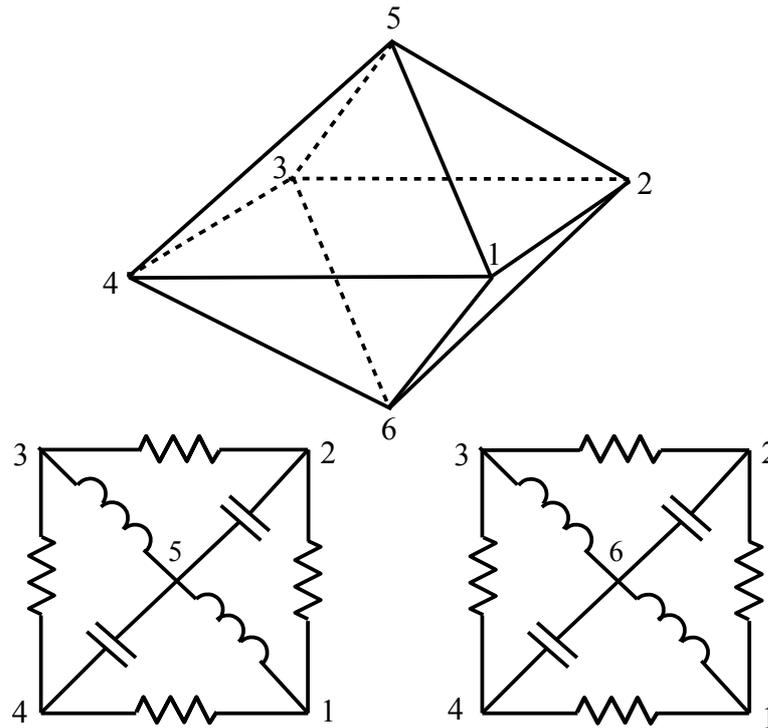


Fig.6.2 The model of the octahedral shell

This network is specified by a 8×8 matrix of impedances. Interaction of this shell with the central one results in the latter's axis being oriented along one of the axes of the octahedron, thus creating a more complex system of central symmetry. This symmetry suggests the idea of rotation about the center - *spherical symmetry*. This suggestion leads to the *icosahedral shell* (18-shell), because the dodecahedral symmetry, with its pentagonal faces, does not suit the atomic structure based on the interaction of three types of components.

6.4. The icosahedral shell

This kind of shell containing 18 D-atoms is materialized, in particular, in the atom of krypton, with its four shells of 2, 8, 18 and 8 D-atoms, respectively. Nuclear interaction in the 18-shell is represented, in the rough representation, by an electric network with 30 components placed along the ridges of an icosahedron and connected at its vertices, as shown by the map-like image of the network in Fig.6.3, where the outer circle represents the vertex opposite that in the center of the map. This model has central symmetry which means the same symmetry of the 18-shell. Thus the latter proves compatible with the center of the atom. The network has 20 meshes, each with three different components except two meshes marked in Fig.6.3 by asterisks; these two meshes, having only two different components each, serve to close the sphere and cannot represent D-atoms. Thus the icosahedral shell has only 18 D-atoms and is characterized by an 18×18 matrix of impedances.

The spherical likeness of the 18-shell suggests restriction of space, its division into internal and external spaces separated by some *border*. This suggested border should belong both to the internal space and the external one and therefore should be of a double structure. So it is quite natural that the idea of the border is materialized in a *double-icosahedral shell* (36-shell).

