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Philosophy in Reality: Scientific Discovery and Logical Recovery

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Abstract: Three disciplines address the codified forms and rules of human thought and reasoning: logic, available since antiquity; dialectics as a process of logical reasoning; and semiotics which focuses on the epistemological properties of the extant domain. However, both the paradigmatic-historical model of knowledge and the logical-semiotic model of thought tend to incorrectly emphasize the separation and differences between the respective domains vs. their overlap and interactions. We propose a sublation of linguistic logics of objects and static forms by a dynamic logic of real physical-mental processes designated as the Logic in Reality (LIR). In our generalized logical theory, dialectics and semiotics are recovered from reductionist interpretations and reunited in a new synthetic paradigm centered on meaning and its communication. Our theory constitutes a meta-thesis composed of elements from science, logic and philosophy. We apply the theory to gain new insights into the structure and role of semiosis, information and communication and propose the concept of 'ontolon' to define the element of reasoning as a real dynamic process. It is part of a project within natural philosophy, which will address broader aspects of the dynamics of the growth of civilizations and their potential implications for the information society.

Keywords: dialectics; epistemon; information; logic in reality; natural philosophy; ontolon; semiotics

1. Introduction

Philosophy, science and logic are systems of thought devised by human beings to describe their world and what it means to exist in it. In the classical West and to a certain extent in the East, throughout history, there was no separation between the disciplines. However, the value of philosophy, especially today in the West, has been diminished by several major errors: the work of Aristotle and other classical Greek, and later Western European thinkers has been misused and misunderstood, without the proper attention paid to necessary corrections and extensions made possible by modern science. The value of dialectics as the basis of reasoning, and the need for a logic based in science rather than language are major examples. In the last 100 years, phenomenology and semiotics have been proposed to bridge the gap between knowledge and reality, but all suffer from reliance on the epistemic principles of classical linguistic logic. Dialectics, in particular as expressed by Hegel, was diverted from its initial objectives and used to support limited political-economic idealism and ideologies.

The objective of this paper is to define a philosophy of and in reality that effects a 'rejunction' with some less familiar insights of Aristotle and recovers them to serve the current social objectives of the emerging information society. Rapidly, there is in Aristotle the basis not only for modern bivalent linguistic logic, but also for a logic that refers to actualizations and potentialities in a physical world of processes. We will propose an extension and development of and to the second logic of Aristotle

that is grounded in modern physics. It makes possible an understanding of real processes in terms of what is essentially a *non*-Boolean logic. We will refer to two little known authors whose thought is essential to our thesis, the Russian Evald Ilyenkov and the Franco-Romanian Stéphane Lupasco. New concepts of the real dynamics of consciousness, creativity and ethics emerge from a study of these authors, making possible a rereading of the work of Western figures such as Spinoza, Kant, Peirce, Whitehead, and Heidegger and, in relation to quantum physics, Heisenberg.

We use a logic of real processes, a Logic in Reality (LIR) [1] to redefine the ontological relations between meaning, communication and language as components of a Philosophy in Reality (PIR). Under the influence of current developments in the science and philosophy of information, as noted by the Chinese thinker Wu Kun [2,3], a new more functional convergence of science and philosophy is taking place. The resulting 'dialectical realism' may make possible a more ethical development of knowledge for the common good.

1.1. Paradigms and Horizons

To describe the complex development of human knowledge, it has become customary to talk in terms of paradigms. Common examples are the scientific paradigm; the linguistic paradigm, the computational paradigm, the holistic paradigm, etc. With these are associated, more or less loosely and more or less well-defined, corresponding ontologies, e.g., digital ontology, and philosophical turns: the linguistic turn, the ontological turn and most recently the informational turn. Changes in paradigm are described as evolutionary or revolutionary.

A concept similar to paradigm is that of 'horizon'. Husserl uses the term intentional horizon to characterize the locus of the 'end' of the experience of self-awareness: "the horizon-structure of our singular empirical thought". Derrida has also called attention to its dualistic character as an opening and a limit, and Heidegger in the sense of what limits or encloses and in doing so discloses or makes available. It has also been proposed by Rafael Capurro to describe the bounds within which any existential thought or system of thought, such as our current thesis, can be made at a given time. This term has the advantage of avoiding the academic associations of paradigm, but both can be considered as applicable to our thesis, of which such dualities, and their evolution, is a key component.

Three disciplines address the forms and rules of human thought and reasoning in the generation of knowledge: logic, which has been available since antiquity; dialectics as a broader conception of logic, considered as the 'science' of correct reasoning; and semiotics which focuses on the epistemological properties of reality—the extant domain. Semiosis is the cognitive process of 'doing' semiotics.

The difficulty with both the paradigmatic-historical model of knowledge on the one hand, and the logical-semiotic model of thought on the other has been that both tend to emphasize the separation and differences between the respective domains. As discussed elsewhere below, we see this as a consequence of the retention of the basic premises of bivalent, linguistic logic separated from an adequate, physically grounded realism. Even the current holistic paradigm, as holistic science, apart from its discussion of medicine which will not concern us here, uses classical conceptions of, e.g., parts and wholes and their relation.

1.2. Forms of Thought

Human thought, its codification in knowledge and its evolution are highly non-linear processes. A key concept in our approach is that the dynamic structure of this non-linearity and in fact all non-linear phenomena have not been adequately captured by available dialectical, logical or semiotic paradigms, ancient, modern or contemporary. (A brief discussion of non-linearity is provided below). Our critique of the role of logic and dialectics per se can be summarized as follows:

- Logic has moved from being a science of nature to that of formalism for its abstract structures, exemplified in the work of George Boole [4]. The term logic is also applied in a generalized, non-scientific way to obvious regularities in the macroscopic world. Only limited relations are

established to the microscopic world and its underlying quantum structure, and quantum logic remains limited to the quantum world.

- From its initial formulation by Plato-limited as Deleuze [5] has shown—dialectics has suffered from its association with Hegelian idealism, then with Marxist dialectic materialism.
- In a similar fashion as dialectics, semiotics has suffered by association with the ultimately reductionist epistemology and logic of C.S. Peirce and the lack of scientific grounding of Saussure. Noam Chomsky's generative grammar is (in our opinion) a further example of a flawed dynamic approach that still dominates linguistics.

In this paper, we will attempt to maintain a balance between the form and content of thought, in order to give proper ontological status to the former in its obvious dialectic relationship to the latter.

1.3. Objective and Outline of Paper

We are thus very much concerned in this paper with the "thinking behind the thinking". It can be seen also as a metaphilosophical contribution to knowledge, as will be clear from the reference below to the philosophy of information as a metaphilosophy. We therefore begin, in the next Section 2, with a discussion of dialectics, with the intention of showing its clear applicability to current philosophy and science. We discuss the nature and role of dialectics in knowledge and the society and recover it from reductionist interpretations. In Section 3, we present our concept of a new logic as necessary for the success of our project and an approach to a new paradigm. In particular, we propose the replacement of linguistic logics of objects and static forms by a dynamic logic of real physical-mental processes designated by Brenner as the logic of and in reality or Logic in Reality (LIR) [1]. We show that LIR has clear methodological links to dialectics and implies a metalogic that is an expression of the fundamental recursive properties of existence.

The field of information and its philosophy are having a major current impact on thought, as information involves both meaning and the physical transmission and reception of meaning. In the context of our *dialectical realism* [6], we establish in Section 4 a new set of working relations between the concepts of meaning and semiotics, a dialectics of meaning. As we will see elsewhere below, LIR provides a *naturalization* (bringing into science) of Adorno's concept. We deconstruct the concept of semiotics as an *antithesis*, an anti-dialectical system considered as one of the most general but partly misguided and misleading horizons for knowledge. We reposition prior work of Igamberdiev as a semiosis in which links to physical phenomena are stated explicitly, joining the concept of Logic in Reality as a *kind* of semiosis. We continue in this vein in Section 5, where we propose a picture of meaning in relation to the physical and cognitive phenomenon of information that is a semiosis, dialectical and logical, in our dynamic logical terms. The role of the philosophy of information as a metaphilosophy in the conception of Wu Kun is related to our new vision of semiosis.

In Section 6 we approach all four major themes—dialectics, logic, semiosis and information in terms of a new concept of the dynamic parts of existence, ontological and epistemological, for which we propose the neologisms of 'ontolon' and 'epistemon' respectively. In our Summary Conclusion Section 7, we further position our approach in relation to natural philosophy, but also make a statement of principle about the role of our project in the information society. We plan to extend these ideas to address broader aspects of the dynamics of the growth of civilizations and their potential implications for the common good.

1.4. The Scope of Philosophy in Reality

We should first state we do not presume to offer a definition of reality that would be either provable in some way or acceptable to all or most people. We refer the interested reader to the book of Colin McGinn [7] on the 'basic structures' of reality and the earlier concept of D'Espagnat of a 'veiled reality'. Perhaps the least incorrect thing one can say is that reality is something like what one thinks it

is. We insist only on the existence of the dialectic between reality and appearance and the operation of the mind moving from one to the other according to the Principle of Dynamic Opposition.

To paraphrase a well-known statement in scientific theory, our philosophy of/in reality is not and is not intended to be a 'philosophy of everything'. It would be fatuous and presumptive to say that our theory covers, for example, transcendental philosophy or philosophy based on beliefs about the origin or a possible purpose of the universe. What characterizes such positions in general is their reference to an inaccessible *un*-reality, sometimes expressed by the first and last letters of the Greek alphabet, alpha and omega.

We limit the scope of our Philosophy in Reality to what is also the content of *natural* philosophy as it is currently being redefined by Schroeder and Dodig-Crnkovic [8] as well as Brenner and others. The potentially useful criterion which Brenner has proposed for delimiting natural philosophy from philosophy as a whole is its logic [9], the Logic in Reality which will be the subject of Section 3. For the prolegomenon to an integral paradigm of natural philosophy written by Igamberdiev see [10].

2. Dialectics

Dialectics appeared in Ancient Greece as a discourse between two or more people holding different points of view about a subject, but wishing to establish the truth through reasoned arguments. Formal logic—developed later—refers to subjects concerned with the most general laws of truth. This means that dialectics refers to the world consisting of multiple acting subjects, while formal logic refers to a unified sub-set of the laws common to all observers.

2.1. Dialectics in Ancient Greece

A discourse between several people providing reasoned arguments about the reality common to all of them follows from the multiplicity of the world containing interacting observers. From the logical point of Parmenides that Being is undivided and unmoved, a position which was claimed to be substantiated by the Zeno paradoxes, a search for the explanation of movement in the perceived world led to (1) substantiation of the smallest existing spatio-temporal "quanta" of movement called "atoms", referring to physical reality and (2) the formulation of cognitive pure ideal forms called *eidoi*. This separation into physical and cognitive reality came from the necessity of attributing the property of existence to Being, basically something accessible only to conscious (human) beings. This attribution is analyzed in detail in Plato's dialogue "Parmenides", which is considered as the most outstanding example of antique dialectics and in which Plato, to analyse the notion of existing Being, abandons narrowly interpreted principles of his philosophy of ideas for the goal of explaining the phenomenon of existence. The thesis substantiated in "Parmenides" is formulated in the following way: "The existing One appears as Many". Thus the existing world is present as a multiplicity that corresponds to the principle of multiplicity of primary elements called "seeds" in the philosophy of Anaxagoras. These were later defined by Aristotle as "*homoeomeria*". They include both potential and actual constituents and are harmonized in the *omnium* of their relations by the principle called "*Nous*" by Anaxagoras. A similar philosophical concept was formulated in modern times by Leibniz, who called these elements "monads". Below, we will discuss monad in relation to our definition of an "ontolon" as the element of real existence. The definition of the principle uniting *homoeomeria* as "*Nous*" assumes that a non-physical 'discourse' reasoning between them takes place that results in their harmonization in the Universe. Such harmonization can be either based on the ideal pre-established principles defined by Leibniz as a "pre-established harmony", seen in antiquity in the concept of the Demiurges of Plato's dialogue "Timaeus", or it can be achieved through a kind of a principle of natural selection that was formulated explicitly in the poem "*De rerum natura*" of the Roman poet Lucretius, who followed the atomistic philosophy of Epicurus.

The philosophy of atomism of Leucippus and Democritus initially appeared as a response to Parmenides and Zeno as an attempt to introduce movement in the world. At first glance, it avoided dialectics by claiming atoms as real existing elements, between which was emptiness (the vacuum).

In the early versions of atomism, atoms were not considered as ideal essences that could be involved in a kind of discourse, although there is some evidence that Democritus sometimes called atoms "ideas". The strict determinism of the Democritean universe does not leave room for the possibility of a 'discourse'. Later, Epicurus postulated an unpredictable movement (swerve; swerving) of atoms called by Lucretius "*clinamen*" which introduces potentiality in the universe of atoms and makes it more diverse and variable. These deviations initially appear arbitrary, but they can be controlled resulting in higher levels of organization. In this picture, finally, human consciousness appears which controls them further. The atoms of Epicurus can be viewed as quanta in the process of actualization and the actualized Being is Multiplicity due to the *clinamen*. Without *clinamina* that enlarge the field of potentialities, a strictly deterministic universe would not be able to evolve and generate a multiplicity of events, phenomena and realizations. However, the principle defined by the term *clinamen* cannot be well developed without the more advanced concept of potentiality and actuality introduced in Greek philosophy, by Aristotle despite the fact that Epicurus lived after Aristotle. Aristotle developed his concept of potentiality without reference to atomism, and Epicurus was not influenced by Aristotle's understanding of potentiality.

The most important point here is that atoms possessing *clinamina* escape from the strict determinism of the Democritean world. They can enter into a process that reduces the field of potentialities defined by their *clinamen* and form a kind of discourse or 'communication'. This discourse is not strictly physical as it escapes physical determinism being based on the consistency during interaction. The result of such interaction is a *consistent history* that is produced in it[1]. The complexification of interaction is associated with generation of predictability of the movement defined as *clinamen* and the possibility of its control. This corresponds to the development of cognition in systems of interaction of atoms possessing *clinamina*.

By the introduction of *clinamina* as the properties of atoms, it becomes apparent that the atoms interact not only via application of deterministic forces but also via the influence of the potential fields of their possible unpredictable deviations, recursively modifying their capacity for such unpredictable movement. Moreover, if atoms unite in organized structures, these capacities become restricted to a certain extent. The interaction via the effects of *clinamina* on each other can be described as a mutual measurement process, and when atoms become united into organized structures this measurement appears as an internal measurement within the structure. This kind of measurement can lead to further complexification of the system via reduction of the potential field and self-referential 'memorization' of such reduction.

The significance of Aristotle in understanding such a discourse involving potential reality makes him the greatest figure in dialectics. The common opinion is that Aristotle mainly developed formal logic which is the content of his Categories (part of his *Organon*), but he also introduced a kind of logic in reality (see below the logic of/in reality of Lupasco and Brenner). This includes the transition from the potential to the actual, although the opposite transition is not analysed in detail. The great achievement of Aristotle is the inclusion of *potentia* in his second logic (dialectics). This is seen in his *Metaphysics* and in more detail in *De Anima* (On the Soul). Heredity can be understood in Aristotelian terms as the transfer of information, defined as "entelechy as knowledge" in a seed as compared to the realized "entelechy as the actual exercise of knowledge" of the developed organism (cf. G. Stent's *Molecular Genetics* [11]. Matter in Aristotle's conception is a pure potentiality which is a prerequisite of two types of actuality: one is information ("entelechy as possession of knowledge") and the other is actual realization/presence ("entelechy as the actual exercise of knowledge"): "Now the word actuality has two senses corresponding respectively to the possession of knowledge and the actual exercise of knowledge" [12]. In the latter ("actual exercise"), a selection from two or more possible

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[1]   Attempts have been made to make a 'consistent histories' approach to quantum phenomena. We consider these as tautological and ultimately reductionist. As we will see in Section 3, our approach assigns ontological value to *inconsistency.*

realizations takes place according to the first type ("possession of knowledge"), and the discourse becomes incorporated in the total reality instead of being a result of interaction of reasoned arguments of conscious subjects. Being in the philosophy of Aristotle includes the unity of potential reality and its realizations, a concept which was developed by him in detail but which had arisen in the concept of the primary substance as *apeiron* outlined more than two centuries earlier by Anaximander. According to Carlo Rovelli [13], Anaximander was the founder of scientific thought in human civilization.

Another important aspect is the understanding of a soul as a *capacity*, inseparable from the body, which we later find in the concept of substance in the philosophy of Spinoza. According to Aristotle, " ... the soul neither exists without a body nor is a body of some sort. For it is not a body, but it belongs to a body, and for this reason is present in a body, and in a body of such-and-such a sort" [12]. On the other hand, different bodies can be animated by the same set of capacities, by the same kind of soul, so soul can be used in a singular, not plural, sense. This was earlier substantiated in Plato's dialogue "Parmenides" formally, while Aristotle presents this as a foundation of a kind of natural science which was later defined as psychology. The discourse of different potential realizations becomes incorporated into the reality that evolves from the inanimate potential matter to the actual realization, bearing form and being capable of an information transfer through the discourse of the substance with itself and in which it appears as a multiplicity of "seeds" sharing the same "soul".

2.2. Dialectics in Modern Times

In modern times, the logic of discourse was incorporated into philosophical thought following the main feature of the new European philosophy that was formulated by Rene Descartes as the distinction between a *res cogitans* and a *res extensa*. Being initially represented as two separate essences, they were unified in different philosophical systems in different ways, and dialectics appeared as the discourse for establishment of such unification. Thus, we can see the development of dialectical principles in the systems of Spinoza, Leibniz and Kant. After Kant, dialectics became associated with Hegelian idealism on the one side and Marxian materialism on the other. In this Section, we will discuss these advances in modern times, their limitations and possible future developments.

Another important aspect here is that if substance is a *causa sui*, it cannot be fully cognizable, since only mechanisms can be fully cognizable in the framework of mechanics. That is why Spinoza ascribed to substance an infinite number of attributes, among which only cognition and spatio-temporality are perceivable by us. In relational terms, only these two attributes can be involved in relations, while other attributes cannot be cognized although they can be involved in some sense in the shaping of the *res potentia*. The statement of the infinite number of attributes by Spinoza has similar meaning to the statement of Leibniz that "monads have no windows" (there is no window through which to see these attributes) and to the statement of Kant about the non-cognizability of the *Ding-an-sich*. The latter also appears as a monad and should not be mixed with the physical object, as it cannot be reduced to its spatio-temporal structure or to its ideal form. Later in this paper, we will call this primary unit "ontolon". The "non-cognizable" attributes shape the potential of monad/Ding-an-sich/ontolon. These attributes correspond to the Epicurean *clinamen* which, as noted above, is beyond shape and form.

The great progress in philosophical thought made by Immanuel Kant, which he called the Copernican revolution in philosophy, was the revelation [14] that mind is not the basis of Being but only the instrument of human cognition. Real Being is beyond mind and can be defined as a *Ding-an-sich* (thing-in-itself). The later development of German philosophy (Fichte, Schelling and Hegel) abandoned this basic statement and returned to a Mind in its totality that generates the material world as an *Anderssein (Andersheit)* in its dialectical discourse. On the contrary, Arthur Schopenhauer associated the *Ding-an-sich* with the primary energy called *Wille* (will) whose permanent goal is actualization *via* generation of representation (*Vorstellung*). Another trend, which overturned Hegelian idealism, resulted in Marxism in which dialectical discourse is located in an inanimate reality called matter. However, Marxism did not develop the concept of substance in the sense of Spinoza or other earlier

philosophers. Dialectical discourse appeared, in particular, in Engels' interpretation, as a vaguely formulated set of "laws of dialectics", which emerge without proper substantiation.

Friedrich Engels, in his unfinished work *Dialectics of Nature*, formulated "three laws of dialectics" [15]. He elucidated these laws as the immanent properties of dynamics of material substance, although his concept is, however, not elaborated well as compared, e.g., to Spinoza. These "laws" are the following: (1) the law of the unity and conflict of opposites (which arises in Heraclitus); (2) the law of the passage of quantitative changes into qualitative changes (generally based on the ancient paradox of the heap), and (3) the law of the negation of the negation (which may be considered as the invention of Hegel). In fact, in comparison to Hegel's philosophy where dialectics appears as an internal discourse of the Absolute Idea, in Engels interpretation dialectics is positioned far away from any discourse and represents a set of vaguely and rather reductively defined formal laws. This became the basis of "dialectical materialism".

