Graph kinematics of discrete physical objects: beyond space-time. III. Heisenberg — Dyson’s two-layer physics approach

V. E. Asribekov

All - Russian Institute for Scientific and Technical Information, VINITI, Moscow 125315, Russia
(e-mail:peisv@viniti.ru)

Abstract

In part III is realized the consistent development of Heisenberg—Dyson’s two-layer matrix approximation to the graph formalism for postulating discrete physical objects (DPO) introduced in parts I–II in the form of discrete sets of graphs—skeleton (SvT) or root (RvT) v-trees, beyond common space—time. It is noted that already in the late-1950s one made an attempt to formulate in physical theory the discontinuity as an element of some special diagram technique. In the framework of pointed Heisenberg—Dyson’s two-layer matrix scheme, with an incidence $I$ and a loop $CD(\delta)$ graph matrices, are got the following main results: (1) the many-“planes” SvT or RvT representation of any DPO in opposition to one-“plane” physical objects in continuous physical models; (2) the superposition of different types of interaction for any microobject where RvT representation for short-ranged interactions (weak, strong) is one-“plane” and for long-ranged interactions (gravitational, electromagnetic) is many-“planes”; (3) based on the incidence matrix $I$ (upper layer) “graph geometry” of real DPO describes their peculiar many-“planes” inner structure beyond common space—time; (4) the notion of interacting “charge” can be extracted only from the symbolical quantities for the quasi-continuous field “objects” by means of the loop matrix $CD(\alpha)$ (under layer); (5) the set up strong correlation between upper (discrete material objects) and under (quasi-continuous field “objects”) layers of full two-layer matrix, with the help of Maxwell’s equations, may be eliminated in the frame of DPO conception, by the way of transition to the “universal linearity” beyond space—time; (6) the problems of a stability (reproduction) of stationary states, of a transition itself (“jump”) of electron and of a sudden emission (“production”) of photon in atoms are solved directly for stable atomic shell system in many-“planes” RvT representation including its permanent reproduction with non-open “transferability” between “graph isomers”; (7) the possibility of a “fatigue” of atomic shell system is discussed; (8) the introduction of “true discontinuity” for structural discrete microobjects (instead of “QN-discontinuity” from quantum mechanics) and the realization of the “top hierarchy” with a superposition sum of Riemann’s “counting homogeneous elements” for RvTs of constituent parts and a creation of $(r, s)$ — subsequences
are carried out; and some other concrete results of an analysis of structural peculiarities of DPO.

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1 INTRODUCTION

According to Dyson’s opinion in well-known paper (Ref. [1]) — see also Ref. [2] — the correct fundamental theories will be developing only after twentieth century.

1.1 Heisenberg—Dyson’s analysis of Maxwell theory

At the same time Dyson (Ref. [1]) as well as Heisenberg (Ref. [3]) were set up that in the broadest sense a central idea of Maxwell theory, how it is considering now, can be formulated as a conception of the two-layer structure of nature. In the under more deep layer we have the electromagnetic fields, peculiar “objects” with simple wave equation’s description, and in the upper layer we can observe the real material objects, their energy and forces. The symbolical field quantities for so-called “objects” from an under layer such as electric and magnetic field strengths, the main continuous quantities in Maxwell’s equations, are the purely mathematical abstractions (for a given case see particularly the special Weyl’s investigation in Ref. [4]) and for this reason can be determined only through their energy and forces in an upper layer.

In general these results are true for the same continuous quantities of any other fields that on the whole give rise to an unsound situation which will alter completely only by the transition to a new mathematical description of the basic real physical objects taking into account a possible their discontinuity and a probable changing of the existed correlation between under and upper layers (see especially the foundation papers of Maxwell, Einstein and Bohr in Refs. [5–7]).

1.2 On the new fundamental theories

Indeed therefore one can consider the possibility of any concrete realization of the indicated perspective Heisenberg—Dyson’s conception of two-layer physics (see Refs. [1, 3]) with new adequate mathematical description of the basic real physical objects, including both discrete (predominantly) and continuous ones, as a steppingstone toward the cardinal changes of competing contemporary fundamental theories — the quantum field theory, the S-matrix theory, the group theory (see, for example, Ref. [8]) — and also toward the most natural propositions on the initial principles for future fundamental theories, all the more that an introduction of some accepted in the present-day physics principles was done to a great extent “by hands”. From these new principles above all one must call — besides a discontinuity — a hierarchy (a subjection and a consubjection), a reproduction (an immediate or an intermediate mechanism), an integrity of discrete physical object and its non-reducing as a whole to the sum of parts (a correlation of the whole and its quasi-autonomic parts), a replication (an evolution of structures with one or many hierarchical centres), a non-overcumulation (particularly, in graph vertices, analogously to an equation of continuity),
and so on, as distinct from earlier evident primary principles of an inertia, a stability, a space—time extension, a superposition, etc., and also derivative principles of an equilibrium, a homogeneity and an isotropy of any space, a symmetry, etc.

Once more it is necessary to emphasize that the creating fundamental theories with ordinary continuous physical objects and with postulated discrete (or quasi-continuous) physical objects are the antipodes which mutually cannot serve as an justification of one for another that is pointed out yet in Introduction (section 1) to part I of paper and especially in Introduction (subsection 1.1) to part II of paper, in agreement with the Riemann’s postulates.

As it is noted by Dirac (see Ref. [9]): “there will have to be some new development that is quite unexpected, that we cannot make a guess about, which will take us still further from classical ideas... But if we cannot find such a way... we simply have to take into account that we are at a transitional stage and that perhaps it is quite impossible to get a satisfactory picture for this stage”.

1.3 Graph kinematics for postulating discrete physical objects beyond space—time

Let us return to parts I–II of paper (see Refs. [10–11]) where it is described a graph kinematics of some postulating discrete physical objects as the one of possible ways to realization of such two-layer physics conception. For a full physical process graph, including subgraphs of separate fragments of the structural physical objects, is introduced the universal, beyond space—time, formalism based on the special two-layer matrix

\[ M(\delta) = \left\{ \begin{array}{c} I \\ CD(\delta) \end{array} \right\}, \]

where \( \delta \equiv \omega, \alpha, \ldots \), etc., composed from an incidence \( I \) and a loop \( CD(\delta) \) graph matrices. This adequate mathematical formalism, in agreement with the above-mentioned Heisenberg—Dyson’s two-layer scheme (see Refs. [1, 3]), allows to represent any real discrete physical object and each derivative quasi-continuous field “object”. Furthermore it could be led to the concrete analysis of the basic notions and quantities, in accordance with structural peculiarities of these objects, and to the following their interpretation. In spite of the limited number of non-oriented or oriented graph parameters, namely \( v \) and \( n = v - 1 \) in particular case of non-directed or directed \( v \)-trees, there are just enough possibilities for determination of the different characteristics of everyone from the pointed objects only by the way of various graph vertices configurations, i. e. we obtain factually a specific graph method for description of the real discrete physical objects including their interactions in physical processes of all kinds.

Practically from parts I and II of paper we have already in the framework of appropriate aspects of the graph theory for non-directed as well as for directed trees technique (initiated by Kirchhoff)

— a “graph geometry” for the real discrete physical objects, described their structure by means of an incidence matrix \( I_{(v-1 \times n)} \) (upper layer) with the proper skeleton or root trees basis where \( v \) is a number of vertices and \( n \) is a number of lines ("edges") of corresponding non-oriented \((v, n)\) — graph,
— an “extremal equilibrium” condition for the symbolical quantities of quasi-continuous field “objects” as complex systems, described all-round by means of a loop matrix
\[ C \cdot D \]
(\( \delta \)) (under layer) corresponding to the \( l \) different independent loops of suitable oriented \((v, n)\) — graph with the same proper skeleton or root trees basis.

Below, beginning from section 2, we will go on a development of postulated earlier graph kinematics formalism.

A simplicity of the graph mathematics, caused apparently by the rejection from the “Extension learning” (die Ausdehnungslehre) in the frame of generally accepted notion of space—time and by the transition to a new conception with the natural insertion of so-called “Binding learning” (die Verbindungslehre) already beyond space—time in old understanding, may be demonstrated with the help of the essentially linear principles including the linear principle of superposition in graph technique and the corresponding additional linear principles of a “non-overcumulation” in graph vertices and a “cyclic stability” along independent graph loops.

### 1.4 On a possible evolution of dimensional symmetry in the physicist’s picture of nature

The transition from an old mathematical scheme to the graph kinematics formalism beyond space—time does not exclude the dimensions problem. It will emerge also in the following introduction of the new fundamental physical theories.

However, according to Dirac’s conclusion in due time (see Ref. [9]), then obtained results within the framework of space—time consideration had inevitably led us to doubt how fundamental the four-dimensional requirement in physics is: “A few decades ago it seemed quite certain that one had to express the whole of physics in four-dimensional form. But now it seems that four-dimensional symmetry is not of such overriding importance, since the description of nature sometimes gets simplified when one departs from it”. In this connection, if already a picture of nature with four dimensions, after the pass from a picture of nature with three dimensions, is not completely symmetrical, one can formulate the next very general propositions:

1. it is apparently a false direction of development of theoretical models with a progressive increase of dimensions as follows from an above-noted not quite perfect four-dimensional symmetry (see Ref. [9]),

2. it is probably a non-adequate way of postulating of the “fractals” or finding of the more hidden types of dimensional symmetry as a key physical notions for new theoretical models, particularly in case of microphysics,

3. finally, taking into account 1. and 2., one must simply postulate an absence of common space—time, at least in microworld.

Obviously this last conclusion 3. corresponds to an initiate assumption of this paper.

It is important to note also that graph is topologically an one-dimensional simplicial complex or a linear complex which consists from vertices (points) and “edges” (lines) (see, for example, Ref. [12]).
2 MICROWORLD PHYSICS IN THE FRAME OF GRAPH KINEMATICS FORMALISM

The extraordinary complicated main subject of microworld physics has been forming by quantum theory for the past almost 100 years. However the essential successes in a solution of this immensely hard problem of the quantum theory came only with the discovery of quantum mechanics.

2.1 Dyson’s analysis of quantum mechanics and discrete microobjects problem

According to Dyson’s conclusion (see Ref. [1]) a central idea of quantum mechanics, again in the broadest sense, can be realized by an extension to microworld of the two-layer structure conception as it was occurred already for Maxwell theory. At that the proposition about two-layer construction of the nature in quantum mechanics leads us, as a next step, to the general physical theory, classical as well as quantum, which is more consistent, realistic and universal itself than a former one.

In the under layer we have now the electric, magnetic and other fields with their strengths and in addition the mathematical abstractions of the same kind, namely the wave functions which describe a behaviour of different microobjects. In the upper layer besides the energy and forces of any real objects there appear the probabilities of occurrence of various events.

Thus we come factually to an unified two-layer picture for Maxwell’s theory and quantum mechanics, at least roughly. Nevertheless there are lots of distinctions in details between a classical electromagnetism picture and a behaviour of microobject; all the more the latter has an enough inexact or inaccurate definition itself. Apparently all microobjects must be discrete and therefore could be described generally by means of a special mathematical formalism which is to follow from the specific microworld conditions expressing the primary principles of discontinuity.

On the other hand, in part I of paper (see Ref. [10]) it is assumed that one can choose, in particular, the transition itself to microworld physics as an optimum stage for postulating of the discrete physical microobjects in a form of the new “physical graphs”. On this assumption one must use the old Feynman diagram technique as a starting point in frame of the S-matrix theory, which intense-investigated earlier (see Ref. [8] and references in [10]) together with the field theory and the group theory.

