The 3-fold Way and Consciousness Studies

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Contents

I.1. Conventional Quantum Mechanical representations.

Accordingly to quantum mechanics, each object is described by its state, or wave function. We prefer to use "state", since (initially, at least) it is neither numerical-, nor vector-valued. Rather, it is a section of an induced vector bundle over space-time. It can be converted into a function (with values in a prescribed "spin space") but one needs to go through the "parallelization" procedure (see our III.2, III.3 for more details).

When dealing with an elementary particle, the respective Hilbert space is determined (as part of the induction procedure, see below). It has become an acknowledged way of modern theoretical physics to describe elementary particles and their interactions in terms of induced representations of the (respective) symmetry group. To say a little bit more, "the main philosophical point of these developments is perhaps the importance of induced representations, not purely as representations, but as actions on the homogeneous vector bundles that naturally emerge from the induction process. This additional structure provides a spatio-temporal labelling of the vectors (or states, KL) in the group representation space that is absolutely essential for the formation of local nonlinear interactions, and relatedly, for causality considerations. Although a few decades ago, practical physics resisted and abominated the "Gruppenpest", in recent times it has surrendered…" ([Se-86, p.133]).

Conventional Quantum Mechanics uses representations of the Poincare group which are induced from its Lorentz subgroup as in Wigner's seminal work, [Wi-39] . The underlying space-time is the Minkowski world M (the one of Special Relativity).

Let us refer to the entire construction (which we do not specify more) as to a **representation**; each (microscopic or macroscopic) object is described by a certain representation. Let us now turn to **chronometric** representations.

I.2. Chronometric development of Quantum Mechanics and the DLF-perspective.

The reader is referred to III.1 to learn more details on Segal's Chronometry. In this paragraph, we only indicate some of the features which distinguish the "chronometric quantum mechanics" (or the "D-generalization" of QM) from the conventional theory.

The underlying space-time D is "larger" here: the Minkowski world M can be canonically embedded into D. The latter might be viewed as a modified version of the Einstein static universe, if to use terminology from the General Relativity Theory.

The symmetry group P of M is a subgroup of the symmetry group G of D (G is known as the "conformal group"). Similarly to the conventional quantum mechanics, its D-version also uses induced representations (see the previous paragraph) to classify elementary particles. Now, to get respective representations of the group G one has to induce from its subgroup P.

Chronometric energy of an object in a given state is always greater than its conventional energy in this state.

A characteristic feature of a typical chronometric representation is its indecomposability. As a consequence, one has to distinguish (see [Se-91] or [Le-95, Sect.6.1]) between an **exact particle** which is represented by a section (or state) of the respective induced bundle, and a **reduced particle**, a theoretical entity obtained by formation of quotient representations. The latter correspond to conventional representations. (In this regard, we are tempted to associate the mathematical

procedure of formation of quotients with an esoteric "emergence", or "descent".) This mathematical procedure is known as "factorization".

The "exact object" is described by the evolution of its state in the upper level (BEFORE factorization), whereas the object's conventional QM-state belongs to the space of the factor-representation. Certain amount of information about an object is lost as the result of that factorization.

Also, the above construction seems to be an appropriate way to mathematically model two (or more) **levels of reality**.

In the next paragraph we talk about such theoretical physics notions as particles, fields, interactions, etc. It is appropriate to let the reader know that in Segal's theory there are three fundamental interactions (this list is **mathematically complete!**). Here are certain details (from [Se-91], mainly). We apologize for the rather heavy use of physics-mathematical terminology in the forthcoming passage. Some of the notions are mentioned (if not defined) in other portions of our text. Clearly, they can be found in one of the numerous books on the subject (like [De-92]). The "ω" below is for the so-called conformal weight. The sum of conformal weights of the three particles (which build the respective currents) has to be 4 (for the interaction Lagrangian to be G-invariant, G is the symmetry group of the Segal's theory).

There are **three different types of interactions**, in terms of the relativistic limit.

(i) Two ω=3/2 fermions and a ω=1 boson. The fermions are electrons and neutrinos. The bosons include the photon and the weak bosons (called W- and Z-bosons).

(ii) A ω=3/2 fermion, a ω=5/2 fermion, and ω=0 boson. This is not readily characterized in relativistic terms but seems to underlie low-energy-electron and top-neutrino interactions with baryons and light mesons.

(iii) Two ω=5/2 fermions and a ω= -1 boson. This interaction appears as purely strong in relativistic terms.

Remark. We can notice the **absence of the gravitational interaction** in this list. See our other comments (in II.1 and elsewhere) regarding gravity (which we DO NOT consider as a fundamental interaction).

The above indicated "D-features" do not go away when we LF-develop Segal's theory (see III.2 for details of such a development). Rather, the geometric situation becomes "richer", or more complex.

It now becomes clearer what is to be understood by the LF-development of Segal's theory and by the DLF-generalization of QM. We have to consider worlds L and F on equal footing, essentially, with the spacetime D (as if the three worlds form a single object; hence, the **3-fold way**). Are there mathematical grounds to do so? Yes, there are (see our paragraph III.2).

In brief, the DLF-approach sets up quite a new perspective in physics. It is worth mentioning that during the second half of the 20^{th} century the "D-part" has been quite well developed (by I. Segal and his collaborators).

I.3. Fields of biological subjects.

As it is stated in many texts representing the "mainstream science", there exist four kinds of **fundamental interactions**: strong, electromagnetic, weak and gravitational (ordered by decreasing strength on the microscopic level). In this article gravitational interaction is NOT considered to belong to the class of fundamental interactions (see our paragraph II.1 below). Some experts are less radical but they, essentially, support such a view for practical reasons, like [De-92, p.6]: "Gravitational forces are far too weak to cause measurable microworld effects. Therefore, in models to be discussed, gravity will only be a "background", represented by the geometry of the spacetime in question… Interactions among particles proceed with the aid of ("are mediated by") certain special kinds of particles, known as intermediate bosons, or interaction field quanta. These are the photons for the electromagnetic interaction (a single species), 8 kinds of gluons for the strong interaction, and the weak (intermediate) bosons W^+, W^- and Z^0…
"Ordinary" particles which are not the interaction carriers just listed, are referred to as matter particles or **matter fields**."

The above extract was to support our point that the notion of a **field** is quite commonly used (since the beginning of the 20^{th} century or earlier) in theoretical physics for description of both categories of particles. Each material object is made of (or "consists of") particles. No surprise that, eventually, experts in other areas (see [KK-95, K-02] and many references therein) have started to use the notion of a field as a foundation of their theoretical constructs.