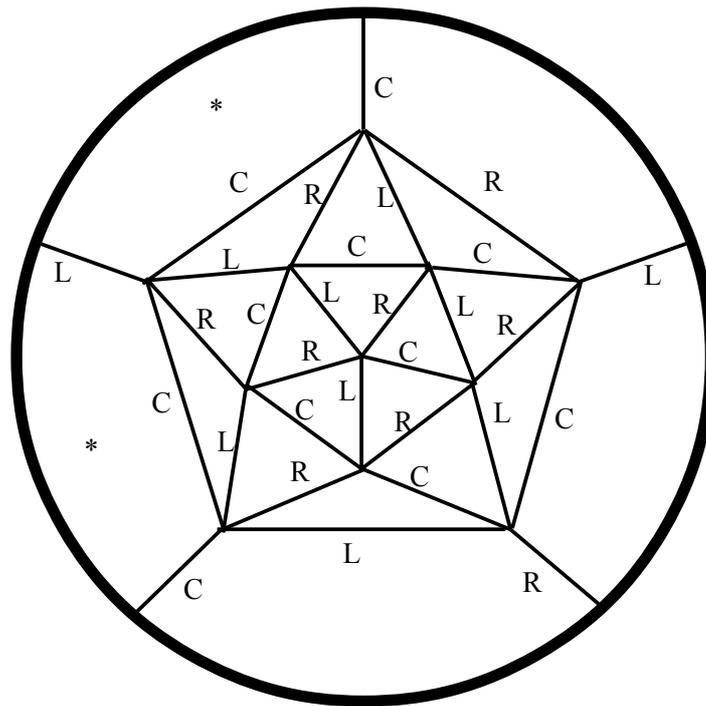


Fig.6.3 The model of the icosahedral shell

6.5. The double-icosahedral shell

This shell contains two close 18-shells interacting with one another. To maintain symmetry, the pairs of interacting D-atoms should cling to their common radii. When considering the electric model of the 36-shell, which should contain two interacting networks, we find the only way of interaction to be through mutual inductance of two respective inductors in each of the 18 pairs of meshes. In physical terms, this means interaction by exchanging neutrons, with their magnetic capacity, between respective D-atoms.

The 36-shell is realized in full in the U-atom and in part in atoms with less atomic numbers as, for example, in the Rn-atom, with its six shells of 2, 8, 18, 32, 18 and 8 D-atoms manifesting themselves by the respective electronic shells. The incompleteness of the 36-shell in the Rn-atom is most likely due to the incompleteness of its external shells and the necessity, for that reason, of additional transparency and versatility of the border-shell.

The double shell suggests *inverse symmetry* between its two icosahedral shells relative to some middle sphere; this in turn suggests the full inverse symmetry between the internal space and the external space of the atom, the necessity for *inverse shells*.

6.6. The inverse shells

There are three inverse shells with 18, 8 and 2 D-atoms, respectively. The inverse 18-shell, opening the *external space* of the atom, is realized first in the atom of platinum and accounts for its unique physical properties. The inverse 8-shell, symbolizing the *external space proper*, is realized first in the atom of radon already mentioned. The inverse 2-shell is realized first in the atom of radium and symbolizes *interaction with, and transition to, ether, infinity*.

With the above three inverse shells implemented, there begins completion of the 32-shell until it rises to the 36-shell in the U-atom. The system of inverse symmetry is thus implemented in full in the last natural element of the periodic table, the U-atom, with its seven shells of 2, 8, 18, 36, 18, 8

and 2 D-atoms, respectively, 92 in total. The perfection of its structure manifests itself, in particular, by the great stability of the U-atom: its half-life being 4.5×10^9 years as compared with those of its preceding Pa-atom, 32 480 years, and its succeeding, artificial Np-atom, 2.2×10^6 years, and Pu-atom, 24 400 years.

6.7. Inter-shell interaction

In atoms with a developed shell symmetry, the shells able to form joint symmetrical patterns interact to achieve the highest degree of symmetry and stability. This interaction, as suggested above, is performed by additional neutrons alternating between shells, which, in terms of electric representation, is equivalent to creating magnetic links between the shells. The U-atom is the best illustration of this. In the U-atom, there are essentially four 18-shells to be coordinated and bound into a single icosahedral structure, as shown in Fig.6.4.

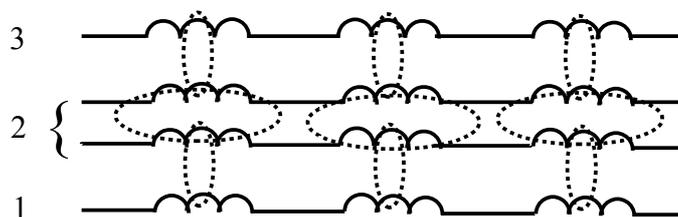


Fig.6.4 The model of interaction of the 18-shells:
1- the internal 18-shell; 2- the central 36-shell;
3 – the external 18-shell.

