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Time and Life in the Relational Universe: Prolegomena to an Integral Paradigm of Natural Philosophy

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Abstract: Relational ideas for our description of the natural world can be traced to the concept of Anaxagoras on the multiplicity of basic particles, later called "*homoiomeroi*" by Aristotle, that constitute the Universe and have the same nature as the whole world. Leibniz viewed the Universe as an infinite set of embodied logical essences called monads, which possess inner view, compute their own programs and perform mathematical transformations of their qualities, independently of all other monads. In this paradigm, space appears as a relational order of co-existences and time as a relational order of sequences. The relational paradigm was recognized in physics as a dependence of the spatiotemporal structure and its actualization on the observer. In the foundations of mathematics, the basic logical principles are united with the basic geometrical principles that are generic to the unfolding of internal logic. These principles appear as universal topological structures ("geometric atoms") shaping the world. The decision-making system performs internal quantum reduction which is described by external observers via the probability function. In biology, individual systems operate as separate relational domains. The wave function superposition is restricted within a single domain and does not expand outside it, which corresponds to the statement of Leibniz that "monads have no windows".

Keywords: Leibniz; monad; internal quantum state; relational biology; reflexive psychology; self

1. Introduction: Relational Ideas in Philosophy and Science

After Thales (c. 624-546 BC), who formulated the concept of substance and is recognized as the first philosopher, Anaximander (c. 610-546 BC) became the founder of scientific thinking [1]. His definition of the primary substance as *apeiron* introduced the idea of potentiality in philosophical thought. According to Anaximander, "things are transformed one into another according to necessity and render justice to one another according to the order of time" [1]. Time orders things by separating them in a way that the simultaneous contradiction is avoided. While Pythagoras (c. 570-495 BC) is regarded as the founder of mathematics, and Parmenides (c. 540-470 BC) was the founder of logic, Anaxagoras (c. 510-428 BC) can be considered as the founder of the relational science. Anaxagoras claimed the multiplicity of "seeds" called later by Aristotle *homoiomeroi*—the particles having same nature as the whole [2]. *Nous* (mind) in the philosophy of Anaxagoras orders all homoiomeroi and can be related to the philosophical idea of pre-established harmony. Later, the relational concept of knowledge was developed in detail by Aristotle (384-322 BC) who, in his tractate *De Anima (On the Soul)*, attributed the notion of self to the internal determination within living systems [3], and introduced two types of time in *Physica*, one which is measured and one by which we measure, suggesting that our visible world is generated by a reflexive loop that involves these two types of time [4]. This loop assumes the minimum action that cannot be further divisible, which provides a possibility of the

physical movement and establishes the quantum nature of the physical space and time. The idea of indivisible quantum arises to Democritus (460-370 BC) who, by accepting the atomic structure of the world, escaped the paradoxes of movement formulated by Zeno of Elea (c. 490–430 BC). The idea of external time was later relationally elaborated in the special and general theory of relativity, while the concept of internal time, appearing as a reduction of potentialities, became the basis of quantum mechanics. The contradiction between the foundations of the general relativity and quantum mechanics arises to the incongruity of the external and internal times in the Aristotelian sense.

The temporality as a bridge between the ideal mathematical world and the real physical world represents the central point of the philosophy of Aristotle. We can say that the actual existence resides at the crossing point of the two types of time defined by Aristotle. The logic of life, according to Aristotle, involves a profound component that is referred to the temporal transformations. While Plato (427-347 BC) analyzed the forms beyond time, Aristotle observed them also in the temporal world, and for this observation he developed a complex conceptual apparatus that describes the phenomenon of actualization. It is important to emphasize that the space-time of Aristotelian physics is clearly relational. He considered time as the measure of movement which, when viewed as external, can itself be the subject of measurement. Aristotle developed the concept of *res potentia* (if we use Latin terms), which has relevance to Anaximader's *apeiron* and through which the worlds of *res cogitans* and *res extensa* are interconnected and mutually arranged. He called it *entelechy* which can be either in the form of knowledge (as referred to the noumenal world of *res cogitans*) or as *energeia* (as linked to the phenomenal world of *res extensa*). The theory of actualization is represented in Aristotle's philosophy in great detail, while further philosophers often misinterpreted or ignored it, with the most radical view (in some positivist theories) claiming that *res potentia* does not really exist.

The modern concept of thinking arose from the understanding of the dual nature of the world by René Descartes (1596–1650). To resolve the duality of *res cogitans* and *res extensa,* Baruch Spinoza (1632–1677) considered these two perceivable properties, among an infinite number of others that we do not perceive, as the qualities of the ultimate *causa sui* substance. Gottfried Wilhelm Leibniz (1646–1716) challenged this solution and, in fact, revitalized Plato's concept that the "existing one" is actualized as "many" in the real world (the dialogue "Parmenides" [5]). The actual *res cogitans* represents the pluralism of monads [6], where coexistence is expressed as a "pre-established harmony", while the *res extensa* appears as the relational space-time of interacting monads being their intersubjective pattern. The exposition of *res cogitans* into the world of *res extensa* takes place via the common potential field which corresponds to the *existing one* of Plato's philosophy [5]. Each monad possesses a kind of subjective being, spanning from the subatomic levels with the pilot-wave duality to the sophisticated living beings having free will and consciousness. The internal time of monad is arranged by the reflections of the monad on itself, while the space comes as a set of reflections on the whole. The parameters of space-time satisfy the condition of coexistence of monads and correspond to the observability of the world. Such a representation of the world replaces its objectivity by an intersubjective pattern arising from the relativity of a single picture represented by the monad's point of view and having the characteristics common to all individual beings. The temporal evolution of the world is a process aiming to overcome the limits of its individual representation; it has no external frames and opens into infinity (for details see [7–12]).

The relational physics that appeared two centuries after Leibniz, is based on the relational nature of space-time. This space-time comprehension in the special theory of relativity was later substituted by the quasi-substantial space-time of the general theory of relativity and its recent developments. The unification theories of modern physics often abandon the relational nature of space-time, which is particularly noticeable in the models of the Universe evolution assuming the uniform time flowing from the Big Bang to the future phases of its expansion.