To realize discourse, an element of the world should represent a monad that performs some kind of internal 'computation', which in the more materialistic view can be defined as an "ontolon" (see below the discussion on ontolons in Section 6). In this sense it is more logical to discuss "dialectical organicism"[2] as suggested by Joseph Needham [16] than "dialectical materialism". In the organicism interpretation, the dialectical discourse of simple monads, ontolons in our terms, generates the complex structure of space-time, and, as in Spinoza's philosophy, this discourse rises to the *causa sui* principle. The formulation of "dialectical materialism" without clear definition of the concept of substance as matter that would justify the *deductive necessity* of the "laws of dialectics" resulted in the difficulties of development of this concept by the next generations of philosophers. We will show later that the concept of an ontolon can resolve the difficulties in the ontological interpretation of dialectics in nature.

We will turn now to the "post-Marxist" philosophers Merab Mamardashvili [17] and Evald Ilyenkov [18] who performed the most important re-evaluation and development of the Marxian dialectical concept of consciousness. Since the developed concept of substance is lacking in Marx' theory, Merab Mamardashvili refers to Descartes and Kant in its description, while Ilyenkov is grounded mostly in Spinoza. Both Mamardashvili and Ilyenkov refer rather to the logic of *Das Kapital* of Marx than to the *Dialectics of Nature* of Engels. To what extent the newly formulated principles really arise in Marx or are the result of the major reformulation performed by Mamardashvili and Ilyenkov is not so important, but in our view their interpretation goes far beyond the basic formulation of Marx. We will outline first the approach to dialectics as it was formulated by Mamardashvili and then turn to Ilyenkov.

According to Mamardashvili (1930–1990), who significantly contributed to the rationalist theory of perception whose origin was in Descartes and Kant [17], the relation of subjective signifying consciousness to objective reality (the set of signified material bodies) is mediated by the potential set of the whole system of, in particular social and political relations organized hierarchically. This means that Marx, according to Mamardashvili, discovered the phenomenological nature of consciousness via its quasi-objective nature by introducing an abstraction that allows the analysis consciousness as the objective transformation of external objects into quasi-objective patterns, without direct involvement of the processes taking place in internal subjective reality. This means that the nature of consciousness is placed beyond the phenomena that serve for the maintenance of the social system of communication. "Being–consciousness" becomes unified, so that Being and consciousness appear as the different aspects of one continuum in which the object and the subject, the reality and its representation, the real and the imaginary are not strictly separated, while remaining relatively differentiated and non-identical to one another. They are connected in the continuum via the relational operator of transformation realized in the course of social dynamics. This is represented as the "dialectical" nature of consciousness in which

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[2]　The application of the principles of Logic in Reality allows one to cut through the endless discussion of organicism *vs.* realism *vs.* holism *vs.* reductionism. Complex dynamic part-whole relationships are possible, as in the first concept, without the system being 'alive', but which are not reducible to their energetic substrates.

the discourse between conscious subjects, mediated by the incorporation of the actualized material reality into this discourse, generates the conditions for social dynamics and progressive social evolution. The actualized material reality appears primarily as the result of previous human activity that has formed the signified social memory that represents the basis on which the current social structure is built. This "basis" is not only material but also cultural, and it shapes social structure by providing already existing forms or models. In other words, it "geometrizes" the society in the same way as Spinoza's substance geometrizes the world in the course of its self-actualization.

2.3. Dialectics in Ilyenkov's Conception and Beyond

The concept of dialectics as a metalogic based on reasoning and discourse was developed by Evald Ilyenkov (1924–1979), who incorporated its principles into basic substance understood in the sense of Spinoza and having the basic property of a *causa sui*. Despite his close association with Marxist dialectic materialism and apparent rethinking of Hegelian idealism, Ilyenkov suffered from the attacks of both orthodox Marxists and anti-Marxists, which resulted in his premature death. According to Ilyenkov, substance perpetually generates objective forms of subjective activity which follow a logic external to a material body. In this regard, the process of cognition which includes discourse and reasoning is not transcendent to the being, but immanent to it. Before Ilyenkov, such a point of view was formulated in the Marxist psychology of Lev Vygotsky and Leontiev in the 1930s, later substituted by a reflexology grounded in the works of Ivan Pavlov. The main idea on which Ilyenkov's concept of dialectics is based is the unity of cognition and space-time, of a *res cogitans* and a *res extensa*, which are linked via a *res potentia* (see below). The unity of *res cogitans* and *res extensa*, which is the central point of Spinoza's philosophy, is attributed to substance from the lowest levels of its organization and becomes highly expressed at the highest levels such as human civilization. The basic property of cognition, following Spinoza, is a capacity of a body to build a trajectory of its movement across other bodies according to a logic of arrangement of these bodies in the space external to that body. The idea of a thing in this regard becomes fully coincident with the way of its being, which is its generation based on this idea. In other words, the idea as *eidos* turns to be the idea as *technos* as defined by Mamardashvili [17], and these two aspects of idea (eidos/technos) are inseparable in the generating activity. As an example, a geometric shape is ideal because it represents a way of formation/generation of all material bodies possessing this shape.

The basic function of intellect, according to Spinoza and Ilyenkov, is to move and arrange external objects. Humans perceive the world only because they move and arrange external bodies in their activity. This activity is not based on the mechanic causality but on the causality which immanent to the primary substance which is *causa sui*. Mechanical causality is always external to the body, while substance possesses causality in itself realizing self-movement via establishing relation to external bodies by its abstracting capacity which generates pure (ideal) forms of reality. In this activity, the *ordo et connexio idearum* coincides with the *ordo et connexio rerum*, in other words, ideal activity results in valid practical implementations. At the level of social organization, intellect is involved in establishing relations not only to external material objects but to other intellectual beings, which becomes the basis of morality and successful social communication.

The unity of cognition and space-time needs to be incorporated not only in philosophical thought but also into the foundations of mathematics. This has been realized only recently in the concept of meta-mathematics developed by Voevodsky [19] who included geometrical foundations of mathematics in its basis. The intrinsic logic of meta-mathematics corresponds in this approach to the spatio-temporal structure that is generated internally on the basis of this logic. When geometry is introduced into the foundations of mathematics, the world becomes shaped in a particular way fitting its habitability, 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 developed by Voevodsky the basic foundations of mathematics can be verified computationally [19]. The grounding of Ilyenkov's dialectics in Spinoza's concept of substance represents its major advance, but it has

certain limitations due to the apparent disregard of relational principles in the operation of cognitive activity. In fact, Spinoza's substance is a manifestation of the 'One', while Plato, in the dialogue "Parmenides", had already substantiated that the existing One appears as Many. In the universe of the forms of existence or "ontolons", the spatio-temporal order appears as a relation between objects established in their interaction. The intrinsic limits of computation shape the spatio-temporal order and also pose limitations on cognitive activity. They represent the principles that are inherent to our world and may result from the transcendent action of the establishment of the actualized physical world from the pure logical principles that are insufficient for its appearance. To what extent this transcendent action is similar to our cognitive activity remains open, but in this paper we present what amounts to an 'immanent' alternative in the work of Lupasco. David Hume [20] indicated a possibility of such similarity. If the basic property of consciousness, according to Spinoza and Ilyenkov, is the establishment of space-time, then the introduction of fundamental constants at the birth of the Universe is a 'conscious' act that sets the limits of (and for) actualization of the *res extensa* from the *res potentia*. The assumption of a *res cogitans* here seems apparent, otherwise we need to introduce the principle of natural selection between universes, as in the multiverse of Smolin [21] which assumes the unsubstantiated actual pre-existence of them all. The anthropomorphic 'bootstrapping' by a basic 'intelligence' that determined the limiting conditions of the physical world is, however, beyond scientific reasoning and cannot be discussed in this paper.

3. Logic in Reality (LIR)

On many occasions, Brenner has discussed the principles of Logic in Reality and their derivation from the logical system proposed by Lupasco, for example in articles on consciousness [22], ecology [23] and natural philosophy [9]. Underlying this work is a vision of Lupasco's Principle of Dynamic Opposition (PDO) as operative in nature. We reproduce from [1] the best and simplest expression of this principle: "The antagonistic dualities of our world can be formalized as a structural, logical, and metaphysical principle of opposition or contradiction instantiated in complex higher-level phenomena (Principle of Dynamic Opposition—PDO). The fundamental postulate of LIR is that for all energetic phenomena (all phenomena) alternate between degrees of actualization and of potentialization of themselves and their opposites or 'contradictions' but without either going to the absolute limits of 0% or 100%. The point traversed at which a logical element and its opposite are equally actualized and potentialized is one of maximum interaction from which new entities can emerge. It is designated by Lupasco and Basarab Nicolescu, the physicist colleague and major continuator of Lupasco [24], as a 'T'-state, T for included middle or third (*Tiers-inclus*). A relatively simple example of a physical T-state is the transition state in a chemical reaction. This is the point at which the number of molecules of reactants moving toward more thermodynamically favored products and the number moving in the reverse direction is the same. We use the concept of T-states to evaluate both philosophical and scientific theories, including patterns of human individual and social behavior. A dynamic systems view can be used to focus on the feedback or recursion present in all natural processes."

The absence of debate of these concepts of the dynamic general properties of natural phenomena has given them the appearance of a statism when the opposite was intended. The choice of the domains in this paper—dialectics, semiosis and meaning/information, to which the PDO is intended to apply, is in part based on the difficulties of explaining them through the use of standard doctrines, as well as the desire to 'mobilize' the PDO as an explanatory methodology. As Brenner suggested at the 2015 Information Summit Conference of the International Society for Studies of Information in Vienna [25], the concept of scientific method is only one of those meaningful in the contemporary practice of science. Computational methods can be and are applied routinely in all the sciences, but their limitations demand a directed interpretation. In the human domain, it is the application of operative or organizational principles to an individual or social cognitive process to determine its dynamics, what "forces are at work", that we consider essential for the determination of an informational commons.

In a conception discussed at the Vienna Conference, the Information Society is at three crossroads in terms of its future development: we quote from Brenner's paper [26]: (1) a Socio-Political Crossroads where trends toward improvement in the quality of life are offset by a regression and degradation of the mental and social environment, both in part due to the massive role of information in the society; (2) a Transdisciplinary Crossroads, where the science and philosophy of information as disciplines may develop in the direction of integration in an Informational Turn, a new way of Informational Thinking as proposed by Wu Kun [27] that can support efforts toward a Global Sustainable Information Society, in the term of Wolfgang Hofkirchner [28]. Alternatively, they may diverge or regress in the direction of increasingly socially irresponsible specialization and scholasticism; and (3) a Metaphysical Crossroads, inseparable from the first two, involving the direction of development of the science and philosophy of information as a metaphysics, a crossroads that includes a definition of the dynamic relation of man to the universe. Like the other two, there is a positive branch leading toward less dysfunction at the individual and social level. The negative branch implies an on-going blockage of ethical development of the society.

In our view these three domains are also at their own crossroads: they can continue in separation or accept a logic and methodology that places the emphasis on their non-separability and co-evolution. The dialectic logic of/in reality outlined above offers a methodology that provides for linking them dynamically.

3.1. The Philosophical Logic of Stéphane Lupasco

In the broadest possible sense, this is a paper about change, better about changing and processes in the real world. We are interested primarily in ontological change, about which little has been written from a logical standpoint. The reason is obvious: change is ubiquitous in existence and experience. Theories of change, however, have focused on making it mathematically, computationally and logically tractable, within the framework of standard logic.

Differential equations provide an excellent description of continuous change, but what if the change in question is partly discontinuous, recursive and/or random? In fact, change is contradictory: the most familiar thing about change is that it never occurs in isolation from stability. Change is regular *and* irregular; consistent *and* inconsistent; continuous *and* discontinuous. Since the only logics available have been propositional bivalent logics, incapable of accepting real contradictions, they have been incapable of describing change.

Brenner has written several articles in the last decade which describe the non-standard, non-linguistic logic that we see instantiated in changing processes [29]. It is based on the logical system proposed by the Franco-Romanian thinker Stéphane Lupasco (Bucharest, 1900–Paris, 1988). The extension of Lupasco's system made by Brenner is called Logic in Reality (LIR), and it has been applied most recently to the fields of information [30] and the philosophies of information and ecology, as noted above.

Despite its publication in some fifteen books in his lifetime and its continuation by his associate Basarab Nicolescu [24], Lupasco's system of thought has remained unknown outside France, where it had been rejected by the academic community. With a few notable exceptions, Brenner's publications have suffered the same fate. The reason here is less obvious, but in our opinion it has to do with the fact that acceptance of our logic of and in reality requires the acceptance of a new, scientifically grounded concept of the dynamics of change in all complex, interactive phenomena at biological, cognitive and social levels of reality.

The comparison of the Lupasco logic with standard logics is rendered difficult due to the limitation of the latter to the linguistic domain. These semantic logics, bivalent or multivalent and their most recent epistemic, paraconsistent and paracomplete versions still require absolute separation of, for example, continuity and discontinuity, space-time and matter, chance and necessity, etc. and lead in linguistics to the paradoxes with which we are all familiar. Paraconsistent logics, which accept contradiction, capture only the linguistic as opposed to the physical aspects of processes, although some real inconsistencies in simple change (Sorites problems) are accepted. Logics of epistemic change

are based on linguistic abstractions. No logical characteristics are ascribed to the physical processes of change. It is thus not surprising that no generally applicable theory of change has been developed for the extant domain of macroscopic, complex and interactive processes.

3.2. Logic in Reality: Axioms and Categories

As noted in Section 2, Aristotle outlines his fundamental concept of potentiality and actuality in the "*De Anima*", ("*On the Soul*"). In this already metaphysical context, he writes that potentiality is matter and actuality is form. Thus, we need to know what matter and form are, but we can assume they are different. Why, to use a more modern term, potentiality should be instantiated in matter and actuality in form is not clear. What is more important for this study, however, is the relation that *Aristotle* sees between potentiality and actuality. In *De Anima* there is no direct indication that one can be transformed or transform itself into the other, but this is implied by his concept of life as an internal transformation of the body. If it is implied by Aristotle's view of the movement of energy, there is certainly no indication of the possibility of movement from actuality to potentiality.

As discussed by Brenner in [1], Lupasco's definition of the two terms in terms of energy has place for this contrary forward movement. It is implied by the fact, observable in part, that no complex process goes to the absolute limits of 100% potentiality or 100% actuality, except in trivial cases or those in which there is no real interaction. The entire literature around Schrödinger cat fails as 'alive' and 'dead' are not interacting states. Given this interpretation, why is not more attention paid to it in philosophy when it fits modern physics?

3.3. Toward a New Non-Boolean Logic

Since George Boole published his *Laws of Thought* [4] in 1854, Boolean logic has been the canonical logic of science and philosophy. Boole demonstrated that classical, bivalent propositional logic could receive an algebraic formulation and proposed a general symbolic method for logical inference. His algebra contains terms for both quality and quantity and provides the basis for standard probability theory. However, his terms for *quality* are strictly limited to formalizable, binary properties of phenomena. Non-Boolean logics and algebras [31] have been shown, relatively recently, to be really necessary in the area of quantum mechanics, with a few interesting but constructed exceptions in the work of Diederik Aerts [32], Elio Conte [33] and others.

However, as should be more widely appreciated, Boole himself was aware of the limitations of his own system and was completely open to others, sometimes of a striking modernity: "we sometimes find more just conceptions of the unity, the vital connexion and the subordination to a moral purpose, of the different parts of truth, among those who acknowledge nothing higher than *the changing aspect of collective humanity* (italics ours), than among those who profess an intellectual allegiance to the Father of Lights". Further in a key Appendix to [4] he writes that the central role of mathematics as derived from his Laws of Thought, it is not a sufficient basis either of knowledge or of discipline, "As truly, therefore, as the cultivation of the mathematical or deductive faculty is a part of intellectual discipline, so truly it is only a part."

Balance is necessary in any view of the operation of the human mind: "I would especially direct attention to that view of the constitution of the intellect which represents it as subject to laws determinate in their character, but not operating by the power of necessity; which exhibit it as redeemed from the dominion of fate, without being abandoned to the lawlessness of chance," Boole's logical laws of thought can manifest their presence "otherwise than by merely prescribing the conditions of formal inference." The distinctions between true and false, between correct and incorrect, are cornerstones for his and all other standard logics. But this distinction "exists in the processes of the intellect, not in the region of physical necessity".

Boole is honest in admitting not to have found a *construens* to accompany his *destruens*, but several of his remarks suggest that some aspects of Logic in Reality would have been congenial to him. One was to the effect that his Laws of Thought (logic) were capable of precise scientific expression, but were

invested with a lower 'authority' than the laws of nature in general. "Were the correspondence between the forms of thought and the actual constitution of Nature proved to exist, whatsoever connexion or relation it might be supposed to establish between the two systems, it would in no degree affect the question of their mutual independence." "Wherever the phenomena of life are manifested, the dominion of rigid law in some degree yields to that mysterious principle of activity", a teleology accomplished "not, apparently, by the fateful power of external circumstances, but by the calling forth of an energy from within." We quote Boole *in extenso* [4], because we have seen no references to these passages elsewhere. It has been left to Lupasco to continue and talk about the 'laws of energy' and their deployment and to show that some real macroscopic processes follow a logic whose terms do not commute or distribute and are accordingly non-Boolean. This extension of logic, as noted, has not been widely accepted in the literature.

3.4. The Link to Dialectics

As stated by Lupasco, dialectics can be considered neither more, nor less, than the generalization and mental expression of conflicts in nature and civilization, and their resolution, that man has observed from time immemorial. "Beings and things seem to exist and are able to exist only in function of their successive and contradictory conflicts" [34]. For Heraclitus, conflict did not mean the splitting or destruction of the unity of reality, but its constitution. The *logos* is the only "abiding thing", the orderly principle according to which all change takes place as a 'binding-together'. Conflict (*polemos*) and *logos* are the same. As defined in Lupasco's Table of Deductions, ortho- and para-deductive chains of implication are thus an integral part of logic. A *disjunctive* dialectical oscillation is required between the first three implications of implications, and between the three implications of implications of implications controlled by the former, and so on, of which the following is the first sequence (A = actual; P = potential; T = T-state):

$$[(\supset A) \supset (\overline{\supset}P)\,] \lor [(\overline{\supset}A) \supset (\supset P)\,] \lor [(\supset T) \supset (\overline{\supset}T)\,]$$

This implication formula defines the meaning of disjunction as the mechanics of dialectics: no dialectic without disjunction and vice versa. It is disjunction that is implied by the fundamental postulate that permits the dialectic, and the dialectic implied by the same postulate, as principle of antagonism that permits and requires the disjunction, the connective 'or' [35]. In an early paper [36], Aerts describes the failure of the classical 'or' but offers no adequate replacement.

The operation of the fundamental structural logical principle of LIR implies a type of *dialectics* at all levels of reality between the two terms of any interactive duality. In other words, the dialectical characteristics of energy—actual and potential, continuous and discontinuous; entropic and negentropic, identifying or homogenizing and diversifying or heterogenizing—describe the dynamic structure of all interactive phenomena, physical and mental, including information, propositions and judgments.

We quote here another key concept in Lupasco [34]:

"Energy must possess a logic that is not a classic logic nor any other kind based on a principle of pure non-contradiction, since energy implies a contradictory duality in its own nature, structure and function. The contradictory logic of energy is a real logic, that is, a science of logical facts and operations, and not a psychology, phenomenology or epistemology."

