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Relational Universe of Leibniz: Implications for Modern Physics and Biology

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Abstract

In Leibniz philosophy, the multiplicity of the world is represented by the infinite set of ideal essences called monads. The ideas of G.W. Leibniz can be traced to the principle which Plato attributed to Parmenides ("the existing one should be many") and to the statement of Anaxagoras on the multiplicity of *homoiomeroi* (particles having the same nature as the whole). Monad can be considered as a logical basis for the physical world and represents an embodied logical machine. Each monad computes its own program and performs its own mathematical transformations of its qualities, independently of all other monads. Leibniz considered space as a relational order of co-existences and time as a relational order of sequences. This approach came in physics with the new type of mechanics, after two centuries from Leibniz (the special theory of relativity). However, this relational concept of space-time was again partially displaced by the modernized framework of the substantial space-time in the general theory of relativity and in modern models of Universe evolution. According to Leibniz, a change is less a transformation than an ordered revelation of the entity, and the creation stands outside the temporal order. In this approach, the objectivity of space-time is relational. The action of monad generates its framed output located in the external space. Inside the decision-making system, its internal volition-based and implying quantum reduction behavior occurs in the way that the external observer describes via the probability (quantum wave) function. In biology, Robert Rosen was the follower of Leibniz's methodology and considered the individual biological systems as separate relational domains. The Everett's interpretation of quantum mechanics works in these domains but not between the domains. The reality of superposition of the wave function is limited by the single monad and does not expand outside it, and in this sense "monads do not have windows", as originally Leibniz proposed.

Keywords: Leibniz, Monad, Internal Quantum State, Relational Biology, Self.

Introduction

The dual nature of the world claimed by the founder of modern philosophy, René Descartes (1596-1650), was attempted to be resolved by Baruch Spinoza (1632-1677), who suggested that the two properties (*cogitans* and *extensa*, among the infinite number of others which, according to Spinoza, we do not perceive) are the true characteristics of the one substance which is *causa sui*. However, the relation of these two "properties" in this "monist" model remains unresolved. This was fundamentally challenged by Gottfried Wilhelm Leibniz (1646-1716) who, in fact, revived the concept outlined in Plato's dialogue "*Parmenides*", that the "existing one" should appear as "many". The existing *res cogitans* in the philosophical system of Leibniz appears as a pluralism of monads, i.e., as a multiplicity of existing souls. The potential soul is one (like God as "Being-potentiality" in the philosophy of Nicholas of Cusa), and it appears as a "pre-established harmony", in which many actualized substances (monads) are co-existing. In this concept, *res extensa* represents the relational space-time of interacting monads. Although monads, according to Leibniz, "have no windows", they coexist; and the "objective pattern" of their coexistence forms *res extensa*. The exhibition of *res cogitans* takes place in the world of *res extensa,* and they are connected via their common potential field which in fact corresponds to the existing one of Plato's dialogue "*Parmenides*", and, according to the logic of this great opus, the one, by acquiring existence, becomes many, i.e. the world exists as a multiplicity of monads. This statement became the basic principle of Leibniz philosophy. In the ancient Greek philosophy, it was developed into the complete philosophical system by Anaxagoras, who claimed the multiplicity of *homoiomeroi* – the particles having same nature as the whole. The concept of *Nous* in the philosophy of Anaxagoras corresponds to the idea of pre-established harmony in Leibniz philosophy.

Leibniz portrayed the Universe as an infinite set of fundamental units (monads), each having a kind of psychological being, from the primitive (as expressed in modern science in the uncertainty of quantum reduction at subatomic levels and presented as a pilot-wave duality) to the sophisticated (as in living beings having free will). Each monad realizes the non-computable choice, i.e. makes a decision. The space, according to Leibniz (1714, 1768), is a pattern of coexistences, and the whole world is a universal harmony (mutual complementarity) of monads. Each monad has its own time, consisting of the set of points of view (reflections) of the monad on itself, while the space is a set of points of view on the whole. In other words, the space is a set satisfying the principle of the universal harmony of monads, and there should be certain parameters uniting time and space, which would satisfy the principles of coexistence of monads, i.e. of the observability of the world. Such representation of the world explains its objectivity from the relativity of a single picture represented by monad's point of view. This relativity means uncertainty in the formal representation of the view of the single monad. The temporal evolution of the world serves as an engine to overcome such uncertainty; this process has no external frames and opens into infinity (for details see Igamberdiev, 2004, 2007, 2012, 2014, 2015)

The problem of how the space-time is formed was clarified in a new type of mechanics after two centuries from Leibniz, which is based on the relational space-time (the special theory of relativity, STR). However, this relational concept of space-time was again partially displaced by the modernized framework of the quasi-substantial space-time in the general theory of relativity (GTR). Modern physics often abandons the relational nature of space-time in the course of development of the unification theories. This is particularly evident in the current models of the evolution of Universe that are based on the uniform time flowing independently from the moment of Big Bang to the final stages of expansion that can proceed up to infinity.