Just in those years Landau (see Ref. [13, 2]) had fixed that the specific diagram technique for determination of singularities in the quantum field theory quantities is really beyond a formalism of this theory. Taking into account a non-equivalence of such “old” diagram technique, based only on the stable microobjects — both “simple” and “complex”, to a perturbation theory, Landau had decided that solely a straight use of diagram technique is completely consistent and under such estimation we should make factually the first steps to successive development of a “new” diagram technique which is the generalization of an “old” one. It is very likely that this “new” diagram technique itself could serve, according to Landau, as a ground for an adequate future fundamental theory. To a certain extent similar put forward hypothesis one must take also into consideration at least as an initiate attempt to do without the customary continuous physical theory.
2.2 General survey of two-layer conception in microphysics and deterministic picture problem

Owing to the set up uniformity of a possible realization of two-layer conception in macro-physics (Maxwell’s theory) as well as in microphysics (quantum mechanics) we can carry out the following typical specification of the graph kinematics formalism (see subsection 1.3) first of all in an area of investigation of the discrete microobjects (or their discrete parts) which appear inevitably in this theoretical scheme. Without going into details one can note that for every separate discrete microobject, from the whole physical system of microobjects, an incidence matrix \( I \) in (1) gives as usually a representation of its inner structure (or inner structure of its discrete parts) on the base of the non-directed root trees vertices configuration, while a loop matrix \( \text{CD}(\alpha) \) in (1) reflects the loop-forming quasi-continuous field “object” produced by a “fusion” of several discrete parts of microobjects together or, more exactly, by a corresponding superposition of their directed root trees vertices with conservation of the total number of lines (“edges”). For example, in a case of the most evident forecast of “fusion” or vertex-corresponding superposition of two leptons \( e^- \) and \( e^+ \) as the discrete microobjects, having an elementary form of two-side directed root \((v=2)\)-trees:

\[
\overset{-}{\bullet} \overset{r}{\bullet} (e^-) \quad \text{and} \quad \overset{+}{\bullet} \overset{r}{\bullet} (e^+),
\]

one may create a photon \( h\nu \) or the simplest quasi-continuous field “object”, having a form of oriented multigraph—semicycle:

\[
\overset{-}{\bullet} \overset{r}{\bullet} \overset{+}{\bullet} (h\nu) \quad \text{with} \quad v = 2, \ l = 1.
\]

In general, it is significant that a transformation of non-oriented graphs into oriented ones within the framework of a developing graph formalism is carried out with the help of a doubling — operation consisted in a substitution of every or separate non-directed line (“edge”) by a cycle pair of opposite directed lines (“edges”) (see, for example, Ch. 1 in [19]), analogous to above—represented in (2b) oriented multigraph — semicycle of photon.

Additionally, in connection with obtained results it will be noted that an ordinary description of microobjects in contemporary general quantum theory of fields and particles by means of the probability distributions for continuous quantities in a space—time become apparently insufficient in a case of the graph kinematics scheme beyond space—time, with a reliable direct “count” for evident discrete quantities (homogeneous elements) in elementary physical processes. Perhaps the mere fact that this giving up of determinacy has been a very controversial subject, which is due certainly to quantum theory and some physicists (Einstein especially) do not like it at all, shows simply a non-adequacy of the picture of nature in the infinitesimal to the space—time basis notions.

In some or other way, a today’s “continuous” picture of microworld with probability description of microobjects in a space—time, which had always taken for granted, will be changed radically under the more obvious ways of a transition to the graph kinematics formalism beyond space—time for the doubtless discrete microobjects.
2.3 Basic graph characteristics for microobjects and Ulam’s hypothesis.

Awareing the importance of studying of the main properties of graphs, and especially trees, which could serve as a basic tool for description of microobjects within the graph kinematics, we pass to the consideration of a set of concrete graph characteristics for microobjects and special hypotheses from the graph theory.

Beforehand one must introduce for graph \( G \) with \( v \) vertices the power of vertex \( v_i \)

\[
\mathcal{M}(v_i) \equiv M_i
\]  

i.e. a number of components for graph \( G_i = G - v_i \). According to Ulam’s hypothesis in Harary’s interpretation (see Ref. [12]) for a case \( v \geq 3 \) one takes place the reconstruction (or, more exactly, the reproduction) of a graph \( G \) from a collection of subgraphs \( G_i = G - v_i \). The proof of Ulam’s hypothesis for trees had presented by Kelly (see Ref. [14]). But later the Kelly’s result had generalized by Harary and Palmer (see Ref. [15]) and at last had improved by Bondy (see Ref. [16]). Starting from propositions of Ulam’s hypothesis, these authors had proved a possibility of the reconstruction (the reproduction) of a tree \( T \) from a collection of subtrees \( T_i = T - v_i \) where \( v_i \) are the terminal (Harary, Palmer) or the peripheral (Bondy) vertices; for the latter an eccentricity

\[
e_T(v_i) = d_{\text{max}}(u, v_i),
\]  

where \( u \) — any vertex of \( T \), is equal to a diameter of \( T \)

\[
D_T = \max_{(v_i)} e_T(v_i); \quad i = 1, 2, \ldots, v.
\]  

These convenient formulations of Ulam’s hypothesis for trees can be put forward as the initial theorems for a graph consideration of stable and quasi-stable physical systems in microworld. Additionally it will be noted also that for trees the power of vertex \( v_i \) is equal to its degree

\[
\mathcal{M}(v_i) = \deg v_i.
\]  

Taking into account that we separate from the all trees only the root \( v \)-trees (\( RvT \)) with one detached root vertex \( (v_R) \) from a total number of vertices \( v \) (see section 3 in part II, Ref. [11]) one can thereby determine the most “chief” \( RvT \) which includes only “core” vertices \((v_R)\) and \((v_F^c)\) with \( v_R = 1, v_F^c = v - 1, v = v_R + v_F^c = 1 + v_F^c \), \( d_{\text{min}}(v_R, v_F) \equiv d(v_R, v_F^c) = 1 \) and characterizes the pure “core” of discrete microobject. Here solely one vertex \( (v_R) \) possesses the maximal power \( \mathcal{M}_R \equiv \mathcal{M}_{\text{max}}(v_R) = v - 1 \) whereas the other \( v - 1 \) vertices \((v_F^c)\) of “core” have the minimal power \( \mathcal{M}_{\text{min}}(v_F^c) = 1 \). At first sight it is seemed that, owing to maximal value of the power \( \mathcal{M}_R \) for a single root vertex \((v_R)\) in the pure “core”, just this “chief” \( RvT \) reflects the principal inner structure of corresponding discrete microobject, as it were its “genetics”, and the properties of its various interactions with the another microobjects. Probably the rest \( RvTs \) represent mainly the peculiarities of a constitution of different microworld systems and their typical reactions.
2.4 About four sorts of “charge” in old concept

At last going over to an interpretation of the main microobject’s graph characteristics, corresponding in the first place to “charges”, it is important to emphasize that an appearance of these notions in a new graph formalism may be connected with some difficulties, especially if we follow a logic of independent introduction of the primary oriented graph notions.

First of all, with a view to avoid any misunderstanding, we pay attention again to an above—concerned problem of a setting up of the characteristics of symbolical quantities for a quasi-continuous field “objects”, in a form of some multigraphs, in comparison with the ones for continuous field. In the framework of an old concept, a continuous field itself acquired physical reality in a space—time, and an interaction of microobjects had to be described usually with the help of an intermediate, conditionally real, “field of force”. It turned out that the properties of microobjects with respect to an exchange interaction with similar, conditionally real, “field of force” had to be determined by a single parameter — so-called the specific “charge” of microobjects, which initially must be different for the case of various “fields of force”.

In very such a way one set up the four known fundamental interactions whose distinctions had to be explained by multiple exchange mechanisms as well as by intensity of these exchanges (proportional to corresponding “charges”) into a “microobject — field” system in conventional space—time, or more exactly, in the presence of common metric characteristics of space—time.

On the other hand, just at the like approach it is easy to come to the conclusion that the most specific peculiarity of an old concept concerning the fact of an existence only four possible sorts of “charge” (that is also in a formal agreement with the conclusion of Hurwitz’s theorem about four basic kinds of hypercomplex numbers (four extraordinary algebras — see Ref. [17])) may be inconsistent with the proposals, immanent construction and general principles of graph kinematics formalism. It is necessary to bear in mind that an inner structure of microobject has to be included into an incidence matrix \( I^{(v-1\times n)} \) that is realized as a “graph geometry” for the discrete microobject. However the usual “field’s characteristics of interaction” one must determine with the help of a loop matrix \( CD(\alpha) \) i. e. a “charge” or an interaction “charge” has to be extracted from the new loop-forming quasi-continuous field “objects”.

2.5 What is now a “charge” for?

Indeed, due to the absence of the main notions of an old concept and in exchange for a continuous, conditionally real, field and an interaction of microobjects with corresponding intermediate “field of force” in space—time, these new field “objects” can be represented beyond space—time as the oriented multigraphs with some loops which are composed from two or more directed \( RvT \)s. At that in a given case we have no parameters of interaction for microobjects but there are the original “fusion” or vertex—corresponding superposition processes already for vertices of the initial directed \( RvT \)s and the resulting oriented multigraphs from which one can extract a notion of the graph equivalent of something having a likeness with the “charge”.

8
In developing formalism every microobject may be represented integrally as a set of $\mathbf{RvT}$s i.e. as a whole which consists in a hierarchical order from many quasi-autonomous parts — independent “planes” generating a complicated “graph geometry” of structural microobject. Of course, an appearance of other physical characteristics of this microobject may be provided only for special symbolical quantities following from a consideration of corresponding quasi-continuous field “object”.

If one can write down the various symbolical quantities for the loop-forming quasi-continuous field “objects” in a form depending from different configurations of the oriented multigraph vertices then the problem of an interaction “charge” interpretation will be reduced to an analysis of definite procedures, including a graph reproduction of discrete microobjects, a recombination of “core”-vertices or any reconstruction of corresponding microobject graphs (non-directed and directed $\mathbf{RvT}$s and oriented multigraphs) using particularly the results of an application of Ulam’s hypothesis. Later we will continue this graph approach by investigation of some concrete examples.

As above, the symbolical quantities for quasi-continuous field “objects” are derived from an “extremal equilibrium” condition with the help of a loop matrix $\mathbf{CD}(\alpha)$. In addition, it is notable however that there exists a “mechanical” version of interpretation of an analogous “extremal conditions” along $l = n - v + 1$ loops for an old Feynman diagram (see Ref. [13]) which earlier was discussed by Coleman and Norton (see Ref. [18]). These authors were shown that $l$ “extremal conditions” are equivalent to the condition that the relevant Feynman diagram be interpretable as a picture of an energy — and momentum — conserving process occurring in space—time, with all internal microobjects real, on the mass shell, and moving forward in time, for just the correct distances and times to “tie together” the entire directed graph. The Feynman parameters $\alpha_i$ ($i = 1, 2, \ldots n$), associated with $n$ internal lines of this graph (see 4-momenta $q_i$ in subsection 1.2 of part I), were identified with the time microobject exists between collisions, divided by its mass.

Thus, at a time taking into account this evident “mechanical” picture of the continuous microobjects interaction in space—time, on the one hand, and assuming an “invisible” separate photon as the elementary quasi-continuous field “object” (a simple oriented multigraph in (2b) accounted for electromagnetic interaction) beyond space—time, on the other hand, one can admit also the another quasi-continuous field “objects” which are represented as the various oriented multigraphs, reflected the different interaction processes and the further procedures of decay reconstruction and exchange reaction mechanisms, with the use of initial discrete microobjects beyond space—time. Perhaps in such a way we could solve the problem of a microobject “charge”.