Contradictions or dynamic oppositions thus exist in things being continuous and discontinuous, unified and diversified, wave and particle, local and global, in some way at the same time, but not completely so, only in the sense of alternating between ideal limits which are never reached. A standard Aristotelian logic—one which tries to eliminate or avoid contradiction of any kind—is not adequate to describe real systems, all of which are derived from energy in all its *macroscopic thermodynamic* forms: mechanical, electromagnetic, electrostatic (chemical). LIR is not intended to apply to gravity and quantum entities as such. Some paraconsistent logics permit true contradictions, but retain idealized, abstract concepts of truth and falsity. Consequently, they fail to give an adequate picture

of the emergence of complex, real-world phenomena. These points apply to all phenomena: ideas, theories, propositions, as well as physical systems.

Contradictions, in the physical sense of real opposing processes, entities or properties can never disappear completely, since this would imply, ultimately, going below the quantum limit, defined by the Planck quantum of action. All phenomena thus continually but non-reflexively (that is, without 'perfect' circularity) alternate between degrees of actualization and of potentialization of themselves and their opposites or contradictions. The application of the logic of the included middle implies an open, incomplete structure of the set of all possible levels of reality, similar to that defined by Gödel for formal systems[3]. Concatenations of systems and dialectics in the sense of a Hegelian or Marxist synthesis never yield a third term. Hegel's vision was solely philosophical, without the advantage of the physical grounding we now have. The Lupascian T-state is not a static term, but a dynamic state, and emergent T-states, at a higher level of reality, can also enter as elements into contradictory relations. In a sense, which remains to be explored in greater detail, *relations are T-states*, conceptualizations of change that are nonetheless energetic within the laws of physics. This scheme reflects only one step in what Lupasco called the 'ortho-dialectic' processes of processes that constitute change, looking from the process standpoint. From the point of view of the entity, since no real process returns to the same point, if the process is going in the direction of non-contradiction (of diversity or identity, the net result is that it will be more of an identity or more of a diversity in consequence. In this scheme, the process that leads to more and more differentiated individuals, that is, biological processes, is one of heterogenization which should be distinguished from the contradictory process that creates homogeneous individuals from a multiplicity of entities.

The fundamental axioms of LIR imply that entities can be *both* the same and different, *both* distinguishable and indistinguishable. This seems consistent with the interpretation of Krause [37] for quantum cases. More formal ways are still needed, however, to distinguish between macroscopic process elements involved in an 'active' process and objects for which the dialectics are 'frozen': subject to an input of energy, they are to all intents and purposes in the 'classical' part of the LIR theory. This is similar to the quasi-set situation, for macro elements that are distinguishable; the set-theoretical description has a classical part[4].

Jainist philosophers in India [38], in the first half of the 1st Millennium made similar statements in a positive mode: quoting from Stcherbatsky, the nature of reality, they said, is permanent and impermanent at the same time, finite and infinite, particular and universal. They realized that a being with absolute identity would be unrelated to all others and could not exist, but without some identity, it would be indistinguishable from everything else. Many authors use this construction when they are unable to provide a satisfactory explanation of the phenomenon under study. However, no explanation is given of how such states of affairs might be instantiated, and the phrase 'both at once' can only be understood metaphorically.

The performance of philosophy can thus be considered as a dynamic and dialectical process itself, in which one oscillates between analytic and synthetic approaches, each serving as a control of the other. In the LIR conception, all physical processes, including mental or neuro-psychic, are first of all real *qua* the energy involved in their instantiation. To think about something being an illusion or an abstract entity requires energy to do so. The logic of/in reality proposes a dialectical relation between 'reality' and its appearance to a conscious observer. It is the totality of this picture that we consider realism; reality and appearance are both real. What is *not* real then is not in the sense of lacking any character of dynamic opposition, that is, non-spatio-temporal phenomena such as abstract entities of

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[3]   Computational logic now includes concepts of formal systems as open, capable of handling changing or evolving information, replacing the Hilbert concept of formal systems as closed.

[4]   This is again similar to the contextual concepts of Aerts. It should be considered the rule rather than the exception that macroscopic systems as well as quantum systems have classical and non-classical parts.

all kinds. We see here the basis for our 'discovery', outlined below, of a criterion for distinguishing between natural philosophy and all philosophy.

A standard anti-realistic argument is that since perception can be and often is unreliable, realist theories such as LIR that that are based on it are invalid. We consider treat experimental discovery, as for example the components of perception, as *generally* empirically reliable, and, subject to consensus, an adequate naturalistic philosophical explanation of why our beliefs based on perceptions represent knowledge about objects that are independent of those perceptions to all intents and purposes. The availability of what Brenner has called catastrophic counterexamples will not change this conclusion. Accordingly, any change to a new theory can preserve structural properties allowing a certain ontological continuity accompanying a conceptual revolution as discussed by Cao [39]. This ontological *synthesis* is a dialectical picture of growth and progress in science that reconciles essential continuity with discontinuous appearance in the history of science, a process that, again, is a logical one in LIR.

3.5. Logic in Reality and Hegel

The major precursors of the logic of/in reality are discussed in [1] and in several papers by Brenner. However, because parallels to Hegel's dialectics, logic and ontology exist, we will state explicitly how LIR should be differentiated from Hegel's system. Lupasco considered that his system included and extended that of Hegel. However, one cannot consider Lupasco a Hegelian or neo-Hegelian without specifying the fundamental difference between Hegel's idealism and Lupasco's realism. Both Hegel and Lupasco started from a vision of the contradictorial or antagonistic nature of reality; developed elaborate logical systems that dealt with contradiction and went far beyond formal propositional logic; and applied these notions to the individual and society, consciousness, art, history, ethics, and politics.

However, Lupasco proposed *two* dialectics, ascending and descending (*diverging*) toward the non-contradictions of identity and diversity and a *third* dialectics *converging* toward contradiction. As above, the ubiquitous contradiction in nature is that inherent in energy and is the only existent reality. To say that material-energetic reality was the result or emanation of some other necessity as the foundation of the real amounts to tautology or mysticism, and Hegel's "obscure logical descriptions remained without a future for logic and science". As Lupasco expressed it, Hegel's system was "only half of a dialectics" [40]. In Hegel, the affirmative value of identification always transcends the negative value of diversification. In LIR, contradiction between them, and what can emerge from them, is established at the basic physical level.

As pointed out by Taylor [41], Hegel's thesis depends on a premise of ontological necessity that in turn would depend on a contradiction of the finite. Hegel established or expounded his resulting ontological structure at 'high' levels, but his project required demonstration of his ontology at the lowest level of simply determinate beings, and his attempted proof of contradiction failed. The realism of LIR successfully answers this major objection to the coherence of Hegel's system, without requiring a commitment to the idealist part of his doctrine.

The Hegelian philosophical vision of "embodied subjectivity, of thought and freedom emerging from the stream of life, finding expression in the forms of social existence, and discovering themselves in relation to nature and history" is still relevant. However, Lupasco's view of contradiction founded a dynamics, whereas Hegel's did not, precisely because his system is *not* metaphysically and physically grounded at the "lowest level of simply determinate beings" that is, microphysical entities. Lupasco [34] showed that there is no *deductive* necessity in Hegel for thesis generating anti-thesis, let alone any subsequent fusion[5]. In line with our effort of naturalization of philosophy in general, LIR can be considered as Hegel *naturalized*, since a physical basis in reality for Hegelian change has been defined.

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[5]　Lupasco rejected Hegel's dynamic relation between being and becoming, since he wanted to limit contradiction to the domain of becoming, which drastically limits the value of Lupasco's thesis. In fact, Lupasco's universe consists of almost nothing but Becoming as functional contradiction, the alternation of the actualization of a phenomenon, with the potentialization of its contradiction, and the actualization of the former, plus emergent T-states. Contradiction is absent only in affect or

We note with regret the absence of any resonance of Lupasco's work in French thought, other than in the relatively non-scientific context of the International Center for Transdisciplinary Research founded by Nicolescu, Lupasco and a few others. Lupasco lost his position in the French National Scientific Research Center (CNRS) because no one could decide in which field his logic and approaches to biology and psychology should be placed. In the 1980's his work was referred to disparagingly as just 19th Century German romanticism. In a competition for a key position in the Collège de France in the 1950s, Merleau-Ponty was chosen over his contemporary rival—Lupasco. The marginalization of Lupasco can be dated to this event. More recently, no mention of Lupasco is to be found in the 'dialectical walk in the sciences' of Évariste Sanchez-Palencia [42]. He wrote in 2012 that if dialectics is defined as the "general theory" (or logic) of change and evolution, we are dealing with forms of reasoning which do not function by 'yes' and 'no', the principle of the excluded middle is clearly inoperative and in this thus totally different from formal logic. Ironically, Sanchez-Palencia although Spanish spent his entire academic career in the French CNRS in which Lupasco had started it.

3.6. Dialectical Logic

The paraconsistent logician Graham Priest [43] has pointed out that Hegel distinguished between dialectics and formal logic—which was for him the Aristotelian logic of his day. The law of non-contradiction holds in formal logic, but it is applicable without modification only in the limited domain of the static and changeless. In what is generally understood as a dialectical logic, which LIR superficially resembles, the law of non-contradiction fails. Subsequent developments of formal logic, starting with Frege and Russell, have forced Hegel's conception of contradiction to be rejected or interpreted non-literally. Neo-Hegelians have attempted to conserve *this* principle of contradiction by emphasizing the factor of time: A is not identical to A, because time has passed in which changes have occurred; contradictions take place one after the other, etc. Articles purporting to describe dialectical logics still appear. In one example, a relation is proposed with non-linear dynamics in which dialectical logic is enhanced by mathematical logic. Nevertheless, the question is not addressed, here and in Hegel, of what drives the change from thesis to antithesis to synthesis, that is, how any term cannot 'stand on its own' but 'goes over' into its opposite or contradiction. Russell demonstrated, before Lupasco, that Hegel's logic could be deconstructed because it still presupposed traditional Aristotelian logic, but not for this more important reason, namely, the absence of a grounding in physical reality.

Piaget, also, did not go beyond the standard Hegelian form of Marxist dialectical materialism. This correctly accords a central role to conflict and contradiction in the transformation of social realities. However as pointed out by Priest [44], and further discussed by Igamberdiev [10] and in this paper, Marxist dialectics fail to give an adequate account of the true contradictions involved in society: an inconsistent or paraconsistent logic is necessary for such an account, albeit in our view not sufficient. A logic of the LIR form seems required to characterize the emergence of new structures from real contradictions.

In the LIR view, cybernetic systems, natural or artificial, *are* dialectical, since each one involves an alteration, a perturbation by an antithetical contradictory process, followed by the return to the (state of) regulation required for the system to be "stable". In other words, a cybernetics alternately actualizes certain phenomena and potentializes the antagonistic, contradictory phenomena in consequence. It is an "oriented dialectical systematization of energetic events, inherent in the nature of energy" [45].

As will be discussed in more detail elsewhere, Logic in Reality differs from standard forms of thought in showing the importance of implication as a process in contrast to reliance on equations. The astrophysicist Stephen Hawking, for whom we have the greatest respect, once asked: "What if the universe and human beings were governed by the same equation?" We ask a somewhat different

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affectivity, which has no energetic aspects and is the only constituent of being. This metaphysical position is incompatible with the non-naïve realism of LIR.

question: "What if the universe and human beings were governed by the same thing, but it is not an equation?" It is not an *inequality*, which to us a just an equation that does not admit it. It is something like an *inference*, but inferences are associated too strongly with language and its limitations. We have therefore pleaded in this paper for attention to be paid to the strength of *implication* in describing what governs the world. David Bohm [46] had a similar intuition in his proposal of an implicate as well as an explicate order in the universe.

3.7. Dialectics and Logic in Reality in Marx and Engels contra Hegel

With the basic concepts of Logic in Reality in hand, including its dialectical base, let us how it can be related to some dialectical aspects of the economic theories developed by Marx and Engels, as well as their roots in Hegel. The objectives of this paper do not include in-depth study of dialectics in economical and political theory and practice. In this Section, we simply look at some aspects of this field which can be usefully addressed by combining dialectics, as described in Section 2, with the perspective of Logic in Reality outlined here.

Engels saw dialectics as a fundamental method for gaining knowledge of nature, and as a thought process of involving a real opposition of ontological as well epistemological contraries, similar in appearance to that of Logic in Reality. Arthur [47] points to what we can see are critical weaknesses in Engels' dialectics. One was a tendency to rely on a compilation and classification of examples and another was the presentation of a triadic paradigm as the 'three laws' of dialectics', without a basis in science. To anticipate, we find exactly the same structural weaknesses in the epistemological triads of Charles Sanders Peirce that are considered the foundations of standard semiotics (next Section 4).

The point of departure for knowledge for Engels was the "qualitative aspect of things and phenomena and not their quantitative side". As Brenner has discussed elsewhere [1], for Engels "Dialectics is the science of universal interconnection, of which the main laws are the transformation of quality and quantity—mutual penetration of polar opposites and transformation into each other when carried to extremes—developments through contradiction or negation of negation—spiral form of development." Logic in Reality is a way of giving a physical picture of the transformation of the polar opposites operating in complex systems: it is never complete, and the extremes of 0 and 1 are never reached except in trivial cases. Contradiction or better countervalence inheres in physical processes, and negation of negation remains at the level of linguistic logic. The concept of spiral form of development is an absolutely essential one which Brenner described in detail as a consequence of Deacon's concepts, grounded in developmental biology, of "incomplete nature" [48] (cf. Section 5.1 below).

We look next at the discussion by Arthur [46] of the 'new dialectic'. For example, it is statements like those of Marx that correspond to our view of the ontological priority of real phenomena—the "logic of the body" rather than a "body for the logic", as echoed by the contemporary work of Lakoff [49]. 'Our' dialectics is systematic (with an internal dynamics) rather than historical (demonstrating temporal dynamics). However, it goes beyond the systematic dialectics of Marx in its necessary inclusion of insights from 20th Century physics. We can thus easily dismiss empty concepts in Hegel such the realm of logic being 'timeless'; only standard binary linguistic logics, including that of Hegel, are 'timeless'. Arthur further suggests that Engels applied what was basically a linear logic as he, as the majority of other thinkers, did not have room for the recursive aspects of real processes in the 'sinusoidal' movement from actuality to potentiality and vice versa. Marx's apodictic statements about the 'means of production employing workers' rather than the reverse need not be taken as dialectical contradictions in the LIR sense; the two opposites are in different linguistic domains, turning on two senses of 'employ'.

Logic in Reality thus provides a new, more physically acceptable view of neo-classical concepts in dialectics, for example that a logical progression is at the same time a retrogression. Instead of reading this as a succession of abstract categories, we consider it a description of the dialectical evolution of real processes, for which the simplest model would be graph with two mutually dependent time axes, and which, to quote Arthur, "has nothing in common with a vulgar evolutionism predicated on extrapolating an existent tendency", we add, unidirectional.

A feature of *Das Kapital* [50] is its exposition of the "reciprocal conditions inherent in a whole and not a quasi-historical (linear) development from primitive conditions to advanced ones". Logic in Reality establishes the applicable reciprocity in reality that gives this insight its scientific value. Where we disagree with the dialectical and logical formulations of Marx and Engels is in their essential use of standard categories as constitutive of a systematic dialectic and in their treatment of contradictories. Engels' famous 'three laws of dialectic', referred to earlier, such as the negation of the negation, are restatements of the laws of linguistic Aristotelian logic. The concept of the properties of capitalism as emergent from such laws is an epistemological one, and bourgeoisie and revolutionary proletariat are terms that lack sociological reality.

In LIR, these are not to be resolved in an eliminative sense, as it is from them that new concepts can emerge without requiring their total disappearance. However, Arthur suggests that one may "draw upon" Hegel's categories to show that anything and everything can become a bearer of value. Our position is no more or less than that anything and everything—that exists—is a bearer of value since it is a bearer of meaning. We discuss further aspects of meaning in Section 5.

It is however, exactly these 'classical' aspects of Hegel's logic that make it relevant to the ontological foundation of the capitalist system. As is becoming more and more obvious, the 'inhuman' aspects of the emergent contradictions in capitalism—the *absolute* dialectic of capital and its quasi-logical primitives (Arthur), are exactly where classical logic gives a reduced, binary picture of the world. It using the principles of LIR that we can accept, by giving a physical dialectical meaning to it, the statement that the separation of "quantity and quality from each other is not absolute".

We will not analyze in detail Hegel's views of Being and Nothing (to which we prefer the 'Nothingness' of Sartre). Heidegger's ontological *Dasein*, while not describing a sufficiently 'full' presence, approaches more closely the physics of LIR. Regarding Hegel's discussion of correlative pairs in thinking, the question cannot be of actualizing an 'inner unity' which does not exist.

Hegel's idealism and absolutism led him to make a further error in respect to necessity and contingency by leaving no place in his Essence-Logic for the latter, while ascribing 'Actuality' to the former [41]. "The sole aim of philosophical inquiry is to eliminate the contingent". What is false here, exactly as in the tychism of Peirce that sees chance as most fundamental, is the absolutism. It is the dialectic between chance and necessity, or determinism and indeterminism that is essential and it is Lupasco who deserves the credit for placing this dialectic on a basis in science.

There are serious limitations in Arthur's analysis of value and form, let alone dynamics and process, by his emphasis on linguistic concepts. In looking for the relation between form and content he mentions as an interesting case the "logical form of a proposition being independent of the variables in it. We speak here then of two sides indifferently united". We are far here indeed from the real world in which even propositions are not topic-neutral. We thus agree with Arthur that capital has a "certain conceptuality to it" in which a peculiar interpenetration of ideality and materiality is expressed as a contradiction between value and use value. That this leads to a "concrete mediatedness without ever reaching a final resolution" is far from concrete, however.

The Logic of the Concept defined by Hegel shows his struggle with the relations between individual and universal, continuity and identity. Marx used Hegel's terminology for his logic of capital: capital is a universal distinct from its moments (instantiations) while being at the same time continuous and identical with these moments. We will not attempt to discuss the historical validity of Marx's concept but only suggest that the dichotomies only make some sense when considered as partial and interactive in the LIR sense.

Marx's *critical* systematic dialectic is also closer to LIR than Hegel's *affirmative* systematic dialectic in that the contradictions inherent in capital are not eliminated or sublated but deepened or developed as it evolves. In the same Compendium, Carrera [51] cites Marx's aphorism that "philosophers (such as Hegel) have only interpreted the world in various ways; the point is to change it". Here Marx is being too classical: serious interpretations can also 'change the world', given a favorable terrain.

Both Hegel and Marx and their commentators suffered from reliance on epistemological readings of dialectics. Bellofiore [52] mentions the "inner connections of objects and concepts"; "capital as an invisible subject in a kind of perennial movement in a circle", moving[6] (?) from simple and abstract categories to more complex and concrete notions", with 'redefinition' of the categories." The problem in our terms is that both authors defined a category as a principle unifying different particulars, reconciling the universal and individuals by the principle of the complex unity of identity in difference. This fails (in LIR) by the impossibility of *complete* unity, when it incorporates the moment of difference. Stating that this demonstrates a *negation of the negation* has no meaning in an ontological sense. Although we thus have problems with the stages of Bellofiore's argument, we can agree with his conclusion, namely that we are dealing with two antagonistic ontologies, and a proper reading of *Capital* implies that Hegelian circular views about capitalism are false in practice.

In contrast to the heavily ideologically loaded and hence largely incorrect tenets of the economics of Hegel and Marx, the work of the Japanese economist Kôzô Uno [53] and his colleague and translator Thomas Sekine [54] illustrate the kinds of balanced, non-dogmatic positions that are possible in approach similar to ours. Uno argued that capitalism, throughout the 20th Century, must be studied at three distinct[7] levels of abstraction: (1) pure theory in the form of Hegelian dialectics; (2) concrete capitalist history, "which must be recounted with full empirical detail; and (3) at a mid-range level between the two, focused on capitalism's developmental stages". Obviously, it is this mid-range level that is most adequate for the understanding of complex real processes such as capitalism.

In his Appendix 2 to [54], Sekine characterizes the "true teaching of Uno's economics, which lies in his grasp of capitalism as something that exceeds the confines of formal (i.e., tautological logic)". Uno assigns proper ontological value to a capitalism whose nature cannot be concealed, and it thus can be seen to follow a logic that is independent of any ideology, Marxist or bourgeois supported by mathematical myths. A rational dialogue about the problems generated for both the society and the environment becomes possible.