Turning to living organisms, we observe that they are essentially closed ("closed to efficient causation", according to Rosen, 1991), thus having a similarity to Leibniz monads), and in this way they possess the internal causes of their dynamics. Immanuel Kant mentioned in this regard that "it is quite certain that we can never adequately come to know the organized beings and their internal possibility in accordance with merely mechanical principles of nature, let alone explain them; and this is so certain that we can boldly say that it would be absurd for humans to make an attempt or to hope that there could ever arise a Newton who could make comprehensible even the generation of a blade of grass according to natural laws that no intention has ordered; rather we must absolutely deny this insight to human beings" (Kant, 1781). In biology, Robert Rosen was the follower of Leibniz's methodology and considered the individual biological systems as separate relational domains. According to Rosen's concept, living systems "rescue and organize their natural autonomy by internalizing and thus isolating entailments from external information" (Kineman, 2012). 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" (Kineman, 2012).

We will further discuss Leibniz's philosophy with the aim of its translation into the language of modern science. This task has been outlined in the previous works, in particular in two monographs (Igamberdiev, 2012, 2015).

Leibniz and Relational Logic

The relational approach to objectivity of the world arises to early philosophers. In Plato's dialogue "*Parmenides*", the origin and development of multiplicity follows from the logic imposed by the existence of one through the self-referential process of generation of numbers. The objective counting arises as a consequence of this self-referential development. Paradoxically, this process is perceived by the mind in reverse: the complexity of the composition is what is seen; the concept of the entity that generates complexity is unseen and can be comprehended only in the philosophical thought. According to

Leibniz, a change is less a transformation than an ordered revelation of the entity, and the creation stands outside the temporal order. In this approach, the objectivity of space-time is relational. It is also relational in Kant's theory of the transcendental ideality of space where the '*Ding an sich*' can be considered as the sum of possible histories, while the perception selects 'real' things in the 3D space (not necessarily Euclidean) via a kind of non-deterministic transition. Objectivity of the space-time comes as a fixed condition of perception generating the phenomenal reality of the observed world. Following Parmenides, Plato and Leibniz, we can say that the primary substance is rather not a number, as it was originally suggested in the philosophy of Pythagoras, but the numbers are generated through the activity that introduces them.

A monad's internal decision to perform calculation procedure is the initial cause, which is viewed as an event that can be evaluated externally via the spatiotemporal representation. Thus the causality principle can be re-formulated based on the monadological approach. According to Leibniz, monads are self-sufficient internally, they have no windows to look through toward outside. Really, there are no windows to perceive the other's self, but the internal program of a monad harmonizes its spatiotemporal representation in the world in itself, like performing the modeling of this window. If we turn to physics, we explore the external world generated by the spatiotemporal representation of monads. The window to this world is actually the window to monad's own spatiotemporal representation, so it is not a real window but it helps to evaluate monad's possibilities of acting in the relational physical world.

In "*Opuscules*" Leibniz wrote: "The existent may be defined as that which is compatible with more things than is anything incompatible with itself... I say therefore that the existent is the being which is compatible with most things, or the most possible being, so that all coexistent things are equally possible". In relation to this, Bertrand Russell (1945) in his "*History of Western Philosophy*" in the chapter about Leibniz stated: "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."

Further reading of Leibniz's "*Opuscules*" reveals the following statement: "Every substance is infinitely complex, for it has relations to every other, and there are no purely extrinsic denominations, so that every relation involves a predicate of each of the related terms. It follows that every singular substance involves the whole universe in its perfect notion." This can be translated in a way that the notion involves infinites, and so the matter can never be brought to a perfect demonstration, but this can be approached more and more nearly, so that the difference shall be less than any given difference.