Nevertheless it will be noted that instead of various types of fields and interactions with different “charges” of microobjects in conventional space—time, we have now an unified $\mathbf{RvT}$ — description where the different quasi-continuous field “objects” may be distinguished beyond space—time solely by the sets of vertices in oriented multigraphs (composed from directed $\mathbf{RvT}$s), their configurations and corresponding powers. From an old concept one must remember still that each vertex interaction could occur as an instantaneous event in space—time.
2.5.2 Graph equivalent of microobject “charge” and decoding of symbolical quantities

Returning to Heisenberg—Dyson’s analysis of Maxwell theory (see subsection 1.1) one can go on the decoding of the symbolical quantities for the loop-forming quasi-continuous field “objects” but keeping in view also a possible existence of some prototypes in an old concept for a sought graph equivalent. This problem may be solved, in particular, with the help of a preliminary consideration and an analysis of Dirac’s assumption (Ref. [9]) about a picture of “discrete (quantized) Faraday lines of force”, each associated with an electric charge (\(-e\) or \(+e\)). Starting from an old idea that the Faraday lines of force with continuous distribution are a way of picturing electric fields and going over to quantum theory, Dirac brought a kind of discreteness into a classical picture and replaced it by just a whole number of discrete lines of force with no lines of force between them. These lines of force in the Faraday picture end where there are charges (for lines of force extending to infinity, of course, there is no charge) and we shall have an explanation of why charges always occur in multiples of one elementary unit, \(e\), and why does one not have a continuous distribution of charge occurring in nature. Some of these lines of force, forming closed loops or simply extending from minus infinity to infinity, will correspond to waves; others will have ends with the charges. The breaking of a line of force would be the picture for the creation of an electron \(e^-\) and a positron \(e^+\). One can consider also a picture of the discrete lines of force as “strings”, and then the electron in the picture is the end of a “string”.

Dirac’s picture of “discrete Faraday lines of force” (or, perhaps, a picture of some “strings”), demonstrated an existence of the elementary units — constants — of discrete charges, in general different, may be used in our case (see (2a)) for the setting up, analogously, an evident graph equivalent for an elementary “charge” (a simplest directed \(\mathbf{RvT}\)) as well as for corresponding an elementary “inertial mass” (a simplest non-directed \(\mathbf{RvT}\)) of microobject. In subsection 3.2 of part I we have already a graph definition of an “inertial mass” \(m_e\) for an electron in a form of the simplest non-directed \(\mathbf{RvT}\) with \(v=2, n=1\).

Thus one may postulate the first \((v=2, n=1)\) — graph definitions for “charges” \(e^-\) and \(e^+\) and “inertial mass” \(m_e\)

\[
\begin{align*}
\text{\[\bullet\rightarrow (e^-) \quad \bullet\rightarrow (e^+) \quad \bullet \rightarrow (m_e)\] (6)}
\end{align*}
\]

Naturally, the “gravitational mass” or scalar “gravitational charge” has a graph equivalent also in a form of the simplest directed \(\mathbf{RvT}\) as well as the other scalar “charges”: \(g_1 \equiv e\) (above—mentioned), \(g_2 \equiv G_W\), \(g_3 \equiv g_S\).

Obviously, these introduced graph equivalents could contain also the another characteristics of discrete microobject besides a “charge” and an “inertial mass”, for example a “spin” (later we revert to this problem).

Still for a clarity of an accepted approximation in direction of the decoding of a meaning of every symbolical quantity which describes the quasi-continuous field “objects” in the framework of an oriented graph technique, one must take into consideration a definite set of loop combinations — in accordance with a loop matrix \(\mathbf{CD}(\alpha)\) from (1) — of the different graph equivalents, included in corresponding graph representation of the various physical processes (decays, collisions, scattering, reactions, etc.) as a rule with the conservation of a total number of lines (“edges”) that is carried out by the use of the vertex-corresponding
2.6 Superposition of different types of interaction

The most unexpected feature of a developing new physical graph technique is a possible “parallel” presence of the four (and more) different sorts of interaction “charges” all over for any microobject and for its symbolical quantities. All these interaction “charges” have the unific graph representation in a form of the various subsets from the full sets of vertices \((v_i)\) in corresponding \(RvT\)s for a given microobject. Similar full sets of vertices \((v_i)\) can be distinguished mainly by their disposition towards a “core” of \(RvT\) and, of course, by their powers \(M(v_i)\), especially into a “core”, and every interaction “charge” may occur in multiples of one elementary “unit” presented by some number of \(RvT\)’s “core” vertices of different powers. In other words, if we accept such concept, the definite disposition of these vertices in a “core” subset and some combination of their powers must be responsible for a concrete interaction “charge”.

On the other hand, taking into consideration that certain physical processes would be arisen out of an existence of fixed interaction “charges”, one can specify in such a way the different interaction “charges” of a single microobject. Thus we have a criterion of identification of the different interaction “charges” of microobject on the base of a typical classification of various elementary physical processes. It is easy to see also that one cannot study the “charges” at rest as well as the corresponding forces between them and the fields associated with them; in other words we haven’t a “charge” statics but there is only a so-called “charge” dynamics.

Many-“planes” representation of any microobject as a set of non-directed or directed \(RvT\)s with a superposition of the different sorts of interaction “charges”, for the first time mentioned in subsection 2.5.1, arranges now in Tables 1–3 where are introduced also some “graph—vacancies” like \(C_{vF}\) for further filling at \(v_F=2\div4\) and an additional physically stable graph—compositions from several known microobjects.

First of all in Table 1 we repeat (see above (2a), (2b), (6)) a collection of the graph equivalents of microobject’s masses, interaction “charges” and their annihilation in a form of the symplest non-oriented and oriented \((v=2, n=2)\) — graphs (with \(l_{\text{max}}=1, n_{\text{max}} = v - 1 + l_{\text{max}}=2\)) which are accompanied by the diverse graph matrices (see Ref. [19]).
Table 1. Graph equivalents of basic microobject characteristics and suitable matrices of these (v=2, n=2) — graphs.

| (v = 2, n = 2)-Graphs | Non-Directed \(\text{RvT}\) | Directed \(\text{RvT}\) | Directed \(\text{RvT}\) | Oriented multigraph-\(\text{semicycle}\) |
|------------------------|----------------|----------------|----------------|----------------|
| Matrices of (v=2, n=2)-graphs |                  |                |                |                |
| Vertex-edge incidence matrix \(\mathbf{I}_{(v-1 \times n)}(\epsilon)\) | \((1 \ 0)\) | \((1 \ 0)\) | \((0 \ -1)\) | \((1 \ -1)\) |
| Vertex incidence matrix \(\mathbf{J}_{(v \times v)}(\epsilon)\) | \((0 \ 1)\) | \((-1 \ 0)\) | \((0 \ 1)\) | \((0 \ 0)\) |
| Edge incidence matrix \(\mathbf{K}_{(n \times n)}(\epsilon)\) | \((0 \ 0)\) | \((0 \ 1)\) | \((0 \ 0)\) | \((0 \ 1)\) |
| Loop matrix \(\mathbf{A}_{(l \times n)}(\alpha) = \mathbf{C} \cdot \mathbf{D}_{(n \times n)}(\alpha)\) | \((\alpha_1 \ 0)\) | \((0 \ -\alpha_2)\) | \((\alpha_1 - \alpha_2)\) |

Here vertex incidence matrices \(\mathbf{J}_{(2 \times 2)}(\epsilon)\) for \(e^-\) and \(e^+\) may reflect a “spin”—characteristics of these discrete microobjects all the more that due to the absence of an imaginary unit “\(i\)” beyond space—time for a reproduction of known properties of Pauli matrices we have only: \(\mathbf{J}_{(2 \times 2)}(e^-) + \mathbf{J}_{(2 \times 2)}(e^+) = \mathbf{J}_{(2 \times 2)}[h\nu]\); at the same time \(\mathbf{J}_{(2 \times 2)}[m_e]\) may determine the other “anti-charge” (non-magnetic) intrinsic angular momentum of \(e^\pm\). Simultaneously edge incidence matrix \(\mathbf{K}_{(2 \times 2)}(\epsilon)\) for \(h\nu\) must represent also some “spin”—characteristic of photon because a matrix equation: \(\mathbf{K}_{(2 \times 2)}[h\nu] = \mathbf{K}_{(2 \times 2)}[e^-] + \mathbf{K}_{(2 \times 2)}[e^+]\) can be considered analogously with corresponding matrix equation for \(\mathbf{J}_{(2 \times 2)}(\epsilon)\). In other words, both matrix “spin”—characteristics for \(h\nu\) appear as a summary “spin”—characteristics of \(e^-\) and \(e^+\).

In the main from Table 1 follows that the loop-forming quasi-continuous field “object” as an oriented \((v=2, n=2)—\)multigraph for \(h\nu\) (semicycle) can be described now by the respective simplest symbolical quantity with the help of loop matrix \(\mathbf{A}(\alpha) = \mathbf{C}\mathbf{D}(\alpha)\)

\[
\mathbf{A}_{(1 \times 2)}(\alpha)(\mathbf{Q}_2) = \begin{pmatrix} q_1 \\ q_2 \end{pmatrix} = \alpha_1 q_1 - \alpha_2 q_2
\]
what elucidates an use of evident “mechanical” version of interpretation of the “extremal equilibrium” condition (see again a subsection 2.5.1) and allows to set up a form of the “source expression” for an extraction of the interaction “charge” notion (corresponding to the “field’s characteristic of interaction” in an old concept).

Shortly before a concrete analysis of the superposition of different interactions on the basis of $\text{RvT}$s at $v \geq 9$ for practically all subnuclear microobjects (because according to Table 2 in part II of paper (see Ref. [11]) there is factually a full spectrum of these microobjects at $v \geq 9$) we make allowance also for some physically stable $\text{RvT}$ — compositions (quantum systems) and several “graph—vacancies” (for unknown physical microobjects) as an exception. Toward this end in view we take into account at the first place a disposition and a power of pure “core” vertices in corresponding $\text{RvT}$s. At best one may begin from the simplest pure “core”, which is characterized by minimum distance from root vertex ($v_R$): $d(v_R, v'_F) = 1$ for any “free”—terminal—vertices ($v'_F$), again in a form of non-directed ($v = 2$) — $\text{RvT}$ for “$m_e$” (“core” $C_{v_F=1}$) or directed ($v = 2$) — $\text{RvT}$ for “$e^\pm$” indicated in Table 1. However it is more interesting to consider in such a way the following $\text{RvT}$s, all over with a pure “core” separately, which correspond to an interval $v = 3 \div 8$ i. e. to a region of atomic and nuclear stable (shell) systems: see Table 1 in Part II of paper (Ref. [11]). Below Table 2 contains in some detail only the first part of a pointed interval, namely an interval $v = 3 \div 5$ for the non-directed $\text{RvT}$s.
Table 2. Non-directed \((v, n = v - 1) - RvT\) for \(3 \leq v \leq 5\) with summary power \(M^c\) of “core” vertices

| Number of vertices: \(v\) | Number of \(RvT\)s: \(T_v\) | \(RvT\) — compositions for stable quantum \((n_{QN}, l_{QN})\) — systems with \(3 \leq M^c < 2(v - 1)\) | Pure “core” \(RvT\)s with \(M^c_{\text{max}} = 2(v - 1)\) as “graph-vacancies” |
|-------------------------|------------------|-------------------------------------------------|----------------------------------|
| \(3\) | 2 | \(l = 0\) | \(C_{v_F=2}\) |
| | | \(M^c = 3\) | |
| | | \(n_{QN} = v - 2 = 1\) | |
| | | \(l \equiv l_{QN} = 0\) | |
| | | \(M^c_{\text{max}} = 4\) | |
| \(4\) | 4 | \(l = 0\) | \(C_{v_F=3}\) |
| | | \(M^c = 3\) | |
| | | \(M^c = 5\) | |
| | | \(n_{QN} = v - 2 = 2\) | |
| | | \(l \equiv l_{QN} = 0, 1\) | |
One must mention still the second part of a pointed interval, namely a rest interval $6 \leq v \leq 8$, which includes the further analogous ${\bf RvT}$ — compositions for atomic and nuclear quantum $(n_{QN}, l_{QN})$ — systems up to a case $v=8$, $T_{v=8}=115$ (corresponding to a magic number for protons in nuclear shells) and also at $v=6$ and $v=7$ for two light $u$- and $d$-quarks from $(1,0)$-subsequence (see next section 2.8, Table 5).