Our approach remains beyond the criticism of dialectics because the dialectical concept in the form of a Lupascian synthesis avoids final truths that were claimed by Hegel, Marx and which, in their application to social reconstruction, resulted in totalitarian societies. In fact, Engels in his later years was ready to support the idea that social progress can be achieved by peaceful means, which include incremental legislative reforms in democratic societies as was further developed by his disciple Eduard Bernstein. The dialectical approach developed here is in concordance with the humanistic trend that can be dated back to a 1795 essay by Immanuel Kant "Perpetual Peace: A Philosophical Sketch". The main statement of Kant, which is truly dialectical, is that permanent peace is a goal which mankind can approach gradually in the course of its improvement. A conscious ethics commits us to act such that perpetual peace can be reached; this represents an example of the categorical imperative. With our new formulations of both dialectics and logic in hand, we now turn to their applications to aspects of meaning and its instantiation in the areas of semiotics, information and communication.

4. Semiotics and Semiosis: The Dialectics of Meaning

The views of dialectics and logic that we have developed can be used as tools to reconceptualize the areas of semiotics and semiosis. The key concept in semiotics has been the introduction of an ontological and epistemological role for the sign. Signs are elements or units of language that are assumed to convey meaning to living beings capable of receiving and interpreting them, that is, of evaluating their relevance to the on-going processes of survival and growth, physical and intellectual. Two names in the thought of the last 150 years are associated with semiotics as a discipline, Charles Sanders Peirce

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6   The term 'moving' here raises many questions which it would be otiose to follow.
7   As usual in our critique, calling appealing to some abstract concept of distinctness adds nothing to the argument. It is neither necessary nor desirable to make absolute separations between dialectical theory and the necessarily historical developmental stages of a social phenomenon.

and Ferdinand de Saussure. The problem with these authors and their countless followers is that their theories are non- or anti-dialectic. Simply, contradiction is given a purely negative interpretation.

As soon as living beings appear in the universe, meaning appears as process aspects essential to their survival and reproduction. With the arrival of self-awareness of existence, say, at the level of human beings and cats, semiosis describes the active, ontological process of the *discovery* of meaning in and as existence-as-process. It is creative, participatory and relational; semiosis carries an emotional stance or feeling toward existence and the self as part of that existence, which includes the capacity for its perception. It is a phenomenon within the scope of natural philosophy, with its own dynamic 'logic' of processes.

4.1. The Semiotics of Peirce

In contrast, the semiotics of Peirce is an epistemological doctrine describing the classification or categorization of the meanings or meaning-processes inherent in all existence. It is reductive and inert, since inserting the concept of sign or representation between a phenomenon and meaning adds no new meaning [55]. According to Peirce, semiotics is a logic and is logical, but only in the sense of standard, bi-valent or multi-valent linguistic logics. Peirce's famous 'three-tailed' graphs do nothing but provide a visual equivalent of bivalence.

For us, the discovery of new relations between categories is a semiotic process, but only because it takes place *outside* the epistemological categories. To say that it is 'Thirdness' is a tautology, and the entire structure of Peircean semiotics lies in the domain of non-natural philosophy.

Our concern with semiotics stems from the feeling not that it is wrong in some absolute sense, but that it addresses secondary aspects of the complex phenomenon of meaning and its exchange. The hermeneutic process adopted by Peirce illustrates this: he takes the extant domain and categorizes it without making an ontological commitment as to its basis, something which we consider an unavoidable necessity if the properties of existence are to be correctly represented.

In the realistic approach adopted in this paper, we suggest that the only possible hermeneutic process requires starting from a correct assignment of ontological priority. We have access to an historical emergence of knowledge, defined as a mental process for insuring the flourishing of living beings, as individuals and species. Since survival, if possible without pain, is the objective, knowledge of how to accomplish this is what is meaningful for the individual; it is constitutive of meaning.

Logic in Reality, which provides a rigorous framework for discussing presence and absence and their interactive relation, provides a non-linguistic definition of a sign as a perceived phenomenon in relation to meaning in the above sense. For a deer, the information received as the smell of a lion, or sight of its droppings, *are* the lion as a potentiality, in potential form. The deer, having interpreted these signs, undertakes actions to insure this potentiality does not become actualized nearby.

Peirce based his theory on a division of phenomena into categories of Firstness (possibility), Secondness (existence) and Thirdness (reality). The 'First' is a 'Sign' or 'Representamen' which is in a genuine triadic relation to a 'Second', called its 'Object' so as to be capable of determining a 'Third', its 'Interpretant' to assume the same triadic relation to its Object in which it stands itself to the same Object'. The term 'Sign' was used by Peirce to designate the irreducible relation between the three terms, irreducible in the sense that it is not decomposable into any simpler relation, such as some form of part-whole relation.

In our view, the Peircean categories invert the ontological priority in the universe and fail to add to knowledge or how to acquire it. The problem was succinctly addressed by Petre Petrov in his "Mixing signs and bones: John Deely's case for global semiosis", [56]. On p. 412 he writes: "The transformation of physical reality into objective sign reality is the same as the transition between Peirce's categories of Secondness (a binary relation of opposition, impact, cause and effect) and Thirdness (a triadic structure in which one item relates to another *for* yet another, the last one being the 'interpretant' of the dynamic between the first two).

The trick succeeds only because one has put the rabbit in the hat beforehand only to pull it out later. Secondness is already implicitly Thirdness, and the so-called physical relation is already implicitly objective" (italics ours).

When one tries to talk to Peirceans about possible overlaps between the categories when applied to real change, one is told "Oh yes, Peirce was aware of them and they exist". However, there seems to be no more grounding for any physical relationships in these than in the original categories.

Lupasco devoted major studies to application of his logic to living systems [45] as discussed elsewhere by Brenner. In current terms, his logic is consistent with a view that life emerges from the recursive processing possible in some still undefined proto-structures, and what can be called semiosis in higher animals from some further recursive processing of information within life's physico-chemical structures. Only physical processes are required for meaning; for us, they can be and **are** meaning. Signs are inert, *a posteriori* epistemological constructions without explanatory value. (In our approach, biological 'codes' are not signs. They are static scientific abstractions.) The concept of operators is useful here [57]; it is the chemical structure of nucleotides in the DNA that 'operates' the genetic process.) Let us now therefore leave the austere world of Peirce and his acolytes and discuss concepts of semiotics and semiosis from other logical and scientific standpoints

4.2. The Semiotics and Semiosis of Igamberdiev

From the earliest known examples of abstract thinking, humans faced the two types of paradoxes, one referred to as semantic and the other as kinematic. The first apparent formulation of the semantic liar (*pseudomenos*) paradox was that of Epimenides of Cnossos who was a semi-mythical thinker of the 7th or 6th century BC. Its later formulations belong to Eubulides (4th century BC), and in other cultural traditions to Bharthari (India, 5th century AD) and to Nasir al-Din al-Tusi (the Islamic tradition, Persia, 13th century), who identified the liar paradox as self-referential. This paradox substantiates the impossibility of non-contradictory application of binary logic to the process of signification (assigning of meaning).

The first known formulation of the kinematic type of paradox in the West was by Zeno of Elea, who was the disciple of Parmenides (5th century BC). They were formulated independently by the representatives of the School of Names (Míngjiā) in China (5th-3rd centuries BC) and by Nagarjuna in India (3rd century AD). The origin of kinematic paradoxes is in the impossibility of a non-contradictory formulation of an infinite space-time and to the incompleteness of any formal representation of it. In such representations, contradiction appears between the description of space consisting of an infinite number of points and the possibility of moving past them in finite intervals of time.

Over many centuries, the semantic and kinematic paradoxes were analyzed independently of one other. The main challenge was to try and unite them in a single dynamic process. This was, in particular, reflected in the designation of Cretans as liars in the Epimenides-Eubulides paradox in which the physical (kinematic) parameter (movement) was introduced. If we remain within the physical domain and observe a moving object (*e.g.*, Zeno's flying arrow) embedded in physical space, we can introduce a semantic constituent by assuming that the arrow, at a concrete finite moment of time, is present at a certain point of space, and at the same time is absent there, beyond the semantic field of the person who launches it (the bowman). The dynamic process thus includes the contradiction that is embedded into the moving system and can be fixed logically. Space-time is structured by physically defined parameters that appear to fulfil the function of avoiding the apparent inconsistency of its representation as infinitely divisible to allow movement in it. These parameters represent the fundamental constants of the physical world, and the physical complementarity which manifests itself, in particular, in the impossibility to define strictly the position and momentum of a particle simultaneously. This arises as the consequence of the process of representation into the represented (measured, observed), which continuously produces an infinite recursion. Quantum measurement appears as a semiotic process in which signification takes place continuously and in which the kinematic and semantic constituents are complementary and emerge in tandem from a still unknown *pleroma*.

The incompleteness theorems formulated by Kurt Gödel represent modern interpretations of the semantic paradox but at the same time they have a kinematic constituent which appears in the process of obtaining proofs. The claim that any sufficiently rich formal system is incomplete means that it contains statements which cannot be proved inside the system, but they can be enumerated (encoded) in the representation of the system. A system of axioms can never be based on itself since the statements about the system itself must be used in order to prove its consistency. The great invention of Gödel [58] in his first incompleteness theorem is that its proof is achieved via assigning statements about the whole system (corresponding to meta-mathematical statements) to the elements of the system. Signification is therefore attributed to the dynamic process of (epistemologically) developing the proof of incompleteness itself. Although this dynamic process is not analysed logically (or "dialectically"), it represents the necessary condition for obtaining the proof for the theorem. As shown by Igamberdiev earlier, *a* process of obtaining proof, which necessarily generates the encoding in the system, is continuously realized in living systems and their evolution [59]. However, the latter is not the same as proof of statements or their mathematical equivalents. At a higher level of reflexion, it is present as a dynamic process of evolution of social systems and civilizations [60]. A concept that attempts to explain biological encoding as a consequence of metabolic reflexive loops in the system, "closed to efficient causation" in the Aristotelian sense was developed by Robert Rosen [61], discussed further in Section 6. Its further development can be based on analysing the dynamics that results in generation and further complexification of these loops.

To understand this dynamic process, we need to analyze the course of obtaining the proof in Gödel's sense which will characterize the process itself and generate encoding in the system such that it becomes a semiotic entity (seme). During this process, growth of complexity takes place and the system acquires *information* about itself and about the external (to it) reality. In other words, Gödel contributed much more for understanding semiosis than Peirce or Saussure because he explained the necessity of encoding as a required step in the signification process. This process represents a dialectical discourse of the system with other organized systems embedded in the systems reality external to them... The complementarity between the formal Gödel system and Gödel numbering is based on the separation between the system itself and its embedding that represents its encoding. It follows or tracks the growth of complexity via the dynamics that is inherent to Gödel's self-reflexive loop and includes a certain freedom as the encoding (Gödel's enumeration) can be reached by many alternative, i.e., complementary, ways. Thus the growth of complexity is based on the contradiction between a system and its representation (including its internal "encoded" representation), generating new levels of "gradation" of organizational structure, and includes the relational abolition (negation) of previous steps. Some arrangements that were actualized in previous steps emerge later but at a higher level of complexity, as suggested by the Axiom of Emergence in LIR. These moments of the dialectical discourse loosely correspond to "three laws of dialectics" formulated by Engels. This dynamic process was defined by Heraclitus as the self-growing Logos (*logos heauton auxon*).

When Kurt Gödel enumerated metamathematical statements about the system by encoding them within the system, he incorporated at the same time the paradox in the nature of the dynamical system. The next task is to describe in logical terms the procedure of the proof of incompleteness itself. This introduces another paradox: to describe the origin of logic by logical means and the origin of computation by computable means. This means that we enter into a discourse between our own logic and the internal logic of the system with which we interact and which we aim to describe. The nature of this paradox has not been fully analyzed in human thought, except in Plato's dialogue "Parmenides" and perhaps a few other philosophical works. It is very easy to slip from the dialectical discourse to the concept of final truth. This was not avoided by Plato himself (finally in his "Laws") and by Hegel and Marx who abandoned their own well-developed discourse for such a "final synthesis". This synthesis, in fact, rejects the very nature of dialectics and results in total failure for the conceptual field and in social practice.

For resolving the paradox of describing the origin of logic by logical means, it is important to consider Friedrich Wilhelm Joseph Schelling as an essential figure in natural philosophy. According to Schelling's views, since the coming into being is not a finished entity but yet becoming and always contingent, existence and movement cannot be a logical category [62]. For the purpose of describing the process of actualization, we need an instrument that can in some way overcome the frames of purely logical description of the process of coming into being, and dialectics represents a substitution for descriptions using classical logic. Arran Gare [63], analysing Schelling's views, comes to the conclusion that Schelling developed a theory of emergence and a new concept of life relevant to current theoretical biology. This theory is grasped in Logic in Reality in the Principle of Dynamic Opposition (PDO) operative at the most fundamental physical level as well as all higher levels of reality. The PDO and contradiction or counteraction, and a robust notion of potentiality, is required for understanding the relation between substances, events and processes. (We note in this connection the debate in Buddhist logic on whether dynamic (al) opposition was or was not real ([38], pp. 404–406), involving, like LIR, an included middle.

The concept of emergence introduced by Schelling was further developed by Alfred North Whitehead [64]. Following Whitehead, it is only events that are the actual entities of the physical world which need to exist in order to have a physics. This leads to a new idea of physical substances, that of a distribution of potentialities, "powers" or propensities, that are "reasonable consequences of a theory of processes" as Thompson [65] suggested. He talks of eternal objects with only a 'pure potential' for ingression into reality in which potentiality is realized (actualized). However what Whitehead designates as Categories of Explanation include highly relevant statements of the ontological foundations of Logic in Reality as a logic of process [64]. Thus

(i)　　(That) the actual world is a process and (that) the process is the becoming of actual entities.
(ii)　　(That) *how* an actual entity becomes constitutes *what* that actual entity *is*. . . . Its being is constituted by its becoming. This is the principle of process.

We do not hesitate to characterize this aspect of Whitehead's philosophy as natural: "For you cannot abstract the universe from any entity, actual or non-actual, so as to consider that entity in complete isolation." Whitehead contrasts the philosophy of organism, basically what we discuss in this paper, with that of propositions as abstractions. It is of interest is that Whitehead has no difficulty in integrating being and becoming without conflating them. Whitehead integrates both physical and philosophical senses of 'potential difference'. The further differentiation of processes by Whitehead into macroscopic and microscopic, efficient and teleological, complete and incomplete and their comparison with the principles of Lupasco will be discussed elsewhere.

Another important philosophical concept of organizational evolution of matter is tektology of Alexander Bogdanov [66]. It was analyzed recently by Arran Gare [67]. In this concept Bogdanov put process and organization in the center of perpetually evolving reality seen as an organizational process of the Universe. Science itself, according to Bogdanov, is comprehensible as a development within and of nature. Tektology claims that processes are the primary reality rather than things or substances and their attributes, which assumes that a non-formal language is more appropriate for characterising the basic characteristics of nature, and mathematics should be seen as having a derivative status [68].

The aim of modern synthesis in science is to explain the phenomenon of complexification which lies at the foundation of evolution of the Universe [69,70], in evolution and morphogenesis of living systems [71–73] and in social progress [74,75]. For this purpose, the dialectical ideas of Plato and Aristotle revived in modern times by Schelling, Whitehead, Bogdanov and Lupasco represent an essential alternative to the positivist interpretation of reality that dominated science for many years.

4.3. Epistemic Perspectives and Logic in Reality

The perspicacious reader will have noticed that, although we claimed at the outset to focus on the ontological entities of natural philosophy, we have introduced *three* concepts in the discussion that are

primarily epistemological: (1) the *clinamen* in Section 2; (2) the ontolon above, which retains substantial epistemic character in its relation to the epistemon, and (3) essential properties of quantum entities that are outside standard quantum physics as generally understood.

We justify the inclusion of these perspectives, as we do that of Peirce, for their hermeneutic value. They can provide additional insight once it is established and clearly understood that there is no direct physical evidence for the existence of the respective entities *qua* entity. In fact, we have returned in restated terms to the dialectics of appearance and reality. The novel feature that we are able to introduce into this dialectics is the availability, offered by LIR, of a dynamic relation between the two—no appearance that is not also partly reality and vice versa, sometimes changing in proportion with time. Meaning inheres, implicitly and explicitly, throughout the domain.

Let us now examine these considerations in the newly available language of information science and philosophy.

5. Information and Communication: The Dialectics of Meaning (2)

In Section 4, we saw an example of a field of which both formal and non-formal descriptions are possible. Formal approaches are not necessarily incorrect, but they are when they equate to the use of bivalent or multivalent linguistic logics and standard category theory which in our view have limited explanatory value. Non-formal or partly formal approaches have been much less developed, but they offer interpretations of phenomena in terms of dialectics and a non-standard logic of processes, Logic in Reality (LIR), as outlined in Sections 2 and 3.

The two lines of thought are present throughout the human and social sciences and philosophy. Again, the second group has received less attention as being allegedly unscientific and non-rigorous, as most of the time it is. In this Section 5 and the next Section 6, we will address the fields of information and communication and *their* relation to meaning. We will provide a summary of the standard well-known interpretations which we will describe, for convenience, as non-dialectical (ND) and then of ours based on the parallel use of dialectics and LIR.

Also in previous Sections, we have referred to both meaning and information separately, pointing out some of the difficulties with standard conceptions of meaning in relation to semiotics or semiosis. In this Section we study what can be gained in the understanding of both concepts by looking more closely at the dialectics and logic of the relation between them. Even placing them in conjunction has significant consequences—in what sense are meaning and information the same or different?

Many authors have noted the complexity of information and the difficulty of giving a 'single, clear' definition of it. Attempts to do so are typical of standard substance ontologies, where hard definitions are automatically given preference. The failure of such attempts suggests that major categorial errors are being made. We therefore make the following lapidary statement which we will try to justify in what follows:

Meaningful information is reality in potential form.

It is derived from the Lupasco/LIR conception of consciousness outlined in [76] which basically looks at the real dialectical interactions between internal and external, better internalizing and externalizing processes as they move between potentiality and actuality.

In order to understand how our approach to logic and dialectics adds value to the discussion of meaning, information and communication and their interrelation, we need to summarize briefly in this Section the major developments in these fields made in the 20th Century and the last twenty years, both in the West and in China. The concomitant formulation of theories of information in which it was related to the clearly developing information society resulted in a new rationale and methodology for information studies. From the point of view of this paper, the overall movement was from non-dialectical mathematical theories to dynamic ones, including critical aspects from biological science is to be welcomed. Yet each of the kinds of theories outlined in the Sections 5.1–5.4 suffers in some way from the absence of explicit recognition of the dialectical/logical principles underlying the operation of 'Information in Reality' [30].

5.1. Communication Theory—Information Science—Meaningful Information

The concept of information as an 'immaterial' substance, involving meaning in some way, has been available since antiquity (cf. Capurro [77]). It is fascinating to note that the nature of information, often viewed today as 'just' a philosophical question, in fact requires the best available concepts of physical science of the origin and fundamental structure of the universe to be correctly addressed. The modern origin of a theory of information is often ascribed to the work of Shannon on theories of communication, in which information is related to the removal of redundancy in a formal manner. This approach was specifically intended *not* to address or define meaning, but it nevertheless gave rise to many other formal theories of which the most modern and comprehensive is that of the mathematician Mark Burgin [78].

In the 1950's however, the discussion of information was almost fatally polarized by the statement of other mathematicians, Norbert Wiener and his follower John Wheeler, to the effect that information was not matter or energy. This statement gives the sense that there is something truly 'different' about information, but scarcely gives an indication of what it might be. Such theories are not wrong but they are incomplete in that the scientific and logical origin of the dialectical, that is, in our terms real physical interactions described is not specified. Faced with the multitude of theories of information of all kinds, Brenner gave his 'personal synthesis' [79] of a several competing theories, from which a few key benchmarks for philosophy can nonetheless be taken as discussed further in this Section.