Propositions about what exists could be known *a priori* if we complete an infinite analysis, but, since we cannot, we can only know them empirically. Monads put mathematics into motion. The programs of all monads define the spatiotemporal physical world. The program, that monad runs, simulates the whole physical world. The internal logical motion proceeds in parallel with a physical motion that has a price (physically described as spending energy).

Following the philosophy of Parmenides (as it was described by Plato in the corresponding dialogue) that one can exist as a set of many essences, we conclude that every possible world exists as an infinite set of monads. This also means that not every set of monads is a possible world, since every possible world must be coordinated (symphonic).

Existence is equivalent to the embodied number which comes as a realization of the computational activity, and this activity is attributed to the single substance (monad) which observes itself in the world. In modern interpretations of quantum mechanics, the approach to see the world as a consistent history can be traced to Leibniz and to his unpublished (at his time) logic: the existence is related to the events that are consistent with more events than other possible events. Observability from the quantum mechanical point of view means a possibility to perform multiple quantum measurements in such a way that their results are compatible and can form the pattern which corresponds to our trivial sense of the absolute space-time common to all beings. Thus the challenge to physics is not to resolve the problem of relational *versus* substantial space-time but to explain how the observable substantial perception of spatiotemporality arises from the set of relations generated by multiple perceptions of the individual monads.

Leibniz and Relational Physical Universe

The space-time, while having relational properties, for the observability condition should meet the criteria of universality upon certain limits (established by the theory of relativity at the upper limit and by the quantum mechanics at the lower). In other words, the external space-time appears as the medium ('environment') suitable for the coexistence of monads. It cannot afford coexistence of everything possible, but it should allow coexistence of maximal possible things. Not every set of monads is a possible world, since every possible world must be coordinated (symphonic): some programs cannot be implemented into bodies, and some bodies cannot coexist with others. The set of fundamental physical constants defines and introduces the condition of pre-established harmony to our world. Really, these constants correspond to observability of the world and represent the natural limits of computation that generate the observable physical Universe (Igamberdiev, 2007). They may change over a kind of meta-evolutionary process in which the history of decisions made by monads is generated (Nakagomi, 2003). The pre-established harmony appears, according to this view, as a process of evolution in which the fitting of monads together through the actualization of monads' programs generates the spatiotemporal world. This world unfolds in a way that the events actualized via monads' program interact and form the actualized pattern.

In other words, in the physical world monad represents an active unit that makes the decisions to perform quantum measurements. These decisions do not necessarily mean consciousness, but they mean some original elementary *Wille* that produces the decoherent output, i.e. *Vorstellung* in Schopenhauer's terms.

Only when all decisions are held within a prolonged coherent medium where a higher monad rules other simpler monads, a possibility for consciousness arises. In other words, monad is not a physical unit, but the basic semiotic structure that defines the physical event. A monad is characterized by the system of qualities that can be viewed as a system of equations, i.e. as a computational program that monad runs. The qualities of monads serve as a logical basis for the spatial structure of the physical world via putting mathematics into motion. Monads are all symmetrically coordinated but none acts on any other (Steinhart, 1997). However, their bodies, i.e. the patterns on their spatiotemporal representation, act one on another in the external actualized world.

The development of physics in the XX century generally followed the way of returning back to the substantial concept of space and time. This generated real difficulties in the unification of physics. We discuss the age of the Universe, its generation by the Big Bang, further inflation and expansion, and even try to understand what was before the Big Bang. However we prefer to not discuss the conditions of its observability before or at the Big Bang. The alternative to the general theory of relativity model of Edward Arthur Milne (1935) supposes that the gravitation interaction is not included into the model. This actually means that the substance does not have the property of expansion as basic and therefore the difference between approaches of Einstein and Milne is the same as between Spinoza and Leibniz. The model of the Universe of Milne was developed further in the sketch of theory suggested by John J. Kineman who proposed the "relational self-similar space-time cosmology" (Kineman, 2010, 2011) based on development of the ideas put into life in the relational biology by Robert Rosen, who in fact was one of the few followers of Leibniz's methodology in the modern science.

Individual substances stand in the spatial relation to each other, but the relations of this sort are reducible in logic to the non-relational features of windowless monads. In exactly the same way, the temporal relations can be logically analyzed as the timeless properties of individual monads. This can be compared to the statement of Heraclitus "An invisible harmony is better than a visible one". The realization of computation could be possible only at certain fundamental symmetries serving as preconditions. These symmetries correspond to the fundamental physical laws. The Planck's values underlie these symmetries and provide the condition for spatiotemporal representation of monads. Computation has its physical limitation, which belongs to the fact that any calculation action has a price (Liberman, 1989), e.g. the addition of one takes energy, and this energy cannot be reduced to the zero value.