At last from the very beginning of a consideration of the superposition of different types of interaction it is necessary to lay emphasis again on a possibility of existence of every interaction for any microobject. Owing to this orientation we can formulate a comprehensive superposition problem particularly for a concrete microobject at $v=11$ with $T_{v=11}=1842$ (see below Table 3). Nevertheless, if we assume that in a general case the full $T_v$-set of non-directed and directed microobject ${\bf RvT}$s, at a given number of vertices $v$, is responsible for an all types of microobject interaction then naturally to introduce a division of $T_v$-set on the corresponding ${\bf RvT}$-subsets: every of these ${\bf RvT}$-subsets describes a definite type

| Number of vertices: $v$ | Number of ${\bf RvT}$s: $T_v$ | $\bf RvT$ — compositions for stable quantum $(n_{QN}, l_{QN})$ — systems with $3 \leq M^c < 2(v - 1)$ | Pure “core” ${\bf RvT}$s with $M^c_{\text{max}} = 2(v - 1)$ as “graph-vacancies” |
|------------------------|-------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------|
| 5 | 9 | ![Diagram](https://example.com/diagram.png) l = 0, $M^c = 3$ | $C_{v=4}$ |
| | | ![Diagram](https://example.com/diagram.png) l = 1, $M^c = 3$ | ![Diagram](https://example.com/diagram.png) l = 2, $M^c = 5$ |
| | | ![Diagram](https://example.com/diagram.png) l = 1, $M^c = 4$ | ![Diagram](https://example.com/diagram.png) l = 2, $M^c = 6$ |
| | | ![Diagram](https://example.com/diagram.png) l = 1, $M^c = 5$ | ![Diagram](https://example.com/diagram.png) l = 2, $M^c = 7$ |

![Diagram](https://example.com/diagram.png) $n_{QN} = v - 2 = 3$

$l \equiv l_{QN} = 0, 1, 2$
of interaction. In other words, different \textbf{RvT}s or different subsets of \textbf{RvT} from a full \( T_v \)-set of microobject \textbf{RvT}s represent the concrete sorts of interaction “charge”. An essential role in the distribution and arrangement of various \textbf{RvT}s among the different interactions of specific microobject may be attributed to the properties of corresponding \textbf{RvT}s “core” within which for every “free” — terminal — vertex \( v_F \) a distance from root vertex \( v_R \) is equal to 1 and none of these vertices, adding in root vertex, can be “seen” in isolation i. e. we have a peculiar “invisible “core” vertices confinement” into \textbf{RvT}s (analogously with a “quark confinement” hypothesis).

First of all one must separate from a full \( T_v \)-set of \textbf{RvT}s only the pure “core” \textbf{RvT}s with \( M_{\max} = 2(v-1) \) and compare them with some suitable interactions. Most probably that on the basis of the pure “core” \textbf{RvT}s, due to “vertices confinement”, may be described namely the short-ranged or “contact” types of interaction, i. e. \textit{strong and weak (with “breaking”) interactions} which operate \textit{at very short range inside the corresponding microobject}. In other words, we have in this case an entirely “microworld situation” in which must figure only typical discrete microobjects with “invisible “core” vertices confinement”.

On the other hand, \textit{gravitational and electromagnetic interactions} are \textit{long-ranged and generally macroscopic} (in space—time the strength of like force falls off with the square of the distance between the interacting micro-, meso- and macroobjects). At that one takes place a transition from “microworld situation”, reflected by the pure “core” \textbf{RvT}s, to “mixed or pure macroworld situation” where at first one or several \textbf{RvT}-vertices, beyond a “core”, get “visible” and therefore one arises the “deconfinement” of still more number of \textbf{RvT}-vertices, determined a construction of corresponding stable physical systems (see, for example, shell systems of atoms and nuclei in Table 2), their decays and reactions providing with the Ulam’s hypothesis.
Table 3. Superposition of different types of interaction for concrete microobject with a “core”-source of “charges” at \( v=11 \), \( T_v=1842 \).

| Types of interaction | \( \text{RvT} \) — subsets with \( M^c \) — intervals | Number of \( \text{RvT} \) s in subsets | Systems, decays and reactions with corresponding root vertex in “fission” and “fusion” (\( n_{QN}, l_{QN} \)) — systems |
|----------------------|-----------------------------------------------|---------------------------------|------------------------------------------------|
| Gravitational and electromagnetic (long-ranged) | \( \cdots \) | \( 1840 \) | \( n_{QN} = v - 2 = 9 \) with \( 0 \leq l_{QN} \leq 8 \) |
| \( M^c = 3 \) | \( \cdots \) | \( \cdots \) | \( M^c = 4 \) |
| \( M^c = 5 \) | \( \cdots \) | \( \cdots \) | \( M^c = 5 \) |
| \( M^c = 6 \) | \( \cdots \), etc. | \( \cdots \) | \( M^c = 6 \) |
| \( 3 \leq M^c \leq 18 \) | \( 1 \leq v_F \leq 7 \) |
| Types of interaction | \( \textbf{RvT} — \) subsets with \( \mathcal{M}^e \) — intervals | Number of \( \textbf{RvT}s \) in subsets | Systems, decays and reactions with corresponding root vertex “fission” and “fusion” |
|----------------------|-------------------------------------------------|------------------------------------------|--------------------------------------------------------------------------------|
| **Weak (short-ranged)** | ![Diagram](image1) \( (n^0) \rightarrow (e^-) \rightarrow (e^+ \rightarrow (p^+ \rightarrow \bar{\nu}_e) \) | 1 | For neutron’s decay \( n^0 \rightarrow p^+ + e^- + \bar{\nu}_e \) where \( \bar{\nu}_e \) is identical to \( C_{v_F=2} \) with a pair \( e^- - e^+ \) or to a binding energy of neutron \( n^0 \) (variable) |
| **Strong (short-ranged)** | ![Diagram](image2) \( \mathcal{M}^e = 2(v - 1) = 20 \), \( v_F^e = v - 1 = 10 \) | 1 | For schemes of various decays and reactions \( C_{v_F=10} \Leftrightarrow 2C_{v_F=5}, \Leftrightarrow 2C_{v_F=5} + C_{v_F=3} + C_{v_F=2}, \Leftrightarrow 2C_{v_F=4} + C_{v_F=2}, \) etc. adequate to root vertex-corresponding superposition |

It is interesting that for \( \pi_e \)-represented \( C_{v_F=2} \) an incidence matrix \( \textbf{I}_{(2 \times 2)}(\epsilon) = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \) corresponds to one of Pauli’s spin-matrices.

Thus, in the framework of many-“planes” \( \textbf{RvT} \)—representation of every known interaction of microobjects one occur some typical \( \textbf{RvT} \)—compositions with different sets of “free”—terminal—vertices \( (v_F) \), so-called “hedgehogs”. Characteristically, that the short-ranged interactions, as against the long-ranged ones, can be described by a single “hedgehog” — \( \textbf{RvT} \) i. e. for this case there is an one-“plane” \( \textbf{RvT} \) — representation which must reflect at the same time a “compact” inner structure of microobject in respect to a given interaction. On the contrary, in a case of the long-ranged interactions there are many “hedgehogs” — \( \textbf{RvT}s \) determined to a large degree “transparent” inner structure of corresponding physical systems having also many-“planes” \( \textbf{RvT} \) — representation. Such “transparent”
inner structure can be considered as an adequate hierarchical scheme of levels or “orbitals” with the different sets of “hedgehog” — \( \text{RvT} \) (for this aspect see also the Table 2 and the following section 2.7).

It is noteworthy that a superposition of four (or more) types of interaction occurs here necessarily as a result of the compulsory “stratification” of a corresponding set of “hedge-hogs” — \( \text{RvT} \) s. Only after the superposition of different types of interaction one can regard wholly any microobject with many-“planes” “hedgehog” — \( \text{RvT} \) representation, that must naturally solve the problem of the whole and the parts within the framework of an immanent construction of many-“charge” microobject.

However, in this connection it is significant to emphasize that a central problem of contemporary unified — field theory, that would relate the electromagnetic, gravitational, strong, and weak interactions in one set of equations and no like solution has yet been found (some progress has been made in the unification of the electromagnetic and weak interactions), now transforms to the completely new problem of decoding and interpretation of a many-“charge” discrete microobject as an indivisible set of “stratification planes” in the frame of a “hedgehog” — \( \text{RvT} \) formalism.

### 2.7 Atomic events in the new graph kinematics formalism

As it was emphasized by Bohr and Einstein in due time (see Heisenberg’s statement in Ref. [20]) a stability of atom means a permanent reproduction (an immediate mechanism) of the same stationary forms or steady states in the framework of which

— according to Bohr’s postulates, we have an electron moving about in certain orbit of atom and occasionally making a jump from one orbit to another; in agreement with Bohr—Heisenberg’s opinion (see Refs. [20, 21]) it is impossible to describe similar jump in the old notions as a discrete process in space—time,

— following to quantum mechanics, we have in atoms the so-called “orbitals” i. e. the regions of space where it is not possible to give a definite path for an electron but only a probability distribution or an electric charge distribution (averaged over time) around the nucleus; one strong Einstein’s objection(see again Refs. [20, 21]) consists in the opposition of this conclusion to the real paths of electrons in the Wilson cloud chamber.

It is known that both very different and naturally interconnected aspects of these phenomena, reflected the unexpected stability (a reproduction of the same steady states) and the evident discontinuity (an electron jump between orbits) of atomic system dynamics, are presented mathematically in contemporary quantum mechanics of atom which allows

— to calculate the discrete energy levels of stationary states,
— to take into account an inexplicable stability of the “orbitals” or the definite stationary states which are distinguished one from another in respect of their shapes and each could be reproduced formally again and again,
— to estimate a probability of the sudden emission of photon as a result of the discrete transition between stationary states.

Nevertheless, according to Einstein (see Ref. [20]) in spite of these doubtless achievements, many problems, especially the problem of a transition itself between stationary states (without regard for the real path of electrons) and the problem of a sudden emission (or
production”) of discrete photon, originated as the results of an analysis of the purely discontinuous atomic events, haven’t any satisfactory explanation in quantum mechanics and demand the more accurate description. Unfortunately, it is easy to set up that de facto these old unresolved, but clearly formulated principal problems of quantum mechanics were thrown off at the stage of a branching of fundamental physical theory in a middle of the twentieth century in favour of some alternative variants of development that lie now into the mainstream of current research.

This dead end for similar comprehensive conceptual problems give rise to the many inappropriate latent difficulties in some new developing physical models including the widely known divergence difficulties. Therefore it is very notable that similar discontinuous events may be described immediately on the base of graph formalism for discrete atomic systems beyond space—time. Indeed, the unconditional introduction of a such discrete graph technique provides for the various subnuclear microobjects some single sets of the concrete $RvT$ s at a given $v$ with the aim of a determination of their masses, directly proportional to $T_v$ — numbers or their fractional $(r, s)$ — “fragments” $T_v/2^r3^s$. While a structure of the stable atomic and nuclear shell (many-level) systems can be described certainly with the help of the several sets of $RvT$ s corresponding already to the different number of vertices $v$ and thereby to the different principal quantum numbers $n_{QN} = v - 2$. At that in every $RvT$ these $v$ vertices must have a definite disposition which additionally may be presented in some alternative configurations, producing the “graph isomers” with the same number of vertices ($v_i$) but the different values of their powers $M_i$ (identical to their degrees or valencies, according to (3) and (5)).

Naturally the so-called “valence-isomerism” will be realized by means of the partitions (see Ref. [12]) and their representative trees i. e. $RvT$ s. Factually, the realizability of a set of integers (in spite of “fractals”) as degrees of the vertices of a specific $RvT$ with the detachment of a root vertex ($v_R$) and a “core” can be illustrated par example on the next partitions for ($v = 5, n = 4$) — $RvT$ from Table 2 (with the completeness — number on the left):

\[
\begin{align*}
8 &= (1+2)+2+2+1 \\
8 &= (1+2)+3+1+1 \\
8 &= (1+3)+2+1+1 \\
8 &= (2+2+1)+2+1 \\
8 &= (4+1+1+1+1).
\end{align*}
\]

Here we apply on the base of (5) a known theorem about the tree-realization of the partitions (see Refs. [12, 19]):

\[2n \equiv 2(v - 1) = \sum_{i=1}^{v} \text{deg}v_i \equiv \sum_{i=1}^{v} \mathcal{M}(v_i). \quad (7)\]

The complex of $RvT$ s in Table 2 is responsible, in particular, for a three-level shell system with the principal quantum number $n_{QN} = v - 2$, equal to 1, 2 and 3, and with the corresponding possible values for the orbital quantum number $l_{QN} = 0, 1$ and 2.