This coordination is implemented by three groups of additional neutrons, 18 in each, carrying out interaction between the respective D-atoms of adjacent 18-shells and thereby raising the atomic weight of the U-atom to 238. Clearly, interaction between the two middle shells is much stronger than their interaction with the other two shells. As a whole, these four bound 18-shells of the U-atom, accounting for over 83 percent of its atomic weight, constitute a *middle (icosahedral) substructure* dominating the structure of the atom. Depriving this substructure of its three neutrons moving along the same radius reduces the U-atom to its isotope U235 with a drastically weakened stability. The other four shells of the U-atom seem to interact with the middle substructure by means of its respective internal and external neutrons piercing at random all the respective internal and external shells and thus coordinating them with the middle substructure.

6.8. Ether, stars and atoms

6.8.1. The star

The star is formed in ether, interacts with it and therefore is thoroughly consistent with it. As the components of the star are quite different from those of ether, the consistency with ether means that the stellar matter simulates the conditions characteristic of ether, which results in its separate atoms becoming models of ether in their own manner. This is achieved through the adaptability of the D-atoms as shown below.

6.8.2. The D-atom

Nuclear interaction in the D-atom, the interaction of its structurally dual and mutually transformable components, H-atom and neutron, means their alternate mutual transition into one another with the respective transformation of their structure and energy. In that process, the neutron

adapts itself to the environment and *continuously* passes the results of that adaptation, in the form of the set $\{C_k\}$ of its structural function (2.34), to the H-atom, where they transform into generally different set of coefficients $\{T_k\}$, as shown in (3.15), and enable the H-atom to achieve and maintain its time consistency with the stellar environment. Thus the D-atom achieves its consistency with the stellar environment both in space and time. As the stellar environment simulates ether, the D-atom proves consistent with ether.

6.8.3. The m -atom

(a) The electric model. The atom with an atomic number m , the m -atom, is a system of m interacting D-atoms. It adapts itself to the stellar environment through nuclear interaction in its D-atoms, thus achieving its consistency, m -consistency, both with the stellar environment and ether and becoming their m -model. The m -atom responds to vacuum excitations by emitting its specific m -neutrinos with its characteristic spectrum of radiation.

The nuclear structure of the m -atom, including its m electrons, is represented by an electric LCR- network with m degrees of freedom. The process of the network is described by a homogeneous vector differential equation,

$$\mathbf{L} \frac{d^2 \mathbf{Q}}{dt^2} + \mathbf{R} \frac{d \mathbf{Q}}{dt} + \mathbf{D} \mathbf{Q} = 0 \quad (6.2)$$

where \mathbf{L} , \mathbf{R} and \mathbf{D} are the matrices of mutual inductances, resistances and elastances, respectively, that is

$$\mathbf{L} = (L_{ik}), \quad \mathbf{R} = (R_{ik}), \quad \mathbf{D} = (D_{ik}) \quad (6.3)$$

$D_{ik} = 1/C_{ik}$, L_{ik} , R_{ik} , C_{ik} are the mutual inductance, resistance and capacitance, respectively, of the ik -branch separating the i -mesh and k -mesh of the network; \mathbf{Q} is the vector of charges circulating in the meshes,

$$\mathbf{Q} = \begin{pmatrix} Q_1 \\ Q_2 \\ \dots \\ Q_m \end{pmatrix} \quad (6.4)$$

Q_k being a charge, $I_k = \frac{dQ_k}{dt}$ a loop current circulating in the k -mesh.

(b) The pulse response. The pulse response of such a network is a $4m$ -component vector function,

$$\mathbf{f}_m(t) = \sum_{k=-m}^m F_{mk} A_k \exp(\lambda_k t) \quad (6.5)$$

$$\sum_{k=-m}^m F_{mk} A_k = 0 \quad (6.6)$$

$\{F_{mk}\}$ being the set of coefficients providing consistency of the m -atom with ether, with the relation necessary to satisfy the equality $f_m(0)=0$, in accordance with the reasoning in Chapter 5. The vector

$$\mathbf{A}_k = \begin{pmatrix} A_{k1} \\ A_{k2} \\ \dots \\ A_{km} \end{pmatrix} \quad (6.7)$$

is a $2m$ -component vector characterizing the form of oscillation with the frequency λ_k .

