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New Paradigms on Information, Reality and Mind

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Abstract

We brought arguments in favor of the ontological character of information, along with energy and substance, as well as the structural-phenomenological unity at all scales and levels of reality. We used an interdisciplinary, inductive-deductive methodology, within the broad framework of the naturalistic conception. Our argumentation started from the current reality, which is the impact of information technology, of information networks, of virtual reality and of artificial intelligence, insisting on the role of information in the gnosiological approach. The preponderance of a logical reductionist positivism in scientific research, as well as the exaggerated focus on particle and high energy-physics, but also a certain axiomatic blockage connected to the existence of the immaterial, have made it possible for the problem of information to be almost completely eluded. Even Shannon and Weaver's (1963) information theory considers information only from a quantitative viewpoint, and only through its relation to entropy and the second law of Thermodynamics. The development of chaos theory, fractal geometry and

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topology in the field of non-linear dynamics, and especially the spectacular development of information technology in the last two decades, necessitate a systematic analysis of defining information and its importance in the structuring of reality along with energy and substance. From this perspective, all our concepts, from physical reality to psychological imaginary reality, can be coherently understood through the same paradigms, irrespective of whether we are talking about conservation law, the Euclidean dimension, the fractal or topological dimension or the multidimensional processing mechanism through syntactic, semantic, pragmatic and hermeneutic processing of human and artificial language and knowledge. This new paradigm is the informational one, which assumes the existence of a functional, phenomenological, potential background represented by information, and which can be mathematically modeled through topology.

Key-words
Information; Paradigm; Axiomatic systems; Topology; Complex space.

Introduction

Information represents informational energy. It is expressed by topological patterns and configurations that are scale invariant, and also by dimensional levels. Together with substance and energy, information represents an ontological triad. The topological patterns can be found in a fractal form in the substance structure (through a spatial metric), and in the corresponding spectral field (through an angular metric). Information is concentrated in the wave phase, in the complex plane of the magnetic vector, where it is connected with the complex space which, in our view, is a physical space, not an abstract one. Here, all information of the Universe can be found in a potential form. In the real space, any corpuscular network is doubled by a spectral one, with which it is coherent. Consequenly, the neuronal network is doubled by a spectral one. The dynamics between them give the mental function. The mind-brain duality becomes two aspects of the same physical phenomenon, the neuronal network and the corresponding spectral one. Information gives the dynamics between the two networks and it represents what we call consciousness. The concept of information is a subject for reflection and analysis in information theory, communication theory, knowledge theory,

logics, semantics, philosophy, and theology. Mainly, data forms information and information constitutes knowledge. Actually, the phenomenon is not reduced only to an inclusion of one field into another. The theory of information is connected to Shannon and Weaver (1963), who defined information as an entity which is neither true nor false, neither significant nor insignificant, neither credible nor doubtful, neither accepted nor rejected. As a result, it is not worth studying anything else but a quantitative component of information, yet not the semantic part, which allows for the association of information with the second theory of thermodynamics, with entropy, the information or the quantity of information being in an inverse ratio to it. Weaver connected Shannon's mathematical theory with the second thermodynamic law and asserted that entropy determines the information generation ratio.

1. The mathematics of axiomatic systems in the cognitive perception of reality

The need for axiomatic systems to rationally understand reality appeared in Antiquity. Such systems had been drafted before the Pythagoras School, Thales of Miletus, Anaxagoras, etc., but Pythagoras was the one who actually built the first axiomatic system based on numbers. The greatest impact on science and knowledge is attributed to the Euclidean axiomatic system, which is still used nowadays, although it is completed by the Non-Euclidean Geometrical axioms. Hilbert set himself the goal to build a complete system of axioms in mathematics, but was stopped in his endeavor by Gödel's incompleteness theorems.

The need to formulate axioms is not present only in the mathematical approach. It is a general necessity of the gnoseological capacity, which allows knowledge to be discovered.

Gestalt psychology has formulated arguments connected to a topological mechanism for information processing, which leads to an axiomatic system based on which information is processed. This axiomatic system builds what psychologists call the nucleus of beliefs, convictions and certainties which lie at the basis of the knowledge and understanding of reality. It is different from one historical period to another, from one culture to another, from one community to another and even from one individual to another.