Then an above-pointed “valence-isomerism” reflects a many-“planes” representation of the like hierarchical shell systems as atoms and nuclei (several $RvT$ — sets) that is simply an expression of their stability. Therefore just the simultaneous or “parallel” presence
of all "planes" or stationary forms of any stable shell system in \textbf{RvT}'s description means its permanent reproduction by the way of non-open "transferability" between "graph isomers" with the same number of vertices. Thus one obtains an adequate interpretation of the \textbf{RvT} — representation of steady states for every shell system where may be taken into account additionally a possible appearance of the degenerate levels. Still more it seems very significant also that the indicated \textbf{RvT} — representation is congruous with the corresponding one in Table 1 which describes the real path of free electron, particularly in the Wilson cloud chamber (beyond atom).

2.7.1 Graph schemes for elementary processes

Now the transitions or "jumps" between such steady states of the shell systems become absolutely evident as occurring with an exchange of lines in their \textbf{RvT}s and corresponding oriented multigraphs. They take place in the next concrete examples which can be considered by the special "graph schemes" or "graph equations" for various atomic and nuclear elementary processes.

The graph scheme for an emission of photon by atom with jump down of electron contains the loss of one of the peripheral vertex \((v_p)\) in pointed below suitable \textbf{RvT} from a collection of subtrees \(T-v_p\), corresponding to Bondy’s condition

\begin{equation}
 e_T(v_p) = D_T
\end{equation}

in agreement with (4a) and (4b):

\begin{align}
 \begin{array}{c}
 \text{Atom (neutral, } v) \\
 \begin{array}{c}
 \text{...} \\
 \text{(}v_p\text{)} \\
 \text{...}
 \end{array}
\end{array}
& \quad \rightarrow \quad \begin{array}{c}
 \text{Atom (neutral, } v-1) \\
 \begin{array}{c}
 \text{...} \\
 \text{...}
 \end{array}
\end{array}
& + \quad \begin{array}{c}
 \text{Photon } h\nu
\end{array}
\end{align}

(9)

In (9) neutral atom with \(v - 1\) vertices can be reconstructed by means of an use of Ulam’s hypothesis (according to Bondy) for \(T-v_p\) up to initial neutral atom with \(v\) vertices corresponding to \(T\). At that we have a production of photon with an emergence of the root vertex and a photon “core” formation (in the \(h\nu\) — semicycle form).

It is easy to understand that an use of the directed \textbf{RvT}s for describing of concrete processes with the charged microobjects instead of the non-directed ones for an estimation of microobject masses may be carried out by the way of a treatment of the totally or partially enumerative \textbf{RvT}s i. e. \textbf{RvT}s already with marked vertices (in particular, with \((v_p)\) — vertex in graph scheme (9)). Naturally, in any single case we have a conservation of the total number of non-directed and cycle paar of opposite directed lines for enumerative \textbf{RvT}s in these graph schemes; all over there are balanced signed digraphs.

The graph scheme for an absorption of photon by atom with jump up of electron contains the result of an insertion of the photon’s \(h\nu\) — semicycle into the peripheral vertex \((v_p)\) accompanied with a doubling — operation for the peripheral line:
In (10) we have on the right an excited neutral atom with $v$ vertices where the peripheral line is transformed to a neutral signed semiwalk presented an excited state of atom.

At last we consider the graph scheme for photoelectric effect i. e. for the liberation of electron from a substance atom exposed to electromagnetic radiation:

$$
\text{Atom (neutral, } v) + \text{Photon } h\nu \rightarrow \text{Excited atom (neutral, } v) \tag{10}
$$

This graph scheme (11) describes an atom influence on photon with the “destruction” of the photon’s $h\nu$ — semicycle which as if spontaneously is transformed into $e^-$ and $e^+$, with the following inclusion of $e^+$ into the peripheral line of atom and production of (+)-signed semiwalk for positive ionized atom. The maximum kinetic energy, $E_k$, of the photoelectron is given by Einstein’s equation: $E_k = h\nu - \varphi$ ($\varphi$ is the work function of the solid). On the other hand, graph equation (11) may be considered also as an insertion of the photon’s $h\nu$ — semicycle into an “atom — $\text{RvT}$” which is accompanied by the exchange emission back again of an “electron — $\text{RvT}$”.

2.7.2 About so-called atomic system “fatigue”

At last an efficient consideration of similar graph schemes—or graph equations — for any typical microobject, having as a rule the shell structure (with a presence of the sets of quantum numbers), can be carried out only on condition that one taking into account an obligatory “isomerism” in the complex $\text{RvT}$ — representation of every compound microobject — system and additionally a many-value variety of every graph scheme with participation of corresponding interacting reagents (photons, electrons, etc.)

Obviously, that it is very naturally for a like situation to suppose a possibility of the various failures in a complicated $\text{RvT}$ — representation of the composite microsystems.

In this connection, one may arise with some probability a specific shell system “fatigue”, including particularly a “fatigue” of an atomic system with steady state sets, which can be appeared perhaps in result of some default of a peripheral part of the “graph isomers”, for example after an emission of photon and suitable reconstruction of atom (see graph equation (9)), i. e. in spite of an assertion of Ulam’s hypothesis, or in result of some transformation of this peripheral part into the balanced signed semiwalk of excited atom already, in particular by an absorption of photon (see graph equation (10)). Thus one may probably create an accidental situation of non-full reproduction of atom (in spite of an experimentally line spectra of excited atoms and ions with enough strict invariability),
connected straightly with many - “planes” $\text{RvT}$ — representation of atomic system, which will cause the combinatorial failure after a some number of the like regular and even cyclic processes.

Analogous failure can be occured also at the photoelectric effect in atom (see graph equation (11)) and generally in every graph scheme with shell structure of the main “fatigueless” microobject where figures the many - “planes” $\text{RvT}$ — description.

2.8 Mass-classification of subnuclear microobjects and $(r, s)$-subsequences

Among the chaos of the experimental mass values $(M/m_e)_{\text{exp}} [\mathbf{X}]$ (in $m_e$ unit, with $T_{v=2} = 1$ for electron) of “initial” and “excited” subnuclear microobjects $[\mathbf{X}]$ in Table 2 of part II of paper (see Ref. [11]) may be traced the several basic $(r, s)$ — subsequences along with a number of “chief” microobjects at $r = s = 0$ corresponding to the pions $[\pi^0]$ and $[\pi^\pm]$ ($v = 9, T_{v=9} = 286$), to the $N$ — baryons — just proton $[\mathbf{p}]$ and neutron $[\mathbf{n}]$ — and some light unflavored and strange mesons ($v = 11, T_{v=11} = 1842$), to the charmed baryons $[\Lambda^+_c], [\Sigma^-_c], [\Xi^-_c], [\Xi^0_c], [\Omega^-_c]$ and a series of mesons and baryons ($v = 12, T_{v=12} = 4766$) and, probably, to the $d$ — quark ($v = 6, T_{v=6} = 20$). Of course, the indicated “chief” microobjects at $r = s = 0$ can be described completely by the above-mentioned sets of “hedgehog” — $\text{RvT}$.

At first we have in Table 4 one of such $(r, s)$ — subsequences, namely, the main $(0,2)$-subsequence of lepton masses, where two known leptons disposed at $v = 11$ ([µ]) and $v = 14$ ([τ]), and of meson and charmed meson masses — at $v = 13$ ([ρ], [ω]) and $v = 14$ ([D^0], [D^±], [D^±_s]).

Table 4. (0,2)-subsequence (“bi-triplets”) of lepton and other particle masses

| $v$   | 9  | 10 | 11 | 12 | 13 | 14 | ... | 18 |
|-------|----|----|----|----|----|----|-----|----|
| $T_{v}/2^r3^s$ | 32 | 80 | 205 | 530 | 1387 | 3664 | 191 300 |
| $(r = 0, s = 2)$     |     |     |     |     |     |     |     |     |
| both leptons         | | | | | | | | |
| [µ]                  | | | | | | | | |
| [τ]                  | | | | | | | | |
| other particles      | [ρ] | [D^0], [D^±] | charmed strange meson |
| [ω]                  | [D^±_s] | and oth. |
| (M/m_e)_{exp} [X]    | 207 | 3474 | 1507–1530 | 3649–3852 | 178 448 |
The next main (1,0)-subsequence in Table 5 includes a whole collection of various particles and consists from the masses of five quarks \([u], [d], [s], [c], [t]\) at \(v = 6, 7, 10, 12, 17\), of strange mesons \([K^\pm], [K^0, \bar{K}^0]\) at \(v = 11\), of \(\Lambda^0, \Sigma^-\) and \(\Xi^-\)-baryons at \(v = 12\) and at last of \(c\bar{c}\)-mesons \([\eta_c], [J/\Psi], \chi_c]\) at \(v = 13\).

Table 5. (1,0)-subsequence (“doublets”) of quark and particle masses

| \(v\) | 6  | 7  | \ldots | 10 | 11 | 12 | 13 | \ldots | 17 |
|-------|----|----|---------|----|----|----|----|---------|----|
| \(T_v/2^r3^s\) \((r = 1, s = 0)\) | 10 | 24 | 360 | 921 | 2383 | 6243 | 317424 |
| Hypothetical and real particles | quark | quark | quark | meson | baryons | \(c\bar{c}\)-mesons |
| \([u]\) | \([d]\) | \([s]\) | \([\eta]\) | \([\Lambda^0, \Sigma^+, \Sigma^-]\) | \([\Xi^0, \Xi^-]\) | \([\eta_c]\) | \([t]\) |
| \([K^\pm], [K^0, \bar{K}^0]\) and oth. | \([c]\) and oth. | \([\chi_c]\) and oth. |
| \((M/m_e)_{exp}[X]\) | 1071 | 2183–2343 | 5829–6870 | 966–974 | 2544–2585 | 352250 |

Below we add two more Tables 6 and 7 with (2,0)- and (2,1)-subsequences of the particle masses which contain the baryon \([\Omega^-]\) at \(v = 13\) and the quarks \([c]\) and \([b]\) at \(v = 14\), and also mentioned already quark \([s]\) at \(v = 12\).

Table 6. (2,0)-subsequence (“bi-doublets”) of quark and particle masses

| \(v\) | 13 | 14 | \ldots | 17 |
|-------|----|----|---------|----|
| \(T_v/2^r3^s\) \((r = 2, s = 0)\) | 3122 | 8243 | 158712 |
| Hypothetical and real particles | baryon | quark | boson |
| \([\Omega^-]\) | \([b]\) | \([W^\pm]\) |
| and oth. and oth. | |
| \((M/m_e)_{exp}[X]\) | 3273 | 8415 | 157201 |
Table 7. (2,1)-subsequence of quark and particle masses

|  | 12  | 13  | 14  | 15  | 16  |
|---|-----|-----|-----|-----|-----|
| $T_v/2^r3^s$ (r = 2, s = 1) | 397 | 1040 | 2748 | 7318 | 19 615 |
| Hypothetical and real particles |   |   |   |   |   |
| quark meson | [η] | [c] | “excited” | “initial” | cc-mesons and |
| strange baryons |   |   |   |   | bb-mesons |
| mesons | [Ξ^0], [Ξ^-] |   |   |   | |
| [K^±], [K^0, K^0] and oth. |   |   |   |   | |
| $(M/m_e)_{\text{exp}} [X]$ | 1071 | 2544 |   | 6683–7906 | –21 564 |
|   | 966–974 | 2573–2585 |   |   | |

It will be noted that baryon $[\Lambda^0]$ belongs also to (1,1)-subsequence at $v = 13$ whereas in (0,1)-subsequence must be included charmed strange mesons $[D_\pm^s], [D_\pm^{*s}]$ and charmed baryon $[\Lambda_+^s]$ at $v = 13$ and also bottom mesons $[B^\pm], [B^0], [B^{*}]$, bottom strange meson $[B_0^s]$ and bottom baryon $[\Lambda_0^s]$ at $v = 14$.