Living organisms, viewed in the frames of the relational concept, are characterized by an internal cause of their dynamics in the Aristotelian sense which was defined by Rosen [13] as a "closure to efficient causation". For Immanuel Kant [14] it was certain "that we can never adequately come

to know the organized beings and their internal possibility in accordance with merely mechanical principles of nature". Vladimir Lefebvre [15] defined living system as a body that has at least one point in which its movement is not determined physically. This determination corresponds to the internal efficient cause in the sense of Robert Rosen [13]. By introducing the concept of relational biology, Rosen followed Leibniz's paradigm in which individual biological systems appear as separate relational domains. According to Rosen, living systems "rescue and organize their natural autonomy by internalizing and thus isolating entailments from external information" [16]. Living systems correspond to Leibniz monads as the "multiple complementarity, decomposable into generative (intrinsic) and interactive (extrinsic) relations comprising causal entailments in contextually related categories" [16]. While the concept of relational biology was outlined by Rosen, the appearance of conscious systems corresponds to a new level of reflexive structure where the subject reflects and estimates itself. The reflexive structure of a subject, anticipated by Freud [17] and Lacan [18], was formally described by Lefebvre [19]. This structure was defined as a double homunculus [20] and its role in the dynamics and evolution of social systems was further analyzed in detail [21].

2. Relational Logic and Mathematics

Plato's dialogue "Timaeus" [22] has a special relevance to the relational structure of the physical world from the point of view of the foundations of mathematics. According to this dialogue, the structure of the world is based on the principle of optimality and follows the paradigm that was later presented by Leibniz as "the best of possible worlds". In "Timaeus" Plato described a distinction between the physical world and the eternal world. The physical world changes and perishes, while the eternal world never changes and can be apprehended by reason. According to Plato, the origin of the Universe is based on the eternal and perfect world of "forms" (*eidoi*) as a template. Plato assumed that the minimal particle of each element has a special geometric shape corresponding to ideal Platonic forms. Tetrahedron is the constituent of fire, octahedron represents air, icosahedrons are constituents of water, and cube represents earth. Each of these perfect polyhedra would be, in turn, composed of triangles of certain triangular shapes. If we consider triangles not only as spatial shapes but as basic structures of reflexive systems, we can understand a profound importance of the views developed in Timaeus [23]. Different essences can transform between each other—they are disassembled to triangles and then assembled again. Only cube (earth) is not transformable. This 3D world is disassembled to 2D and then assembled back. The world, according to Plato, consists of the two types of triangles: equilateral and rectangular isosceles. When disassembled into triangles, the essences cease to be bodies, and the 2D triangles exist in the ideal space. Therefore, the basis of the world is the mathematical structure, which, in its transformation, forms first ideal bodies and then material bodies. Plato perceived the world geometrically; from triangles he developed the plastics of the ideal.

For the real logic of *eidoi* (forms) becoming the templates for the physical world, the most important is Plato's dialogue "Parmenides" [5]. It represents pure dialectics and avoids speculations that are apparent in "Timaeus". The most important here, from the point of view of generation of the physical world, is how the pure logical being becomes the "existing one". The action in the physical world is presented here as "*exaiphnes*" (instant, sudden): "Then the one, if it is at rest and in motion, must change in each direction; for that is the only way in which it can do both. But in changing, it changes instantaneously, and when it changes it can be in no time; and at that instant it will be neither in motion nor at rest". Thus, the movement is always signified (we can call it "*semiokinesis*" [24]), it is initiated by the action of signification being its real cause, which precedes movement and is absent at the time present in the point occupied by the moving object. In another place of the dialogue "Parmenides", Plato states: "Then let us say that, and we may add, as it appears, that whether the one is or is not, the one and the others in relation to themselves and to each other all in every way are and are not and appear and do not appear". In Plato's dialogue "Parmenides", the multiplicity originates from the logic imposed by the existence of one via the self-referential process of generating numbers. The objective

counting becomes a consequence of this self-referential process which is perceived by the mind in reverse: it perceives the complexity of the composition but not the entity that generates complexity, which can be comprehended only in the philosophical thought.

In Leibniz's philosophy, the actualization represents an ordered revelation of the entity taking place outside the temporal order, bringing the idea of the relational nature of objectivity of the space-time. The space-time is also relational in the philosophy of Kant, where the '*Ding an sich*' can be viewed as a sum of possible histories, which in the course of perception is reduced to the actual thing existing in the 3D space. Objectivity of the space-time appears as a fixed intersubjective precondition of perception that generates the phenomenal reality of the observed world. Following Parmenides, Plato, and Leibniz, it can be stated that the primary substance is rather not a Pythagorean number but mere the *apeiron* in the sense of Anaximander that precedes the process of counting and is actualized via generation of numbers.

The existence is equivalent to the embodied number that comes as a realization of the computational activity, and this activity is attributed to the single substance (monad) that observes itself in the world. Bertrand Russell [25] in his "*History of Western Philosophy*" states: "the relations of essences are among eternal truths, and it is a problem in pure logic to construct that world which contains the greatest number of coexisting essences". In modern interpretations of quantum mechanics, the approach to see the world as a set of consistent histories [26] can be traced to Leibniz and to his unpublished at his time logic: the existence is formed by the events that are consistent with more events than other possible events. Observability means a possibility to perform multiple quantum measurements in such a way that their results are compatible and can form the pattern that corresponds to our trivial sense of the absolute space-time common to all beings.