In modern physics, the pre-established harmony corresponds to the formulation of the anthropic principle. Mathematically expressed physical parameters may strictly correspond to the observability of the world by embodied living organisms having internal digital structure with the alphabet and grammar, generating a unique solution for the appearance of free will and consciousness. The free will theorem of Conway and Kochen (2006) states that, if we have a certain amount of "free will", then, subject to certain assumptions, so must some elementary particles. The existing values of the fundamental constants and dimensionality of space-time may represent the only solution for the existence of shielded coherent states corresponding to living states and consciousness. It is rather impossible to mathematically prove this unique solution; what we can only get are the sets of empirical data showing that this solution fits to the observability of real world. In other words, we can prove the validity of fundamental constants like Diogenes proved the existence of movement by walking (i.e. via establishing the limits of computation that shape “the best of possible worlds”).

Leibniz, who developed the theory of relational space-time, rejected the consideration of extension as a basic property keeping only *cogito* as the property of substance. His representation of the Universe therefore appears as the *omnium* of self-maintaining units called monads which “have no windows”. While it was difficult to interpret such picture of the Universe in physics, it was mainly ignored in science. However this task is extremely important if we agree with the idea of a profound relational nature of the space-time. The internal observers, acting as measuring agents, constitute a network of interactions between these agents mediated by the environment, in which the refinement of the wave function generates objective patterns corresponding to perception of the reality of external world (see also Rosen, 1993).

The computability principle in the physical world can be introduced via some sort of spontaneous activity brought by the elementary units (monads) linking mathematical equations to a materialized physical world. A self-moving monad realizes computation by establishing its logical set embedded into the world. The programs of all monads define the spatiotemporal physical world while the program that single monad runs simulates it. The principle of ‘pre-established harmony’ is simply a condition satisfying the possibility of reflection of whole external world to individual internal programs of monads (Nakagomi, 2003).

It is the perpetual activity of solving the semantic paradox that generates what Leibniz called the “pre-established harmony”. The harmony does not exist independently of monads. It comes as a possible solution in the physical world, and the Planck’s quantum, as the measure of action, plays a role in establishing its existing version in this Universe. Such interpretation of the monadological approach is not exactly isomorphic to what Leibniz introduced initially but has a similarity with the original monadology in its conceptual basis. Leibniz by himself in his letters and unpublished works developed the ideas that are not identical to his original monadology. For example, in his unpublished logic, he considered a condition for a phenomenon to be existent if it is in a harmony with a higher number of phenomena than some other potential event. This is close to the understanding of the perpetual activity of solving the semantic paradox.

Leibniz and Relational Biology

To understand the nature of living beings, we need to analyze in detail the problem of self. Generally, "self" can be attributed to a unit that has spontaneous activity, and thus introduces computation. The cause of such "spontaneous" behavior always arises to a non-computable decision of the controlling system (corresponding to Leibniz monad) preceding the control. When we formalize the decision-making (i.e. living) system, we transform it into a program for a macroscopic computer without any internal point of view and freedom of will. The approach to see the world as a consistent history can be followed to Leibniz and to his unpublished logic at his time: the existence is related to the events that are consistent with more events than other possible events.

Schrödinger (1944) suggested that the nature of self is quantum mechanical, i.e. it is a state beyond quantum reduction, which generates emergent events by applying quantum reduction externally and observing it. The correspondence of mental and physical events occurring simultaneously, which corresponds to a pre-established harmony in the paradigm of Leibniz, can be viewed as a correspondence of a statement and a meta-statement within the reflective loop. The statement will represent the physical event and the meta-statement corresponds to its sensor representation, while consciousness is the process (*cogito*) holding them both in the whole unity. The whole act of thinking (*cogito*) generates its primary model (the finite set of statements), which includes the existence (*ergo sum*, the meta-statement within this set). The subject self-determines possible finite models for his relation to the external world. By constructing the space-time image, the observer self-determines the picture of the external reality in which the reality has a property of self-maintenance. This has a direct relation to the anthropic principle.