These particular varieties of $(r, s)$-subsequences to a certain degree remind the group combinations — “conglomerates” or multiplets of particles from a more sophisticated “numeralogy” in the framework of special well-known formalism based on the symmetry principle with a common interpretation. In our case a notion of “multiplet of particles” arises from a natural analysis simply of \( \frac{1}{2} \)-part or \( \frac{1}{3} \)-part of the “whole”, for example $T_v$, and is regulated alternatively by the hierarchical rules of a double- and a triple-splitting mechanism for the “hedgehogs” — $RV\mathbf{T}$ on a base of the evident recurrent inequalities for $T_v$ (see particularly in section 4 of part II of paper — Ref. [11]). Thus the “doubleness” (“doubletness”) as well as the “tripleness” (“tripletness”) are simply a result of use of the “hedgehog” — $RV\mathbf{T}$ formalism for a representation of the discrete microobjects as the fundamental constituents of all the matter in the universe.

Under any realization of this “doubletness”—“tripletness” graph concept one must set up the various possibilities and lastly some definite rules for a more exact practical estimation of mass parameters of the discrete microobjects along with a rough approach to $T_v$ and its fractions $T_v/2^r3^s$ in part II of paper (see Ref. [11]).

At first, starting from the recurrent inequalities for $T_v$ in a form

\[
\frac{T_{v+1}}{2} > T_v > \frac{T_{v+1}}{3}
\]

one can determine an “interval-function” $\Delta(T_v)$ which allows to calculate for every $v$ the distribution range of $T_v$-values (see below Table 8).
Table 8. “Interval-function” \( \Delta (T_v) = \frac{1}{6}T_{v+1} \)

| \( v \) | \( T_v \) | \( \Delta (T_{v+1}) \) | \( v \) | \( T_v \) | \( \Delta (T_{v+1}) \) |
|-------|-------|----------------|-------|-------|----------------|
| 3     | 2     | 0.6(6)         | 9     | 286   | 119,83(3)     |
| 4     | 4     | 1.5            | 10    | 719   | 307           |
| 5     | 9     | 3.3(3)         | 11    | 1842  | 794.3(3)      |
| 6     | 20    | 8              | 12    | 4766  | 2081          |
| 7     | 48    | 19,16(6)       | 13    | 12486 | 5495.5        |
| 8     | 115   | 47.6(6)        | 14    | 32973 | 14635,16(6)   |

Thus in Tables 4–7 we have an essentially original “concentration” of the whole sets of particle group masses, with “mixing” of meson and baryon particle categories, near the definite number of vertices (especially within an interval \( v=11 \div 14 \)) of corresponding “hedgehogs” — \( \text{RvT} \) s which in various configurations are responsible for the structural peculiarity of different microobjects and in such a way one can be set up their concrete physical characteristics. In this connection one must elaborate for the developing graph formalism an adequate graph interpretation which could allow to reproduce some general physical picture. At that one can be taken into consideration: a) all above-stated graph (“hedgehog” — \( \text{RvT} \)) regularities, pointed out as different \( (r, s) \) — subsequences for microobject masses; b) the further graph schemes (see, for example, equations (9)–(11)) for various atomic and nuclear reactions with conservation as well as non-conservation of a number of vertices and, moreover, c) also the developing group formations for other microobject characteristics, including “charge”, “spin” and so on, that are in agreement with the studying graph formalism.

Table 8 indicates a sharp increase of \( \Delta (T_v) \)—values with \( v \), in other words an enlargement of the possibility diapason for the “hedgehog” — \( \text{RvT} \) formalism in respect to a description of mass parameters as well as of other characteristics of microobjects including the heavy physical and further the complicated biological microobjects.

3 TWO-LAYER PHYSICS ACCORDING TO HEISENBERG — DYSON

It still remains a mystery why the physicists were not among the first investigators of a graph aspect of Kirchhoff’s work about an electric network of 1847 (see Ref. [22]) and are enough indifferent so far to the development of graph — or, more exactly, tree — theory which now is a section of the discrete mathematics wide-using in applied sciences. Apparently, such passivity occurs as a result of the full hegemony of the continuous mathematics in physics and correspondingly the preferable construction of the so-called one-“plane” continuous models, in opposition to the initially many-“planes” discrete models how it is easy to see from the above-pointed examples of the discrete mathematics application. Therefore a break-through in “discontinuity” didn’t happen before in physics.
3.1 Peculiarities of microobjects description in Heisenberg—Dyson’s physics

Up till now through a development of the continuous physical models, based on the methods of corresponding sections of a continuous mathematics, the most part of an appropriate concept notions can be included in a contemporary theoretical representation of natural events and can be used as a base for an introducing any new model. However after the transition to microworld many conceptual conclusions, following from the pointed continuous models, have turned out experimentally proofless and even senseless that is due to some earlier included concept notions which haven’t adequate interpretation.

Among such non-adequate notions in old concept one may call artificial quasi-objects like the quarks, although similar quasi-objects can be predicted as the certain \((r, s)\) — subsequences in the framework of a proposed graph formalism for discrete microobjects in a “hedgehog” — \(\text{RvT}\) representation (see section 2). Indeed, in Tables 5–7 one comes to light a “multiplet” from five quarks in \((1,0)\) — subsequence: \(T_v/2\) at \(v=6\) ([u] — “up”), \(v=7\) ([d] — “down”), \(v=10\) ([s] — “strange”), \(v=12\) ([c] — “charm”), \(v=17\) ([t] — “top”) and an alternative “doublet” from \((2, 1)\) — subsequence: \(T_v/12\) at \(v=12\) ([s] — “strange”) and \(v=14\) ([c] — “charm”). Besides these main subsequences for the fundamental constituents in an old concept one must mention in passing some other kind of “doublet” from the quarks at one value of \(v=14\): [c] — “charm” from \((2,1)\) — subsequence \((T_v/12)\) and [b] — “beauty” or “bottom” from \((2,0)\) — subsequence \((T_v/4)\).

In this arisen consideration it is noteworthy also the creation of a new “top hierarchy” of particles with a distinct separation of the “chief” particles, including the pions and the \(N\) — baryons (at \(r=s=0\)), and the main leptons in \((0,2)\) — subsequence, whereas any other categories of particles may be interpreted as the following, possibly “derivative”, layers of such “top hierarchy”. Here it is important to emphasize also that in quantum mechanics one can set up only a peculiar discontinuity of dynamical quantities — depending from the sets of quantum numbers — for physical microobjects but we haven’t yet a straight quantum description of their discrete complicated structure and, still more, of their many-“planes” representation beyond space—time.

Meanwhile an existing problem of description of the microobjects structure and their interactions beyond space—time is solved above (in section 2) in the framework of linear two-layer approach or two-layer matrix (1) (at \(\delta = \alpha\)) approximation by means of the specially introduced notions of the “graph geometry” in a linear “hedgehog” — \(\text{RvT}\) representation and the linear loop-forming quasi-continuous field “object” as an oriented multigraph with some loops (composed linearly from two or more “hedgehogs” — \(\text{RvT}\)’s responsible for separate discrete microobjects). Just in this way one can occur the linear two-layer physics of microworld according to Heisenberg—Dyson with an inclusion of the new essential features of atomic and nuclear stable systems and subnuclear particles.

3.2 Macro networks in Heisenberg—Dyson’s physics

On the other hand, Heisenberg—Dyson’s physics of macroworld coincides with Kirchhoff—Maxwell’s two-layer physics approach, formulated in part I of paper (see Ref. [10]) and constructed on the two-layer matrix (1) at \(\delta = \omega\) with skeleton trees basis. By
using of such skeleton trees basis one can write down the all possible solutions for various
macro networks, as a some graph prototype of any macroobject. In the main, the linear
equations, derived from two-layer matrix representation, allow to set up the linear structure
of all fragments of any macro network i.e. the linear superposition of corresponding real
sets of $\mathbf{S}_n \mathbf{T}$, determined by famous Kirchhoff’s theorem (see for example, Ref. [12]).

In this connection, including the total of subsection 3.1, it is immensely important to
note that on the whole a graph (tree) conception, appeared initially from the linear algebraic
Kirchhoff’s laws (Ref. [22]) in the form of $\mathbf{S}_n \mathbf{T}$ — formalism, may be considered generally
as an one-value result of the “universal linearity” of physical laws of the nature. Although,
according to Ulam’s reminiscence, yet Fermi on this occasion said: “Well, it does not say in
the Bible that fundamental equations of physics must be linear”.

According to an originated problem of the creation of an initial pre-condition for ade-
quate graph description of macroworld it will be noted that any physical theory for the
consideration of different discrete or quasi-continuous macroobjects can be constructed on a
base of the concrete simplest “geometrical figures” (in a general sense) taking into account
the main peculiarities of these natural macroobjects and giving a “native” representation
of their structure in the framework of existed models picture. These “geometrical figures”,
in other words, can be applied as a some physical image of the complex macro process
with a participation of macroobjects and, lastly, these ones must be transformed to the
corresponding equivalent graphs (trees) according to some macroworld rules, in agreement
with the Kirchhoff’s rules and the corresponding macroworld principles. In this way we
should have a generation of the graph prototype for macroobject as an analog of macro net-
work (compare, for example, the various “geometrical figures” for crystals, macromolecules,
biological objects, etc.).

It is remarkably in a development of the continuous physical theory for macroworld that
already at the stage of an appearance of the Maxwell’s equations for electromagnetic field,
written down here in two-layer matrix form

\[
\begin{pmatrix}
-D + \text{curl } \mathbf{H} \\
(\text{ic div } \mathbf{D})
\end{pmatrix} = \begin{pmatrix}
\mathbf{j} \\
(\text{ic } \rho)
\end{pmatrix},
\begin{pmatrix}
\mathbf{B} + \text{curl } \mathbf{E} \\
(\text{c div } \mathbf{B})
\end{pmatrix} = \begin{pmatrix}
\mathbf{\theta} \\
0
\end{pmatrix},
\] (13)

one was carried out, with a a great virtuosity, the crossing over of the components of “charge”
part $\begin{pmatrix}
\mathbf{j} \\
(\text{ic } \rho)
\end{pmatrix}$ (a known 4-vector) and the components of remaining “curl field” part with $\mathbf{E}$,
$\mathbf{D}$, $\mathbf{H}$, $\mathbf{B}$. As a result one could obtain then, without any transition to the discrete physical
objects conception, only a “mixed” picture that don’t allow to separate directly the upper
layer (discrete material objects) and the under layer (quasi-continuous field “objects”) in the
framework of a proposed Heisenberg—Dyson’s two-layer matrix (1) scheme, right however for
the solutions of pointed equations (13). And, at last, starting from the Maxwell’s equations
in emptiness, one should mention the description of electromagnetic radiation where the
energy can be regarded as waves propagated through usual space requiring no supporting
medium: in this case figures only one under layer.
3.3 Heisenberg — Dyson’s two-layer approach to study of microobjects structure

Returning again to microworld in the course of an analysis of the Heisenberg — Dyson’s two-layer physics one must take active part firstly in the further decoding of the postulated “physical graph” as a some derivative, already within discrete two-layer matrix scheme, analog of a solution of the differential equations for continuous physical models. In other words, while passing through a stage of the physical dynamics i.e. a stage of an investigation of corresponding differential equation itself (with Newton’s, Lagrange’s, “evolution’s” and other differential operators) in favour of a two-layer matrix approximation for its solution, one can go over to a straightforward explanation of the structure and the properties of discrete physical microobjects, without reference to dynamics aspects in space—time. Substantially, a two-layer matrix approximation for pointed solution must be derived by the way of its extremal transformation to the two-layer system of linear algebraic equations (for a natural description of “physical graph”, as an analog of “Kirchhoff’s laws graph”).