The logic of the dynamical process unfolding in the reality rather than describing the formal change determines the state of three dynamic elements, which are the opposites A and non-A, and the middle state T ("included middle"). The predecessor of this logic was Nicolai Vasiliev [27] and in the advanced form it was introduced by Stéphane Lupasco in 1930s [28] and further developed by Joseph Brenner [29,30]. Aristotle described the process of actualization through the introduction of a non-classical logical scheme [3], which differs from the well-known Aristotelian logic operating in the actualized world. In the actualized world, the middle state T is excluded, but it is always present in the dynamical process that holds the energy of actualization of A or non-A, and uses it for switching from A to non-A, which become separated by time interval and diverged spatially. This evolutionary process forms new entities, generates new events through the separation and synthesis of the particulars of oppositions, and incorporates new spatiotemporal solutions in the course of this dynamics.

While every possible world exists as an infinite set of monads, not every set of monads represents a possible world, since it must be coordinated (symphonic). In the actual Universe some programs cannot be implemented into bodies, and some bodies cannot coexist with others. The relational foundations of mathematics consist in the origin of numbers from the counting activity as developed in Plato's dialogue "Parmenides". The universal principles representing foundations of mathematics were sought in logic by many authors, and the tradition arising to Parmenides was revived in early XX century by such different authors as Frege and Russell, Gilbert, and Wittgenstein. To bring mathematics to the phenomenal world, the geometrical constituent needs to be included in its foundations. The idea arising to Pythagoras, Plato, and Anaxagoras was further developed by Leibniz in his Universal Program [6] and revived in a new approach to mathematical foundations called the theory of homotopic types developed by Vladimir Voevodsky [31]. The idea of form incorporated to the foundations of mathematics is based on the supposition that they should include geometry. The intrinsic logic that is revealed in the foundations of mathematics corresponds in this approach to the spatiotemporal structure that is generated internally on the basis of this logic. When geometry is introduced to the foundations of mathematics, the world becomes shaped in a certain particular way fitting to its inhabitability, which resembles the anthropic principle in physics. The limits of geometry become

associated with the limits of computation of the particular world, and in the theory of homotopic types the basic foundations of mathematics can be verified via using a computer [31].

The geometric form appears to be computable and possesses certain laws of its computability. The concept of geometrization of foundations of mathematics approaches us to the anthropic principle in mathematics. In Greek philosophy, Pythagoras initially introduced geometry in the mathematical pattern of the world. The *musica universalis* (harmony of the spheres) maintaining the movement of planets and stars according to mathematical equations and producing an inaudible symphony, has the fundamental geometrical constituent. Music is a reflexive mathematics according to Leibniz [6]. Geometric atoms appeared in the foundation of world's structure in the philosophy of Anaxagoras who called them "seeds", then these atoms were named as *homoeomeria* by Aristotle. Actualization of the ideal essences in the physical world was metaphorically associated with the process of seed germination, which occurs via the imposition of temporality.

3. Relational Physical Universe

The transition from the mathematical world to the physical world occurs via the imposition of limits of computation that appear as the set of fundamental constants. These limits shape the spatiotemporal physical world and determine its dimensionality and curvature. The idea that the physical world is shaped by the limits of computation arises to Parmenides and Plato and then to Leibniz, it is introduced in modern science [32] and represented, in particular, as the existence of limits of computing in the Universe [33]. The parameter, which is intrinsic to the action introducing computation, is time which separates contradictory statements [8] and defines the velocity of observation propagation [34]. The physical complementarity corresponds to the non-simultaneous existence of contradictory statements and properties, which, in turn, generates recursion and flow resulting in complexification [35]. In the dialogue "Parmenides", Plato introduced multiplicity via the process of assignment of the being by the existence. This assignment takes place via temporality, and the existing being appears in its multiplicity. The existing models of the Universe should explain the existence of multiple particles of the same properties such as electrons etc. The idea of retrocausality which is outlined by Matsuno [36] and needs to be further developed, helps to understand the origin of multiplicity via what can be described as the directions forward and backward in time. From the only few retrocausal loops corresponding to the basic elementary particles appearing as antiparticles in the reverse direction, the whole Universe is unfolded in correspondence to the one electron model of the Universe [37]. In the flow of time, the contradictory statements appear as the retention-protention relations according to Husserl [38]. Memorization of retention leads to certain basic values of the actualized structures such as the golden section [23]. Only few geometric atoms are needed if they are implemented in the physical world moving back and forth in time. The physical world emerges when time is introduced into the mathematical world [9], in other words, when the numbering comes into being as a result of measurement. Measurement as the basic underlying process in physics corresponds to the relation in which time and space become connected via the certain values that are the physical fundamental constants.

While both the special and general theory of relativity deal with the external time which is measured, the quantum mechanics in the concept of quantum reduction or decoherence is associated with the internal time by which we measure and which itself can be measured provided that quantum measurements are performed in a regular way, with low dissipation of energy [12]. In this case the quantum system becomes an internal autonomous clock that distinguishes the past (memory), the present (life), and the future (anticipation based on the reproducible model). Both the theory of relativity and the quantum mechanics are the relational theories but they use different concepts of time. Their synthesis can be also only relational and it can be based on the development of the concept unifying both types of time. The internal time (by which we measure, according to Aristotle) separates contradictory statements while in the external time (which is measured) they appear as separated and sequentially ordered. The agency of time traffic-controls the contradictions sequentially. For the

unification of physics in a general theory integrating the general relativity and quantum mechanics, the question of the relation between the external, and the internal time has to be rethought and further developed. In the frames of the external time envisioned in special and general relativity, the generative aspect of contradictions is not anticipated, however, the generative aspect is latently present in the internal time grounded upon the quantum phenomena. The mitigation of the gap between the external and internal time has been a hard problem since Aristotle, and only the resolution of this problem can open the way for the unification of physics and for its constructive integration with the other fields of knowledge including biology.

