Original Article

Klein Bottle Logophysics, Self-reference, Heterarchies, Genomic Topologies, Harmonics and Evolution.

Part I: Morphomechanics, Space and Time in Biology & Physics, Cognition, Non-Linearity and the Structure of Uncertainty

Diego L. Rapoport*

Abstract

In this first part of a series of articles we discuss the torsion geometry of biology, physics, cognition and perception. We discuss the relations with the non-linear morphomechanics of organisms and the integration of the body's chiralities. We present the connections with the topology of neural networks as heterarchies and with multi-loci logics as a basis for the HyperKlein Bottle logophysics in genomics, systems theory and cognition. We discuss the link to the relational paradigm for biology, systems theory and physics. We introduce the relations of torsion with self-reference as a generating principle, and as a protosemiotic agency. We present the relations of heterarchies to cognition and systems theory. We discuss the relation between chaotic dynamics, blown-up systems, the non-linear logophysics of the KB and the paradoxical structure of the real numbers. In particular, we elaborate on the breakdown of the continuum hypothesis, the origin of singularities, particularly with respect to General Relativity, and the non-linear elasticity of biological development. We discuss the relation of computational error and the KB logophysics. We present the heterarchical logophysics and the constitution of the self as a model and of a sense or reality as a primary epistemic state further promoted to a dual ontology, which we discuss in terms of the foundations of mathematics in set theory and topoi, and the measurement problem in quantum mechanics. We introduce a fundamental Inside/Outside image-schema in cognitive semantics and discuss its pervasive role in cognition and the framing of the sciences, and give several examples of this. We introduce logical systems as formalizations of ontologies, their role in cognition, the neurosciences, cybernetics and biocomputation, and discuss their setting in terms of the positional HyperKlein Bottle logics and classical dual logic as a particular case. We develop a phenomenological approach to unified science. We discuss the time operator. We discuss the relations of the present logophysics to R.Rosen's proposal of an approach to systems theory based on the calculus of differential forms and with regards to the topological approach to theoretical physics and Chemical Topology. We discuss the relation between the present logophysics and Spencer-Brown's Laws of Form.

Key Words: bioinformatics, biocomputation, biophysics, blown-up systems, cognition,complexity, Hadamard matrices, harmonics, heterarchies, image-schemas, morphomechanics neural networks, non-classical logic, non-linearity, ontology, palindromes, pattern recognition, phenomenology, physiology, quantum holography, time-operator, torsion geometries, systems theory, vortices.

Quantum Biosystems **2016; 7 (1) : 1-73**

*Corresponding author: Diego L. Rapoport
Address: (Retiring from) Departamento de Ciencia y Tecnologia, Universidad Nacional de Quilmes, Bernal, Buenos Aires, Argentina.
e-mail: diego.rapoport@gmail.com

1. Introduction. Genomic Matrices, Topology, Non-orientable Surfaces: The Torsion Geometry of Nature, Semiosis, Cognition and Heterarchies

Introducing a special issue on the mathematics of genomics, Sergey Petoukhov offers a reflection on the subject, quoting the work of I. Stewart *"The biological meaning of genetic informatics is reflected in the brief statement: "life is a partnership between genes and mathematics"* (Stewart, 2011).

But, what kind of mathematics has relationship with the genetic code and what kind of mathematics is behind genetic phenomenology? This question is one of the main challenges in the exact natural sciences today (Petoukhov, 2012a).

The author proceeds to comment on the relations between the problem of noise-immunity for the transmission of genetic information which comprise as well the coordination of all the subsystems which make up an organism as an integrated being operating through cyclical processes, as well as the problem of self-reproduction of both the genetic system and organisms: these are problems for mathematics to deal with. In relation with the problem of noise-immune transmission of information, these problems have been solved technologically.

They resort to the implementation of the theory of Rademacher and Hadamard matrices, which allow for such a feat as the transmission and reconstruction of digital photographs of planets and the Solar System itself, taken by several devices.