Given their origin in communication science and its significant dependence on technology, it is not surprising that theories of information emphasize formal concepts and standard logics. From the human, *natural* philosophical standpoint—we do not separate these—communication as the transfer of information is a human activity, and its nature and changes must follow the rules and logic of the latter.

5.2. Geometry/Position or Energy/Force

In seeking the grounding for philosophy and knowledge, one is confronted by at least two age-old, unresolved arguments. One is whether space, defined by position and geometry or energy, defined by movement and change is more fundamental—has ontological priority—in the universe. Another is whether matter is somehow constituted by our consciousness of it, the doctrine of anti-realism, or consciousness evolved from or together with matter. Those who prefer the first elements of these two pairs, including the major figures of Norbert Wiener and John Wheeler, also favor the position that information is *sui generis*, neither matter nor energy, present in some way in the form of digital bits, the so-called It (things, processes) from Bit position.

The proposal of Logic in Reality outlined above and in [80] is that what emerges from the still unknown ground of the universe, position and energy, or statics and dynamics, can be rigorously described in dialectical terms as two different, opposing but non-separable aspects of that ground, a position similar to that taken by Diaz Nafria and Zimmermann [81]. Digital bits, now part of knowledge are an emergent epistemological phenomenon—the 'Bit-from-It' position, and the overall situation can be described by an 'onto-epistemology', whose components are 'ontolons' and 'epistemons'.

If as argued energy is fundamental, so in our view are its properties, in any real system, of actuality in a non-separable relation to potentiality. Change is a consequence of our existence within an overall energy gradient moving locally from higher to lower grade forms, finally to heat (low energy photons). The movement of elements itself is sinusoidal, from predominantly actual to predominantly potential and the reverse. No element goes to the absolute, idealized limit of 100% one or the other, except in trivial cases in which there is no interaction between the initial and final states, as in snooker balls falling into pockets. The hypothetical pre-thermodynamic universe is supposed to be something like a quantum vacuum, with elements moving into and out of existence, without reference to time. As attempts to show a direct coupling of such a world with ours, we feel that they are not required for our subsequent analysis. The desire to demonstrate such coupling must be placed in the same domain as that of religious beliefs which by definition cannot be the subjects of scientific proof, except of their *own* existence.

As proposed by Lupasco and discussed by Brenner in [1], whether a dialectics of energy and position, or of consciousness and non-consciousness or of a polarized position of absolute opposites is preferred is a question of individual psychology. Lupasco saw individual human beings as instantiating change and hence preferring the stability conferred by belief in identities, stasis, rather than the dynamics of diversities. This dialectics, the dualistic oppositional properties of energy is reflected in the properties of information. Information and energy are both the same *and* different, as the focus of the mind moves from one aspect to the other.

The major difference is, of course, that information is alleged to be and convey meaning, and the emergence of meaning from a meaningless substrate has been impossible to explain. In our view, the question of the emergence of meaning is equivalent to that of consciousness as a higher order of mental processing by animals capable of that processing, related to their survival. We admit the tautology here, but claim that the fact that no explanation of the emergence of meaning exists does not mean that the ascription of dialectical properties to information is invalidated.

5.3. Why Information is Enough

The cybersemiotic approach of Søren Brier is outlined in his major book [82], *Cybersemiotics*. The title reflects is program of defining a new semiotics that in his view emerges from the computational processing of knowledge. The subtitle is *Why Information is not Enough* and refers to the limitations of standard logical and computational theories of information. Brier refers here to the lack of an adequate rigorous framework for philosophy, now including phenomenology, in an adequate relation to the natural sciences.

As Brenner has noted elsewhere [1,30,55], Brier among other semioticians have based their underlying world view on proposals of Charles Sanders Peirce for logic and semiotics, in fact of a theory that implies their equivalence. Peirce made a classification of phenomena into those instantiating categorial properties of Firstness, Secondness and Thirdness, roughly related to the degree of interaction present. The problem for us is that the properties selected have, by Peirce's own admission, no grounding in any physical reality. They thus rejoin the body of knowledge referred to in Section 5.2 as anti-realistic. The semiotics of Peirce, and accordingly of Brier, is a description of the world, including living systems, in terms of 'signs' to which human beings can give an interpretation = meaning. Biosemiotics has become a highly active field of inquiry designed to explicate the role of complex signs in knowledge.

In our view, the approach of Brier and other semioticians displaces the emphasis from the ontology of the world to its epistemology without giving an adequate reason or substitute for it. Peirce did not claim that his system was based on any ontological commitment as to the ground of his signs, but that did not prevent him or his followers from assigning major hermeneutic value to them. We will return elsewhere in this paper to a discussion of phenomenology as such. We simply restate here the advantages of the LIR physical view of the energetic aspects of the origin and propagation of information, without reference to signs. Information inheres in both the physical and epistemological evolution of real processes and hence serves as a concept unifying the physics, biology and neuroscience of mind.

The somewhat apodictic statement by Lupasco cited above that physical processes, and hence their informational content *are* meaning is supported by the Kaufmann-Logan notion of biotic or instructional information [83]. It is also dualistic approach in which intrinsically meaningless Shannon information, the lowest level that characterizes a physical system without the self-reference present in living systems, is contrasted with biological information which always entails meaning. It emerges from the material-energetic structure of the latter in a process of which the 'structure' is a dynamic part. As originally emphasized by Lupasco [84] "everything is structure" or better a *structuring* (*structuration*), and Logic in Reality describes the evolution of these structurings.

5.4. Information in Presence-Absence Dualism

The basic philosophical position of Logic in Reality requires a dynamic interaction between opposites at and in respect to all levels of metaphysics. We have seen above the dialectics and logic of

the relation between the degree of actuality and potentiality of opposing process elements, as well as the new entities which can emerge from them (included middle or third term states—'T-states'). A key pair of metaphysical opposites to which we ascribe a physical dialectical meaning are presence and absence. We have noted that LIR ascribes value, in ways that are more explicitly scientific as well as logical, to concepts generally considered negative—contradiction, inconsistency and vagueness. This approach is echoed by the work of the biologist Terrence Deacon of a metaphysics of incompleteness [85]. Deacon defined what is missing from theories of information in a paper with that title [86] and that this absence is an essential part of its content. For us, also, information refers to something that is not totally present now, or is not present yet.

We will not repeat here in detail Deacon's key concept that information is a relational property of systems that emerges from constraints of signal probability, discussed by Shannon, signal generation, by Boltzmann and those required for an apparently teleological dynamics, essentially those of Darwin in regard to evolution. We refer the reader to Deacon's major work, *Incomplete Nature* [48]. The three properties reflect three levels of entropy reduction that is an informational 'architecture' of recursivity. There is a rough parallel here to the notions of syntax, semantics and pragmatics, here, the pragmatics of Darwinian survival. The hierarchy of levels is that of data, content and significance, but the principles of LIR permit an interaction between them rather than the absence of interaction as between quantum and non-quantum levels.

At the cognitive level, according to Lupasco Principle of Dynamic Opposition, presence and absence correspond to consciousness and unconsciousness and actuality and potentiality in a non-intuitive contradictorial manner. Forgetting as also an active process, and in the complex dynamics of mind, a 'fact' or concept that was present and then relegated to the unconscious is an actuality with a potential for being recalled into consciousness.

5.5. Information and the Laws of Thermodynamics

In a general way, the discussion of complex real processes still suffers from the lack of an appropriate language which takes into account both intrinsic and relational properties of a system at the same time. Deacon defines constraints as relational properties, but LIR amplifies this by the rules for their evolution of the potential as well as actual aspects. Ulanowicz [87] has made an extension of the Deacon approach by connecting concepts of entropy to the Third as well as the Second Law of Thermodynamics, in order to define entropy in a relation to a degree of system constraint (actuality) and its conjugate state of residual freedom interpretation of the Third Law, deliver meaning. In a picture of entropy and information whose terms are always relative implies that like those of quantum physics, they do not commute [88].

In several papers, Igamberdiev further develops the idea that the Third Law of Thermodynamics is more important for understanding life than the Second Law which is considered the basis of Prigogine's dissipative structures. The Third Law establishes the reference state with the lowest entropy in relation to which the order (described as information) can be referred [89]. This state, according to the Third Law, is achieved at the temperature of absolute zero. However, living systems operate at temperatures near 300°K, in fact far from this reference state. It has been suggested that they maintain a long-lived cold decoherence-free internal state (called the internal quantum state), within macromolecular structures which is achieved by applying error-correction commands to the internal state and by screening it from thermal fluctuations [90,91]. Iosif Rapoport was the first who suggested to describe the stability of genetic structures by introduction of special thermodynamic principles explaining the maintenance of low entropy in living systems [92]. Mental processes could be associated with such long-lived internal states maintained within the nervous system [93]. This could be sufficient for Lupascian T-states, and a corresponding non-Boolean logic, as a possible physical precondition.

In our picture, the difference between these domains and those in which classical (Boolean) logic and the law of the excluded third operate is determined by the degree of interactivity and sinusoidal movement between them (primarily actual to primarily potential and vice versa, alternately and

reciprocally), involving communication between actual and potential states on a macroscopic level. Stated in this way, the Principle of Dynamic Opposition (cf. Section 3) goes beyond thermodynamic principles. It requires implications in addition to mathematics for description of its operation in complex processes, given their non-Boolean evolution. The operation of the PDO thus functionally replaces the notion of a 'temperature' in metabolic cycles. According to Nicolescu [94], the Principle of Dynamic Opposition is not and should not be described as a thermodynamic principle. The thermodynamics of energy underlies all phenomena in opposition, but it does not characterize all of them. Ontolons, as described above in our picture, are constituted by predominantly actual states, but these are not independent of potential states. Together they lead to the emergence of new entities (T-states). Further complexification of ontolons at the interpersonal level generates perpetually evolving socially organized structures [75,95]. In the next Sections 5.6 and 5.7 we will summarize the approach to the science and philosophy of information coming from the philosophical side, which we immediately wish to characterize as part of natural philosophy.

5.6. Wu Kun and the Metaphilosophy of Information

The 35+ years of pioneering work of the Chinese information scientist and philosopher Wu Kun has inspired the following discussion. Wu's innovation in philosophy is that information is not immediately given as matter or energy, even though always requiring them, implies an emerging crisis in philosophy. Information is required as an additional philosophical category, and Wu redefined the philosophy of information as a *metaphilosophy* [96]. The implications of this change are only beginning to be realized.

Through papers in English by Wu and jointly by Wu and Brenner, including some in this journal, many of Wu's conceptions are now broadly available. A key aspect of this approach is that it *defines* a *stance*, the Informational Stance. Wu and Brenner consider that the "opposites" in information are not captured by the classical concept of a classical, static "unity of opposites", but by the dialectical interaction of opposites, classified by Wu based on his general philosophy of natural ontological levels that captures the essence of the properties of information. The resulting doctrine of objective information, subjective information and human information in society constitutes Wu's information theory and establishes it as a unified philosophical foundation for information science.

The Informational Stance, is a philosophical position and attitude that is most appropriate for, and above all not separated nor isolated from, the emerging science and philosophy of information itself. The Informational Stance is a more 'active' formulation of Wu's concept of Informational Thinking, which offers an alternative to standard 'Systems Thinking' in which most standard views of logic are retained. The Informational Stance is an attitude that requires attention to the informational aspects of complex processes as a methodological necessity, starting from the level of an existence theory for information and a methodology for its investigation. Especially, the Informational Stance supports and generalizes the recent work of leaders in the area of information ethics, including Floridi, Capurro and Wu himself, grounding the attribution of ethical value to all existence in informational terms. Wu's Philosophy of Information combined with LIR yields a *philosophical* structure of information that is compatible with its dynamic physical and logical structure and has no obvious direct precursor, either in or outside of the field of information.

5.7. Meaning and the Convergence of the Science and Philosophy of Information

Wu's definition of the role of information in philosophy is the critical *first step* in the characterization of the complex phenomenon of information and information processes. Further, Wu's classification provides a basis for an understanding of a key current development, the convergence of Information Science and the Philosophy of Information as the precursor of en emergent Unified Science of Information [97]. This convergence is obviously not intended to imply an 'end' to philosophy or its conflation with science. Philosophy will continue to explore issues that arise, in particular, in relation to language and knowledge in their aspects as unique cognitive products of the human condition,

with a substantial abstract content. But the question of the relation of that condition to the rest of the world logically requires retaining the scientific properties of that world to insure the validity of the comparison.

There is thus a set of new and unique relationships that are developing between the classical disciplines of science and philosophy as a consequence of new understandings of the science and philosophy of information. The overall movement is that of a philosophization of science and a scientification of philosophy leading to their convergence. However, in this paper and elsewhere, we use the term Unified Science of Information. This is not strictly accurate, as our convergent theory includes the Philosophy of Information as a proper part, without conflation. Wu and Brenner therefore propose, despite its awkwardness, the term Unified Science-Philosophy of Information (USPI) as the best possible description of the field of endeavor. We thus believe we are witnessing the emergence of a new system of science, a metascience in a complex, dynamic reciprocity with philosophy that amounts to a paradigmatic revolution in thought.

In a paper in *Information* [98], Wu describes the current situation as follows. We cite this passage *in extenso* as it is a textbook example of the kind of new paradigm we referred to at the objective of this paper. "As a result of establishing the fundamental role of information in the existential domain, the Philosophy of Information provides a kind of dual-existential and dual-evolutionary theory of matter and information which describes information as a general phenomenon existing in everything in the cosmos. This leads to the acknowledgement of the dual dimension of matter and information in all forms of research. Because the lack of an informational dimension in traditional philosophy and science, it is necessary to transform them completely to take into account the new scientific paradigm provided by the current Science and Philosophy of Information. By means of that transformation, all scientific and philosophical domains become involved in an integrating, developing trend of paradigm transformation, which Wu and Brenner has called the "informational scientification of science" [99].

The current interaction and convergence of the Science and Philosophy of Information represents a fundamental and basic path for the development of scientific and philosophical knowledge. This "philosophization of science" and "scientification of philosophy", anticipated in the progression from ancient philosophy to modern science and philosophy, now represents a completely new way of thinking that is that distinct from that in the contemporary Western philosophy of consciousness. It resists an absolute separation between science and philosophy and establishes interactive, mutually defining feedback loops between science and philosophy which emphasizes their interrelation.

Given the properties of information outlined above, we claim that the relationship between its science and its philosophy is one of non-separability, leading to the convergence described. We assume that the Philosophy of Science is not identical to the Science of Philosophy, which remains to be defined. However, if as Wu and we suggest science and philosophy are converging, under the impact of the science and philosophy of information, the two cannot be considered as totally independent, separated or separable. The emergence of a revolution in philosophy, as suggested in [100] implies a revolution in the philosophical perception of science. In this paper, we have defined the parameters of and paradigm applicable of the Revolution in Philosophy and its implications for the Philosophy of Science. We see the two as a pair of doctrines in opposition in the sense of Lupasco. One may talk about a "New Kind of Philosophy" by analogy with the "New Kind of Science" proposed by Wolfram [100].

5.8. Logic in Reality, Meaning and Information

We have shown above that meaning and information are not identical but also not separable at the cognitive level which is the one of interest here. They follow the logic of real processes that is the thread running throughout this entire current paper. It is thus an integral part of Philosophy in Reality and of our proposed synthesis with the Philosophy of Information of Wu Kun. In the changes in stance or perspective, dialectical movement **is** both epistemological and ontological. Knowing not is not totally separate from the Known, what we know. It is true that the "map is not the not territory", but stated in this simplistic way, the relation restored or recovered by LIR is obscured.

The hierarchy for existence and essence established by Heidegger and by Capurro [101] and its formalism (_is_, _as_) can be placed into correspondence with a logical-physical theory of real processes, that of Lupasco and Brenner. The two 'languages' are linked by a concept of a dynamic relation between potentiality and actuality in both the physical and philosophical senses. The first consequence of this approach for semiotics is that one can clearly differentiate between the description of language as 1)) becoming, being-in-the-process of becoming meaning, involving real potentialities and actualities and their mutual conversion into one another and 2) as being - a static, binary phenomenon, in which philosophical potentiality inheres. McLuhan's apodictic statement that "The medium is the message" is only meaningful if the '_is_' is at the same time an '_as_', whose ontological sense is that of real processes of generating, sending, receiving and understanding messages as in the Angeletics of Capurro (see next Section). The current usage of media as a singular noun is incorrect from the standpoint of Latin grammar in referring to several kinds of medium—press, TV, cinema, etc. Oddly, it is more correct if 'media' is taken to refer to the complex dynamic properties of the messaging process, "the media is the message". The process and the process_as_meaning then have the proper ontological relation and value. A good example of our current approach is in its reading of the 'liar paradox', which was referred to and analyzed in Section 4.2. In the usual linguistic perspective applied, it is an epistemological dead end, oscillating between ideal limits of one or the other of two idealized alternatives. In the original perspective of one of us (AUI), the system subdivides into levels, with two actors. In the epistemological mode, Epimenides and the Cretans are separated by non-existence: Epimenides is a signifier, and the Cretans are the signified. The standard logical contradiction, which appears when we realize this one-level formalization of this system, is to be expected in this mode.

From our newer ontological perspective, the actors are the same but the relation is logical and contradictorial in the sense of Logic in Reality. The following consequences can be deduced from this consideration. Epimenides as an individual can be regarded as an element of the set which signifies this set, having *discovered* it in the sense of Capurro. The set (the society of Cretans) acquires its own dynamics having acquired the property of being 'liars' in conflict (antagonism) with, but not totally separate from, Epimenides. Different possibilities for the dynamic behavior of a system arise from this. What is important to note is that the 'dynamic behavior' with which we are concerned is that of real persons, individuals and groups, and their relations, dependent on their deep psychology.

On this basis we go to the next level of complexity which is that of meaning and information in human communication, outlined in Section 5.9 below. At this level, we will pay close attention to the concept, also due to Capurro, of "angeletics" or messaging theory as an extension of information theory as such.

5.9. Progress in Communication Theory

We have indicated in Section 5 some aspects of recent rapid developments in the science, logic and philosophy of information in relation to meaning. In particular, we have mentioned the dialectical convergence of science and philosophy under the influence of the philosophy of information. The convergence is no more functional than in the field of communication. We have also mentioned briefly their origin in the last Century in the science and technology of communication and their enormous increase with the advent of computer technology. Progress in communications is a part of the current digital ontological paradigm identified by Capurro in numerous publications in which, also, attention is called to their social consequences [102].

From our standpoint, progress in communication is by no means univocal. In the case of natural languages, for example, the basis for human communication, their evolution in the direction of increased efficiency and reduced redundancy is clear. The latter is off-set in many instances by context, as in Mandarin Chinese, where a single tone-symbol may have a dozen meanings, but this may be an exception. That such developments are accompanied by an impoverishment in the quality and depth of language and communication is also clear. Routine errors in English are made and become codified in defining media, e.g., CNN. The loss of redundancy in individual languages is paralleled by

the disappearance of entire 'native' language groups. The destruction of the languages of indigenous populations employed was part of the political strategy of the Catholic Church in Mesoamerica, the conquest of the North American continent by Europeans and is part of that strategy in Asia and Africa today. The society is impoverished by such losses as much as it is by the loss of animal species, such as the moa[8], literally eaten to death in Australia in the 19th Century.

Under these circumstances one can only welcome movements in the direction of the saving of surviving languages and the recomplexification of our own. Such a process cannot be formal and artificial, but we propose what is essentially a third case of recovery, by the reintroduction of references to classical portions of our cultural heritage, not classicism for its own sake. We are thus proposing a rehumanization and de-digitalization of communication theory which is not intended to eliminate digital perspectives but to provide some balance to them. Capurro correctly points to the prevalence of a 'Digital Ontology' today [101], but this does not mean that a non-digital ontology is not active, admittedly to a lesser degree.

5.10. Messaging Theory (Angeletics)

Following McLuhan, further emphasis has been placed on communication as the exchanges of messages—'messaging' involving the triple of message, its sender and its receiver. Capurro coined the term 'angeletics' to replace that of information for the description of the exchanges of messages between human beings, going back to the ancient Greek word for messenger *angellos.* The choice of the term Angeletics for the study of messages and messaging is to signal the use of a philosophical framework, closest to that of Heidegger, which is ultimately based on Being of which the irreducible uniqueness of the individual human consciousness is a part. A major discussion by Capurro and others of the concept of Angeletics is given in [103].