When time is viewed as the engine separating contradictory statements, we face the necessity of reconsideration of the evolution of the Universe from the Big Bang, which in the relational world will appear in a different way than usually depicted in handbooks. In the relational Universe the Big Bang remains real but not in a local way. The "delocalized" Big Bang represents a knot being a kind of fixed point for all reflexive loops of observation of the physical Universe from which everything emerges. The generation of the Universe is a process in which the unique set of fundamental constants is defined via quantization of the elementary action. Evolution of such Universe is dependent on the observation propagation velocity which differs in the different systems of observation. Time may go fast or slow depending on the observation or even be absent like in some relational models of the physical world [39]. The action of separation of contradictory statements is quantized, so the Planck's constant represents the constant of action, which also quantizes information by determining the number of events in the Universe. The minimal quanta are the units of action representing the loops of quantum gravity while the macroscopic quanta correspond to hypercycles, cells, self, and finally conscious beings. The process of avoiding infinity is the basis of quantized physical world. It is introduced as the quantum of action, which was understood by Democritus as a necessary operation to escape from Zeno paradoxes. The operation of renormalization is always applied in quantum mechanics to avoid infinities. It relates to the internal measurement where the minimum quantum of action is applied. Renormalization corresponds to the process of putting finite limits to make the system computable. The physical world emerges as divided into the computable and non-computable parts [40]. The computable part is shaped by the fundamental constants while the non-computable part represents the set of actions that introduce computation in the real world.

The highest velocity of observation propagation corresponds to the speed of light. This universal constant determines the synchronization of signals between the observers communicating via a vacuum. The observation propagation velocity can be slowed down significantly in the coherent media. A shielded state with very low temperature is characterized by long relaxation times corresponding to the macroscopic scales. This is explained via the Heisenberg's uncertainty relation between time and energy, where very low dissipation corresponds to the extended times of relaxation. In these coherent states, the speed of light is slowed down to very low values. Several years ago, the lowest registered speed of light was recorded as 17 m s^{-1} via the vapors of sodium at 1 K [41]. However, later much lower speed of light of 0.2 mm s^{-1} was reached in the Bose–Einstein condensate of cold rubidium atoms [42]. Light speed reduction realized the transition of the system to the macroscopic time scale, which is observed in living systems. It has been hypothesized that the slow relaxation of biological macromolecules is explained by the reduction of observation propagation in the coherent medium of the shielded internal quantum states [7–9]. Thus, the molecules such as enzymes can function as precise measuring devices that recognize the substrate and transform it into the product with high precision or generate a precise signal transduction event in the case of receptor molecule.

In the relational world, the external space-time appears as the medium ('environment') suitable for the coexistence of individual units having their own substantiality; i.e., monads. These units are "seeds" realizing a small part of potentially possible actualizations, and their own actualization cannot afford coexistence of everything possible. The simplest monads correspond to the quantum loops in the concept of loop quantum gravity. Space, according to modern views, represents a fine network of finite loops called spin network. Its evolution over time is called a spin foam. Quantum cells of

space are connected with each other via their internal field and can be referred to geometric atoms. The value of this field is a certain "internal time". The transition from the weak field to a strong field appears as there was a "past", which affects the "future" (causality). In a big universe these cells merge forming the common space-time [43]. The basic process that underlies complexification and expansion is the quantum measurement. It establishes the spatiotemporality and determines its growth via continuous measurement of the system plus environment [12]. This special non-Newtonian causality corresponds to the expansion of the Universe viewed as a consequence of quantum measurement. The *ceteris paribus* principle is not generally working in the real Universe, it rather follows the principle of *pratitya-samutpada* (dependent-arising) of Buddhist philosophy [44].

The solution of realization of monads' programs in the actualized world is a difficult philosophical problem. It had different ways of being solved in biology and recently the same challenge appeared in the implementation of the multiverse idea in physics. The principle that is beyond simple logic was introduced in biology as the principle of natural selection. It still dominates in biology and can be applied in cosmology as the natural selection of universes [45]. In physics it brings the final cause for observability, i.e., it is based on the anthropic principle, while in biology it is based on the survival of the fittest, which has also the teleonomic nature in the Aristotelian sense. This principle was introduced explicitly by Lucretius, who borrowed it from Epicurus and probably from earlier philosophers. The principle of natural selection can be considered as the consequence of spatiotemporality generated by multiplicity of monads but it cannot directly explain complexification and the necessity of evolutionary growth unless it is viewed as a consequence of the more general process of actualization.

The relational space-time for the observability condition should meet the criteria of universality for all observers defined by the set of fundamental physical constants. These constants correspond to observability of the world and represent the natural limits of computation that generate the observable physical Universe [8]. It is possible that their values may evolve in the meta-evolutionary process [46]. In the physical world, monads can be viewed as active units that perform quantum measurements. In certain conditions, when the measurements are held for prolonged times with precise outputs within the organized structures (bodies) where a higher monad rules other simpler monads, the cognitive phenomena and consciousness arise. None of the monads act on any other but the patterns of their spatiotemporal representation physically interact in the external actualized world [47].

Physics of the XX century generally evolved in the direction to the substantial understanding of the space-time. It incorporated such concepts as the age of the Universe, its inflation and expansion, and raised the question what was before the Big Bang. The alternative to the general theory of relativity model suggested by Edward Arthur Milne [48] excluded the gravitational interaction from the model of the Universe expansion. In fact, the internal measurement takes place in the gravitational field. All other fields have entropy, and the complexity of structures is relational to the basic field, which is gravitational. That is why Roger Penrose [49] links measurement to reaching the Planck's gravitational mass. Any complexity is relational, it is not the property of the system but the property of its observation, according to Robert Rosen [13]. The relational complexity means also the relational entropy which acquires exact value only in relation to the primary non-entropic field appearing to us as the gravitational field.

This actually means that the property of the Universe expansion follows from the development and complexification of patterns generated in the individual quantum measurements performed by monads. John J. Kineman proposed the sketch of theory that he called the "relational self-similar space-time cosmology" [50,51] where the individual substances form the spatial relations to each other, which logically refers to the fundamental features of windowless monads. The temporal relations in a similar way logically arise to the timeless characteristics of individual monads. This understanding can be seen in the statement of Heraclitus: "An invisible harmony is better than a visible one" [52]. The realization of computation could be possible only at certain preconditions expressed in the basic symmetries and corresponding to the fundamental physical laws.