Yet, while Hadamard matrices play a role in the theory and practice of coding information immune to noise, in the case of two by two Hadamard matrix , they are nothing but the matrix representation of a two-dimensional surface: the Klein Bottle (Rapoport, 2011a, 2011b, 2011c, 2011d).

This surface, globally considered, has one single side; locally considered it seems to have two sides.

This surface is non-orientable,which means that a normal vector, i.e. a perpendicular vector to the surface, is unique; this stands in distinction with orientable surfaces, which have two different sides, and thus two different normal vectors exist, one for each side.

The Klein Bottle surface has no global Inside nor Outside but as local states which are connected and intertransformed, rather than separated.

This connection and inter-transformation of local Outside and local Inside is produced by the self-penetration of this surface.

Thus, this surface rather than being contained in ambient three dimensional space, it is defined and produced by its self-containment due to the self-penetration.

Alike genomes, the Klein Bottle is self-referential (Rapoport, 2011a, 2011b, 2011c, 2011d, 2012, 2013).

As for the mathematics advocated by Petoukhov, they reveal algebraic codings of genomes using structures which are also common to quantum mechanics and to several areas of physics which may appear in first consideration to be unrelated to genomics (Petoukhov and He, 2010; He and Petoukhov, 2011).

The principle derived from this mathematics which is also basic to physics and chemistry is that of symmetries, which is also basic to biological morphologies. It is impossible to conceive of biochemistry without considering issues of enantiomerism, as early discovered by Pasteur, and enantiomerism is all about symmetry, and its disruption: Chirality (handedness) plays a crucial role to biochemistry and life, and already appears in the double helix model of DNA, which, in principle, may have any of the two chiralities.

Enantiomerism is essentially related to the non-orientable Möbius strip surface, which we can think of as a surface contained on a line, which also has no Outside nor Inside; actually, two collated enantiomeric Möbius strips generate a Klein Bottle. As it turns out to be the case, the algebraic structures of genomes revealed by Petoukhov, have a more basic root in the algebraic coding of the Klein Bottle surface as a non-dual logic, which admits a binary representation, which is the cornerstone of informatics and particularly of genomes (Rapoport, 2011b).

This coding leads to reveal a fractal-like topology of genomes, as HyperKlein Bottles, family of Klein Bottles structured as an heterarchy, of which we shall present numerical evidence of it in the human genome.

Symmetries in genomes appear in many forms, already related to their chirality; also, the pervasive existence of palindromic sequences, as ordered structures interspersed in what is conceived to be an extremely complex genomic structure, whose fundamental changes are considered to be random. But randomness is a word for ignorance: ontologically, randomness seems not to exist, at least not independently of symmetry as related to non-orientability.

This follows from sixty years of continuous experiments of great diversity, based in what is usually conceived as random phenomena, that has shown the existence of a universal cosmological factor, influencing the fine structure of supposedly random fluctuations (Shnoll, 2012).

Indeed, their histograms developed as time series appear to have the form of palindromes, appearing as time cycles; this is the Shnoll effect, attributed to cosmological factors (Shnoll, 2014; Rabounski and Borissova, 2014); see note no. 1. Genomic palindromes are crucial to evolution (Koonin and Wolf, 2012).

Despite their complexity, these data reveal a remarkable topological symmetry, actually a family of shapes, which can be conceived as Möbius strips and iterated Klein Bottle and HyperKlein Bottles, as we shall see. In fact, this *shape of data* will be the focus of our attention in bioinformatics and else. It is already known that highly dimensional data such as visual input does reduce to two-dimensional shapes (Tenenbaum, 2000; Carlsson, 2008, 2009) solving thus the "curse of [hyper]dimensionality" (Wang, 2012); whereas this is ascribed to the brain we shall see that this phenomenal reduction and shaping of data takes place already in genomes and still appears as basic to phenomenology through the body as a whole.