In modern theoretical physics, such a construct assumes a specification of a **vector bundle** over the respective world (over the totality of spacetime events). It is as if a straight line (in the fifth dimension) passes through each event (to model particles of a non-zero **spin**, one needs more extra dimensions). Each (instantaneous) value of the state of the particle is a point of the respective line (or **fiber**). It is important to keep in mind that such a value is NOT a number, yet. It is already at this stage, however, that the totality of all possible states of the particle forms a (infinite dimensional) linear space (or **Hilbert space** which is one of the key ingredients of quantum mechanical approach). The next stage of the quantum mechanical description of a particle is called a "parallelization of the bundle" (for more details go to our paragraphs III.2, III.3). In the case of a scalar particle (that of spin zero) the parallelization means, essentially, the choice of a scale (or unit of length) in each of the above fibers. The states, as a result, become number-valued functions (or standard quantum-mechanical wave functions).

We now turn to the piece of the theory related to possible experimental detection of fields. A field of energy (or "energy field") is a popular term in different texts. A modern precise notion is the **stress-energy tensor** (of a matter model, [SW-77, pp.76-77]). Formally, a stress-energy tensor on spacetime **W** is a symmetric (2,0)-tensor field **S** on **W (**satisfying an additional algebraic condition, for our purposes there is no need to specify this condition here). Physically, more is involved, as it is discussed on p.71 of [SW-77]: "A stress-energy tensor replaces and unifies the following prerelativistic concepts. Energy of electromagnetism and/or matter,

including rest-mass contributions per unit 3-volume; momentum per unit 3-volume; energy flux; and momentum flux, which corresponds to stress (a physics-mathematical concept, KL), in fact to the pair (pressure, anisotropic stress). Hence the term "stress-energy" (or in some references "energy-momentum") as an abbreviation. The prerelativistic quantities were found independently. They are observer-dependent and quite messy even in simple situations…But around 1905, physicists realized, with glee, that if one interrelates the measurements made by observers in relative motion, a single concept suffices, as follows.

Suppose any instantaneous observer (z,Z) actually measures the energy in any unit 3-volume of his local rest space (here z is for an event, Z is the unit 4-velocity, and the method is indicated more explicitly in [SW-77, p.72], KL). He is supposed to get **S**(Z,Z)… which (this is a number, KL) is the same for all instantaneous observers (observers at z, KL). Thus when **S** is a stress-energy tensor, **S**(Z,Z) is defined as the **energy density** (z,Z) measures for **S**."

In standard physics the energy density is required to be non-negative. This is the case of the three worlds (M, D, and L) considered in this article. The energy density of F (the most puzzling of the four spacetimes) is negative (see our III.2, IV.1 for more details).

Let us say that there is no contradiction between our extracts from [De-92] and [SW-77] since tensors (or **tensor fields**, rather) "live" in certain bundles over spacetime in question. Of particular interest are the so called **induced bundles** (see I.1, I.2, and III.1).

One of the most important and well-understood fields is an **electromagnetic** one. Formally, it is a 2-form (a certain rank two tensor field, KL) on a spacetime. [SW-77, p.74]: "In the end, only this formal definition is essential. But an electromagnetic field replaces and unifies two prerelativistic quantities: an electric field and a magnetic field. Indeed, the simplification thereby achieved was one of the main original motivations for introducing spacetimes." The authors then describe mathematically how the **electric vector field** and the **magnetic vector field** are to be defined (similarly, to a certain extent, to the just described "energy density of the stress-energy tensor"). Omitting this description, we only remind in this regard that vectors are rank one tensors.

A **Hamiltonian** is one other important notion worth mentioning. In the context of the DLF-approach it is discussed in paragraph III.2. Here we just remind that (when realized as a vector field on a spacetime, as a field of force which "drives an object from past to future") it is the image (under respective representation) of the **time generator** (the latter been a distinguished element of the infinitesimal symmetry group). Also, the Hamiltonian has certain properties of a linear operator (to simplify, of a matrix). Its eigenvalues form the **energy spectrum** of the object in question. So to say, **time is energy** (some authors say that "time and energy are dual variables"). Anyway, one concept defines the other. Again, this has been known in physics since the first half of the 20^{th} century.

The idea to "extract energy from time" is attributed to N.A.Kozyrev, a prominent Russian astrophysicist. In the chronometric context of QM this has been mathematically realized in [Le] and in [LLS-96]. The "yes" outcome presumes

existence of such a pair f, g of states of an object that for chronometric energy H(f) > H(g) holds but for conventional energy H', H'(f)< H'(g). This existence question remains open.

The importance of the **Biological Field** which is "a combination of different types of fields…of known and unknown origin…" has been stressed in [K-02] (p.237 and elsewhere). To try to understand those "unknown origins" we build a certain theoretical model, first. Otherwise, as someone said, "we do not have any idea how to detect those new fields, do not know what to measure." The DLF-approach of this article does suggest a piece of a new theory which is then applied (see paragraph IV.2) to explain results of several studies. These results are quite puzzling from the "conventional theoretical" point of view.

II.1 Discussion of some quantum-mechanical topics involved.

This paragraph is primarily based on [GGP, Ha-01, HP-96, Le-95, Le-03, Pe-94, Pe-96].

Subjective (or random) reduction is what happens when an observer measures a quantity in a quantum system: the system is in a "superposition" of possible states, it is not in any specific state until the measurement is performed; that measurement causes the system to reduce ("collapse", which is also called an R-process) to an eigenvalue state.

This is the only reduction known to traditional Quantum Theory.

When no observation is going on, the state of a physical system evolves in accordance with the dynamical equation of motion (call it the U-process).

From [Pe-94, pp.309, 310]: "...there is considerable scope for numerous different attitudes as to what really happens when R is brought in. ... there are those who believe that both U and R represent (to a considerable accuracy) actual physical behavior of a physically real, state-vector-described, quantum/classical-level world. But if one is to take the quantum formalism that seriously, then it becomes hard really to believe that the theory can be completely accurate at all levels. For the action of R, as the procedure stands, is at variance with many properties of U, in particular its linearity."

There exist proposals, according to which the current quantum mechanics is a limiting case of some more unified scheme. Both U and R procedures are to be approximations to some new theory of physical reality.

Some of the proposals ([GGP] being among them) use a quantum-state description just as in standard quantum mechanics, but where the evolution of the state deviates by a tiny amount from the precise Schrodinger (or Heisenberg) evolution U. The suggested deviations from standard U-evolution become noticeable merely when the system becomes "large", in some appropriate sense. This need not refer to physical dimension, but it might, for example, be the number of particles in the system that is relevant. However, commenting on that type of proposals, this is what J.S.Bell says (from [GGP, p.1273]): "It may be that a real synthesis of quantum and relativity theories requires not just technical developments but radical conceptual renewal".

In other proposals it is considered that it is the mass distribution that is all important. In such schemes it is normally taken that it is gravity that is responsible for deviations from the standard quantum rules.