The existing physical parameters may strictly conform to the observability of the world and represent a unique solution for free will and consciousness, as suggested by the anthropic principle. The free will theorem of Conway and Kochen [53] states that, if we have a certain amount of "free will", then, subject to certain assumptions, so must some elementary particles. The minimum action defined by the Planck's constant already has certain freedom of will. It generates the loop of space and can be the basis of retrocausality, so a particle can be multiplied via the reversal of time. The existing values of fundamental constants may represent the only solution for the shielded coherent states of living beings. This unique solution may appear beyond mathematics and can be substantiated only by the sets of empirical data revealing that it perfectly fits to the observability of real world. Like the reduction of uncertainty during decision-making occurs in the unconscious prior to its awareness [54], the proof of validity of the fundamental constants comes in a way like Diogenes proved the existence of movement by walking; i.e., via establishing the limits of computation that shape the physical world.

Leibniz, being the proponent of the relational space-time, kept only *cogito* and not extension as the basic property of the substance. He observed the Universe as the pattern of self-maintaining units—monads having "no windows". Such representation has certain interpretational difficulties in physics, therefore, it was mainly ignored in science. However, the understanding of a fundamental relational nature of the space-time requires the interpretation of Leibniz paradigm that is compatible with foundations of physics. In this interpretation, the internal observers, acting as measuring agents, constitute a network of mutual interactions, in which the refinement of the wave function generates intersubjective patterns having universal characteristics and corresponding to perception of the reality of external world [55,56]. This understanding leads to the idea of the relational quantum mechanics in which all its particular interpretations remain correct [57]. The many-world interpretation of Everett is valid in the area of the mind while the Copenhagen interpretation of Bohr relates to the matter, both being the ultimate representations of the same reality. The relational interpretation of quantum mechanics may not be exactly isomorphic to the monadological approach of Leibniz [58] but it corresponds to it in its conceptual basis.

4. Relational Biology

For understanding the nature of living beings, the problem of self has to be analyzed in detail. The "self" is characterized by a spontaneous activity that introduces computation into the real world, which itself represents a non-computable decision attributed to the living system. Erwin Schrödinger [59] was the first who suggested that the nature of self is quantum mechanical and placed it beyond quantum reduction. It corresponds to the internal quantum state (IQS, the term introduced in [8,9]) that holds the potentiality that directs possible actualizations, is delocalized and pre-programs the *a priori* forms of space and time, generating the spatiotemporal frame in which the world is observed. The Universe, according to Kineman [50], consists of the units called "holons" that possess self and correspond to Leibniz's monads. The Everett's multi-world interpretation of quantum mechanics is valid in these isolated domains but not between the domains as noted by Matsuno [60]. The wave function superposition is limited by the single domain and does not expand outside it which corresponds to the statement of Leibniz that monads have no windows. The principle of "closure to efficient causation" introduced by Rosen for living systems [13], can be seen as the application of Leibniz's "no windows" principle in biology. In the quantum mechanical concept of self, the growth of complexity results from living activity as a necessary consequence of the embedding measurement in which the reduction of uncertainty takes place. Evolution is a process that aims to overcome the physical limits of computability in which the incomplete identification appearing as an uncertainty in the measurement process is read and interpreted as a cause for new realizations. In such a process, the environment continuously changes in the course of adaptation, and evolution becomes a generic phenomenon having its own cause.

The relational biology was introduced by Nicholas Rashevsky [61] and further developed by Robert Rosen [13]. It describes life as ontologically independent generic phenomenon. The generic

property of living systems can be analyzed as possessing self, which is related to internal determination (Aristotle's "*di aytoy*") or "closure to efficient causation" [13]. Life corresponds to a certain relation between elements, and its physical structure can possibly be substitutable. In the system closed to efficient causation, the internal determinant, defined by Lefebvre [15] as "eidos-navigator", ultimately appears. A living system has at least one point of determination by the eidos-navigator, so any living body has a point in which its movement is not determined physically. This movement unfolds into a structure that reflects the internal choice. The navigator in its choice does not use energy but it can operate only in the state within the system where energy does not disturb its bipolar choice; i.e., near the absolute zero. In fact, macroprocesses can be described by quantum mechanics only near the absolute zero [49]. The navigator is a fabric realizing the probability distributions and the infinitely small pushes that direct the evolution of body's state. When smaller systems unite into bigger systems, e.g., in the symbiogenesis corresponding to the origin of eukaryotic cell and then of multicellular organisms, the unification of individual eidos-navigators under the governing one in a bigger system takes place. The temperatures corresponding to the areas where the eidos-navigator can operate are realized in the shielded states and have the values of the millikelvin range or lower [9,50,62] forming Bose–Einstein condensates. These temperatures are much lower than the background radiation of the Universe (2.725 K) and can be found in the internal quantum states of living organisms shielded in the macromolecular complexes [9] and also in the inner worlds of black holes [63]. The shielded proteinaceous macromolecules may realize millikelvin temperatures in some particular folding configurations which stretch beyond the overall macromolecule size in such structures as cytoskeleton. The latter can be viewed as a macroscopic enzymatic system that generates long-range coherent states percolating between cells.

The latter states cannot be discussed at the present time in detail in relation to potential biological consequences, however, the possibilities of reflexive activities in them have been mentioned in the literature [64]. It is possible to speculate that reflective loops corresponding to Rosen's (M,R) systems can be established in Bose–Einstein condensates separated by the horizon from other area of the Universe; i.e., within black holes. For small black holes, the black body radiation emission corresponds to the temperature of about 100 nanokelvin, while larger black holes would be even colder because they let less radiation escape [63], which means that black holes are colder than space itself. The Bose–Einstein graviton condensate in a Schwarzschild black hole has been postulated [63]. A black hole is not purely a perfect Bose–Einstein condensate of gravitons but there could be bosons in a black hole which exist in that state.