The paradoxes identified by quantum physics (see, for instance, Heisenberg) one century ago can be understood from this axiomatic perspective, which presumes a coherence between mental representations, therefore our expectances, and the physical system of reality which, by creating new variants, unveils the one with which our mind can become coherent. Thus, we can understand the paradoxical aspects offered by the slit experiment and generally, the wave-corpuscle duality, which have generated so many controversies.

An axiomatic change is needed in our mind in order to discover reality from the perspective of these new axioms. As long as people extended their discovery area to only what could be covered on foot or with the help of animals, the axiom of the flat Earth was the only one which could be naturally accepted. It was solely the great travels of famous explorers that led to the reality of a round Earth. Geocentricism was the dominant conception for hundreds of years. Only when doubts appeared, due to the discovery of new instruments (Galileo's telescope or Copernicus' calculations), did the process of building new paradigms start in the minds of researchers of the time. This process led to the heliocentric conviction, with Kepler' corrections regarding orbits, and it culminated in Newton's coherent theory of physical reality. The emergence of new paradoxes at the end of the 20th century, based on some experiments, in the case of electromagnetism, for example, or of new mathematical concepts, the non-Euclidean geometries, led to the creation of new axioms, which allowed for general and special relativity theory and quantum mechanics to emerge.

All these examples are not only specific to scientific knowledge (mathematical, physical and algorithmic), but also to the other forms of knowledge (philosophical, religious, artistic), aspects which require that the multi-disciplinary methodology or even the trans-disciplinary one constitute the most suitable approach to the knowledge of reality, under all its axiomatic aspects.

2. Information as ontological category, together with substance and energy

In the era of information technology we are obliged to confer information its right place in the ontological context, that is, in the substance-energy-information triad. Through the theory of relativity, the

beginning of the 20th century opened the way to the knowledge of the dynamics between energy and substance, as quantum physics brought new elements regarding the constituents which lie at the basis of reality.

The preponderance of a reductionist logical positivism in scientific research, as well as the exaggerated focus on the physics of particles and of high energies, together with a certain axiomatic blockage connected to the existence of the immaterial, have all determined the almost complete circumvention of the problem of information. Even Shannon and Weaver's information theory, in the middle of the century, regards information only from a quantitative point of view, and only in its relation to entropy and the second law of thermodynamics.

Developments during the last decades of the 20th century, in the field of the non-linear dynamics of the chaos theory, of fractal geometry and topology, and especially the impetus of information technology over the last two decades, demand for a systematic approach to defining information and to its important role in structuring reality, along with energy and substance.

From the perspective offered to us nowadays by the evolution of scientific knowledge, the insistence on the wave-corpuscle duality seems to be hard to understand, as it has stimulated so many interpretations, thus evading the problem of information. Certain inertia in the change of the axiomatic structure, in epistemology, determines the fact that today, a great majority of researchers do not imply information in the physical and mathematical models with which they operate. Today it is more and more clear that the old hypotheses formulated a hundred years ago, connected to the hidden variables, the sub-quantum potential, the quantum potential and the fractal potential of today, do not describe anything else than the information involved in all structural and dynamical phenomena of the matter. The spontaneous symmetry breaking involved in all matter dynamics, from the collapse of wave formula to aggregation states and auto-structuring, auto-similarity and emergence mechanisms within complex systems, assumes the permanent existence of a functional, phenomenological, potential underlying cause, represented by information and which can be mathematically understood with the help of topology. From this perspective, all our concepts, from physical reality to the psychical imaginary reality, can be coherently understood through the same

paradigms, irrespective of whether we are speaking of conservation law, the Euclidean, fractal or topological dimension or about the multidimensional processing mechanism, through the syntactic, semantic, pragmatic and hermeneutic processing of human knowledge.