R. Penrose [Pe-94,Pe-96] supports a gravitational role in the state-vector reduction. He is trying to hang on to both quantum realism and the spirit of the relativistic space-time view. He thinks that we should seek something that looks very different from the current quantum-mechanical descriptions, though (initially at least) it would be mathematically equivalent to them. We need a profound change of viewpoint, which makes it hard to speculate on the specific nature of the change.

Having Bell's and Penrose's view in mind, let us mention that the proposal of our current article is very radical. It is based on Segal's Chronometric Theory with its space-time arena D, and on its LF-development by Levichev (see respective portions of this article for details). Within this approach, many technicalities are yet to be unfolded. Such an enterprise requires a joint effort from dozens of experts during the years to come.

Before providing more details of the DLF-approach, let us finish with the brief survey of other types of proposals, first.

Objective Reduction (OR) is a Penrose suggestion, part of his attempt at unifying Relativity Theory and Quantum Theory. He says "this suggestion is close to some ideas due to Diosi ([Di-92]) and others" (from [Pe-94, p.339]). Superpositioned states each have their own spacetime geometries. Under special circumstances (which, for example, microtubules in the brain are suitable for; see our II.2 for these and other details on Penrose-Hameroff model) the "warping" of these space-times reaches a point (the quantum gravity threshold) where the system must choose one state. The system then spontaneously and abruptly collapses to that state. The reader is referred to [Pe-94, 6.12] for more details on OR. For our purposes, it is enough to invoke, once more, the main feature of his proposal: it is a gravitationally induced state-vector reduction.

On the contrary, an important feature of the DLF-approach is to consider gravitation as a secondary (to other physical effects) phenomenon. In other words, there is no force of gravity, per se. Acting on a given object, such a force is considered to be the vector sum of forces resulting from other ("true") interactions (such as electromagnetic, strong, and weak, if to list the conventional ones; however, DLF-interactions are not easily related to these three).

We now mention about an approach (see [AV] and [dBW]) where the quantum reality is described by two state vectors, one of which propagates forwards in time from the last occurence of R, in the normal way, and the other propagates backwards in time, from the next occurence of R in the future. The implications of the theory are precisely the same as in standard quantum theory. Its advantage over standard quantum theory is that it enables one to have a completely objective description of the state in Einstein-Podolsky-Rosen situations which can be represented in space-time terms consistently with the spirit of Einstein's relativity.

II.2. Quantum coherence, quantum computation, and where to seek the physical basis of mind.

It seems that the brain activity, accordingly to the mainstream viewpoint, is to be understood in terms of classical physics, mostly. Namely, any possible significant activity that takes place in a brain is either occuring or not occuring. The superpositions of quantum theory, that would allow simultaneous occuring and not occuring is considered to play no significant role. There are certain dissenting opinions from this. Some of them are listed in [Pe-94, p.349] but we proceed, right away, with one particular opinion, namely, with the Penrose-Hameroff model.

The first key notion is 'quantum coherence'. Here is a suitable passage from [Pe-94, p.349]: "This phenomenon refers to circumstances when large numbers of particles can collectively cooperate in a single quantum state which remains essentially unentangled with its environment. (The word 'coherence' refers, generally, to the fact that oscillations at different places beat time with one another. Here, with 'quantum' coherence, we are concerned with the oscillatory nature of the wave function, and the coherence refers to the fact that we are dealing with a single quantum state.) Such states occur most dramatically in the phenomena of superconductivity (where electrical resistance drops to zero) and superfluidity (where fluid friction, or viscosity, drops to zero). The characteristic ingredient of such phenomena is the presence of an energy gap that has to be breached by the environment if it is to disturb this quantum state."

Such phenomena have been found to occur only at very low temperatures, that is why "there had been a general skepticism about the possibility of quantum coherence effects having any relevance to such a 'hot' object as the human brain – or, indeed, any other biological system.

In recent years, however, some remarkable experimental findings have shown that, with suitable substances, superconductivity can occur at very much higher temperatures…"

Then (on p.352) Penrose discusses one other possible way how collective quantum effects can occur in biological systems. Namely, instead of needing a low temperature, the effects arise from the existence of a large energy of metabolic drive.

Let us now discuss 'quantum computation'. This theoretical concept has been put forward in 80s and is now being actively explored by a number of people. Again from [Pe-94], pp.355-356:

"The idea is that the classical notion of a Turing machine is extended to a corresponding quantum one. Accordingly, all the various operations that this extended 'machine' undertakes are subject to the quantum laws – with superpositions allowed – that apply to a quantum-level system. Thus, for the most part, it is the action of U that governs the evolution of the device, with the preservation of such superpositions being an essential part of its action. The R-procedure would become relevant mainly only at the end of the operation, when the system is 'measured' in order to ascertain the result of the computation…

It is found that although a quantum computer cannot achieve anything beyond what could already be done in principle by conventional Turing computation, there

are certain classes of problem for which quantum computation is able to outperform Turing computation in the sense of complexity theory (cf. [De-85]). That is to say for these classes of problem, the quantum computer is in principle much faster – but merely faster – than the conventional computer…

If we are to believe that neurons are the only things that control the sophisticated actions of animals, then the humble paramecium presents us with a profound problem. For she swims about her pond with her numerous tiny hair-like legs – the cilia – darting in the direction of bacterial food which she senses using a variety of mechanisms, or retreating at the prospect of danger, ready to swim off in another direction. She can also negotiate obstructions by swimming around them. Moreover, she can apparently even learn from her past experiences – though this most remarkable of her apparent faculties has been disputed by some (several references follow, KL). How is all this achieved by an animal without a single neuron or synapse? Indeed, being but a single cell, and not being a neuron herself, she has no place to accommodate such accessories.

Yet there must indeed be a complicated control system governing the behavior of a paramecium – or indeed other one-celled animals like amoebas – but it is not a nervous system. The structure responsible is apparently part of what is referred to as the cytoskeleton."

On the view that Penrose and Hameroff are putting forward, consciousness would be some manifestation of quantum-entangled internal cytoskeletal state and of its involving in the interplay (e.g. by means of OR, objective reduction) between quantum and classical levels of activity. From [Pe-94, p.376]: "The computer-like classically interconnected system of neurons would be continually influenced by this cytoskeletal activity, as the manifestation of whatever it is that we refer to as 'free will'. The role of neurons, in this picture, is perhaps more like a magnifying device in which the smaller-scale cytoskeletal action is transferred to something which can influence other organs of the body – such as muscles. Accordingly, the neuron level of description that provides the currently fashionable picture of the brain and mind is a mere shadow of the deeper level of cytoskeletal action – and it is at this deeper level where we must seek the physical basis of mind!"