While the eidos-navigator in Lefebvre's concept operates in the states with extremely low temperatures, its bipolar choice should be fixed within the thermodynamic machine of living body which operates in a steady non-equilibrium state that supports the shielded state and is capable of evolving. The argument against Bose–Einstein condensates in living beings refers to the thermal movement of molecules which occurs at the temperatures of ca. 300 K. However, as shown by Matsuno and Paton [62], the effective temperature of shielded states within macromolecules corresponds to millikelvin values. Biological protein bodies can be viewed as "refrigerators" in which very low temperature is achieved *inside* macromolecules. Macromolecules by themselves are involved in the thermal dissipative processes [65] in which the condition of stable non-equilibrium [66] supports metabolic closure and the maintenance of the internal coherent state. While the maintenance of the system in a homeostatic state occurs via the conservative type of stable non-equilibrium that tends to keep the initial state, the generic capacity of biosystem in their individual development and evolution is related to the special type of closure which is called hyper-restoration [67] and corresponds to the stable non-equilibrium of the second type that leads to the increased external work, according to Ervin Bauer [66]. The complexification of biological systems at corresponding stages of evolution generates different levels of organization such as prokaryotes, eukaryotes, multicellularity, and finally reflexive consciousness.

In the metabolically closed stable non-equilibrium systems, the precision of information transfer is achieved via the self-reflexive loops of autocatalysis. The autocatalytic systems appear at a certain level of complexity [68] and can be realized even within sufficiently complex polypeptide sets. The probability that the set of polypeptides up to the length M contains a reflexively autocatalytic subset can be calculated and graphically presented [68]. At higher level of complexity, proteins can reproduce themselves via encoding in nucleic acids which represent the complex versions of coenzymes. Encoding formally corresponds to the generation of Gödel numbers appearing in sufficiently complex formal systems, and as a result an internal logic emerges in these systems. It leads to the appearance of precise self-reproduction [69]. The level of complexity corresponding to (M,R) systems [13] is homologous to a self-maintained internal model and advanced generic properties. The structure of (M,R) system is an example how the internal logic generates the topological structure and the abstracting capacity of the system [70]. At the very high level of complexity the double homunculus structures appear having an internal reflexive model of themselves and corresponding to the conscious beings [20].

5. Relational Psychology

While physics and even biology developed for a long time within non-relational paradigms, the understanding of psychology remains very limited if we do not consider the problem of self and its relation to other self. This means that psychology by definition is a relational field of knowledge. In the tractate of Aristotle "*De Anima*" [3] the basic principles of psychology have been formulated. While the living system is characterized by internal determination, which was later defined as a closure to efficient causation, the internal efficient determinant can be called "eidos-navigator" in the terms of Lefebvre. In "*De Anima*" Aristotle defined the structure of soul that includes the constituent of possession of knowledge and the constituent of the actual exercise of knowledge operating in the field of potentialities defined as matter. In fact, Aristotle formulated the triadic model of soul in which the actual exercise of knowledge operates in the potential field being determined by the constituent of possession of knowledge associated with an imposed determinism.

In unconscious living beings the actual exercise of knowledge corresponds to metabolism, while the possession of knowledge is fixed in the genetic system, and the field of potentialities is formed by the available chemical resources. This model became explicitly present at a new level in reflexive systems where it corresponds to the Freudian triad of *Ego* as an exercise of knowledge operating over the potential field of the Unconscious (*Id*) being directed by the imposed determinism of the *Super-Ego* (the possession of knowledge) [17]. While the triadic structure of soul was formulated by Freud in mythological terms as the Oedipus complex and further expressed by Lacan [18] in semiotic terms, the strict mathematical formulation was introduced by Lefebvre [19], who developed the concept of reflexive psychology and formulated two main opposite types of reflection that are realized in social evolution.

Self-reflection was attributed by Lacan [18] to the mirror stage of development, which he defined as a possibility of a subject to recognize himself in a mirror. This stage corresponds to the development of self-agency. Based on the recent studies of self-recognition of representatives of several species of animals in mirror, which may be related to the development of the system of mirror neurons that can fire through the observation of behavior of the other, as though the observer were itself acting [71], we can suggest that the ability to self-recognition appears at a certain level of brain complexity. Self-reflexive properties arise in cognitive systems upon their complexification like autocatalytic properties. They can be attributed to the development of the "double homunculus" system [20] where the image of the self appears inside the self [15,19]. The field of reflexive psychology established by Lefebvre is, in fact, the field of relational psychology studying how the individual reflexive systems interact with each other using their reflexive structures as reference systems. We can hypothesize that in the Universe the reflexive subject structures can be realized not only via the biological protein-based organisms and

that intelligent beings at certain level of civilization may acquire a capability of changing the physical nature of their bodies.

6. Conclusions

In the framework of the upcoming synthetic natural philosophical paradigm that is discussed here, the observed structure of the world is a result of a perpetual solving activity rather than given *a priori*. This framework corresponds to the philosophical synthesis of ideas of integral biomathics developed by Plamen Simeonov in recent publications and special issues, see, e.g., [72]. The new paradigm of natural philosophy should ultimately be based on relational principles. The reality in this framework can be represented as a set of self-maintaining reflective systems capable for the continuous process of complexification. The solutions appearing in the evolutionary process of growing complexity are based on the most optimal realizations for the physical embodiment of the computing process which corresponds to the well-known Leibniz's notion of the most perfect world among all possible worlds as well as to the contemporary formulations of the anthropic principle [73].