3. Informational topology to integrate reality

With the development of information technology, a paradox is more and more outlined in the epistemology of the last decades. For over a hundred years, we have been speaking about substance and energy, wave and corpuscle, we have built numerous hypotheses and theories, but we have always had the feeling that there is something which eludes our grasp. The hypotheses of hidden variables, of quantum potential, of sub-quantum potential, of the fractal potential, the conservation law, spontaneous symmetry breaking, complex systems dynamics and the nature of the emergence phenomenon are all concepts which cannot be well-defined without the involvement of information as an essential component, along with substance and energy in the structuring of reality.

Since the middle of the last century, the theory of information formulated by Shannon and Weaver (1963) has identified only the quantitative aspect, through the association of information to entropy and the second law of thermodynamics, so that only artificial languages and information technology really raise the profile of the qualitative aspect of information. The proof that information is involved in all processes, at all scales and reality levels, is the very difficulty in defining information.

Surprisingly though, at the same time with the discovery of the importance of information in the last half of the 20th century, another mathematical concept was developed, namely topology. Although the bases of topology were laid in the 18th century by Euler and although it was used by all the greatest mathematicians, it was only the Bourbaki Group that highlighted the importance of the topological approach, starting from the 1950s.

Nowadays, the topological approach is used from string theory to quantum field theory, in fluid and complex systems dynamics and the relativist theories which assume a differential, in Riemannian topology, whereas in mathematics, both algebra and differential geometry are involved in analysis. Practically speaking, just as information, topology is

present at all scales and levels of reality. Network topology, the knot theory of information technology highlight an apparently surprising aspect, the fact that topology is the mathematical instrument suitable for the formalization of information. That is the reason why defining the topology of information could represent the modality of encompassing information under its qualitative aspect and a way of unifying reality through information.

4. Mathematics and reality, complex space and real space

We aim to bring into discussion another space that mathematics has been studying for hundreds of years, but which has been considered an abstract, imaginary space, even though the whole field of mathematics is attributed to it and even if modern physics and the new technologies cannot be formally described without reference to this space. Complex space and complex analysis has been gradually defined by mathematicians starting with the 17th century by Gerolamo Cardano, who formulated the concept of imaginary numbers.

The mathematical models used in the description of the radiation of black matter, electromagnetism, quantum mechanics, non-linear dynamics and generally-speaking, complex systems dynamics were bound to use complex numbers, complex analysis in almost all theoretical and technological contexts. Tegmark (2014) considers that the laws of the Universe can be mathematically expressed.

On the other hand, the Fourier transform and the Fourier analysis, which perform the transfer of information from spectral space to the three-dimensional corpuscle space, were all introduced by Jean-Baptiste Fourier in the context of the formalization of heat, of thermal radiation; it was used with the same significance both in theoretical conceptions regarding the wave-corpuscle duality, in particle physics and high energies physics, as well as in information technology, in the discrete Fourier transform which performs the passage of information from the analogical field to the digital field. The whole fields of electronics and electrotechnics, as well as some of the most advanced technologies (nuclear magnetic resonance) use the Fourier analysis, having as basic instruments complex numbers and implicitly the whole arsenal of complex analysis. Last but not least, the physiology of perception uses the Fourier analysis to highlight

perception and representation mechanisms (the sensory input is oscillating, then comes a phase of corpuscular stimulation, followed by one of spectral processing and representation).

The latest research in the field of quantum information raises serious theoretical problems, which involve new paradigms related to information, with the transformation of energy into substance and with the connection to dynamics in general, at quantum level. Notions such as pseudo-particles or anions, just as the mechanism of modulating information into wave, the role of the magnetic vector from the wave phase in processing information, just as the role of complex functions in its transfer to the phase level, suggest the existence of permanent dynamics between the real and the complex space, the interface being the axiomatic character of the Hilbert space of wave functions. Within this space, the specific properties of other spaces (Euclidean or non-Euclidean) can be axiomatically described, through factorization, including those of the infinitely-dimensional complex space.