Yet, the same conception –although through different algorithms- has been applied in the field of comparative genomics to pools of genes to identify common patterns (Near Universal Trees), and to search for the elusive Tree of Life (Koonin, 2012).

This points out to the existence of metapatterns – which can be used to make predictions (Rabounski and Borissova, 2014), and in particular, in bioinformatics, actually a metagenomic pattern. As we shall see later, this points out to a generic form of checksum in Nature related to non-orientability, as a process by which the symmetry is produced *and* conserved through the dynamics of structures such as genomes.

As it will turn out to be the case of genomes as operated through transposons and palindromes, and as we said, related to cosmological factors in the case of the most diverse seemingly random experiments. It also points out to a form of algorithmic causality which is more basic than all forms of causality (Johansen, 1991) and which underlies both genomic symmetry, as well as the palindromic symmetries unveiled by Shnoll (2012).

Petoukhov puts the case as follows:

> *"Biological organisms belong to a category of very complex natural systems, which correspond to a huge number of biological species with inherited properties. But surprisingly, molecular genetics has discovered that all organisms are identical to each other by their basic molecular-genetic structures. Due to this revolutionary discovery, a great unification of all biological organisms has happened in the science. The information-genetic line of investigations has become one of the most prospective lines not only in biology, but also in science as a whole. The basic system of genetic coding has become strikingly simple. Its simplicity and orderliness presented challenges to specialists from many scientific fields. Bioinformatics considers each biological organism as an ensemble of information systems which are interrelated to each other.*

The genetic coding system is the basic one. All other biological systems must be correlated to this system to be transmitted to the next generations of organisms" (Petoukhov, 2012a).

Yet, there is one fundamental area of mathematics which embodies uniquely in its simplicity these complex structures. This area is topology; etymologically, the study of loci. It is the mathematical study of shapes, yet essentially conceived qualitatively, as equivalent under continuous deformations, rather than analytically nor quantitatively, the latter being at large the predominating conception and operation of mathematics.

Topology appears to be especially adequate to explain biological systems. Already the eminent anatomist and naturalist John Bell Pettigrew (1834–1908) (Pettigrew, 1873, 1908) influenced the founder of the mathematical studies in biology, D'Arcy W.Thompson (1860–1948) (Thompson, 1945) (see note no. 2); both being unaware of topology as a *mathematical discipline*, intuited its fundamental role in biological systems, as viewed from the experience of glass-blowing surfaces and the continuous deformation (i.e. topological transformations which are continuous as well as their inverse) of organic shapes.

Indeed, Thompson viewed allometric transformations of bodyplans of organisms as a basis for the appearance of species in terms of previous ones (following Goethe's Urform, the archetypal plant shape), usually attributed to evolution. Wilhem His, the anatomist and physiologist considered to be the father of human embryology for introducing the three germ layers, practiced a series of topological experiments with rubber and wax tubes aiming to understand morphogenesis.

Thus, His was able through mechanical deformations to reproduce the shape of the gut, brain and other organs (His, 1874).

This was crucial to the later appearance of developmental mechanics as the mechanics of morphogenesis, originally as independent of genes.

The current investigations of biological development already point out that:

"both superficial observation of the developmental processes and their refined analysis up to the molecular level shows that practically all of them are associated with regular and repeatable deformations of material units ranging roughly from cell collectives to single molecules. What is called morphogenesis is actually a succession of such deformations observed at the cellular and supracellular levels. It is but natural to extend this same term to the lower structural levels as well" (Beloussov, 2015).

Accounting for these sequence of topological transformations encompassing several scales, morphomechanics came to the fore as an analytical theory of biological development,in which the non-linear character of the mathematical models with the ensuing non-linear shapes of development is crucial. In fact, in terms of non-linear elasticity evolutions, morphomechanics develops vortical solutions with singularities which we shall discuss further, so that in these terms, bodies upon development must be both continuous and discontinuous, which is notoriously the case.