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References

1. Rovelli, C. *The First Scientist Anaximander and His Legacy*; Westholme: Yardley, PA, USA, 2011.
2. Graham, D. *Science before Socrates: Parmenides, Anaxagoras, and the New Astronomy*; Oxford University Press: Oxford, UK, 2013.
3. Aristotle. *On the Soul*. Translated by Smith, J.A. The Internet Classics Archive; MIT. Available online: http://classics.mit.edu/Aristotle/soul.html (accessed on 12 October 2018).
4. Aristotle. *Physics*. Translated by Hardie, R.P. and Gaye, R.K. The Internet Classics Archive; MIT. Available online: http://classics.mit.edu/Aristotle/physics.html (accessed on 12 October 2018).
5. Plato. *Parmenides*. Translated by Jowett, B. The Internet Classic Archive; MIT. Available online: http://classics.mit.edu/Plato/parmenides.html (accessed on 12 October 2018).
6. Leibniz, G.W. *Opera Omnia*; Dutens, L., Ed.; Georg Olms: Hildesheim, Germany, 1768; Volume 1–6.
7. Igamberdiev, A.U. Quantum mechanical properties of biosystems: A framework for complexity, structural stability and transformations. *Biosystems* **1993**, *31*, 65–73. [CrossRef]
8. Igamberdiev, A.U. Quantum computation, non-demolition measurements, and reflective control in living systems. *Biosystems* **2004**, *77*, 47–56. [CrossRef] [PubMed]
9. Igamberdiev, A.U. Physical limits of computation and emergence of life. *Biosystems* **2007**, *90*, 340–349. [CrossRef] [PubMed]
10. Igamberdiev, A.U. Biomechanical and coherent phenomena in morphogenetic relaxation processes. *Biosystems* **2012**, *109*, 336–345. [CrossRef] [PubMed]
11. Igamberdiev, A.U. *Physics and Logic of Life*; Nova Science Publishers: New York, NY, USA, 2012.
12. Igamberdiev, A.U. Time rescaling and pattern formation in biological evolution. *Biosystems* **2014**, *123*, 19–26. [CrossRef] [PubMed]
13. Rosen, R. *Life Itself: A Comprehensive Inquiry into the Nature, Origin, and Fabrication of Life*; Columbia University Press: New York, NY, USA, 1991.
14. Kant, I. *Critique of Pure Reason*; Cambridge University Press: Cambridge, UK, 1998; (originally published in 1781).
15. Lefebvre, V.A. *What Are Consciousness, Animacy, Mental Activity and the Like?* Leaf & Oaks Publishers: Los Angeles, CA, USA, 2016.
16. Kineman, J.J. R-Theory: A synthesis of Robert Rosen's relational complexity. *Syst. Res. Behav. Sci.* **2012**, *29*, 527–538. [CrossRef]
17. Freud, S. *Introductory Lectures on Psychoanalysis*; Liveright: New York, NY, USA, 1989; (originally published 1917).
18. Lacan, J. *Ecrits*; W.W. Norton and Co.: New York, NY, USA, 2006; (originally published 1970).

19. Lefebvre, V.A. The fundamental structures of human reflection. *J. Soc. Biol. Struct.* **1987**, *10*, 129–175. [CrossRef]
20. Sawa, K.; Igamberdiev, A.U. The Double Homunculus model of self-reflective systems. *Biosystems* **2016**, *144*, 1–7. [CrossRef] [PubMed]
21. Igamberdiev, A.U. Evolutionary transition from biological to social systems via generation of reflexive models of externality. *Progr. Biophys. Mol. Biol.* **2017**, *131*, 336–347. [CrossRef] [PubMed]
22. Plato. *Timaeus*. Translated by Jowett, B. The Internet Classic Archive; MIT. Available online: http://classics.mit.edu/Plato/timaeus.html (accessed on 12 October 2018).
23. Igamberdiev, A.U. *Time, Life, and Civilization*; Nova Science Publishers: New York, NY, USA, 2015.
24. Igamberdiev, A.U. Semiokinesis—Semiotic autopoiesis of the Universe. *Semiotica* **2001**, *133*, 1–26. [CrossRef]
25. Russell, B. *History of Western Philosophy*; Simon & Schuster: New York, NY, USA, 1945.
26. Zurek, W.H. Decoherence, eigenselection, and the quantum origins of the classical. *Rev. Mod. Phys.* **2003**, *75*, 715–775. [CrossRef]
27. Vasiliev, N.A. Logic and Metalogic. *Axiomathes* **1993**, *4*, 329–351. [CrossRef]
28. Lupasco, S. *Logique et Contradiction*; Presses Universitaires de France: Paris, France, 1947.
29. Brenner, J.E. *Logic in Reality*; Springer: Dordrecht, The Netherlands, 2008.
30. Brenner, J.E. The philosophical logic of Stéphane Lupasco (1900–1988). *Log. Philos.* **2010**, *19*, 243–285. [CrossRef]
31. Voevodsky, V. A^1-homotopy theory. *Proc. Int. Cong. Math.* **1998**, *1*, 579–604.
32. Liberman, E.A. Molecular quantum computers. *Biofizika* **1989**, *34*, 913–925.
33. Bekenstein, J. Universal bound on the entropy to energy ratio for bounded systems. *Phys. Rev. D* **1981**, *23*, 287–298. [CrossRef]
34. Gunji, Y.-P. Autonomic life as the proof of the incompleteness and Lawvere's theorem of a fixed point. *Appl. Math. Comput.* **1994**, *61*, 231–267. [CrossRef]
35. Kafatos, M.C.; Kato, G.C. Sheaf theoretic formulation for consciousness and qualia and relationship to the idealism of non-dual philosophies. *Prog. Biophys. Mol. Biol.* **2017**, *131*, 242–250. [CrossRef] [PubMed]
36. Matsuno, K. From quantum measurement to biology via retrocausality. *Progr. Biophys. Mol. Biol.* **2017**, *131*, 131–140. [CrossRef] [PubMed]
37. Feynman, R. The theory of positrons. *Phys. Rev.* **1949**, *76*, 749–759. [CrossRef]
38. Husserl, E. *On the Phenomenology of the Consciousness of Internal Time*; Kluwer: Dordrecht, The Netherlands, 1990; (originally published 1928).
39. Rovelli, C. *Reality Is not What It Seems: The Journey to Quantum Gravity*; Penguin Random House: New York, NY, USA, 2016.
40. Conrad, M.; Liberman, E.A. Molecular computing as a link between biological and physical theory. *J. Theor. Biol.* **1982**, *98*, 239–252. [CrossRef]
41. Hau, L.V.; Harris, S.E.; Dutton, Z.; Behrooziet, C.H. Light speed reduction to 17 m per second in an ultracold atomic gas. *Nature* **1999**, *397*, 594–598. [CrossRef]
42. Wang, J.; Zhu, Y.F.; Jiang, K.J.; Zhan, M.S. Bichromatic electromagnetically induced transparency in cold rubidium atoms. *Phys. Rev. A* **2003**, *68*, 063810. [CrossRef]
43. Ashtekar, A.; Pawlowski, T.; Singh, P. Quantum nature of the big bang. *Phys. Rev. Lett.* **2006**, *96*, 141301. [CrossRef] [PubMed]
44. Nakajima, T. Ecological extension of the theory of evolution by natural selection from a perspective of Western and Eastern holistic philosophy. *Prog. Biophys. Mol. Biol.* **2017**, *131*, 298–311. [CrossRef] [PubMed]
45. Smolin, L. *The Order of Cosmos*; Oxford University Press: Oxford, UK, 1997.
46. Nakagomi, T. Mathematical formulation of Leibnizian world: A theory of individual-whole or interior-exterior reflective systems. *Biosystems* **2003**, *69*, 15–26. [CrossRef]
47. Steinhart, E. Leibniz's palace of the fates: A 17th century virtual reality system. *Presence Teleoperators Virtual Environ.* **1997**, *6*, 133–135. [CrossRef]
48. Milne, E.A. *Relativity, Gravitation and World-Structure*; Clarendon Press: Oxford, UK, 1935.
49. Penrose, R. *The Emperor's New Mind: Concerning Computers, Minds and the Laws of Physics*; Oxford University Press: Oxford, UK, 1989.
50. Kineman, J.J. Relational self-similar space-time cosmology revisited. In Proceedings of the 54th Meeting International Society for the Systems Sciences, Waterloo, ON, Canada, 18–23 July 2010.