If we confer a real existence to immaterial information in general, which is to be found next to structure, and also to the information from software next to hardware, then we can accept the existence of complex space (see also Yang 2010). In complex space, it seems that information is to be found at potential level, under the form of implicit reality (Bohm, 1989), a physical space together with the real space, with which it is in a permanent, dynamic connection. As a result, the existence of this physical space at the interface with the real space, through the Hilbert space, involves the acceptance of the fact that this space contains the real space at potential, a-temporal and a-spatial level (Bohm's implicit reality, 1989). Thus, this space is formed by information before it is substance and energy, the conclusion being that within this space and this interface, the context of human imagination, creativity and psychism is constituted. Just as initially the word "information" means "giving form", to form, to constitute topologically-structured patterns, so the initial term given by Cardano, "imaginary numbers", is not only a metaphor, but an intuition designed to lead to the formalization of the imaginary through complex numbers and complex analysis.

5. New axiomatic paradigms in neuroscience

We intend to bring a valuable and innovative contribution to multi-scale theory in order to explain brain functioning and mechanisms from the perspectives of fractal theory (Mandelbrot, 1983), chaos, non-linear systems dynamics, topology, complex analysis, set-valued analysis etc., which have been brought together in the complex systems theory. We would like to emphasize that not only the corpuscular, but also the wave, spectral part, essentially intervenes in human brain structure and functioning mechanisms (see, for instance de Valois and de Valois (1988), Jung (2006). In this sense, we began to develop in Agop *et al.* (2014, 2015), Crumpei *et al.* (2014, 2014) new models and theories based on complex systems theory precisely, using fractal theory, chaos theory, topology, complex analysis, modern physics etc.

The implementation of the functional structure of complex systems in psychic life can explain a series of classical concepts circulated during the last century. Thus, the unconscious from psychoanalysis can be associated to the unpredictable, non-causal and potential part from the structure of the complex system, while conscience, as well as unconscious behavioral patterns (the superego of psychoanalysis), can be associated to the structured, causal and deterministic part of the complex system. Between the two parts, there exist permanent dynamics through attractors, describable in the phase space. The chaoticity between the two components is absolutely necessary for the functioning of the brain. When it is affected by repetitive cycles (epilepsy crisis), conscience is blurred. This new representation on the functioning of the brain leads to new conclusions concerning different mental processes that have not been fully understood yet.

An analysis of the Toda network, with its fractal but also structural-functional specificity, enables the modeling of neuronal networks under two components: a structural, corpuscular one and a functional, spectral one. This new paradigm could lead to the following aspects:

i) Consciousness could be the result of the dynamics between the two networks: the spectral neuronal network and the structural network. For instance, anesthetic techniques block the structural network. When this structural network becomes again functional, it recovers its dynamics through the multifocal coherence phenomenon with the spectral network

(where memory, the core personality can be found, as detailed in the following). The same happens in an epileptic crisis, in concussions, electroshocks etc., the structural network being unable to achieve coherent dynamics with the spectral network;

ii) In the structure of the brain (as a physical object), memory may be located in the spectral neuronal network, whose spectral, and thus fractal, character has all the properties that are necessary for information storage. Memory means the achievement of coherence among certain structures of the structural neuronal network and the spectral one, where this information has been memorized;

iii) Memory localization could give clues to how personality is structured. Classically, personality has two components: temperament and character. Temperament is made of behavioral and information processing patterns originating from the genetic setting (and which are organized in the structural network). The second component, character, represents the programs built from the individual relationship with the external medium (education, experience, cultural environment, analyzers' setting etc.). It is organized in the spectral network, representing information, behavioral and information processing patterns, that are set in programs resulting from the system and external medium dynamics. The genetic patterns found in the structural neuronal network give stability, and the programs built in the spectral neuronal network are adapted to the environment, in a specific form given by the dynamics with the genetic patterns from the structural network. Thus, personality has stability via some of its components, but it also has specificity and adaptability;

iv) It seems that the potentiality that Chomski (1982) was talking about, related to every child's ability to learn the language or the languages to which he or she is exposed, is related to the spectral neuronal network which gives space to memory, while the structural network represented by Wernicke and Broca center (of speech understanding and speech expression, built by patterns transmitted at the genetic information level) offers the language processing structure;

v) In the context of new discoveries about mirror neurons, our model concerning the functionality and structuring of the psyche could give explanations about mirror neurons' functioning and their integration in the psychological functioning in general. So far, experimental data emphasize