(c) Representation of the H-atom. Comparing equation (6.2) and function (6.5) with equation (3.8) and function (3.15), respectively, the latter two characterizing the H-atom, we see their formal similarity. However, unlike the obscure set $\{\mathbf{U}_k\}$ in (3.15), characterizing the structure of the H-atom, the set $\{\mathbf{A}_k\}$ in (6.5) is thoroughly articulated and determined by the structure of the m -atom represented by its electric model. That means that, with the H-atom and the m -atom both seeking consistency with ether and having similar pulse responses, the m -atom becomes a physical, *engineering*, representation and realization of the H-atom. When $m \rightarrow n$, $\{\mathbf{A}_k\} \rightarrow \{\mathbf{U}_k\}$ and $\{F_{mk}\} \rightarrow \{T_k\}$, which takes place in the U-atom, these representation and realization are complete.

(d) The m -quarks. With the equations (3.8) and (6.2) having similar structures, the matrices \mathbf{L} , \mathbf{R} and \mathbf{D} in (6.2) become representatives of the matrices A , B and Γ in (3.8), respectively, thus exposing the structure of the respective quarks of the H-atom. This also implies that the m -atom itself consists of three quarks, m -quarks, \mathbf{L}_m , \mathbf{R}_m , \mathbf{D}_m , which accordingly may be called *the magnetic quark*, *the exchange quark* and *the electric quark* of the m -atom, respectively. This conclusion confirms the validity of our using the terms *nuclear quarks* and *C-quark* in Sec.6.1. So the evolution of the atom may be considered the evolution of its quarks.

6.8.4. The U-atom

The nuclear structure of the atom achieves its complete and most perfect development in the U-atom, its atomic number being 92. With its most developed transparency and symmetry, it presents the most perfect possible realization of the ideal model of ether implied by the ideal of the H-atom (5.1), thus revealing the number, $n=92$, of its constituent pairs of conjugate compositums and, due to its perfect symmetry, exposing the vector function (3.15) as simply a scalar function of the parameter $s=r=ct$,

$$g_n(s) = \sum_{k=-n}^n S_k \exp(\chi_k s) \quad (6.8)$$

which therefore presents the most perfect approximation of the space-time correlation function of ether (1.14).

Thus the H-atom is implicitly an ideal project of the U-atom to be realized through the building up of the nuclear structure; the ideal of the H-atom, function (5.1), is actually the correlation function of that ideal project. So the implicit structure of the H-atom is realized and turned explicit through the building up of the nuclear structure and achieves its complete development in the U-atom, the spectrum of which is supposedly the exact copy of that of ether, including its cut-off region. This is the great unification of space and time, on the one hand, and the great unification of matter and ether, on the other. The latter means matter merging with ether, *the liberation of matter*, which manifests itself by the effect of *natural radioactivity*, on the atomic level, and by the phenomenon of *supernova*, on the cosmic level. Indeed, having developed the atomic structure to

the utmost and produced all sorts of atoms in the proportion and quantity necessary for its consistency with ether, the star loses its purpose of further existence and ends its life, exploding and ejecting most of its matter.

6.9. Discussion of the results

Summarizing the above evolution of the nuclear structure, it is worthwhile to emphasize its basic eight levels corresponding, except for the first one, to the respective nuclear shells and having their specific connotations and implications as shown below:

Table 6.1

<i>N</i>	<i>Shell</i>	<i>Logical Implication</i>
1	D-atom (0-shell)	Nest of nuclear interaction; embryo of the atom; element of nuclear structure
2	2-shell	Center; foundation of the atom; here and now
3	8-shell	Internal space
4	18-shell	Restriction of the internal space
5	36-shell	Boundary between the internal and external spaces
6	Inverse 18-shell	Openness of the external space
7	Inverse 8-shell	External space proper
8	Inverse 2-shell	Transition to ether; interaction with ether, infinity

It is necessary to emphasize that the above representation of the nuclear structure by electric networks opens the way to the application of the powerful methods of linear algebra to the exploration of the atom.

Conclusion

The part of the research stated in this chapter complements that of the preceding one, and together they discover both the nature of nuclear interaction and the nuclear structure of the atom, thus solving one of the most fundamental problems of atomic physics and paving the way to new fields and methods of research.

References

- [1]. Mayer M.G. and Jensen J.H.D. *The Elementary Theory of Nuclear Shell Structure*. Wiley, New York, 1955.
- [2]. Elliott J.P. and Lane A.M. *The Nuclear Shell Model*. Handbuch der Physik, vol.39. Springer, Berlin, 1957.