51. Kineman, J.J. Relational Science: A Synthesis. *Axiomathes* **2011**, *21*, 393–437. [CrossRef]
52. Heraclitus. *Fragments*; Translated by Robinson, T.M.; University of Toronto Press: Toronto, ON, Canada, 1987.
53. Conway, J.; Kochen, S. The free will theorem. *Found. Phys.* **2006**, *36*, 1441–1473. [CrossRef]
54. Libet, B. Unconscious cerebral initiative and the role of conscious will in voluntary action. *Behav. Brain Sci.* **1985**, *8*, 529–566. [CrossRef]
55. Rosen, R. Drawing the boundary between subject and object—Comments on the mind-brain problem. *Theor. Med.* **1993**, *14*, 89–100. [CrossRef] [PubMed]
56. Igamberdiev, A.U. Objective patterns in the evolving network of non-equivalent observers. *Biosystems* **2008**, *92*, 122–131. [CrossRef] [PubMed]
57. Rovelli, C. Relational quantum mechanics. *Int. J. Theor. Phys.* **1995**, *35*, 1637–1678. [CrossRef]
58. Leibniz, G.W. *Monadology and Other Philosophical Essays*; Translated by Schrecker, P.; Schrecker, A.M.; Bobbs-Merrill: Indianapolis, IN, USA, 1965; (originally published 1714).
59. Schrödinger, E. *What is Life?* Macmillan: New York, NY, USA, 1944.
60. Matsuno, K. Chemical evolution as a concrete scheme for naturalizing the relative state of quantum mechanics. *Biosystems* **2012**, *109*, 159–168. [CrossRef] [PubMed]
61. Rashevsky, N. Topology and life: In search of general mathematical principles in biology and sociology. *Bull. Math. Biophys.* **1954**, *16*, 317–348. [CrossRef]
62. Matsuno, K.; Paton, R. Is there a biology of quantum information? *Biosystems* **2000**, *55*, 39–46. [CrossRef]
63. Alfaro, J.; Espriu, D.; Gabbanelli, L. Bose–Einstein graviton condensate in a Schwarzschild black hole. *Class. Quantum Grav.* **2017**, *35*, 015001. [CrossRef]
64. Lefebvre, V.A.; Efremov, Y.N. Cosmic intelligence and black holes. *World Futures* **2008**, *64*, 563–576. [CrossRef]
65. Prigogine, I. *From Being to Becoming*; Freeman: San Francisco, CA, USA, 1980.
66. Bauer, E.S. *Theoretical Biology*; Akadémiai Kiadó: Budapest, Hungary, 1982; (originally published 1935).
67. Beloussov, L.V. Morphogenesis as a macroscopic self-organizing process. *Biosystems* **2012**, *109*, 262–279. [CrossRef] [PubMed]
68. Kauffman, S.A. Autocatalytic sets of proteins. *J. Theor. Biol.* **1986**, *119*, 1–24. [CrossRef]
69. Von Neumann, J. *Theory of Self-Reproducing Automata*; Burks, A.W., Ed.; University of Illinois Press: Urbana, IL, USA; London, UK, 1966.
70. Matsuno, K. Self-identities and durability of biosystems via their abstracting capacity. *Biosystems* **2014**, *120*, 31–34. [CrossRef] [PubMed]
71. Agnati, L.F.; Guidolin, D.; Cortelli, P.; Genedani, S.; Cela-Conde, C.; Fuxe, K. Neuronal correlates to consciousness. The "Hall of Mirrors" metaphor describing consciousness as an epiphenomenon of multiple dynamic mosaics of cortical functional modules. *Brain Res.* **2012**, *1476*, 3–21. [CrossRef] [PubMed]
72. Simeonov, P.L.; Ehresmann, A.V. Some resonances between eastern thought and integral biomathics in the framework of WLIMES. *Progr. Biophys. Mol. Biol.* **2017**, *131*, 193–212. [CrossRef] [PubMed]
73. Igamberdiev, A.U. *Relational Universe of Leibniz: Implications for Modern Physics and Biology*; Athens: ATINER'S Conference Paper Series, No: PHI2015-1439; Athens Institute for Education and Research: Athens, Greece, 2015.