II.3. The Penrose-Hameroff Orchestrated Objective Reduction model and a "stream" of consciousness

The main references for this paragraph are [PH-96], [Ha-01], and [Pe-94].

Conformational states of individual tubulin proteins in brain microtubules are sensitive to internal quantum events (e.g., London forces in hydrophobic pockets) and able to cooperatively interact with other tubulins in classical "automata" computation, which regulates and interacts with chemical synapses, axon hillock, and other neural membrane activities. Quantum superposition of London forces leads to quantum coherent superposition of tubulin conformation supporting quantum computation in microtubules. This phase is governed by the U-process.

[Ha-01, p.87]: “quantum states in microtubules avoid random environmental decoherence by mechanisms that include actin gelation, coherent pumping, ordered water, a condensed charge phase surrounding microtubules, and topological quantum error correction. Enhanced surface area in actin gelation (‘gel”) leads to ordering of water, and isolates microtubules during the quantum phase; actin depolymerization leads to a liquid (solution: “sol”) state for classical communication…

The proposed quantum superposition/computation phase in neural microtubules corresponds to pre-conscious (implicit) processing, which continues until the threshold for Penrose objective reduction is reached.” Objective reduction (OR) - a discrete event – then occurs (see FIGS. 5-7 of [Ha-01]), and “post-OR tubulin states (chosen non-computably) proceed by classical microtubulin automata to regulate synapses and other neural membrane activities.”

FIG.5 of [Ha-01] shows “microtubule automation sequence simulation in which classical computing leads to emergence of quantum coherent superpositions in certain tubulins due to pattern resonance.” Next step (in coherence with other microtubules) “meets critical threshold related to quantum gravity for self-collapse” (this is called orchestrated OR, Orch OR). “Consciousness (Orch OR) occurs in the transition to the next step which represents the eigenstate of mass distribution of the collapse.” The latter evolves by “classical computing automata to regulate neural function.” In the next step quantum coherence begins to re-emerge.

These transitions from pre-conscious possibilities into unitary choices or experiences may be seen as quantum computations in which quantum superpositions of multiple states abruptly collapse (reduce) to definite states at each “conscious moment”. The above Orch OR events are proposed to be conscious because pre-conscious ones are “embedded at the Planck scale.” Sequences (“cascades”) of these events give rise to a “stream” of consciousness, and huge numbers of OR events take place during the course of lifetime.

Much more details to convince the reader about plausibility of the Penrose-Hameroff model can be found on pp.87-98 of [Ha-01]. They mention that Orch OR events may be of variable intensity and duration. On FIG. 7 ([Ha-01, p.90]) quantum superposition/entanglement in microtubules is discussed for five states related to consciousness. Those five states are: **normal 40-Hz experience**; **anesthesia** (when anesthetics bind in hydrophobic pockets and prevent electron delocalizability and coherent superposition); **heightened experience** (Orch OR threshold is reached faster, at higher intensity of experience, and more frequently); **altered state** (when even greater rate of emergence of quantum superposition due to sensory input and other factors promoting quantum state – meditation, psychedelic drug, etc.; predisposition to quantum state results in baseline shift); **dreaming** (prolonged subthreshold quantum superposition time).

II.4. The DLF-approach implanted into Penrose-Hameroff model.

As it has been already discussed, R. Penrose suggests gravitational explanation to the QM reduction problem. This explanation is one of the key features of the

Penrose-Hameroff approach to consciousness. Their point of view is ([Ha-01, p.80]) that "…gravity cannot be regarded as some kind of "emergent phenomenon," secondary to other physical effects, but is a "fundamental component" of physical reality."

Our approach to gravity is based on Segal's chronometric theory. This theory reaches the conclusion ([Se-82, p.852]) that "… there is no gravitational force per se, and that gravity represents simply the totality of the fundamental forces exerted by matter and radiation outside the microscopic region around the point in question. The effects of these forces exerted from all parts of the universe over arbitrarily long periods are observed as action at a distance resulting from the attainment of an approximate equilibrium; and the temporal and spatial homogeneity of the forces account for the apparent uniformity of the masses and coupling constants of fundamental particles throughout the universe. In particular, the concept of graviton is rendered superfluous, and Mach's Principle is given a concrete form."

The main currently accepted description of gravitation is provided by General Relativity. Even within its own scope it is possible to interpret gravitational interaction as a residue of fundamental interactions. This is how one can read ("from right to left") the Einstein equations of General Relativity: "matter and energy determine geometry". Gravity is the effect of the curved geometry of spacetime (see more about **curvature** in our paragraph III.2).

In this regard, a deviation from the Penrose-Hameroff model becomes possible accordingly to, say, the lines that have been indicated in [Le-98] as well as it is mentioned in our paragraph I.2. That change is due to the use of spacetime D, alone. Namely, the characteristic feature of a typical chronometric representation is its *indecomposability*. As a consequence, one has to distinguish (see [Le-95, 6.1]) between an exact particle which is represented by a section (or state) of the respective induced bundle, and a reduced particle, a theoretical entity obtained by formation of quotient representations. The latter correspond to conventional representations. The "consciousness of a photon", say, can be described by its state in the upper level, whereas its "physical arena" be the space of the factor representation.

An other possibility is provided by the presence of unstable (or tachionic, see III.3) components on the upper level (which disappear after formation of the quotient representation. Such a feature might explain *precognition* more naturally than it can be done via a conventional approach to the notion of a particle.

However, the recent ([Le-03, Le-04, Le-05]) LF-development of Chronometry calls for a much more radical change. One is tempted to follow D. Bohm's ideas [Bo-81] to explain the reduction of the wave function (the "R-process" of Penrose, see II.1, II.3). The crude model will be to completely get rid of that R-phase. Similarly to Bohm's example [Bo-81, p.68] (of a Brownian motion of molecules), one can try to put the L-evolution into play (with a possible "chaotic" disturbance due to paradoxical F-properties). The L- and F-components of the wave function will thus be playing the role of (long "wanted") **hidden variables** of Quantum Mechanics. In brief, all quantum mechanical experimental data (presumably) can be

explained by the geometry of the Lagrangian surface (in the configuration space) rather then by some mysterious R-process.

It is too early to speculate more in this regard. This is a "Terra Incognita" waiting for pioneers.

III.1. Segal's Chronometric Theory: a brief overview.

Irving Segal (USA, 1918-1998) was one of the greatest mathematicians of the entire 20th century (see [AMS] and [JFA-02]). After the WWII he spent two years at the Institute for Advanced Study, where he held the first of the three Guggenheim Fellowships that he was to win. Other honors included election to the National Academy of Sciences (USA) in 1973 and the Humboldt Award in 1981. At the University of Chicago (1948-1960) he had fifteen doctoral students, and at MIT, where he was professor from 1960 on, he had twenty five.