The word message is derived from the Latin *mittere*, to send. For us, this describes a 'packaged' portion of a complex process of information in movement that can be also designated as an ontolon. This is consistent with the concept of Holgate [104] that science should continue "the epistemological revolution of our time" and extend relational, that is, ontological concepts to every field of science and the mind (relativity, pluralism, polarities, information exchange, etc.).

Communication involving the sending and reception of a message is a creative act, an energetic process that involves the exchange of energy, overcoming resistance to doing nothing, or not sending any message. Messaging theory or Angeletics must reflect the creative, value-laden characteristics of communication, their reference to the physical survival of the receiver, or more indirectly to his/her mental and spiritual well-being. It is easy to show a central role in philosophy of messaging in a historical perspective and more recently in the ontology of Heidegger. It is this central functional role of philosophy in messaging theory that calls for definition of a new specific field for the clarification of residual problems at the interface of the domains of messages, communication and information, in which the notion of Being plays a central role.

Capurro stated in [101] that the ontic difference between a sender a messenger and a receiver as separate entities presupposes the original unity of Being as sender, the world as message and humans as messengers. We can distinguish this original unity analytically, but we must be aware that any ontic separation (at whatever level of reality and concerning whatever kinds of beings) presupposes our being-in-the-world (to use Heidegger's formula). At the risk of overdoing the form but to make the point, we may use the expression Being in Reality in place of this formula. We propose a synthetic *non*-separation of subject and object and state grounded on the original relationship between man (and humans) and world. In an original angeletic perception, whatever we perceive AS being this or that and on whatever kind of relation (causal or not, etc.) is achieved on the basis of our being originally open to the message of the world that we process, at a higher level, as Being. One of the

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8　　"Can't get 'em, they've et' 'em,, they're gone and there ain't no moa." Australian popular song.

problems posed by discussion of Being in non-transcendental terms is whether one can talk also about it in terms of proper parts, as one can for ontic and epistemic phenomena, using the terms of ontolon and epistemon respectively. This problem is discussed in the next Section 6.

6. Forms of Reality and Existence

The dialectical-logical approach that we have adopted in this paper offers support for a new view of the operation of thought and other real processes at a further complex level. We do not consider this another level of abstraction, in the sense of Floridi [105] dealing with objects 'abstracted' from reality, but in the sense of sets of dynamic moving elements, parts or forms of the processes involved, potentia and actual. It is useful for this purpose to maintain the two domains of ontology and epistemology, where for the latter the concept of 'epistemons' has been proposed by James Barham [106,107]. The 'pieces' of the former will be called 'ontolons'. These two sets of entities could be supplemented by a third referring to the domain of standard philosophy, that of being[9], but this issue is outside the scope of this paper.

The relation of entities to disciplines is thus as follows:

1.   Becoming/Change   Ontology   Ontolons
2.   Knowing   Epistemology   Epistemons

No absolute separation should be taken to exist between the domains. They interact dialectically and logically in our LIR.

The terms of ontolons and epistemons are neologisms, but their derivation from Greek for 'being' and 'knowing' anchors them in a long tradition. Capurro [108] has made the somewhat easier connection of epistemon to 'what can be known', and has related it to Husserl's 'noesis'. This for us implies a process or stream of 'data', better, segments of processes. Ontolon is more complex, as it refers to both the immanent and transcendent aspects of 'being', the former in the English verbal sense. Our logical approach, however, suggests that these aspects are not and do not need to be totally disjunct. This is true in particular in relation to beings who, as we do, have the capacity of self-reference and an 'understanding' of our position, as in Heidegger. In Lupascian terms, we *are* both immanent and *transcending.*

Capurro states that, for Heidegger, ontology and phenomenology are not two distinct philosophical disciplines. These terms characterize philosophy itself with regard to its object and its way of treating that object. Philosophy is universal phenomenological ontology, and takes its departure from the hermeneutic of *Dasein*, which, as an entity—'analytic' or what we call proper part of existence— establishes a guide-line for all philosophical inquiry "at the point where it *arises* and to which it *returns*." LIR provides the framework for the parallel interactive interpretation of ontology and phenomenology.

In contemporary philosophy, phenomenology thus occupies a strange position: on the one hand it seems to place major ontological value on appearance while at the same time denying access to it by science. Phenomenology could thus have the not very felicitous designation of anti-scientific realism.

6.1. Epistemons and Ontolons

Igamberdiev in [95], referring to prior work by Barham, proposed the concept of an 'epistemon' as a description of the sub-systems present in biological functions. Barham [106] regarded living cells as 'epistemic engines', in which a low energy or regulation (epistemic) stroke and a high energy or work (pragmatic) stroke constitute the work cycle. A similar representation was introduced much earlier by the founder of biosemiotics Jakob von Uexküll [109,110]. In fact, Barham may just have rediscovered the latter's semiotic cycle, both phases of the cycle are connected in such a way that the

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9   Whether Being can be talked of in terms of proper parts is an interesting question which has been discussed by Capurro but will not concern us further here.

low-energy (informational) constraints act as signs with respect to high energy (pragmatic) constraints, leading to semiotic, epistemic correlations that have predictive value and which can insure a semiotic, epistemic correlation between the measurement of low-energy environmental signals and the response. The recognition, through its active site of an enzyme to an external chemical stimulus, based on its structure, is such an epistemon. This reaction cannot, at the present level of knowledge, be predicted from the structure *a priori*, but the two components in interaction can be said to be joined by a relation possessing semiotic character. The stability and reproducibility of this relation is made possible via operation of a second semiotic subsystem—the encoding (digital) system. Biological systems therefore include two semiotic subsystems, one based on the structure of imprint and on the recognition of three-dimensional shapes (images), and the other based on the digital linear structure of code.

The interpretation currently preferred by both Authors is based on living systems being first and foremost real, physical, dynamic systems, with a corresponding ontology and hence describable by the 'onto-logic' of Logic in Reality. As in the previous Section, the semiotic descriptions of the meaning-laden biological processes are not false, but are abstractions from the actual flows of energy and molecules in progress. To try to capture these notions, we replace the concept of an 'epistemon' by that of an 'ontolon', an identifiable but dynamic 'individual' (cf. Krause [37]) that refers to or better implies a portion, recognized as such, of that ontological process. As such, an ontolon is a quasi-individual, individual and non-individual, and is an analogue of a quantum system, but only an analogue, quantum-*like*. The ascription of *essential* quantum properties to brain processes is an epistemic ascription.

In contrast to the previous picture, however, our current focus is on actual change rather than on the interpretation of that change, rendering the designation of 'semiotic' almost superfluous. We say almost in order not to exclude epistemological interpretations, but only to insure the proper ontological priority to the dynamics and its logic—LIR. Semiosis in LIR thus describes a *process*, not the application of a doctrine. As a natural process, it is something that starts and stops, and is more or less complete or correct, even persuasive or unpersuasive.

As hypothetical entity, however, the ontolon as some kind of *unit* of real processes-in-progress suggests a kind of identity. We retain for discussion the possibility of a similarity between an ontolon and the Epicurean 'atom' possessing the property of a *clinamen* described above. It thus appears to conflict with our general philosophy of avoiding epistemic identities to describe complex, dynamic phenomena. We argue that there is no *a priori* reason and not to see a process as composed of parts, provided it is understood that these 'parts' are not absolutely separated from a 'whole'. Lupasco showed that a new mereology was implied by the Principle of Dynamic Opposition mentioned above.

Ontolons are thus real, but unlike the epistemological counters of Peirce, we do not require any superaddition of classification or categorization. One can use the concept of ontolons as a device to help focus on the ontological characteristics of processes in relation to other critical aspects such as their ethical valence.

To complete this preliminary discussion of the ontolon as a concept of the parts or entities of dynamic processes, let us briefly consider three other attempts to identify or characterize them. Capurro [111] sees the clear historical derivation from the Greek *ta onta*, a neuter plural participle form best translated by 'existings' or beings. The singular, *to on*, a being, understood as a verbal, participle hence 'dynamic' form would be the equivalent of the ontolon. This interpretation is only acceptable to us if being here includes *becoming*, the processual activity of reality. In our opinion, any attempt to totally separate being from becoming is incorrect. Support (not proof; we are not in a domain of 'proof') comes from the perhaps little-known fact that in several Indo-European languages, the original word for *be* and *become* as the same.

6.2. Ontolons and Information. The Informosome

Following the statement that meaningful information is reality in potential form, we will discuss here how the action of information takes place as a dynamical semiotic process in which the contradictions co-existing as potentialities are resolved during their actualizations and form the basis

of new contradictions. We will show that before studying the dynamic process in physics, biology or sociology, we should define the basic ontolon structure for each system. In the frames of this structure, the contradictions become fixed and the system is able to perform a transition to a new level of complexity realizing the principle of negation of negation. By identifying the dynamical structure of ontolon, we understand the basis of a dialectical discourse in the course of interaction between ontolons. A continuous reproduction of a semiotic relation in the structure of ontolon occurs via the process representing the transfer of information.

Peirce coined the neologism 'phaneron' to designate something like the *idea* of Locke forming the 'immediate content of awareness' as opposed to phenomenon. "The phaneron is what appears, as it appears, even if, as it appears, it appears to be more than mere appearance". The difficulty is that Peirce made no ontological commitment regarding his concepts. He wrote specifically that his 'phaneroscopy' (phenomenology) had nothing at all to do with the question of how far the 'phanerons' it studied correspond to any realities. Elsewhere Peirce says that the phaneron is the totality of what is "in any sense present to the mind, quite regardless of whether it corresponds to any real thing or not." We can only agree with Short [112] that Peirce's positions were "fragmentary, marvelously inconsistent and often unpersuasive". We will attempt to tie our ontolon as closely as possible to the evolution of real physical, biological and cognitive processes.

First, the distinction between *res extensa* and *res cogitans* as the basic attributes of the primary substance in the sense of Spinoza defines the two aspects of movement. While the mechanical cause of movement is well assimilated by physics and can be referred to Aristotelian material and formal causes, the cause associated with *res cogitans* is of a different nature and can be associated with Aristotelian efficient and final causes. It is not necessarily associated with consciousness; rather it is a prerequisite of consciousness at higher levels of complexity appearing during the self-movement of the substance that includes both mechanical and non-mechanical constituents. The basic function of cognition, according to Spinoza, is to move and arrange external objects in which mechanical forces can be controlled but not directly involved.

As discussed in Section 2, in Epicurean terms, the non-mechanical cause will correspond in the control of *clinamen* by the group of atoms that use their own *clinamina* to restrict *clinamina* of other atoms in the organized system. In other words, which are relevant to modern quantum mechanical terms, a group of these atoms appears as a device (representation of an "agency") that measures potential trajectories of other atoms and imposes control over their movement, i.e., it navigates them. The unpredictable deviation of these atoms from the established trajectory becomes a prerequisite of their incorporation into a complex system where their potential deviation is restricted. The complex system of atoms acquires the non-mechanical property of internal measurement [113] in which it is subdivided into levels and attains control. The controlling part (navigator) and the controlled (navigated) part are interrelated within the cyclic structure possessing the property of retrocausality [114] in which the transfer of information takes place and the potential state is taken as the meaningful prerequisite of continuous realization of the stable self-supported state of the system. The action that appears as voluntary in fact represents an example of non-mechanical causality that at higher levels of organization becomes mental causality. When the measuring device represents a part of measured system, the measurement proceeds internally in relation to the whole system. The system undergoes complexification in the course of such continuous internal measurement because it leads to an iterative recursive process. This process corresponds to evolution of the whole system.

The internal measuring device measures, among other elements of the measured system, itself in the state of measuring, which limits possible accuracy of quantum measurement and manifests itself as the uncertainty principle [115]. The increase in complexity as a result of quantum measurement corresponds to the increase in complexity in the course of evolution of the system which can be viewed as a potentially infinite recursive embedding process. There was an attempt to explain the visible expansion of the Universe as a consequence of this infinite recursion [116].

The concept of a dynamic 'unit' of process experience can be found in Wu's concept of an 'informosome'. In his philosophical classification Wu Kun [117,118], any existing material structure contains in itself its 'condensed' history, its current properties and the information of its possible or potential future development. It is a 'condensation' of the contents of all relevant operative relationships. This term is currently in use in biology [119] to refer to mechanisms of protein transfer in the cell, but this process should indeed be understood as informational in the broad sense of this paper. This is a further consequence of our view that both material processes and their informational components evolve together [120]. The term exposome refers to the totality of environmental exposures of an individual from conception onwards, and has been proposed as a critical entity for disease etiology. We note that, interestingly, that like the informosome, the exposome is constituted by a totality of *information*. It *is* an informosome.

6.3. Ontolons and Semiosis in Living Systems. Second-order Non-linearity and Poincaré Oscillators

When we consider a cyclic structure with internal semiosis, we may imagine such structures in living systems; however, even in simple organized physical systems such as the hydrogen atom, the controlled restriction in the field of potentialities takes place. An electron in its conjunction with proton can be actualized within certain restricted spatio-temporal area, and the spontaneous collapse of wave function becomes restricted within the organized structure of the atom. This reduction of the field of potentialities bears the information that elementary particle acquires within the atom. At the next level of interaction, the cyclic dynamic structure can recognize other structures that are external to it and react in a way that aims to resist possible destruction that can appear as a result of direct mechanical contact.

Nonlinearity and non-linear dynamics have become substantial new subjects of research in their own right, with two journals being published with those titles! The simplest description of a non-linear system is one in which the change of the output is not proportional to the change of the input. Generally, one tries to use a non-linear system of dynamical equations to describe a complex system. A complex system is loosely defined as constructed by a large number of simple, mutually interacting parts, capable of exchanging stimuli with its environment and of adapting its internal structure as a consequence of such interaction. The non-linear interactions involved can give rise to coherent, emergent complex behavior with a rich structure. Key concepts in complexity science are, for example, the coexistence of diversity and stability, for which LIR provides an interpretation. Complexity science also looks at the dynamics of systems in transition regions of self-organized criticality, but as these are difficult to solve, they are approximated by linear ones, but some phenomena may be hidden by this strategy such as chaos, singularities, and solitons or, we now would add, ontolons. Thus the dynamic behavior of a non-linear system may appear to be counterintuitive and unpredictable.

For us, this picture is quite primitive, since the interactions at the heart of a process and their movement from actuality to potentiality is obscured. We see the term non-linear as describing the complex path between prior and subsequent states of a process from both mathematical and physical perspectives and, we now add, logical ones as well based on Logic in Reality. Thus, *any* movement from cause to effect can be seen as a highly non-linear, multi-dimensional process.

But in what exactly does the non-linearity of non-linear dynamics consist? Many physical phenomena are described as emergent: tornadoes certainly arise from complex temperature and humidity gradients, and such systems are considered to be the consequence of non-linear dynamic interactions. From the LIR standpoint, they are (almost) pure, actualized macrophysical processes with no form of internal representation or semantics. Other examples are the dissipative, far-from-equilibrium systems described by Prigogine, and the intrinsically simple structures such as the convection cells in heated liquids or certain oscillating chemical systems, as discussed below.

Our conclusion from this brief overview of the standard notion of non-linearity is that it is *not* a domain to which the principles of LIR apply. We might call the phenomena referred to, to try to characterize the relation, as first-order non-linear processes. If we look at phenomena instantiating the

properties of recursion and self-reference, and, consequently, of the Principle of Dynamic Opposition, we start to see an underlying unity which justifies referring to them as instantiating second-order non-linearity. Further parallels can be drawn to concepts of Synchronic Downward Causation.

We propose that this semiotic system first described by Jacob von Uexküll in relation to living systems [109] represents the basic structure of an ontolon as the element of actualized substance bearing not only spatiotemporal but also cognitive attributes. In a different context, this structure was introduced by James Barham [107] in his model of the dynamical informational semiosis. In his theory of the meaning of information he identifies meaningful functions with generalized non-linear oscillators and their associated phase space attractors. By postulating the existence within such oscillators of a component capable of coordinating low-energy interactions with the correct environmental conditions supporting the dynamical stability of the oscillator the meaning of information is interpreted as the prediction of successful functional action. This can be considered as elementary structure of an ontolon, extending Barham's definition of 'epistemon'. The epistemic function should be considered as a secondary to the ontic nature of such structure that represents the basic unit of nature that can potentially evolve into a complex cognitive system.

In fact, the original invention of such structures should be attributed to Henri Poincaré who introduced non-linear dynamics and differential topology in physics in his concept of the Poincaré map describing the simplest non-linear system called the Duffing oscillator. Glass and Mackey [120] suggested that all systems exhibiting limit-cycle behavior should be termed Poincaré oscillators. This structure can be viewed as the basic structure of the ontolon that is realized at different levels of organization. The periodic orbit of the continuous dynamical system is stable if and only if the fixed point of the discrete dynamical system is stable. The trajectory of such oscillators can be called a periodical attractor or limit cycle. The simplest Poincaré oscillator does not assume a developed internal structure, but a complex internal structure can potentially arise as a result of its evolution towards the expansion of its external stability supported by more sophisticated internal dynamics attributed to its "agency". What is important to point out here is that the interaction of Poincaré oscillators having internal information dynamics can be described as a discourse, which result may not be deterministically anticipated. The oscillator itself has its internal rule that appears as its internal logic, and for its revelation in our description as a meta-logic, it is necessary to describe its behavior as a dialectical process.

While classical mechanical movement can be described by bivalent formal logic, the description of the movement that involves control of potential realizations involves another logical scheme that incorporates the potential-actual states as prerequisites of transition (LIR). This meta-logic is the logic of non-mechanical causality and it can be defined as a dialectical logic in its broad sense. It treats causality as the achievement of a solution established in the discourse of communicating ontolons. In this communication, ontolons can oppose each other or unite in larger ontolons in which the unified system of control is formed. We will further consider the internal structure of ontolons corresponding to living systems and to conscious systems. But if we consider all hierarchies of ontolons, we should briefly return to non-living reality and emphasize that even at the lowest quantum level the reality is can be seen with two attributes, one spatial and the other dynamic. This is reflected in the characteristics of quantum as a "wave-pilot" in the de Broglie interpretation [121].

In relation to the phenomenon of life, the ontolon structure is based on the internal constraints that support the uniqueness of each biological system and its self-maintenance. In this representation, it is possible to understand how biological systems enter into a dialectical discourse that corresponds to the operation of the LIR Principle of Dynamic Opposition. It is thus an oversimplification to view biosystems as simply separable into two functional parts, corresponding to a hardware and software. This static approach is still popular in biosemiotics (see previous Section 5) and other rather reductionist concepts. Such concepts ignore the dynamic aspect of semiosis which consists in the fact that the significant system of the genome is internally reproduced within the system and is repaired through sets of internal constraints representing the feedback from the elements that it encodes. Such a system represents a whole with a locally stable point attractor of the Poincaréan type.

The apparent independence of symbol systems from physical laws follows from the analysis of Poincaréan type oscillators representing the basis of the semiotic dynamical cycles described by von Uexküll and Barham. The view that genetic symbol systems have evolved so far from the origin of life and that semiotics does not appear to have any necessary relation whatsoever to physical laws is also true, but it occults the fact that the processes involved instantiate the same categories of Dynamic Opposition and Non-Separability. Pattee [122] states that information does not belong to the category of universal and inexorable physical laws but refers to initial conditions and boundary conditions. Boundary conditions formed by local structures are called constraints, while informational structures such as symbol vehicles are a special type of constraint. Pattee [123] claims that life and evolvability require the complex interaction of rate-independent symbol constraints and rate-dependent physical dynamics. However, the concepts of initial conditions and constraints in physics make sense only in the context of the law-based physical dynamics to which they apply. This is also the case for the concept of information. We agree with Pattee that the illusion of isolation of symbols from matter can arise from the arbitrariness of the apparent epistemic cut. Further, the apparent isolation of symbolic expression from physics seems due to an epistemic necessity, but ontologically it is still an illusion; making a clear distinction is not the same as isolation from all relations. In general, one clearly separates the genotype from the phenotype, but from an operative standpoint, one certainly does not think of them as isolated or independent entities.