General discussion. A brief review of the theory

The research is actually the General System Theory stated in the language of physics; it can be abstracted and used for reforming any other systemic science including humanities; the systemic character of the research is demonstrated by stating its three parts in three tables titled Theory of ether, Theory of particles, Theory of atoms, respectively, as shown below.

Table 1. Theory of ether

Thesis	Antithesis	Synthesis	Formula
Virtual electron (electrino) Wave-particle duality.	Virtual positron (positrino) Particle-wave duality.	Virtual positronium, real particle with energy.	E
Corpuscular interaction. Its energy E_m	Photon exchange interac- tion. Its energy E_p	Complex positronium (composium); state with complex energy.	$E = E_m \pm i E_p$
Repulsion of composiums characterized by constant ε_o	Attraction of composiums characterized by constant μ_o	Primary physical medium, ether; characterized by constant c	$c = \frac{1}{\sqrt{\varepsilon_o \mu_o}}$
Space-time continuum characterized by interval $s = r = ct$	Composium characterized by complex wave number $\chi = 2\pi E / hc$	Coherent multitude of composiums. Function of coherency $\varphi_\chi(s)$	$\varphi_\chi(s) = e^{\chi s}$
Coherent multitude proper; its massiveness A_χ	Boundary of the multitude; its elasticity B_χ	Bounded multitude; its complex measure C_χ	$C_\chi = A_\chi \pm i B_\chi$
Center of bounded multi- tude with its complex measure density $S(\chi) = \frac{dC_\chi}{d\chi}$	Boundless motion of the center along boundary of correlation in half-plane $\Re \chi \geq 0$	Correlation domain, pattern of correlation characterized by correla- tion function of ether $g(s)$	$g(s) = \frac{1}{2\pi i} \int_L S e^{\chi s} d\chi$ $\Re \chi \geq 0$

Table 2. Theory of particles

Thesis	Antithesis	Synthesis	Formula
Self-consistency of ether. Density of correlation $g^2(r)$	Singularity of ether. Density of singularity $\varphi_o(q)$	A self-consistent cloud, a material particle (muon); its matter density w .	$w = g^2 \otimes \varphi_o$
Reflection of composiums within the boundary; its wave function ψ , energy operator \hat{E}_{ref} and energy $E_{ref} = (\psi, \hat{E}_{ref} \psi)$	Exchange interaction with ether; its power $P = (\frac{\partial \psi}{\partial t}, \frac{W}{c} \frac{\partial \psi}{\partial t})$	Balance of reflection and exchange interaction; a balanced cloud (π -meson) with a primitive structure.	$\frac{\partial E_{ref}}{\partial t} = -P;$ $W = w_{max} - w(q)$
Time reflection characterized by energy $E_t = \frac{1}{2c^2} (\frac{\partial \psi}{\partial t}, \frac{\partial \psi}{\partial t})$	Space reflection characterized by energy $E_s = -\frac{1}{2} (\psi, \Delta \psi)$	Effect of self-control; a self-controlled cloud (K-meson) $E_{ref} = E_t + E_s$	$\frac{1}{c^2} \frac{\partial^2 \psi}{\partial t^2} - \Delta \psi + \frac{W}{c} \frac{\partial \psi}{\partial t} = 0$
Multitude of discrete bound states, solutions of wave equation $\lambda U + H U = 0$; $U = U(q)$; H - operator .	A free self-conjugate state, the state of rest; its wave equation $\lambda U + H_o U = 0$ $H \rightarrow H_o, w \rightarrow \varphi_o$	Multitude of free self- conjugate bound states, characterized by the set of functions $\{u_k\}$. A self-conjugate cloud (η -meson).	$u_k = U_k e^{\lambda_k t} + \tilde{U}_k e^{\tilde{\lambda}_k t}$ $u_k = \begin{pmatrix} \frac{\partial \psi_k}{\partial t} \\ \psi_k \end{pmatrix}$
Particular correlations characterized by the set of two-component space functions $\{U_k(q)\}$	The two-component correlation function of ether $G(q) = \begin{pmatrix} g \\ g \end{pmatrix}$	System of consistent correlation; a consistent cloud (neutron); its correlation function $f(q, t)$	$f(q, t) = \sum_{k=-n}^n C_k U_k e^{\lambda_k t}$ $C_k = \frac{(V_k, G)}{(V_k, U_k)}$
A linear system with continuously distributed parameters; a set of standing waves $\{U_k(q)\}$	A set of oscillators with lumped parameters and modes of oscillation $\{e^{\lambda_k t}\}$	A linear system with lumped parameters; an organized cloud (H- atom); its structural function $u(t)$.	$u(t) = \sum_{k=-n}^n T_k U_k e^{\lambda_k t}$ $\{U_k\} \sim \text{vectors}$