In this article we only deal with his chronometric theory. From [AMS, pp.658-659]: "Segal's vision was that the universe is the universal cover D of the conformal compactification of Minkowski space(-time) M… He pursued this vision with passion and immense industry… Why has this work not received an adequate evaluation? Part of the reason lies in Segal's style of scientific exchange – at times it resembles that of Giordano Bruno (later burned at the stake), who very shortly after his arrival in Geneva issued a pamphlet on "Twenty Errors Committed by Professor De la Faye in a Single Lesson." But part of the fault lies with cosmologists and particle physicists intent on defending turf… Segal's work on the Einstein universe as the arena for cosmology and particle physics is a vast unfinished edifice, constructed with a handful of collaborators (KL: more than 120 chronometry-related articles, many of them have been published by the leading journals of mathematics, physics, and astronomy). It is rare for a mathematician to produce a life work that at the time can be fully and confidently evaluated by no one, but the full impact of the work of Irving Ezra Segal will become known only to future generations."

"The chronometric theory by I.Segal is the crowning accomplishment of special relativity", that was the title of the survey article [Le-93]. We adjust that claim below by discussing briefly the main aspects of that theory.

Its world (or spacetime) D consists of the Einstein static universe E as the underlying conformal manifold. E is supplied with a (standard, general relativistic) metric. A future direction of time being chosen, this determines future causal cones in each tangent space of D. "Future sets" are defined in D, itself [Se76]. This causal structure gives rise to the symmetry group G which is the universal covering of (fifteen dimensional) matrix group SU(2,2). The group G acts (without singularities) on D. These and other notions can be found in a greater detail in many Segal's articles ([JFA-02] is dedicated to the memory of I. Segal and it lists all his publications) as well as in [Le-95].

The Minkowski world is conformally imbedded into D via the "Caley transform". The radius R of the (physical, three-dimensional) spherical space in D does not depend on the chosen metric from this conformal class, that is, from the metric in

which it is calculated. In other words, R is a conformal invariant. From [Se82, p.854]: "This radius R (in laboratory units) provides a natural third fundamental constant, in addition to h and c, which is required for fundamental physical theory to complete the program suggested by Minkowski (1908) of replacing limiting cases (as the Galilean group is of the Poincare group, when c goes to infinity, or classical physics as h goes to zero) by less degenerate and mathematically more natural structures."

We denote by K the 7-dimensional Einstein isometry group. It is a so called "maximal essentially compact" subgroup of G. It consists of translations in time and rotations in space. We denote by P (respectively, P_0) the 11-dimensional (respectively, 10-dimensional) Poincare group. The group P acts in M, P_0 being a subgroup. P_0 is generated by Euclidean rotations, Lorentz transformations, and parallel translations. To get P, one has to add scaling transformations.

The chronometric energy H is the generator of time in E. Relative to each point of observation in D, the Minkowski world M is imbedded P-covariantly, and the relativistic (or Minkowski) energy H_0 is the generator of time in M relative to the Lorentz frame in M, which, at the point of observation, osculates the frame defined by the space-time splitting in E. For each unitary positive-energy representation of G, the corresponding chronometric energy exceeds the Minkowski energy by an amount that vanishes infinitesimally but increases with the spatial support of the state in question in terms of the appropriate quantum mechanical consideration. The inertial mass of a cosmologically long-lived particle is represented in accordance with Mach's Principle as its interaction energy with the cosmic background and is correspondingly only K-invariant, implying approximate local P_0-invariance of its rest mass.

Additional background on chronometry is given in Segal's book [Se76] and many other publications (see [JFA-02, pp.1-13]). In these articles the physical particles have been modeled, in accordance with the thrust of decades of theoretical investigation in this area, by induced bundles over causally oriented space-times.

Let us now conclude with the justification of the expression "crowning accomplishment of special relativity". Firstly, the conformal group G is semisimple, in contrast with the Poincare group. Hence, G cannot be regarded as resulting through a contraction process from a non-isomorphic Lie group of the same dimension. Secondly, it arises as maximal local causal group of the special relativistic world M (proved in [AO-53]) in which only the 11-dimensional Poincare group P can be globally (without singularities) realized. When compared with other theories based on the world M or on particular space-time of general relativity, Chronometry has other preferable features; we mention a few:

- the absence of the unique Lorentzian structure (such a structure arises when a particular "metric observer" [Se-76] is chosen),
- a better unification of elementary particles (let us mention a fundamental notion of "stability" here, "stable representations" describe stable particles),
- the existence of "leaking" ([Se-91, Le-95 – 6.1, 6.3]) which gives kinematic explanation of several decays,

- its application to extragalactic astronomy ([SeNi, DS-01] and many references therein) has shown that it is capable of precise and detailed predictions regarding the cosmic redshift and other directly measured quantities, in spite of its lack of adjustable cosmological parameters.

It is worthwhile to mention that there are exactly four 4-dimensional Lie algebras which admit an invariant non-degenerate form of Lorentzian signature ([GL-84, Le-86]). Such a form is a well-known to correspond to a bi-invariant metric on the Lie group in question (M, D are among them, the remaining two being L and F, that is why the "LF-development of Segal's theory").

Summing up, we note that Chronometry is derived from very general considerations of causality, stability, and symmetry. Like special relativity and quantum mechanics it may initially appear contradictory to accepted doctrine. However, past decades have already shown that Segal's theory is an effective point of departure for cosmology and elementary particle physics.

III.2. Spacetimes L, F are on equal footing with D; the list is now complete.

It has been proved (see [Le-03], [Le-04]) that the (local) causal structure of the Minkowski space-time M can be determined by each of the three (curved) worlds D, L, F (this is the complete list which contains the most symmetric general relativistic worlds).

Segal's Chronometry has been described in III.1. It is based on D. To model particles (in a given world), the Hamiltonian (a linear operator which governs the state of the particle evolution) is fundumental. Now, when we have F- and L-Hamiltonians (addtitionally to the D-Hamiltonian), it is quite a new situation in the Particles and Their Interactions theory. The world remains, however, a single (not many-fold) unity of events. To specify it as D, (or F, or L) means to choose a specific mode of the quantum-mechanical measurement.

It has been suggested in [Lev-04] to interpret D, L, and F as the simplest models for (respectively) Dense, Light (= Subtle), and Fiery worlds (these are discussed in many occult teachings, see our paragraph IV.1).

A. The Minkowski world M and the DLF-triad.

Let us recall Special Relativity theory has been developed (for about 100 years ago) by Einstein, Poincare, Lorentz, Minkowski.