Further elaboration of the matter-symbol problem is possible using the two-level framework of analysis implied by LIR. If the illusion of isolation is an epistemic illusion, whose reality is accepted, this means that symbolic expression is not metaphysically isolated from physics. Consequently, their relation or interaction is real, and it can be considered to have an appropriate dynamics. The remaining question concerns the use of antagonism or constraints to characterize these dynamics. This can be resolved by a view of symbolic memory constraints as dynamic processes in themselves, co-evolving with the other components of biological systems [1].

6.4. Rosen's Model and an Endoperspective

Besides the error-correcting cybernetic controls, the system contains anticipatory mechanisms to pre-empt possible errors, as discussed by Rosen and others [124]. These controls are realized through the agency of a predictive model, converting present information into predicted future consequences. These are *ipso facto* essentially potential and their evolution follows the rules of LIR.

Rosen suggested an alternative to a classical dualistic genetic model of the biological system. He called it the (M, R) system where M is metabolism and R is repair or, as later suggested, replacement [125]. Elements of the metabolic system are continuously replaced and the elements that replace them are also replaced, and this can go to the infinite regression. However, Rosen stated that the system can be "closed to efficient causation" and contain the internal principle of organizational invariance [125] which results in avoiding infinite regression and closing the system in a stable non-equilibrium state in which the system, remaining open to the material flows, becomes selective for them and closed to the efficient causes that are locked inside of it. This structure is based on the principle of "organizational invariance" [126] that escapes the infinite regression for the internal system's time T, during which the system stably performs its function and avoids "global system failure".

Rosen's theory formulates the basic ontolon structure for living systems. Other approaches include Eigen's theory of hypercycles [127] and the autopoietic theory of Maturana and Varela [128] which have common features to Rosen's model but remain less developed in relation to their formalizable and hence logical and ultimately computational value, where possible. Rosen's (M, R) system includes the operation defined by β which designates the system as a whole and acts as a generator of the complete enclosed structure of (M, R) systems. There is no rigid algorithm to take β as this operation has its own ambiguity, but when the β is taken, this ambiguity becomes frozen and internal computation becomes possible (cf. the 'frozen dialectics' of Lupasco [35]. Later, Gunji et al. [129] came to the idea of describing the organizational invariance of a biological system from the point of view of

"heterarchy" which naturally involves self-reference through the inherited logical inconsistencies between levels. One description of a heterarchy is as a dualism of the property of self-reference and the property of a frame problem, interacting energetically with each other. The research program of Gunji represents an important current development of Rosen's ideas in which a successful explanation of internally constrained principles of animal behavior and human consciousness has been reached [129]. Rosen's understanding of organizational invariance is similar to Gödel's encoding of statements about the system within it in the application to biological systems. The β parameter representing organizational invariance is equivalent to an agent establishing the set of Gödel numbers generated within the system. The whole biological system can be viewed as consisting of: (a) Metabolism—sets and relations; (b) Replacement—relations on relations; and (c) Organizational invariance—Gödel statements about the sets actually in place and their dynamic relations. It is important to note that Gödel statements are not sets or relations; they are meta-mathematical statements with the dual function of both sets and relations. Logic in Reality is the first *metalogical* system in which such statements can be embedded and given a real interpretation. Thus, the triadic structure of life includes sets, relations, and meta-mathematical as well as metalogical statements (encoded within the system) that are as real and as causally efficient as much as any physical element of the system. Translation of these statements into the system occurs via a sophisticated 'machinery' of transcription, translation and recombination, e.g., splicing events. But we remind the reader that any such event is a consequence of the real dualities or polarities in chemical and biological systems and the movement within them between potentiality and actuality and vice versa.

6.5. The Ontolon Structures of Social Consciousness and Systems

When we turn to individual and social systems instantiating reflexive consciousness, we find more advanced ontolon structures of the Poincaréan type. The theory of functional systems of Pyotr Anokhin [130] explores the basic ontolon structure for such systems. These systems are based not on the linear transmission of information from receptors to executive organs but composed of synchronized distributed elements organized non-linearly. They support homeostasis due to a change of behavior occurring in the course of interaction with the outside world. The Poincaréan systems including Uexkull's biosemiotics system and, in relation to cognitive events, Anokhin's functional system represent these basic non-linear structures viewed externally, partly but not totally separated from the internal reflexive relation viewed from an endoperspective. The endoperspective in the dynamics of organized systems was explored earlier in dialectical discourse starting with Heraclitus, Plato and Aristotle. The movement of science towards an endoperspective today represents a new level of understanding that as demonstrated by the concepts of Rosen and Gunji, to which the principles and dialectics of Logic in Reality apply.

Social communication, in the light of the LIR approach to communication outlined in Section 5.6, becomes a prerequisite of reflexive consciousness. According to Lev Vygotsky and further to Evald Ilyenkov, all higher psychic functions are the internalized social relations. They determine first the interdictive relations where certain actions are prohibited and then turn to the suggestive phase where these prohibitions are internalized (Boris Porshnev [131]) and the person becomes the other for himself and by this controls, regulates and changes his own activity towards other individuals and the external world in total. Almost identical language for the internalization of the nominally external 'other' was used by Igamberdiev to show the ultimately logical rationale for ethical behavior [60]. The work studied by Brenner [1] provides a more detailed scientific explication of Lupasco's insights in this area.

The prerequisite of domination is another important feature of nervous system called the law of dominance formulated by Alexei Ukhtomsky. By "dominant" Ukhtomsky defined "a more or less stable focus of increased excitability, evoked in whatever way, and stimuli newly arriving at the centers of excitation serve to amplify (reinforce) excitation in this focus, while in the rest of the central nervous system inhibition spreads widely" [132]. Through the dominance of the reflexive excitation in nervous system, the "internal speech" is formed that can be represented as a reflexive relation of the structure

of the subject. The mechanism of reference of the subject to himself represents an elementary unit of reflexive consciousness. It also determines the relation of a human being to other human beings which basis is the system of mirror neurons that fire both when the subject acts and when he observes the same action performed by another. The system of references to him/herself and to others leads to the formation of discrete reflexive types that contradict to each other, interact and form complex social relations. This was developed further in the reflexive psychology of Vladimir Lefebvre.

In psychology, the subject becomes a part of a system where it can reflect himself. In this system, the biological reality is represented as unconscious and interpreted as *Ego* through signification by the image of other, *Superego* (Freud) or *Symbolic* (Lacan). It can be considered another logical pattern describing interrelations between consciousness and the external world. It determines the fixation of somebody's image into the other as a possibility to substitute the other [133]. In formalization of this model by Lefebvre [134], the subject A_1 constructs the image of himself (a_2) and his image's image of himself (a_3). The subject's state a_1 will be a composition of the contradictory statements a_2 and a_3. Thus, the subject will correspond to a character $A_1 \equiv a_1 a_2 a_3$. The labor activity of humans is accompanied by the semiotic internalization of tools in the language. The thesis of Vygotsky [135] about the internalization of labor tools in the signs of language is incorporated into this paradigm. To link the labor activity to mental development, the internalization factor is necessarily similar to the "organizational invariance" β in Rosen's theory. This transition reflects the ideas of Vygotsky on development as a process of internalization. The bodies of knowledge and tools of thought evolve and are linked together to form a new dynamic entity of the human culture—an ontolon—internalizing the environment. Development consists of the gradual internalization of the environment, primarily through the language, to form cultural adaptation. Piaget [136] considered that several stages of such internalization during the development of the individual child reflect an evolutionary succession. In other words, such internalization proceeds via the establishment of a relation to the external reality.

6.6. Experimental Metaphysics. Categories

These considerations provide an occasion to say what our approach, in the 'language' of ontolons and epistemons, is *not*. It is not an 'experimental metaphysics' in the concept of Shimony and of Redhead [137]. Methods of valid argument in current philosophy still embody the tautological assumptions of classical, propositional logic and its notion of truth. Redhead's (well-intentioned) movement "from physics to metaphysics» moved further away, not towards, reality.

The metaphysical world-view that is implied by the Principle of Dynamic Opposition (PDO) is compatible with the 'metaphysical revision that has been engendered by quantum mechanics', in the phrase of Vlatko Vedral [138]. One does not have to have a prior 'orthodox' concept of reality in order to define the best possible active role for what is observed, namely, that dualities are present at all levels of reality, starting with that of the quantum field. The dualities in question have a kind of part-whole relation to the world, but one need not assume that at the end of this analysis, one will have captured all the essential aspects of the world. As noted above, one will not have, as a consequence, a 'Theory of Everything' (which was not an objective in the first place), but one will have a framework that can evolve in parallel with further development in the physical understanding of our universe. Our view is consistent with the work of Vedral.

Logic in Reality, as outlined in [1] includes a 'New Energy Ontology' which includes categories but redefines their characteristics. The absolute, binary concepts, exclusivity and exhaustivity are eliminated in favor of a dynamic relation between 'objects and forms' of thought. The role of such categories in ontology is essential in defining LIR as a conceptual structure that has additional explanatory power. In a categorial realist conception, as suggested by Thomasson [139], "providing a system of categories can be seen as a, or even *the* central task of metaphysics". We believe a robustly realist position is made more plausible by the principles of LIR, since they improve our ability to discern intrinsic divisions and redefine changes or movements in physical reality as the "entities" in the category of existence. For our purposes it is not necessary to decide for an ontological or metaphysical reading of the term 'category': both can be used as they complement one another.

6.7. The Ontological Priority of Ontolons

In contrast to the concept of 'monads' (cf. Leibniz) the notion of ontolons as entities or forms of existence—'being in reality'—has received far less discussion. We propose ontolon as our basic term for the essences of beings-in-reality, for the ***forms of existence*** which assume a multiplicity of dynamic processes in the extant domain, including knowing. The epistemon, then, represents the internal semiotic structure of ontolons, their epistemic representation. Logic in Reality provides the framework for the description of both ontic and epistemic processes and their relations, united via the transcending cognitive logical operations involving potential and actual states in interaction. Taken to its logical (*sic*) conclusion, the notion of ontolon is better grounded in reality than that of monad. It can replace the term of monad and, eventually, that of the *Dasein* of Heidegger in a Philosophy in Reality in which the number of non-natural concepts are reduced to a minimum.

7. Summary and Conclusions

In the spirit of this paper, and its emphasis on process rather than products, we see our 'conclusion' also as not final but as a pointer toward processes leading to further and better descriptions of reality. Our description here of reality and its philosophy simply assumes that we apply certain schemes of valid reasoning which are nevertheless based on reasoning as an ontological as well as epistemological process. The reasoning can still be formal or informal. Formal reasoning has proven to be a powerful tool for understanding our world. However, the application of formal reasoning, like any human cognitive process, is partly informal and cannot be fully grasped in terms of formal logic alone. This process is *dialectical* in that if different solutions are present at the same time the optimal one is chosen. It has been described for example by Magnani [140], following Peirce, as abduction, but in our view this approach is limited to an epistemology. It does resemble the search for proper Gödel numbers to analyze the validity of formal description in the proof of the incompleteness theorem. Wittgenstein was the first who suggested that such epistemological processes appear as language games, and their formalization can be processed as description of moves in games. This is achieved in the theory of defeasible reasoning, which is the reasoning that is rationally compelling, though not deductively valid. The approaches to set the limits of formalization of dialectics have been developed by such philosophers as Nicholas Rescher [141], Frans H. van Eemeren and Rob Grootendorst [142], but, again, mainly in the relation to argumentation in communication as solely a linguistic process. A more advanced dynamic approach with application to the nature of consciousness itself is being developed by Yukio-Pegio Gunji et al. [143]. They propose a measurement-oriented inference system comprising Bayesian and inverse Bayesian inferences. In this model, Bayesian inference contracts the probability space while the inverse inference relaxes it which allows a subject to make a decision corresponding to an immediate change in the environment. To date, this model with two inferences represents the best attempt at a representation of the dialectical discourse by means of formal models.

To the extent that dialectics also refers to informal reasoning, the question arises how discourse based on informal reasoning is possible in the real world before the appearance of consciousness. As Engels [15] stated, "nature is the proof of dialectics", and such statements sound like the action of Diogenes who proved the reality of movement by walking as his 'dynamic' refutation of Zeno's paradoxes. In fact, dialectics is an example of informal reasoning itself. The answer to our question lies in the fact that the Being that becomes the Being-in-Reality (*Dasein* in the Heideggerian terms) appears as a multiplicity of the forms of existence for which we have proposed the term ontolons. (Our 'multiplicity of forms' is clearly related to the insights of classical Chinese formulations [144]).

Ontolons are thus the dynamic counterparts of well-known prior entities, namely, the monad and the 'Thing-in-Itself'. Each ontolon, besides the property of deterministic mechanical movement arising from its spatio-temporality (*res extensa*), possesses the property that manifests the internal self (*res cogitans*). Even in its simplest forms it is exhibited in unpredictable (non-deterministic in mechanical sense) movement. This is what Epicurus called the *clinamen*. Being unpredictable originally, it can

become controlled in communication between ontolons, in which a reduction of potentialities for totally free movement takes place.

In reality, of course, we are now in the domain of the further *res potentia* of Heisenberg, reviewed recently by Brenner in [145]. In this discourse, ontolons can be seen as forming more advanced structures, in which potentiality inheres *a priori*, leading finally to the appearance of epistemic properties corresponding to life and finally consciousness. The reality in this framework can be represented as a set of forms of existence capable of a continuous process of complexification in which the most optimal realizations can occur. This is what Luhn [146] has called, coming from the side of Information Science, the 'search' by the universe for new dynamic states.

Self is seen as the principle that governs *clinamina*. We cannot see the self as we do not have "window" (in the Leibniz sense) to see it but we can logically deduce its existence through the observation of reduction of potentialities that takes place and thus we have access to "Processes-in-Themselves", as ontolons. We become involved in the Processes-in-Themselves in a such a way—better we *are* those processes—that we are able to apply formal reasoning to them (and eventually compute those which are computable.) But, to repeat, the process of discovery via formal reasoning remains informal and appears as a dialectical process occurring in nature. A very suggestive link can be made here to the concept of Natural Computation currently being developed by Gordana Dodig-Crnkovic [147] and others. As stated above, it should be described within a framework that includes both ontic and epistemic processes and their relations, united via the transcending cognitive logical operations involving potential and actual states in interaction. The logic of the included middle introduced by Lupasco [35] in its current version as Logic in Reality [1] provides such a framework.

Principles and the Common Good

This paper is about principles of science, philosophy and logic, but it is also a statement *of* principle: we do not believe that any philosophic 'work' of the kind we are engaged in can be justified, as can pure science, if it is 'pure' philosophy. The use of human and natural resources can be justified for science, as such and as a part of natural philosophy, *because* is directed at increases in understanding of the real world. At the other extreme, we have the discussions, following Kripke and others, of possible worlds that have no existence other than that of fictional objects.

There is another operative principle that we can state as a conclusion of this study: any synthesis we seek will not be dependent on any absolute criteria of truth or completeness, but will seek to incorporate or in any event refer as far as possible to contradictory or opposing points of view. The second is that, as a metaprinciple, one can talk about principles at all, which some have contested. We are left with a criterion of utility like that of J. S. Mill which has been considered 'weak' and non-scientific. But this is exactly our thesis, even though by our own criteria we cannot prove or justify it, but support it on a methodological basis, that is, that dialectics and the Lupascian logic give the least abstract possible picture of the world.

Our dialectical approach leads to recovery of both dialectics and semiotics from reductionist interpretations and to their reunification in a new synthetic paradigm centered on meaning and its communication. Our concept unites science, logic and philosophy in a common meta-thesis and provides the real contours of a basic understanding of nature and civilization.

Formalization of dialectical logic cannot be complete and that is why it tends, like other 'diversities', to be ignored in scientific discourse [29]. However, the logic of real processes to redefine the ontological relations between meaning, communication and language will always remain a fundamental task; it forms the background of any description of nature that can accompany the new functional convergence of science and philosophy in progress. We consider the development of this 'dialectical realism' as a basis of the ethical development of knowledge for the common good.

Author Contributions: Conceptualization, J.E.B. and A.U.I.; Writing—original draft, J.E.B. and A.U.I.

References

1.   Brenner, J. *Logic in Reality*; Springer: Dordrecht, The Netherlands, 2008.
2.   Wu, K. The Interaction and Convergence of the Philosophy and Science of Information. In Proceedings of the 2nd International Conference on the Philosophy of Information, Vienna, Austria, 6 June 2015.
3.   Wu, K.; Brenner, J. The Informational Stance: Philosophy and Logic. Part I: The Basic Theories. *Log. Log. Philos.* **2013**, *22*, 1–41.
4.   Boole, G. *The Laws of Thought. On Which Are Founded the Mathematical Theories of Logic and Probabilities*; Dover Publications, Inc.: Mineola, NY, USA, 1958; p. 424, Originally Published by Macmillan, NY, 1854.
5.   Deleuze, G.; Krauss, R. Plato and the Simulacrum. *October* **1983**, *27*, 45–56. [CrossRef]
6.   Alcoff, L.; Shomali, A. Adorno's Dialectical Realism. *Symp. Can. J. Cont. Philos./Rev. Can. De Philos. Cont.* **2010**, *14*, 45–65. [CrossRef]
7.   McGinn, C. *Basic Structures of Reality. Essays in Meta-Physics*; Oxford University Press: Oxford, UK, 2011; p. 174.
8.   Dodig-Crnkovic, G.; Schroeder, M. Contemporary Natural Philosophy and Philosophies. *Philosophies* **2018**, *3*, 42. [CrossRef]
9.   Brenner, J. The Naturalization of Natural Philosophy. *Philosophies* **2018**, *3*, 41. [CrossRef]
10. Igamberdiev, A.U. Time and life in the relational universe: Prolegomena to an integral paradigm of natural philosophy. *Philosophies* **2018**, *3*, 30. [CrossRef]
11. Stent, G.S. *Molecular Genetics; an Introductory Narrative*; W.H. Freeman: San Francisco, CA, USA, 1971.
12. Aristotle. On the Soul. In *The Complete Works of Aristotle*; Barnes, J., Ed.; Smith, J.A., Translator; Princeton University Press: Princeton, NJ, USA, 1995; pp. 641–692.
13. Rovelli, C. *The First Scientist. Anaximander and His Legacy*; Westholme Publishing: Yardley, PA, USA, 2011.
14. Kant, I. *Critique of Pure Reason*; Cambridge University Press: Cambridge, UK, 1998; Originally published 1781.
15. Engels, F. *Dialectics of Nature*; Progress Publishers: Moscow, Russia, 1976; Originally published 1877.
16. Needham, J. *Moulds of Understanding*; George Allen & Unwin: Crows Nest, Australia, 1976.
17. Mamardashvili, M.K. *Cartesian Meditations*; Progress: Moscow, Russia, 1993. (In Russian)
18. Ilyenkov, E.V. *Dialectical Logic, Essays on its History and Theory*; Aakar Books: Delhi, India, 2008; Originally published in Russian 1977.
19. Voevodsky, V. A1-homotopy theory. *Proc. Int. Cong. Math.* **1998**, *1*, 579–604.
20. Hume, D. *Dialogues Concerning Natural Religion*; Cambridge University Press: Cambrdige, UK, 2007; Originally published 1779.
21. Smolin, L. *The Life of the Cosmos*; Oxford University Press: Oxford, UK, 1997.
22. Brenner, J. Consciousness as Process: A New Logical Perspective. *APA Newsl.* **2018**, *18*, 10–22.
23. Brenner, J. The Philosophy of Ecology and Sustainability: New Logical and Informational Dimensions. *Philosophies* **2018**, *3*, 16. [CrossRef]
24. Nicolescu, B. *Nous, la particule et le monde*; Editions du Rocher: Paris, France, 2002; (Originally published in Paris: Éditions Le Mail, 1985).
25. Information and Communications Technologies and Society. In *Proceedings of the Summit Conference on Information*; International Society for Studies of Information: Vienna, Austria, 2015.
26. Brenner, J. Three Aspects of Information Science in Reality: Symmetry, Semiotics and Society. *Information* **2015**, *6*, 750–772. [CrossRef]
27. Wu, K.; Brenner, J. Informational Thinking and Systems Thinking: A Comparison. In Proceedings of the Foundations of Information Conference, Moscow, Russia, 13 June 2013.
28. Hofkirchner, W. *Emergent Information. A Unified Theory of Information Framework: World Scientific Series in Information Studies*; World Scientific: Singapore, 2013; Volume 3, p. 239.
29. Brenner, J. Process in Reality: A Logical Offering. *Log. Log. Philos.* **2005**, *14*, 165–202. [CrossRef]
30. Brenner, J. Information in Reality: Logic and Metaphysics. *Triple-C* **2011**, *9*, 332–341. [CrossRef]

31. Roy, S. Quantum Probability Theory and non-Boolean Logic. In *Decision Making and Modeling in Computer Science*; Springer: Delhi, India, 2016.