It may be seemed that the internal quantum state (IQS, the term introduced in Igamberdiev, 2004) of brain has the role similar to that the pineal gland (epiphysis) played in the concept of Descartes when he tried to solve the problem of interaction between *res cogitans* and *res extensa*, first stating them as two independent essences and then trying to find the area of human brain where they can be linked and "interact". The main difference here is that the IQS is rather delocalized. Probably this "interaction" can be better described by means of the philosophy of Kant following which we can say that the IQS pre-programs the *a priori* forms of space and time, generating the spatiotemporal frame in which the world is observed. The IQS holds the potentiality that directs possible actualizations. Leibniz considered space as the relational order of co-existences and time as a relational order of sequences (see his polemics with Samuel Clarke). One special and advanced case of the pre-established harmony accounts for the apparent interaction of mind and body in a human being as nothing more than the perfect parallelism of their functions. In fact, the human mind is just the dominant member of a local cluster of monads, collectively constituting the associated human body (§63 of Monadology).

The Universe in the concept of Kineman (2010) consists of the units called "holons", which vaguely correspond to Leibniz's monads. They possess simultaneous properties of location and non-location, as a point of non-differentiated whole appearing in a subject-object relation. The Everett's interpretation of quantum mechanics is valid in these isolated domains but not between the domains, the same idea has been suggested by Matsuno (2012) for the individual biological systems taken as separate domains. The reality of superposition of the wave function is limited by the single monad and does not expand outside it, and in this sense monads do not have windows as originally proposed by Leibniz. The principle of "closure to efficient causation", which forms the basis of definition of life in the concept of Rosen (1991), is in fact the application of Leibniz's "no windows" principle to the characterization of living systems.

In the universe of monads, the complexity of environment increases as a result of life itself, which, in turn, produces more complexity in life as reflection of this fact in the course of measurement at the next level of recursion. The uncertainty comes about as a necessary consequence of such embedding measurement. Thus the increase in complexity occurs simply as a result of quantum measurement. Life emerges to incorporate basic computation principles and, in the course of evolution, to overcome the physical limits of computability. Biological evolution, viewed as adaptation to the fitness landscape changing in the course of evolution, becomes its own cause, a universal property of the living world. Incomplete identification connected with uncertainty in the measurement process is read and interpreted as a cause for new realizations. Biological systems are adapting to the environment that is changing in the course of adaptation.

The relational biology, introduced by Nicholas Rashevsky (1954) and Robert Rosen (1991), describes life as ontologically independent generic phenomenon. The development of relational biology, which is substantially based on Leibniz paradigm, will result in resolution of the contradiction of reductionism and holism in the description of living systems. In fact, the conceptual basis of reductionism follows from the acceptance of substantiality of the space-time, while the basis of holism is the substantiality of the spiritual "one" governing the multiply divided "matter". The relational approach would aim to reveal the limits of both reductionism and holism and provide a paradigm in which the unity of life, space-time and consciousness will receive a new far-reaching understanding and clarification.

Conclusion

In the framework of the paradigm that is discussed here, the pre-established harmony is a result of a perpetual solving activity rather than of something divine and given *a priori*. The Planck's quantum and other fundamental physical constants form the basic condition for the spatiotemporal representation of monads' projections and exposition to the outer world.

Monad in Leibniz's sense can be considered as a logical basis for the physical world and represents as an embodied logical machine. Each monad computes its own set of algorithms, performs its own mathematical transformations of its qualities, independently of all other monads. Monads are self-powered: the power that causes the changes is due to the internal logical structure or, more precisely, to the perpetual solution of the semantic paradox. Its relative solution has a creative power in the embodied world.

The reality can be described as a set of self-maintained reflective systems exhibiting themselves externally on the macroscales and interacting via perpetual process of signification through reducing the microscale, which introduces the universal computable laws harmonizing their interaction. The evolutionary growth of information occurs via the language game of interacting programs, representing an open process without frames.

The solutions coming to the existence are based on the most optimal way for the physical embodiment of the computing process, and this is in agreement with Leibniz's notion about the most perfect world among all possible, which corresponds to contemporary formulations of the anthropic principle. Possessing free will and consciousness, we can accept this world as a suitable place for living or reject it, i.e. to express the optimistic or pessimistic ethical view, but its mathematically formulated physical parameters may strictly correspond to its observability by the embodied living organisms having internal digital structure with the alphabet and grammar, which generates a unique solution for the appearance of free will and consciousness (Igamberdiev, 2004).

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