Each world is four-dimensional (geometrically), three dimensions for space, one dimension for time. Special Relativity is based on the Minkowski world M. As a set, it consists of elements (x,y,z,t) (they are called events). Physics uses the notion of an "observer" who interprets x, y, z as spatial coordinates of an event which occurs at the moment "t" (accordingly to the clocks of that very observer). Assume that an event (0,0,0,0) describes the birth of a photon. After a time lapse "t", the photon reaches the point (x,y,z) in space. Clearly,

$$(1) \qquad x^2 + y^2 + z^2 = C^2t^2$$

The expression in the left side is the distance squared between (0,0,0) and (x, y, z). Mathematically, C is a positive constant independent of an observer. It is interpreted as the speed of light. The equation (1) determines a surface which is called a light cone (with vertex O).

Recall that the classical mechanics is based on the Newtonian world.

Return now to the space-time M. Clearly, an arbitrary event may be chosen as O. In other words, there is not just one cone. Rather, there is a light cone with vertex at each event. Such a cone is obtained from the cone (1) via translation (by a suitable four-dimensional vector). This system of cones is of fundamental importance, geometrically. It is known how to deduce special relativity in terms of that system (and in terms of transformations which preserve that system of cones), see [AO-53] or [GL-84].

The publication [Le-03] is not easily understood since it uses an up-to-date geometrical apparatus of modern theoretical physics. Formally, [Le-03] contains six theorems. It is possible, however, to present its main content more briefly (with a minor mathematical rigor sacrifice). To do so, let us notice that the totality of all (the above introduced) parallel translations forms a "group of transformations". This group can be identified with the world M, itself.

QUESTION: are there OTHER transformation groups which preserve the same system of light cones?

ANSWER: YES, there are exactly three more - D, L, F.

Remark (for a reader with the knowledge of Lie algebras). The respective Lie algebras are u(2), osc, u(1,1) (in that order). The Minkowski world M corresponds to the simplest (= abelian) Lie algebra. Clearly, we speak of four-dimensional Lie algebras (there are infinitely many of those).

B. How to model particles in modern theoretical physics and in Segal's chronometry

To mathematically model particles (and to state their evolution laws in a certain world), the role of a Hamiltonian is fundamental. It determines the law of motion and possible energy spectrum of the particle. In a simplified version, the Hamiltonian is a matrix; in that case, the above spectrum consists of all eigenvalues of that matrix. A new feature of the suggested theory is the presence of three Hamiltonians (D-, L-, and F-), at once; each "drives" the particle along its world line. A simple example of a world line is the totality {(0,0,0,t)}, which says that a particle rests at (0,0,0), whereas the time coordinate grows from smaller values to

larger ones. This is the mathematical meaning of an expression: "the Hamiltonian drives the particle along its world line". The latter can also be called the life story (of a given particle).

The first of these Hamiltonians has been introduced by Irving Segal somewhat 50 years ago.

The chronometric world D, being curved, differs in this regard from Newton and Minkowski spacetimes. Namely, the (physical) space is represented by a (dim=3) sphere S^3. The radius R of that sphere is interpreted as the third fundamental constant (the other two being the speed of light C, and the Plank's constant). When R tends to infinity, the chronometry deforms to the special relativity theory (similarly to how special relativity deforms to Newton's classical mechanics when the speed of light C formally goes to infinity). The D-Hamiltonian becomes the M-Hamiltonian, the standard one, accordingly to modern science. Events of D can be represented by all possible pairs (s,T); here s is from the above sphere S^3, and a number T is for the time coordinate of an event.

There is an important (for the physical interpretation) canonical correspondence between the Minkowski world M and the world D (as if M is a part of D). It is called the "Caley map" (mentioned in III.1).

C. Certain features of the DLF-triad.

The remaining two Hamiltonians are L- and F- ones, where both L and F are curved space-times. It has been already discussed how D, L, F relate to M. Purely mathematically, D, L, F are determined (see. [Le-03]) by certain conditions (and there are no other choices to satisfy these conditions). It has been proved by Levichev in the early 80s (publications [GL-84, Le-86]). The importance of D and L has been understood right away (due, in part, to the general relativity theory which flourished by that time). The world F, however, seemed to be a mathematical peculiarity since it violated the so called "energy conditions" (in other words, F, itself, serves as an unlimited source of energy). Only later, in 2003, has it been understood that such a property inevitably chooses F to be the only candidate to model the Fiery World, in the simplest way.

To deform F into D, we can go through a (one-parameter) family of surfaces, each of the latter being a representative of L (this result is not yet published by Levichev). We are thus forced to interpret D as the Dense World, and L – as the Light (or Subtle) World (since many teachings say the subtle world to be an intermediate one between D and F).

The scalar curvature is known to be an important geometric invariant of a space-time. It is negative (respectively, positive and zero) for F (respectively, for D and L). The world L having zero scalar curvature, it does not mean being flat (non-curved). The thing is that in dimension four (quite differently, if to compare with dimension two) the complete curvature information can not be expressed in terms of scalar curvature, alone. Recall, for two-dimensional surfaces, that a sphere of radius r has

the (scalar) curvature equal to one over r squared. The curvature of a hyperboloid of one sheet is negative (non-constant). Surfaces like a cone or a cylinder, they have zero curvature (they are called "flat surfaces", they can be unfold into a piece of a plane which is the simplest among flat surfaces). That is why L is the less curved world of the three.

III.3. Can the New Science be based on the DLF-triad?

It is important to realize that it is still the only world (as the totality of events). To represent it in the form of D, of L, or of F – that means to choose an observer (with the respective reference frame). It is not a mistake to say that he/she observes the totality of events as D, L, or F depending on one's (conscious) state (see below a mathematical justification of such an interpretation).

Let us now discuss the following statement: each physical object has its D-, its L-, and its F-properties. To simplify discussion, let us stay with the case of a scalar particle (that is, the spin of the particle equals zero). One of the stages of the quantum-mechanical description of a particle is called a "parallelization of the bundle". It means, essentially, to choose a scale along each of the above straight lines. The states, as a result, become number-valued functions (they are called 'wave functions").

In a case of the particle of a higher spin, it is more difficult to describe parallelization. In each case, however, one can choose parallelizations based on D, L, or F. Such a choice results in the totality of events realized as D, L, or F, respectively.

The importance of the parallelization has been stressed in [PaSe-82a]. On pp.98-116 of this articles there are several theorems proved. These theorems refer to both general as well as to purely chronometric setting. Later, the Segal's group has been mostly using one particular parallelization based on the world D (the so called "left curved parallelization"). It has been compared, from time to time, with "flat" parallelization (based on the world M vector structure).

As regards the mainstream publications, they deal with the 10-dimensional Poincare group G. Induced bundles in question were parallelized by the vector group M *without even mentioning about the parallelization* procedure (since the consideration **started** with wave functions rather than with a prior stage).
The inducing subgroup has been chosen as the Lorentz one (as initiated by Wigner's prominent publication [Wi-39]).