only the elements from the structural neuronal network (excited neurons, highlighted by implanted electrodes or brain areas highlighted by fMRI). Accepting the spectral network could explain complex phenomena, concepts, and feelings that could not be generated only by the activity of several neurons but by complex processing that could take place only in the spectral neuronal network. It might even be possible that the neurons' excitation is achieved through the spectral network, where information originates through spectral ways of interpersonal communications. A series of controversies about mimetic learning, empathy, mind theory, language etc. could thus be explained;

vi) In neuropathology, our model could also generate new conclusions concerning both mental and neuropsychological illness. For instance, in vascular dementia, blood deficiency affects neurons (the structural neuronal network) and on the other hand, it influences the dynamics between the two networks; in Alzheimer dementia, the dynamics between the two networks are primarily affected, with the impossibility to access the stored information, with the damage of spatial-temporal orientation, of behavior and even of the entire personality (see ii above). Certain somatic trauma cases when the phantom limb sensation is manifest (Ramachandran) could have an explanation through the model that we have conceived; the structural network can be inhibited or destroyed by the respective limb or organ, its representation remaining in the spectral neuronal network, generating painful and contracted phantom limb symptoms and allowing alleviation and cure through suggestion and self-suggestion mechanisms (the mirror box technique);

vii) The neuroplasticity phenomenon related to the brain's adaptive capacity would be more understandable if, causally, according to our model, neurons and neuronal connections development would occur through the dynamics between the two networks, based on the patterns developed in the spectral side from the reaction with the environment.

Conclusion

The need for axiomatic systems to rationally understand reality emerged as early as Antiquity. The necessity to formulate axioms is not present only in the mathematical approach. It is a general necessity of the gnoseological capacity, which thus allows knowledge to be discovered. An axiomatic

change is needed in our mind in order to discover the reality from the perspective of these new axioms.

The immaterial character of information (see, for details, Stonier (1990: 155), Introna (2005), Onicescu (1964)) has created difficulties in defining and clarifying the role it has in the structuring and dynamics of reality. The logical positivism which animated epistemology in the 20th century manifested a metaphysical anguish towards information and its immaterial character. Today, in the information era, we are obliged to reassess the old paradigms, to build new axiomatic contexts which could lead us to the formulation of new principles and theories, in order to define reality as accurately as possible.

From the perspective offered to us by the evolution of scientific knowledge, the insistence on the wave-corpuscle duality seems to be difficult to understand; it has led to so many interpretations, thus avoiding the problem of information. Certain inertia in the change of the axiomatic structure, in epistemology, determines the fact that nowadays, a great number of researchers do not imply information in the physical and mathematical models with which they operate. It is ever clearer that the old hypotheses, formulated over a hundred years ago, connected to the hidden variables, the sub-quantum potential, the quantum potential or the fractal potential, do not describe anything else than information involved in all structural and dynamic phenomena of matter. From this perspective, all our concepts, from physical reality to psychological, imaginary reality, can be coherently understood through the same paradigms, irrespective of whether we are speaking about conservation law, the Euclidian and topological fractal dimension or the mechanism of multi-dimensional processing through syntactic, semantic, pragmatic and hermeneutic processing of the human knowledge.

The introduction of information in the ontogenetic triad: substance, energy, information is, perhaps, the most important paradigm change that science currently needs. The hypotheses of hidden variables, of quantum potential, sub-quantum potential, fractal potential, conservation law, symmetry breakings, complex systems dynamics and the nature of the emergence phenomenon, are all concepts which cannot be well-defined without the involvement of information as an essential component, along with substance and energy, in the structuring of reality. Weaver and

Shannon's (1963) information theory grasps only the quantitative aspect, by associating information to entropy and the second law of thermodynamics, so that only artificial languages and information technology finally implement the qualitative aspect of information.