Table 3. Theory of atoms

<i>Atom</i>	<i>2-shell</i>	<i>8-shell</i>	<i>18-shell</i>	<i>36-shell</i>	<i>Inverse 18-shell</i>	<i>Inverse 8-shell</i>	<i>Iverse 2-shell</i>	<i>D-atoms in total</i>	<i>Property</i>
He	2							2	Center
Ne	2	8						10	Internal space
Ar	2	8	8					18	Restriction
Kr	2	8	18	8				36	Boundary
Xe	2	8	18	18	8			54	Openness
Rn	2	8	18	32	18	8		86	External space
U	2	8	18	36	18	8	2	92	Consistency with ether

General conclusion

The research has reformed modern subatomic and atomic physics solving all its cardinal problems, discovering, in particular, the existence of ether, the origin of matter, the origin of the Universe, the nature of nuclear interaction and the nuclear structure of atoms, thus opening new horizons, new methods of research and a new outlook of the Nature in general.

Acknowledgment

I thank Gods for their supposed assistance in that otherwise hardly possible work. I thank Mrs. Yekaterina Nikolajevna Bodyukova, Professor of the Moscow State University, for her assistance and councils during almost the whole course of this research. I thank those former Soviet physicists whose remarks, directly or indirectly, promoted this research.

Appendix. Program for calculating the correlation function of ether

START

Print "Step D, fm"

Input D

Print D

Input L

Print L

Wait

Print "Wave-number step, fm⁻¹"

$H = \pi/(DL)$

Print H

Wait

Print "Log-energy step (eV)"

$P = 8.296 + \log H$

$T = -1$

Label TIME

$T = T + 1$

$K = -1$

$Z = 0, F = 0$

Label FREQ

$K = K + 1$

Print K

$I = -L - 1$

$B = 0, C = 0$

Label SHIFT

$I = I + 1$

$X = 0$

IF $I = 0$ GOTO TRICK

$X = P + \log \text{ABS } I$

Label TRICK

$A = 0$

*)IF $X < 8.5$ GOTO SPEC

$A = 8.5 - X$

IF $X < 9$ GOTO SPEC

$A = 15.7 - 1.8X$

IF $X < 9.5$ GOTO SPEC

$A = 24.06 - 2.68X$

Label SPEC

$A = 0.5A$

$B = B + A/((I - K)^2 + 1)$

$C = C + A/((I - K)^2 + 4)$

IF $I < L$ GOTO SHIFT

$B = B/\pi$

$C = 2C/\pi$

$X = 0$

IF $K = 0$ GOTO JUMP

$X = P + \log K$

Label JUMP

$A = 0$

```

**)
IF X < 8.5 GOTO SPC
A = 8.5 - X
IF X < 9 GOTO SPC
A = 15.7 - 1.8X
IF X < 9.5 GOTO SPC
A = 24.06 - 2.68X
Label SPC
A = 0.5A
O = 1.1513 (C - A)
Z = Z + O
S = 10B
IF K > 0 GOTO PHASE
E = Z/2
Label PHASE
U = S cos (Z - E - O/2)
V = S sin (Z - E - O/2) R = πTK/L
IF K > 0 GOTO FUNC
W = U/2
Label FUNC
F = F + U cos R - V sin R
IF K < L GOTO FREQ
G = (F - W) exp (πT/L)/L
IF T > 0 GOTO FINAL
Q = G
Label FINAL
G = G/Q
Print T
Print G
Wait
GOTO TIME
FINISH

```

The auxiliary program

```

Input M *)
IF M = 1 GOTO AI
IF I = 0 GOTO SPEC
Y = 10(X-8.8)
A = -log (1 + Y2)
GOTO SPEC
Label AI

IF M = 1 GOTO AK **)
IF K = 0 GOTO SPC
Y = 10(X-8.8)
A = -log (1 + Y2)
GOTO SPC
Label AK

```

The auxiliary program assumes an exponential form of the CFE and, when inserted into the places marked *) and **), can be used to test the main program.