32. Aerts, D.; D'Hooghe, B. Potentiality States: Quantum versus Classical Emergence. *arXiv* **2012**, arXiv:1212.0104v1.

33. Conte, E.; Khrennikov, A.; Zbilut, J.P. The Transition from Ontic Potentiality to Actualization of States in a Quantum Mechanical Approach to Reality. *arXiv* **2006**, arXiv:quant-ph/0607196.

34. Lupasco, S. *L'univers psychique*; Denoël/Gonthier: Paris, France, 1979.

35. Lupasco, S. *Le principe d'antagonisme et la logique de l'énergie*; Editions du Rocher: Paris, France, 1987; (Originally published in Paris: Éditions Hermann, 1951).

36. Aerts, D.; D'Hondt, E.; Gabora, L. Why the Logical Disjunction in Quantum Logic is not Classical. *Found. Phys.* **2000**, *30*, 1473–1480. [CrossRef]

37. Krause, D. Separable Non-Individuals. *Representaciones* **2005**, *1*, 21–36.

38. Stcherbatsky, F.T. *Buddhist Logic*; Dover: New York, NY, USA, 1962; Originally published in Leningrad: Academy of Sciences of the U.S.S.R., 1930, p. 17.

39. Cao, T.Y. *Conceptual Developments of 20th Century Field Theories*; Cambridge University Press: Cambridge, UK, 1997.

40. Lupasco, S. *Logique et Contradiction*; Presses Universitaires de France: Paris, France, 1947.

41. Taylor, C. *Hegel*; Cambridge University Press: Cambridge, UK, 1975.

42. Sanchez-Palencia, E. *Promenade Dialectique dans les Sciences*; Hermann Éditeurs: Paris, France, 2012.

43. Priest, G. *Contradiction*; Martinus Nijhoff Publishers: Dordrecht, The Netherlands; Boston, MA, USA; Lancaster, UK, 1987.

44. Priest, G. Dialectic and Dialetheic. *Sci. Soc.* **1989**, *53*, 388–415.

45. Lupasco, S. *L'énergie et la matière vivante*; Éditions du Rocher: Monaco, 1986; (Originally published in Paris: Julliard, 1962).

46. Bohm, D.; Hiley, B. *The Undivided Universe. An Ontological Interpretation of Quantum Theory*; Routledge: London, UK; New York, NY, USA, 1993.

47. Arthur, C. *The New Dialectic and Marx's Capital*; Akkar Books: Delhi, India, 2013.

48. Deacon, T. *Incomplete Nature: How Mind Evolved from Matter*; W.W. Norton & Co.: New York, NY, USA, 2012.

49. Lakoff, G.; Johnson, M. Philosophy in the Flesh. In *The Embodied Mind and its Challenge to Western Thought*; Basic Books: New York, NY, USA, 1999.

50. Marx, K. *Das Kapital: Kritik der politischen Oekonomie*, 1st ed.; Verlag von Otto Meissner: Hamburg, Germany, 1867.

51. Carrera, J. The Consciousness of the Working Class as Historical Subject. In *Marx's Capital and Hegel's Logic. A Reexamination*; Haymarket Books: Leiden, The Netherlands, 2014.

52. Bellofiore, R. Lost in Translation? Once Again on the Marx-Hegel Connection. In *Marx's Capital and Hegel's Logic. A Reexamination*; Haymarket Books: Leiden, The Netherlands, 2014; pp. 164–188.

53. Uno, K. *The Types of Economic Policies under Capitalism*; Sekine, T., Translator; Haymarket Books: Chicago, IL, USA, 2018.

54. Sekine, T. *The Types of Economic Policies under Capitalism*; Sekine, T., Translator; Haymarket Books: Chicago, IL, USA, 2018; p. 325.

55. Brenner, J. On Representation in Information Theory. *Information* **2011**, *2*, 560–578. [CrossRef]

56. Petrov, P. Mixing Signs and Bones. John Deely's Case for Global Semiosis. *Signs Syst. Stud.* **2013**, *41*, 404–423. [CrossRef]

57. Burgin, M.; Brenner, J. Operators in Nature, Science, Technology and Society: Mathematical, Logical and Philosophical Issues. *Philosophies* **2017**, *2*, 21. [CrossRef]

58. Gödel, K. *The Consistency of the Axiom of Choice and of the Generalized Continuum Hypothesis with the Axioms of Set Theory*; Princeton University Press: Princeton, NJ, USA, 1940.

59. Igamberdiev, A.U. Time rescaling and pattern formation in biological evolution. *Biosystems* **2014**, *123*, 19–26. [CrossRef]

60. Igamberdiev, A.U. Evolutionary transition from biological to social systems via generation of reflexive models of externality. *Prog. Biophys. Mol. Biol.* **2017**, *131*, 336–347. [CrossRef]

61. Rosen, R. *Life Itself: A Comprehensive Inquiry into the Nature, Origin, and Fabrication of Life*; Columbia University Press: New York, NY, USA, 1991.

62. *Friedrich Wilhelm Joseph Schelling's Sämmtliche Werke*; Schelling, K.F.A. (Ed.) I Abtheilung Vols. 1-10, II Abtheilung Vols. 1-4; Cotta: Stuttgart, Germany, 1861.

63. Gare, A. From Kant to Schelling to Process Metaphysics: On the Way to Ecological Civilization. *Cosm. Hist.* **2011**, *7*, 6–69.

64. Whitehead, A.N. *Process and Reality. An Essay in Cosmology. Gifford Lectures Delivered in the University of Edinburgh During the Session 1927–1928*; Macmillan: New York, NY, USA; Cambridge University Press: Cambridge, UK, 1929.

65. Thompson, I. Process Theory and the Concept of Substance. *Generative Science*. 1990. Available online: http://www.generativescience.org/ph-papers/subst5c.html (accessed on 13 May 2019).

66. Bogdanov, A.A. *Essays in Tektology: The General Science of Organization*, 2nd ed.; Intersystems Publications: Seaside, CA, USA, 1984; Originally published 1921.

67. Gare, A. Aleksandr Bogdanov and systems theory. *Democr. Nat.* **2000**, *6*, 341–359. [CrossRef]

68. Zelený, M. Tektology. *Int. J. Gen. Syst.* **1988**, *14*, 331–342. [CrossRef]

69. Igamberdiev, A.U. Semiokinesis – Semiotic autopoiesis of the Universe. *Semiotica* **2001**, *135*, 1–23. [CrossRef]

70. Igamberdiev, A.U. *Physics and Logic of Life*; Nova Science Publishers: Hauppauge, NY, USA, 2012.

71. Igamberdiev, A.U. Semiosis and reflectivity in life and consciousness. *Semiotica* **1999**, *123*, 231–246. [CrossRef]

72. Igamberdiev, A.U.; Shklovskiy-Kordi, N.E. Computational power and generative capacity of genetic systems. *Biosystems* **2016**, *142–143*, 1–8. [CrossRef]

73. Igamberdiev, A.U. Hyper-restorative non-equilibrium state as a driving force of biological morphogenesis. *Biosystems* **2018**, *173*, 104–113. [CrossRef]

74. Igamberdiev, A.U. *Time, Life, and Civilization*; Nova Science Publishers: Hauppauge, NY, USA, 2015.

75. Sawa, K.; Igamberdiev, A.U. The Double Homunculus model of self-reflective systems. *Biosystems* **2016**, *144*, 1–7. [CrossRef]

76. Lupasco, S. *L'énergie et la matière psychique*; Editions le Rocher: Paris, France, 1987; (Originally published in Paris: Julliard, 1974).

77. Capurro, R. Foundations of Information Science. Review and Perspectives. In Proceedings of the International Conference on Conceptions of Library and Information Science, University of Tampere, Tampere, Finland, 26–28 August 1991.

78. Burgin, M. *Theory of Information. Fundamentality, Diversity and Unification*; World Scientific: Singapore, 2010.

79. Brenner, J. Information. A Personal Synthesis. *Information* **2014**, *5*, 134–170. [CrossRef]

80. Brenner, J. Prolegomenon to a logic for the Information Society. *Triple-C* **2009**, *7*, 38–73. [CrossRef]

81. Diaz Nafria, J.; Zimmermann, R.E. Emergence and Evolution of Meaning. *Triple-C* **2013**, *11*, 13–35. [CrossRef]

82. Brier, S. *Cybersemiotics. Why Information is not Enough*; University of Toronto Press: Toronto, ON, Canada, 2008.

83. Kauffman, S.; Logan, R.K.; Este, R.; Goebel, R.; Hobill, D.; Shmulevich, I. Propagating organization: An enquiry. *Biol. Philos.* **2007**, *23*, 27–45. [CrossRef]

84. Lupasco, S. *Qu'est-ce qu'une structure?* Christian Bourgois: Paris, France, 1967.

85. Deacon, T.; Cashman, T. Steps to a Metaphysics of Incompleteness. *Theol. Sci.* **2016**, *14*, 401–429. [CrossRef]

86. Deacon, T. What is missing from theories of Information? In *Information and the Nature of Reality: From Physics to Metaphysics*; Davies, P., Gregersen, N.H., Eds.; Cambridge University Press: Cambridge, UK, 2010.

87. Ulanowicz, R. Towards Quantifying a Wider Reality: Shannon Exonerata. *Information* **2011**, *2*, 624–634. [CrossRef]

88. Rosen, R. Complexity as a system property. *Int. J. Gen. Syst.* **1977**, *3*, 227–232. [CrossRef]

89. Davies, P.C.W. Does quantum mechanics play a non-trivial role in life? *Biosystems* **2004**, *78*, 69–79. [CrossRef]

90. Igamberdiev, A.U. Physical limits of computation and emergence of life. *Biosystems* **2007**, *90*, 340–349. [CrossRef]

91. Igamberdiev, A.U. Biomechanical and coherent phenomena in morphogenetic relaxation processes. *Biosystems* **2012**, *109*, 336–345. [CrossRef]

92. Rapoport, I.A. *Microgenetics*; Nauka: Moscow, Russia, 1965. (In Russian)

93. Igamberdiev, A.U.; Shklovskiy-Kordi, N.E. The quantum basis of spatiotemporality in perception and consciousness. *Prog. Biophys. Mol. Biol.* **2017**, *130*, 15–25. [CrossRef]

94. Nicolescu, B.; Brenner. Personal communication, 2019.

95. Igamberdiev, A.U. Objective patterns in the evolving network of non-equivalent observers. *Biosystems* **2008**, *92*, 122–131. [CrossRef]

96. Wu, K.; Brenner, J. Philosophy of Information: Revolution in Philosophy. Towards an Informational Metaphilosophy of Science. *Philosophies* **2017**, *2*, 22. [CrossRef]

97. Wu, K. The Interaction and Convergence of the Philosophy and Science of Information. *Philosophies* **2016**, *1*, 228. [CrossRef]

98. Wu, K. The Essence, Classification and Quality of the Different Grades of Information. *Information* **2012**, *3*, 403–419. [CrossRef]

99. Wu, K.; Brenner, J. Chapter 8: A Unified Science-Philosophy of Information in the Quest for Transdisciplinarity. In *Information Studies and the Quest for Transdisciplinarity*; World Scientific: Singapore, 2017. [CrossRef]

100. Wolfram, S. A New Kind of Science. Wolfram Media: Champaign, IL, USA, 2002.

101. Capurro, R. Hermeneutics and the Phenomenon of Information. In *Metaphysics, Epistemology and Technology. Research in Philosophy and Technology*; Mitcham, C., Ed.; JAI/Elsevier Inc.: Amsterdam, The Netherlands, 2000; Volume 19, pp. 79–85.

102. Capurro, R. Interpreting the Digital Human. 2008. Available online: http://www.capurro.de/wisconsin.html (accessed on 3 March 2015).

103. Capurro, R.; Takenouchi, T.; Tkach-Kawasaki, L.; Iitaka, T. On the Relevance of Angeletics and Hermeneutics for Information Technology. In *Messages and Messengers. Angeletics as an Approach to the Phenomenon of Communication, ICIE Series*; Capurro, R., Holgate, J., Eds.; Wilhelm Fink: Munich, Germany, 2011.

104. Holgate, J. *Homo loquens* meets *homo informaticus*; exploring the relationship between language and information. In Proceedings of the 3rd International Conference on the Philosophy of Information, Gothenburg, Sweden, 12–14 June 2017.

105. Brenner, J. Levels of Abstraction; Levels of Reality. In *Luciano Floridi's Philosophy of Technology*; Springer Science + Business Media: Dordrecht, The Netherlands, 2012.

106. Barham, J. A Poincaréan Approach to Evolutionary Epistemology. *J. Soc. Biol. Struct.* **1990**, *13*, 193–258. [CrossRef]

107. Barham, J. A dynamical model of the meaning of information. *Biosystems* **1996**, *38*, 235–241. [CrossRef]

108. Capurro, R.; Brenner. Personal communication, 6 January 2019.

109. Von Uexküll, J. *Theoretische Biologie*; Suhrkamp: Frankfurt-am-Main, Germany, 1973; Originally published 1920.

110. Von Uexküll, J. The theory of meaning. *Semiotica* **1982**, *42*, 25–82, Originally published 1940. [CrossRef]

111. Capurro, R.; Brenner. Personal communication, 15 February 2019.

112. Short, T. *Peirce's Theory of Signs*; Cambridge University Press: New York, NY, USA, 2007.

113. Matsuno, K. Quantum and biological computation. *Biosystems* **1995**, *35*, 209–212. [CrossRef]

114. Matsuno, K. From quantum measurement to biology via retrocausality. *Prog. Biophys. Mol. Biol.* **2017**, *131*, 131–140. [CrossRef]

115. Matsuno, K. The uncertainty principle as an evolutionary engine. *Biosystems* **1992**, *27*, 63–76. [CrossRef]

116. Kineman, J.J. Relational self-similar space-time cosmology revisited. In Proceedings of the 54th Meeting of the International Society for System Sciences, Waterloo, ON, Canada, 18–23 July 2010.

117. Wu, K.; Brenner, J. An Informational Ontology and Epistemology of Cognition. *Found. Sci.* **2015**, *20*, 249–279. [CrossRef]

118. Wu, K.; Brenner, J. The Informational Stance. Philosophy and Logic. Part II: From Physics to Society. *Log. Log. Philos.* **2014**, *23*, 81–108.

119. Allaby, M. *A Dictionary of Plant Sciences*; Oxford University Press: Oxford, UK, 1998.

120. Glass, L.; Mackey, M.C. *From Clocks to Chaos: The Rhythms of Life*; Princeton University Press: Princeton, NJ, USA, 1988.

121. De Broglie, L.V.P.R. *Certitudes et incertitudes de la science*; Albin Michel: Paris, France, 1966.

122. Pattee, H. The physics of symbols: Bridging the epistemic cut. *Biosystems* **2001**, *60*, 5–21. [CrossRef]

123. Pattee, H. The physics of autonomous biological information. *Biol. Theory* **2006**, *1*, 224–226. [CrossRef]

124. Rosen, R. *Anticipatory Systems. Philosophical, Mathematical and Methodological Foundations*; Pergamon Press: New York, NY, USA, 1985.

125. Rosen, R. *Fundamentals of Measurement and Representation of Natural Systems*; Elsevier North-Holland: New York, NY, USA, 1978.

126. Letelier, J.-C.; Soto-Andrade, J.; Abarzúa, F.G.; Cornish-Bowden, A.; Cárdenas, M.L. Organizational invariance and metabolic closure: Analysis in terms of (M,R) systems. *J. Theor. Biol.* **2006**, *238*, 949–961. [CrossRef]

127. Eigen, M.; Schuster, P. *The Hypercycle: A Principle of Natural Self-Organization*; Springer: Berlin, Germany, 1979.

128. Varela, F.; Maturana, H.; Uribe, R. Autopoiesis: The organization of living systems, its characterization and a model. *Biosyst. (Curr. Mod. Biol.)* **1974**, *5*, 187–196. [CrossRef]

129. Gunji, Y.-P.; Sasai, K.; Wakisaka, S. Abstract heterarchy: Time/state-scale re-entrant form. *Biosystems* **2008**, *91*, 13–33. [CrossRef]

130. Anokhin, P. *Biology and Neurophysiology of the Conditioned Reflex and Its Role in Adaptive Behavior*; Pergamon: Oxford, UK, 1974.

131. Porshnev, B. *On the Dawn of Human History (Problems of Paleopsychology)*; Mysl: Moscow, USSR, 1974. (In Russian)

132. Ukhtomsky, A. *The Dominant*; Leningrad State University: Saint Petersburg, Russia, 1966. (In Russian)

133. Lacan, J. *Écrits: The First Complete Edition in English*; Fink, B., Translator; W.W. Norton & Co.: New York, NY, USA, 2006.

134. Lefebvre, V. The fundamental structures of human reflection. *J. Soc. Biol. Struct.* **1987**, *10*, 129–175. [CrossRef]

135. Vygotsky, L. Thinking and Speech. In *The Collected Works of L.S. Vygotsky*; Springer: Berlin, Germany, 1987; Originally published 1934.

136. Piaget, J. *The Language and Thought of the Child*; Routledge & Kegan Paul: Abingdon, UK, 1926.

137. Redhead, M. *From Physics to Metaphysics*; Cambridge University Press: Cambridge, UK, 1995.

138. Vedral, V. *Decoding Reality*; Oxford University Press: New York, NY, USA, 2010.

139. Thomasson, A. *Fiction and Metaphysics*; Cambridge University Press: Cambridge, UK, 1999.

140. Magnani, L. *Abductive Cognition. The Epistemological and Eco-Cognitive Dimensions of Hypothetical Reasoning. Cognitive Systems Monographs Vol. 3*; Springer: Berlin/Heidelberg, Germany, 2010.

141. Rescher, N. *Process Philosophy: A Survey of Basic Issues*; University of Pittsburgh Press: Pittsburgh, PA, USA, 2001.

142. Van Eemeren, F.; Grootendorst, R. *Argumentation, Communication, and Fallacies: A Pragma-Dialectical Perspective*; Erlbaum: Hillsdale, MI, USA, 1992.

143. Gunji, Y.-P.; Shinohara, S.; Haruna, T.; Basios, V. Inverse Bayesian inference as a key of consciousness featuring a macroscopic quantum logical structure. *Biosystems* **2017**, *152*, 44–65. [CrossRef]

144. Ames, R.; Hall, D. *Chapter 64 in Dao De Jing. A Philosophical Translation*; Ballantine Books: New York, NY, USA, 2004; pp. 177–179.

145. Bishop, R.; Brenner, J. Potentiality, Actuality and Non-Separability in Quantum and Classical Physics: Heisenberg's *Res Potentiae* in the Macroscopic World. *arXiv* **2018**, arXiv:1801.01471.

146. Luhn, G. The Causal Compositional Concept of Information. Part I: From Decompositional Physics to Compositional Information. *Information* **2012**, *3*, 151–174. [CrossRef]

147. Dodig-Crnkovic, G. Nature as a network of morphological info computational processes for cognitive agents. *Eur. Phys. J. Spec. Top.* **2017**, *226*, 181–195. [CrossRef]