After RvT — estimation of the subnuclear microobject masses (an average error ranges 0 to 10 per cent) in part II of paper (see Ref. [11]) we obtain some rough mass-classification with the “concentration” of all microobject masses within an interval of RvT - vertices: $v = 9 \div 14$, as an illustration of the enough adequacy of “hedgehog” — RvT formalism to the clearing of microworld picture. Nevertheless, at the more accurate and complete determination of the structure and the properties of discrete microobjects the leading role must play their interactions (or interaction “charges” according to Table 3) and connected with them different “core” characteristics, including $\mathfrak{M}c, v_{F}, C_{v_{F}}$, as the main representants of hierarchical sets of “hedgehog” — RvT.

However, formerly it is important to elucidate from the point of view of a “graph language” (as an alternative “third language”) that the dynamical quantity, namely “$E$ — energy” provided for the continuous models (side by side with “$L$ — Lagrangian”, “$H$ — Hamiltonian”, etc.) must be “measured” already with the help of dimensionally identical parameter “$c^{2n}$ ([E]$\sim[c^{2}]$) giving a purely numerical — dimensionless — result for mass $m = E/c^{2}$. Indeed, according to the special theory of relativity the mass of microobject is a measure of its total energy content that is equivalent in a “graph language” to the dimensionless $T_{v}$ — numbers or their fractional ($r, s$) — “fragments” $T_{v}/2^{r}3^{s}$ and is, analogously, in a some agreement with the known relation of two periods $\omega = 2\pi/T$ in a “wave language”, i.e. the mathematical period $2\pi$ and the physical period $T$. Therefore, in the case of subnuclear particles there are a sequence of integers $T_{v}$ and fractions $T_{v}/2^{r}3^{s}$ for the straightforward determination of their masses using namely a “native” $T_{v}$ - quantity of “hedgehog” — RvT formalism.

Further, according to our consideration in subsection 2.6, it is significant also that the nature of any microobject mass can’t be determined by one type of interaction inasmuch as for any microobject there are simultaneously all types of interaction (four or more) which determine conjointly a general (“mixed”) mass of every microobject and, consequently, of any macroobject.
3.3.1 Responsibility of different types of interaction for complicated microobjects structure

A “hedgehog” — \textbf{RvT} representation for a single pure “core” of nucleons \((n^\circ, p^+)\) at \(v = 11\), i. e. \(C_{v_F=10}\) with maximum “free” vertices \(v_F = v_{F}^{\text{max}}\) in Table 3, corresponds apparently to a some set of free constituents — quarks which are responsible for an inner “invisible” structure of the strong interacting nucleons and, according to the quark—confinement hypothesis, cannot escape from one another (in QCD, particularly, interactions between quarks get weaker or stronger as the space—time distance between them gets smaller or greater, correspondingly). This unwarranted assumption about a role of the single pure “core” \(C_{v_F=10}\) for the strong interaction of a nucleon stipulates an introduction of the additional suggestion that one of the “planes” in the “hedgehog” — \textbf{RvT} representation of a nucleon can never be “seen”, even in isolation, and at that may be shown only by a some indirect way. Such suggestion concides with a conclusion from section 2.6 about the “microworld situation” within which there is an “invisible “core”-vertices confinement” for any typical discrete microobject. It is easy to see, however, that a presence of the “charges” altogether and quantum numbers in the single pure “core” of nucleons \(C_{v_F=10}\) cannot respond to an integer of the free constituents — quarks, i. e. in our case a linear set of the various quarks in nucleons in the form of superposition sum may be considered simply as a special combinatorial factor for an estimation of the real composition of their “core”-vertices (as opposed to compensation rules for the “charge” multiplets with a concrete, for example, fractional electric charge assigned to the different quarks).

The next single one-“plane” \textbf{RvT} — representation or “hedgehog” — \textbf{RvT} with \(v_F = v_{F}^{\text{max}} - 1 = 9\), \(v_F = 8\), which is responsible for the weak interaction of nucleon in Table 3, on the contrary is quite “visible” and takes part in the decays (for example, \(n^\circ\) in Table 3) and in the construction of the definite real physical systems (for example, nuclei from the sets of separate \(n^\circ\) and \(p^+\)). Indeed in following Table 9 one depict the most evident typical graph constructions of some light nuclei from the separate “hedgehogs” — \textbf{RvT}s of neutrons and protons, within a general “core” with several root vertices. Over this “core” one must arrange the sets of steady states, or one can potentially join the hierarchical schemes of corresponding electronic shell levels controlled by electromagnetic — or other long-ranged — interaction, with 1840 “hedgehogs” — \textbf{RvT}s for every nucleon (according to Table 3).

\textbf{Table 9. “Core” — structure of some light atomic nuclei}

| Nucleus of hydrogen atom | Nucleus of deuterium atom | Nucleus of helium atom |
|--------------------------|--------------------------|-----------------------|
| !(p^+) (e^+)              | !(n^\circ) (p^+) (e^+)   | !(n^\circ) (p^+) (p^+) (n^\circ) |

30
It is already known that positive “charge” of nucleus \( Z \) is determined by a number of separate in-side directed lines beyond “core” connecting with a number of included into “core” protons. These in-side directed lines emerge in the result of a dissolution of lines in some oriented multigraphs (with semicycles for adequate single non-directed lines) which must be disposed beyond the corresponding “core” and may be considered as if the “free radicals” of nuclei with interacting “charges” (compare, analogously, the “free radicals” into the like presentation of chemical or biological molecules). Obviously that additionally to Table 9, a “core” of any next, more heavy, nuclei with \( Z > 2 \) can be immediately constructed in a similar manner.

It will be noted also that a like form of the “core” — structure of atomic nuclei, especially in the region of enough large \( Z \), presupposes a some possible “fission” process similar to the biological cell “fission” according to the principle of replication as an evolution of structures with several hierarchical centres.

### 3.3.2 “Fission” and “fusion” of “core”—vertices under formations and structural changes of microobjects

Every type of interaction between various microobjects as a cause of their structural changes may be realized by means of exchange forces resulting from the continued interchange of “transferable particles” (photons, mesons, gluons, intermediate bosons, etc.) in a manner that bonds their hosts together. For example, it is suggested that in the strong interaction gluons are exchanged between quarks or mesons are exchanged between nucleons; at that mesons jumped from proton to neutron and back again. Also in a case of the electromagnetic interaction there is the covalent bond involving electrons and so on.

On the other hand, all changes in the structure of every real, certainly complicated, microobject, participating in different physical processes (decays, collisions, scattering, productions, reactions, etc.), are accompanied with a “fission” and a “fusion” of “core” — vertices, including the corresponding root vertices, that may be interpreted as a reconstruction, a reproduction, a replication (or a multiplication), and so on, of “core” for various \( \text{RvTs} \).

For concrete illustration from the very beginning it is expedient to consider the simplest example of complex nucleon structure with the set of \( \text{RvTs} \) at \( v = 11 \) in which one must embed all kinds of microobject with the sets of \( \text{RvTs} \) at \( v \leq 11 \), namely in the form of superposition sum of Riemann’s “counting homogeneous elements” for altogether constituent parts of the single pure “core” of nucleons \( (n^2, p^+) \), i. e. \( C_{v_{sp}} = [N](T_{v=11}) \):

\[
[N](T_{v=11}) = k_1 \cdot [\eta](T_{v=11}/2) + k_2 \cdot [K](T_{v=11}/2) + k_3 \cdot [\mu](T_{v=9}) + k_4 \cdot [s](T_{v=10}/2) + k_5 \cdot \{[\pi](T_{v=9}) + [\pi](T_{v=10}/3)\} + k_6 \cdot \{[d](T_{v=6}) + [d](T_{v=7}/2) + k_7 \cdot [u](T_{v=6}/2) + \sum_{i=1}^{4} k_{7+i} \cdot [X](T_{v=6-i}) + \cdots ,
\]

where the last member contains the pure “core” \( \text{RvTs} \) with \( \mathcal{M}_{\text{max}} = 2(v - 1) \) for \( 2 \leq v \leq 5 \) as “graph vacancies” \( C_{v_{sp}} = i; i=1,2,3,4 \) including \( e^\pm \), various \( \nu \) and others. Here we use the next designations.
| [N]-nucleons: [n], [p] |  \( v = 11 \) |  \( e = 0, +1 \) |  \( T_{v=11} = 1842 \) |
|----------------------|-----------|-------------|----------------|
| [u]-quark            |  \( v = 6 \) |  \( e = +2/3 \) |  \( T_{v=6/2} = 10 \) |
| [d]-quark            |  \( v = 6.7 \) |  \( e = -1/3 \) |  \( T_{v=6} = 20, T_{v=7/2} = 24 \) |
| [\( \pi \)]-mesons: [\( \pi^{\pm} \)], [\( \pi^0 \)] |  \( v = 9, 10 \) |  \( e = \pm 1, 0 \) |  \( T_{v=9} = 286, T_{v=10/3} = 240 \) |
| [s]-quark            |  \( v = 10 \) |  \( e = -1/3 \) |  \( T_{v=10/2} = 360 \) |
| [\( \eta \)]-meson    |  \( v = 11 \) |  \( e = 0 \) |  \( T_{v=11/2} = 921 \) |
| [\( \mu \)]-leptons: [\( \mu^{\pm} \)] |  \( v = 11 \) |  \( e = \pm 1, 0 \) |  \( T_{v=11/2} = 921 \) |

Nevertheless, a problem of the Riemann’s “counting homogeneous elements” in expression (14)–(15) can be solved only in the frame of evident discrete \( RvT \) — transformations embraced the necessary permutations of various “core”-vertices, after admissible operations of their “fission” and “fusion” and “core”-generating or “core”-eliminating processes, and also specially the “invisible “core”-vertices confinement” within the nucleon for “free-walking” quark vertices (without root vertex). The last remark concerns two coefficients \( k_6 \) and \( k_7 \) in (14).

It will be noted also that a former Yukawa’s suggestion about the exchange forces between nucleons that held them together involved several generating pions which now, in expression (14), are simply included as a graph constituent part of nucleon with the maintenance of the principles of a graph integrity of nucleon and separately of pions (and any other particles), of a graph non-reducing of nucleon as a whole to the sum of parts and, at last, of a graph reproduction of nucleon.

The further study of the more complicated microobjects may be carried out analogously.

In general terms, under a penetration into the structure and a formation of the theoretical model characteristics of concrete microobject it is necessary to leave out its dynamics and everyone from artificial symmetry multiplets, determined solely the non-structural quasi-discontinuity of “conditional microobject” in a form of the discrete sets of quantum numbers — so-called “QN-discontinuity” (with the following increase of these sets for the classification aims and an experimentally proof comparison). Just then one must essentially alter former description starting from an introduction of the true discontinuity beyond space—time (instead of “QN-discontinuity”) and a direct calculation of the precise proton mass as an initial point of the “top hierarchy” consideration. As it is demonstrated already such true discontinuity beyond space — time can arise only by an acceptance of the axiom of the universal linearity of physical laws in macroworld as well as in microworld; at that above-mentioned “top hierarchy” for microobjects is a natural consequence of the same linearity. Indeed, an initial principle of superposition in the framework of graph formalism may be fulfilled in the form of a sum of the Riemann’s “counting homogeneous elements” including the “hedgehogs” — \( RvTs \), the \( SvTs \) and the other graph “planes” of discrete physical objects, correspondingly.

In the end, summing-up specially the main results of an attained two-layer physics approach to microworld it is easy to see that the set of \( RvTs \) determines the peculiarities of the following many - ”planes” representations of real single microobjects and complex microobject - systems:
- one strong interaction "core" (one set of pure "core" vertices) which is responsible probably for the notion of "Elementary Particle" or for some microobject corresponding only to the set of "invisible "core" vertices",
- one weak interaction "core" (one set of "core" vertices with separate vertex beyond "core") which is responsible for the decaying microobjects - "neutral" as well as "charged", having the single "visible" vertices beyond "core",
- several electromagnetic or gravitational interaction "cores" (several sets of various "core" vertices with additional vertices beyond these "cores") which are responsible altogether for different shell microsystems.