In brief, the parallelization procedure depends greatly on the choice of the four-dimensional parallelizing group N. Moreover, N has to be embedded into the group G, as a subgroup. Here G is the symmetry group (being the Poincare one, in standard physics, or the conformal one, in Segal's chronometry) of the world W in question. N becomes a (kind of) substitute for the original spacetime W. A typical situation is the one with N being a finite-fold cover for W.

The importance of parallelizations based on L and F has thus become clear. The terminology like *the LF-development of Segal's chronometry* or *L-interpretation* of

the totality of events, etc., is now mathematically justified. Using such a language, the *M-interpretation* is nothing but the Einstein's special relativity theory.

Overall, it is necessary to develop the L- and F-issues along the lines which have been significantly explored in the D-approach (by Segal and his group, mostly). Having in mind that each object (starting with an elementary particle) has three types of properties (the D-, L-, and F-ones), we have to figure out precise mathematical and physics' mechanisms on how these three types of properties are interrelated. This is what we have meant by the **New Science based on the DLF-triad.**

Let us now discuss a few more specific issues. It is already in the D-approach that the so-called *tachionic* particles exist. Here we have in mind the pure mathematical existence, as part of induced representations scheme. It roughly means that for the respective particle there is now upper bound on a possible speed, be it a *free* particle. I. Segal (in [Se-88]) has suggested to try to use tachionic subspaces to form local tensor products. He conjectured that positive-energy components could be thus produced. As regarding modeling consciousness, it has been stated in [Le-98] that tachionic properties (on an upper level than the conventional one) might become a helpful ingredient of respective models.

The simultaneous presence of the *D-, L-,* and *F*-properties in a given totality of events seems to be an interesting perspective in *chronometric cosmology* (see a survey [DS-01). It has become possible to combine the *D*-properties (those of the Einstein static universe) with the *plasma universe* (*L*-properties), and with the *quasi-steady-state* cosmology (with matter creation mechanism supported by *F*-properties). These three types of properties are present in some well-known cosmological models (with varying levels of observational evidence, though), see [Da-04]. Be they combined into a single model, it could become a blow to the Big Bang theory. The latter "faces enormous difficulties and it should rationally be forsaken but in view of its present social status, it would take more than a small flock of missionaries to have any of the other contending theories…replace it", [Da-04].

One other *DLF*–perspective is the application of Lie algebras contractions (which are also called deformations). They proved to be of fundamental importance when comparing relativistic physics with the Newtonian one. In the *D*-case, there is an interesting research by S. Sternberg from M.I.T., [St-75]. Now (with better opportunities due to the consideration of three Lie algebras instead of just one) this avenue has to be followed further.

It seems reasonable to present now general relativistic characterization of the three worlds. Essentially, this has been done 20 years ago, [Le-86]. Minor corrections (to the results of curvature calculations in the F-case) are now provided.

The metric tensor is denoted by g. Other general relativistic terminology is used throughout. The *dominant energy conditions* (see [Kr-80, p.71] or elsewhere) mean non-positivity of the Einstein tensor T (for each timelike input v) and non-spacelike character of the *energy flux* vector q. Here q is the image of v under the action of the *operator* T. Recall that $-T(v,v)$ is called the *energy density* (as measured by an instantaneous observer v), this number is non-negative if the conditions hold.

Remark. The number $T(v,v)$ is the energy density be the metric signature of the –, +,+,+ type.

For the (updated) proof of the following statement see [Le-05].

Theorem. 1) *D* is the *ideal fluid* determined by the central *D*-generator. The scalar curvature is $6/R^2$. Pressure and energy density are both equal $1/(R^2)$. The energy flux vector *q* is timelike. Energy conditions hold.

2) *F* is the *tachionic fluid* determined by the central *F*-generator. The scalar curvature is $-6/a^2$. Pressure and energy density are both equal $-1/a^2$. Not necessarily is the energy flux vector timelike or lightlike. Energy conditions are violated.

3) *L* is an *isotropic electromagnetic field determined by the covariantly constant lightlike* central *L*-generator. The scalar curvature is zero. The energy flux vector *q* is lightlike. Energy conditions hold.

IV. Emergence of New Science and the GDV Bioelectrography

IV.1. The three worlds have been known to humanity since ancient times.

This section contains a few extracts from texts dedicated to esoteric teachings. They seem to support our current interpretation of the spacetimes D, L, F.

[Ter, p.337], see below, describes three planes: the material, anima-energetic, and spiritual. [Kib, p.39] talks of the Physical, Mental, and Spiritual. [Br, p.47] uses adjective Astral rather than the above Mental. Agni Yoga speaks of Dense, Subtle, and Fiery planes (worlds). It seems natural to refer them to D-, L-, and F-parallelizations ([Le-03]). Here "L" is for "light" (non-heavy). Some of the sources, however, use seven planes. This includes [Bes], see her p.52. In this regard, a much more comprehensive comparison of esoteric sources has to be done, as well as a deeper research has to be performed on DLF-issues.

It is of interest to be aware about an esoteric description of the physical (or dense) plane. From [Bes, pp.55-56]: "…the physical plane (is) that on which our world exists and to which our bodies belong. …We thus obtain as three subdivisions, or conditions, of matter on the physical plane, solid, liquid, gas. Searching further, we find a fourth condition, ether, and minuter search reveals that this ether exists in four conditions… the last of which consists of the ultimate physical atom, the desintegration of the atom taking the matter out of the physical plane altogether, and into the next plane above."

[Bes, from p.60 and on]: "Man's physical body has two main divisions: the *dense* body, made of constituents from the three lower levels of the physical plane, solids, liquids, and gases; and the *etheric double*, violet-grey or blue-grey in colour, interpenetrating the dense body… The general function of the physical body is to receive contacts from the physical world, and send the report of them inwards, to serve as materials from which the conscious entity inhabiting the body is to elaborate knowledge. Its etheric portion has also the duty of acting as a medium through which the life-currents poured out from the sun can be adapted to the uses of

the denser particles. The sun is the great reservoir of the electrical, magnetic, and vital forces for our system, and it pours out abundantly these streams of life-giving energy. They are taken in by the etheric doubles of all minerals, vegetables, animals, and men, and are by them transmuted into the various life-energies needed by each entity (When thus appropriated the life is called Prana, and it becomes the life-breath of every creature. Prana is but the name for the universal life while it is taken in by an entity and is supporting its separated life.). The etheric doubles draw in, specialize, and distribute them over their physical counterparts. It has been observed that in vigorous health much more of the life-energies are transmuted than the physical body requires for its own support, and that the surplus is rayed out and is taken up and utilized by the weaker. What is technically called the health aura is the part of etheric double that extends a few inches from the whole surface of the body and shows radiating lines, like the radii of a sphere, going outwards in all directions. These lines droop when vitality is diminished below the point of health, and resume their radiating character when renewed vigour. It is this vital energy, specialized by the etheric double, which is poured out by the mesmerizer for the restoration of the weak and for the cure of the disease, although he often mingles with it currents of a more rarefied kind. Hence the depletion of vital energy shown by the exhaustion of the mesmerizer who prolongs his work to excess."