The evolution of science and technology necessitates the change of paradigms. Along with the thorough definition of information and the clarification of its relation to topology, another paradigm which must be changed is the significance which should be granted to complex space. During the last century, and especially in the latest decades of information technology (see Barabassy, 2010), researchers have formulated arguments to approach complex space as a physical space, not only as a mathematical abstraction. Starting from this new paradigm, we can understand phenomena from particle physics, field physics and the physics of complex systems, and we can even formulate new hypotheses related to the structure and functioning of the psyche.

Our article wishes to emphasize the role and the importance of the transdisciplinary approach in understanding some aspects of reality which are otherwise difficult to explore using classical scientific methodology. Collating data from seemingly remote sciences by the reality that we are studying can bring valuable information, allowing new hypotheses and new models in approaching knowledge. The premise from which we start and which allows the extrapolation of knowledge is given by the structural unity of the Universe and of the natural phenomena, the same as fractality, which involves finding the whole Universe in every atom.

References

Agop, M., Gavriluţ, A., Crumpei, G., Doroftei, B. (2014). "Informational Non-differentiable Entropy and Uncertainty Relations in Complex Systems". *Entropy*. 16. 6042-6058.

Agop, M., Gavriluţ, A., Buzea, C.Gh., Ochiuz, L., Tesloianu, D., Crumpei, G., Popa, C. (2015). "Implications of quantum informational entropy in some fundamental physical and biophysical models". *Quantum Mechanics*. IntechOpen, 2015.

Barabassy, A.L. (2010). *Bursts: The Hidden Pattern Behind Everything We Do*. Penguin Group Inc.

Bohm, D. (1989), "Meaning and Information", P. Pylkkänen (ed.). *The Search for Meaning: The New Spirit in Science and Philosophy*. Crucible: The Aquarian Press.

Chomski, N. (1982). *Language and the Study of Mind*. Tokyo: Sansyusya Publishing.
Crumpei, G., Gavriluţ, A., Agop, M., Crumpei, I., Negură, L., Grecu, I. (2014). "New Mathematical and Theoretical Foundation in Human Brain Research. An interdisciplinary approach in a transdisciplinary world". *Human and Social Studies*. 3.1. 45-58.
Crumpei, G., Gavriluţ, A., Agop, M., Crumpei, I. (2014). "An Exercise in a Transdisciplinary Approach for New Knowledge Paradigms". *Human and Social Studies*. 3. 3. 114-143.
Hazewinkel, M. (2001). *Axiomatic method*. Encyclopedia of Mathematics, Springer.
Heisenberg, W. (1949). *The Physical Principles of the Quantum Theory*. Courier Dover Publications.
Introna, L., *Phenomenological Approaches to Ethics and Information Technology*. The Stanford Encyclopaedia of Philosophy (Spring 2005 Edition).
Jung, C.G. (2006). *The Undiscovered Self: The Problem of the Individual in Modern Society*. New American Library.
Mandelbrot, B. (1983). *The Fractal Geometry of Nature*. W. H. Freeman and Company: New York, NY, USA, 1983.
Onicescu, O. (2004). *Enérgie informationnelle*. C. R. Acad. Sci. Paris A 263 (1966). 841-842.
Potter, M. (2004). *Set Theory and its Philosophy, a Critical Introduction*, Oxford.
Ramachandran, V.S. *Mirror neurons and imitation learning as the driving force behind the great leap forward in human evolution*. Edge Foundation web site. Retrieved October 19, 2011.
Stonier, T. (1990). *Information and the Internal Structure of the Universe*. London: Springer Verlag.
Tegmark, M. (2014). *Our Mathematical Universe: My Quest for the Ultimate Nature of Reality*, New York.
De Valois, R.L., De Valois, K.K. (1988). *Spatial vision*, New York: Oxford University Press, 1988.
Weaver, W., Shannon, C.E. (1963). *The Mathematical Theory of Communication*, Univ. of Illinois Press.
Weisstein, E.W., *Axiomatic System*, From MathWorld—A Wolfram Web Resource. Mathworld.wolfram.com.
Whitehead, A.N., Russell, B. (1963). *Principia Mathematica*, Vol. I. Cambridge University Press.
Yang, C.D. (2010). "Complex Mechanics". *Progress in Nonlinear Science*. Vol. 1. pp. 1-383.