Using the far-seeing propositions of Ulam’s hypothesis for graphs (see Ref.[12]), proved later for trees (Refs.[14-16]), it will be noted that every tree (including everyone $RvT$) can be completely presented as a some composition of respective subtrees with the same or less number of vertices. Then any pure "core" for microobject may be written down in the form of superposition sum of some set of pure "cores" for its constituent parts. Therefore, particularly, every "Elementary Particle" can be decomposed as a "whole" in the superposition sum of Riemann’s "counting homogeneous elements" as suitable separate "parts" (perhaps such transitions from one "invisible" "core" to the postulating Riemann’s sum of suitable several "invisible" "cores" are typically for the strong interacting microobjects whereas if we consider the weak interaction one must turn to an analysis of the decaying microobjects and "visible" "charge" reactions). On the other hand, this decomposition must reflect simultaneously a hierarchical non-reducing of the "whole" to the set of "parts" that may be connected with the discretion of $RvT$-basis of "graph geometry" beyond space-time as opposed to the usual bases in "external" space-time with "point-continuity" of coordinate axes (Cartesian frame of reference, for example) which, however, deprive of personal character of discrete physical microobject in corresponding theoretical models.

4 CONCLUSIONS

The proposed model of an introduction of the discrete physical objects in micro- as well as in macrophysics is realized by means of postulating of the new “physical graph” as a discrete microobject and simultaneously using the “Kirchhoff’s laws graph” for an electric “macro network”. These graphs may be presented through the discrete sets of root $v$-trees ($RvT$ — “hedgehog”) for microobjects and skeleton $v$-trees ($SvT$) for any typical macroobject i. e. beyond space—time, insasmuch as the pointed sets of trees form in some way the $RvT$-basis and the $SvT$-basis, correspondingly. In this case the common “Extension axiom” in a space—time is replaced by the more adequate “Binding axiom” beyond space—time. The rejection from space—time agrees, on the other hand, with Eddington’s supposition (see Ref. [23]) that the space and the time are only the approximate notions which must be substituted finally by the more general idea of an arrangement of any events of nature with adapting of the more adequate mathematical formalism and getting accustomed to an absence of generally accepted space—time.

If we are at the some stage where one should realize a discrete object scheme for the description of physical microworld or, more generally, for the creation of an unified physical theory of micro- as well as macroworld then again one may appear a “choice situation” in part of a branching of the directions of development of physical theory (see Ref. [9]).
This “choice situation” is analogous to a similar one in the fundamental physical theories in the mid-1960s (see, particularly, a narration about competition of the $S$-matrix theory, the quantum field theory and the group theory in Ref. [8]) or earlier (Riemann, 1868; Póincare, 1905; and so on). In fact, a discrete formulation of the fundamental physical theory, which should consider, in particular, as a variety of the discrete mathematics, didn’t realize during those periods.

Now one may formulate the principal results of a given paper (parts I–III), which are got in the framework of discrete graph formalism for Heisenberg—Dyson’s two-layer physics, in comparison with the theses of an old and today’s continuous theory.

1. For the first time in the late-1950s one had believed (see, in particular, Landau papers Refs. [13, 2]) that solely a direct use of non-perturbative diagram technique is completely consistent and could serve as a ground for an adequate successive construction of the future fundamental theory without an adaptation to any former continuous theory (QED, QCD and so on) or physical models. Factually it was an initial attempt to show the way for an inevitable introduction of the discontinuity in the present physical theory in a form of special diagram technique or, in terms of this paper, of graph kinematics of discrete physical objects.

2. The most significant and original conclusion following from the graph kinematics, in the frame of the Heisenberg—Dyson’s two-layer approach (analysed in this part III), consists in a many-“planes” $RvT$ or $SvT$ representation of any discrete physical object in opposition to one-“plane” physical objects in continuous physical models. Essentially, that every property and every type of interaction of a concrete discrete microobject can be connected with the definite subsets of such “planes” from the full set of $RvT$ — representation “planes” for a given microobject. In any single case these separate “planes” or their sets must be experimentally shown, directly or indirectly, for every discrete physical object as if crystal faces, for example.

3. A many-“planes” representation of concrete discrete object in a form of the “hedgehog” — $RvT$ or $SvT$ sets may be originated by passing through a stage of the physical dynamics in space — time and by postulating beyond space — time either a “physical graph” as a some extremally derivative algebraic analog of the solution of differential equations for continuous microobject models or simply a “Kirchhoff’s laws graph” as a ground for the construction of a solution of already algebraic equations for macro network. Using the Heisenberg—Dyson’s two-layer scheme one can now practically go over to the two-layer matrix approximation on the base (1) which composed from an incidence $I$ and a loop $CD(\delta)$ graph matrices.

4. Next very important and unexpected result concerns to the superposition of different types of interaction or simultaneous presence of the four (or more) sorts of interaction “charges” all round for any microobject (see Table 3). In the framework of many-“planes” “hedgehog” — $RvT$ representation the short-ranged interactions (weak, strong) can be described by an one-“plane” “hedgehog” — $RvT$ with maximum values of $M^c$ reflected a “compact” inner structure of any microobject in respect to the given interactions. Quite the contrary, for the long-ranged interactions (gravitational, electromagnetic) there are the sets of many-“planes” “hedgehog” — $RvT$ with $M^c < M^c_{\text{max}} - 1$ determined an enough “transparent” inner structure of the same microobject which may be considered as an adequate hierarchical scheme of levels or “orbitals” (see Tables 2–3). Now a central problem of the
theory shifts to the decoding and interpretation of a many-“charge” discrete microobject in
the frame of two-layer Heisenberg—Dyson’s “hedgehog” — RvT formalism.

5. Based on the incidence matrix $I$ “graph geometry” for the real discrete physical objects
describes all main characteristics reflected their peculiar many-“planes” inner structure in
the frame of purely discrete mathematics formalism beyond common space — time. There
is an essential problem to perform the crucial experiment for a suitable determination of
these characteristics.

6. The notion of such kind as an interacting “charge” of microobject in the graph
kinematics concept may be extracted only by means of the loop matrix $CD(\alpha)$ from the
symbolical quantities for the loop-forming quasi-continuous field “objects” in Heisenberg—
Dyson’s two-layer matrix approximation.

7. Strong correlation between upper (discrete material objects) and under (quasi-
continuous field “objects”) layers was set up with the help of Maxwell’s equations (13) and as
a reassured result the “mixed” non-linear picture of nature with the components of “charge”
4-vector $(\vec{j}_{\rho})$ and the components of “curl fields” $\vec{E}, \vec{D}, \vec{H}, \vec{B}$ may be eliminated simply
by the way of an introduction of the discrete physical objects conception in the framework of
two-layer matrix approximation for the linear Heisenberg—Dyson’s scheme. This example
illustrates also a general conclusion about the “universal linearity” beyond space—time.

8. In contrast to quantum mechanics, the set up earlier problems of a stability (or
reproduction) of definite stationary states, of a transition itself (or “jump”) of electron
between stationary states and of a sudden emission (or “production”) of discrete photon
in atoms may be considered naturally and straightforwardly on the base of Heisenberg—
Dyson’s two-layer graph kinematics for discrete atomic shell systems beyond space — time.
The simultaneous or “parallel” participation of all “planes” (or stationary forms) of any
stable shell system in “hedgehog” — RvT’s description means its permanent reproduction
by non-open “transferability” between “graph isomers” with the same number of vertices.

9. It is quite possible, that there are different combinatorial failures in a complicated
RvT — representation of the many-“planes” discrete models for composite shell microsys-
tems as opposed to one-“plane” continuous models. It this way one may emerge, in partic-
ular, a “fatigue” of an atomic shell system with steady state sets (in spite of strictly line
spectra of excited atoms), which can be interpreted as a result of any default of a peripheral
part of the “graph isomers” (some breaking reproduction of initial atom) or as a result of
various transformations of this peripheral part into the balanced signed semiwalk of excited
atom.

10. In the frame of Heisenberg—Dyson’s two-layer physics one may introduce the “true
discontinuity” straightly for an initially structural discrete physical microobject on a “graph
language” beyond space—time, instead of “QN — discontinuity” (the discrete sets of various
free — introduced quantum numbers for the non-structural quasi-continuous “conditional
microobject” and its dynamical quantities in space—time). In this way one can present
the precise nucleon mass, as an initial point of the “top hierarchy” consideration, by an
acceptance of the axiom of universal linearity of physical laws. At that the principle of
superposition must be realized in the form of a sum of Riemann’s “counting homogeneous
elements” including a particular variant of the set of “hedgehogs” — RvTs for constituent
parts of nucleon as a whole.

11. For the certain setting up of an adequacy of “hedgehog” — RvT approach to
the clearing of microworld picture one must carry out at least a rough classification for a total list of the experimental values of subnuclear microobject masses using the fractional “fragments” \(2^{-r}3^{-s}\) of the root trees numbers \(T_v\). At average error of such \(T_v\)-estimation, ranged 0 to 10 per cent, there take place the “concentration” of all masses within an interval of \(RvT\)-vertices \(v = 9 \div 14\) (see part II) and the “tracing” of the several basic \((r, s)\) — subsequences for lepton, quark and other real and hypothetical particle masses (see Tables 4–7).

12. With the use of natural “hedgehog” — \(RvT\) regularities, as the first iteration in a making of different \((r, s)\)-subsequences for microobject masses, one can derive a new “top hierarchy” of particles, instead of more sophisticated “numerology” in the frame of artificial symmetry multiplets within an old “QN — discontinuity” concept. This more regular “top hierarchy” possesses a feature of the distinct separation of the masses of “chief” particles, including electron \((T_v=2=1)\), pions \((T_v=9=286)\), \(N\) — baryons and some mesons \((T_v=11=1842)\) in basic \((0, 0)\)-subsequence (initial 1-st level), and also the masses of main leptons \(\mu\) and \(\tau\) in \((0, 2)\)-subsequence (3-rd level). Any other category of particles belongs to the next more deep levels of such “top hierarchy” with the fixed “chief” particles \((e, \pi, N)\) and several mesons and charmed baryons.

13. The “doubleness” \(2^{-r}\) (or “mass doubletness” \(T_v/2^r\)) as well as the “tripleness” \(3^{-s}\) (or “mass tripletness” \(T_v/3^s\)) for subnuclear microobject masses are simply a natural consequence of the “hedgehog” — \(RvT\) formalism application to the specific representation of these discrete microobjects as fundamental constituents of the matter. Along with a rough approach to subnuclear microobject masses by means of \(T_v\) and its fractions \(T_v/2^r3^s\), reflected permanently “\(\frac{1}{2}\) — parts” or “\(\frac{1}{3}\) — parts” of the “whole”, one may develop this “doubletness” — “tripletness” \(RvT\) concept further for a more exact determination of these masses using some other discrete microobject characteristics including various “charges”, “spins”, and so on, for specification of such “top hierarchy”.

14. The exchange forces between protons, that held them together, involve usually several generating pions. Now in the framework of Heisenberg—Dyson’s approach to graph kinematics of the discrete microobjects these pions are simply included (without any generation) as the autonomic graph constituent parts of proton. In a given form of description one must maintain: (1) the principle of a graph integrity for \(RvT\)s of proton (number of vertices \(v=11\)) and separately for \(RvT\)s of pions (number of vertices \(v=9\)) and also for \(RvT\)s of any other constituent parts (number of vertices \(v \leq 11\)) of proton; (2) the principle of a graph non-reducing for \(RvT\)s of proton as a whole to the sum for \(RvT\)s of autonomic constituent parts; (3) the principle of a graph reproduction (an intermediate mechanism) for \(RvT\)s of proton through \(RvT\)s of pions.

15. Leptons \(\mu\) and \(\tau\) may be considered as the possible original excited states of lepton \(e\) with an increased number of vertices:

\[v_\mu = v_e + \Delta v_\mu = 2 + 9 = 11; \quad v_\tau = v_e + \Delta v_\tau = 2 + 12 = 14.\]

In particular, a muon should be looked as an excited electron for which \(v_\mu\) concides with \(v_p = v_n = 11\) and \(\Delta v_\mu = v_\pi = 9\).
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