[Ter, p.337]: (from the title of a chapter) "...Three planes, or three worlds: the spiritual, anima-energetic, and material."

Pp.339-340: "The world of God, the dwelling of the Clean Spirit and those who are in Spirit, after the liberation of the hindmost ties with the emerged worlds, there is the Indestructible, Immovable, Full of Light, Strength, Wholeness, and Wisdom, the dwelling of Ahura Mazda. Around him ("around" and the following descriptions being the "set" language) above the feeling and forms there lies an infinite circle of the "Mental World" – pure thoughts, all inclusive, in the utmost state of light and serenity. Only the holy, those who attain the apical state of "Profound Comprehension", in a certain state of ecstasy are capable of understanding this First Plane, one which cannot be expressed in words.

The Second Circle is a shadow of the first – the region of feeling and innumerable form, containing the Energetic Universe. This universe is incalculably greater than its shadow - The Third Circle (Material Universe) – the world of existing and fixated form. Together, the three (allegorical) circles compose the "The Triad Universe".

The Mazdeismic Tradition teaches that the Second Circle, which is the "anima-energetic world", contains in itself a boundless amount of worlds, solar systems and planets – from lowest, based on its component of density found in the border of physical matter, to the highest, where the forms of life are unusual and beautiful. The Second Circle is never still, all of its events illuminated by a light of beauty beyond description. In the ongoing gales, in concord with the most dazzling colors and tones, this could indeed be said to be heaven. It contains an innumerable amount of levels, and so if one is to imagine journeying there, the traveler will ascend, as on a staircase, from one step to the next. The content of these levels is incomparably more flexible than those states of matter known to us. The instability of the forms makes

them permanently fluid.The sound and the light there, create endless and delightful music.

[Kl, p.538]: " Of the Subtle and Fiery worlds. Do these worlds exist? Of course, for any esoteric they are as real as the physical world, but in our time, there are less and less people who entirely deny the existence of a deeper spiritual world."

[Kib, p.39]: "For the convenience of contemplating and studying, Hermetic Philosophy assumes, that the Universe can be divided in three colossal divisions of phenomena, better known as The Three Great Plans, or precisely:

1. The Great Physical Plan
2. The Great Mental Plan
3. The Great Spiritual Plan

These sub-divisions are more or less imaginary and arbitrary, because in reality, all these three are nothing else but the ascending steps of life, the lowest point being the most simple (the undifferentiated, one that does not change its form, etc.) matter, and the highest being the Spirit. Furthermore, the various plans imperceptibly modify from one to another, so that a strict or firm separation between the highest Physical phenomenon and the lowest Mental one, as well as one between the highest Mental and the lowest Spiritual cannot be perceived.

Concisely stated, The Three Great Plans can be considered three levels – The Phenomena of Life."

IV.2. Is Direct Vision an example of an L-phenomenon?

In this paragraph (part of) the content of [KB-04] is reproduced. To try to explain the results, we then suggest a (preliminary) theoretical model which is based on the DLF-approach.

Russian psychologist Dr. Vjacheslav Bronnikov developed a technique of mental training for teaching people to perceive information without the need of the vision analyzer. The original intention of this mental training technique was to address personal problems in children to improve self-discipline, concentration of attention, and fostering of imagination. As this method evolved, the discovery has been made that children could perceive information without using a vision analysis. When repeatable results of information perception without using vision were obtained and implications made, the technique evolved to train children to use this capability - leading to the developed phenomenon known as direct vision (DV).

Over a five year time span more than 100 psychically healthy children between the ages of 9-16 from six centers in Russia and the Ukraine were trained in Dr. Bronnikov's technique of DV. This group was comprised of mostly children with normal vision; a group of children with weak vision of varying severity, and 6 children who were actually blind with a known physiological defect in their vision. It was observed that no health disorders were uncovered during the period of mental training on the direct vision technique. In most cases after 3-4 months of training, children mastered the capability of direct vision and could arbitrarily pass in this

state and maintain it for an indefinitely long time according to the tasks set. While in this state, the children were able to perceive information contained on computer screens, printed text and were able to orient in space. All was achieved without using vision. It was observed that adult training is feasible, but the process is more complicated, more time consuming and less overall effective.

Additional findings became evident from further research of direct vision by both the authors of [KB-04] and others. Some of the more salient features are noted below:

1. Tested children, when offered text to read but positioned upside down, could nonetheless perform this task and by their description, they were mentally capable of reversing the analyzed images.
2. Three children studied were unable to either recognize presented objects or read text in the dark room experiment.
3. The majority of the studied children could not recognize the information presented if the source was closed with a non-transparent screen.

In this analysis, the registered characteristics while perceiving information in the direct vision state support the hypothesis that the study participants perceived a signal in the optical spectrum range of frequencies.

4. Experimental sessions with the same tested children performed in the State Institute of Human Brain under the guidance of Prof. Natalia P. Bechtereva (see [Be-02]) confirmed the reproducibility of the studied phenomena.
5. Additional tests performed in 2004 demonstrated that abilities acquired by the participants during half-year training in 2001 have been kept and developed to the everyday habit.
6. The research has shown that after special training, some tested individuals mastered a capability to perceive information placed behind a non-transparent screen.

To provide a (preliminary) theoretical model and to design key features of future experiments let us now try to apply the DLF-picture (which has been described in previous paragraphs). Namely, let us assume that beside the conventional physical body (which might be called the D-body), a human being possesses an L-body, which goes outside of the D-body. When “in the L-body”, a person performs accordingly to L-laws. The detailed theoretical research has yet to be performed but we anticipate that (from the mathematical viewpoint) these L-laws be very similar to D-laws. The respective transition from the Minkowski space-time M to the world D has been thoroughly investigated by I. Segal (with co-authors).

The extent to which the L-body goes outside of the D-body can be figured out by experimenting with lightproof bandages (of different thickness), which are to be put over the volunteers’ eyes.

As regards the (above mentioned) abilities to perceive information placed behind a non-transparent screen, an additional assumption of existence of several L-bodies can be made. Let us remind that the respective geometrical model is mathematically self-consistent, it has been first discovered more than 20 years ago (without any connection to the just presented results of medical research), and that this model is a

possible way to develop both Special Relativity and Quantum Mechanics as we attempted to show it in the paragraphs above and elsewhere. Again, the extent to which the ("second") L-body goes outside of the D-body can be figured out by experimenting with placements of those screens.

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