However, morphomechanics is based on a dualistic assumption: a distinction between forces Inside and Outside relative to the biological tissue, or active and passive forces, respectively, operating through a hierarchy.

Thus morphomechanics is usually conceived in terms of an image-schema which categorizes in terms of an Inside/Outside divide. Yet and most remarkably this categorization is somewhat surmounted along its presentation (Beloussov, 2015).

The steps of morphogenetical processes are considered to be interpretable as a collective of processes mandated by the genes deep *within* the cells:

"... as activation of a gene competent to a structure which should be formed at the given

moment and in the given place… and each step of evolution [should be regarded] as a recognition (or emergence) of a gene which is competent to a new structure never formed before" (Beloussov, 2015).

Thus development and genomes co-operate giving *meaning* to particular locations through *timing*, and this is the Interior's workings. Exterior perturbations in certain periods are incorporated as symmetry breakings. This Inside/Outside dualistic categorization assumed for morphomechanics is also purported to be the case of genomes, particularly upon ignoring epigenetic factors, and in the geometrical model of DNA itself.

Furthermore, the non-uniqueness of genomics in determining and operating biological functioning is related to its surmountal in terms of mutually interpenetrating and self-penetrating heterarchies, which thus transcend this categorical divide, as we shall elaborate below. Following the pioneering work of A. G. Gurwitsch on the so-called mitogenetic radiation, cell division is considered to follow the *integration* of Exterior factors –a signal- and the Interior state of the cell (Volodyaev and Beloussov, 2015).

As it will turn out to be the case, DNA itself is dynamically patterned in such a way as to produce electromagnetic fields with a non-orientable topology which is logophysically homologous to that of genomes, and further related to harmonics.

Furthermore, these non-orientable topologies surmount the Inside/Outside divide.

Studies of self-reference in cognition, artificial intelligence and computer science which stem from and unfold in terms of this dual categorization, claim that the Inside/Outside divide operates as a *belief system* which dominates and structures our cognition- actually our dualistic organization of it.

Thus it is claimed that:

"[I]t would be of great interest to study the structure of these belief systems in detail …their relationship with the deep structure of language. To a certain extent this quest is self-referential, since our tools for studying things are largely based on the concepts of internal and external reality. But self-reference is not necessarily a problem; it can be part of a solution. It is hard to imagine a research programme of greater importance or interest than this one" (Goertzel, 2013).

Indeed, self-reference as embodied in the Klein Bottle is an inevitable element of a solution, since this categorization is a reduction of the non-dual Klein Bottle logic, upon neglecting its reentrance by self-penetration, to be discussed below (fig. 1.III, in Part III). This surface embodies a surmount of this divide, since it is self-contained, thus providing a non-dual ontology for a unified science, yet conceived phenomenologically (Rapoport, 2014b), which is largely missing in its current developments if not claimed to decur from the ontology of classical (i.e. Boolean) logic (Kauffman and Garre, 2015). See note 3.

More contemporarily, topology appears at the very basis of the theory of *relational biology* developed by Nicholas Rashevsky (1899-1972).

He was the father of mathematical biophysics and, in particular, of the notion of neural networks, later pursued by his students, Anatol Rapoport, Robert Rosen and Walter Pitts, among others.

Rashevsky, recovered Goethe's notion of the primeval form (Urform) and further extended Thompson's conception of shapes arising from more elementary ones, the more complicated manifold processes of higher order organisms are related to the processes of simpler organisms.

Thus, Rashevsky proposed a principle, whereby:

"…If the relations between various biological functions of an organism are represented geometrically in an appropriate topological space or by an appropriate topological complex, then the spaces or complexes representing different organisms must be obtainable by a proper transformation from one or very few primordial spaces or complexes" (Rashevsky 1939).

Furthermore, Rashevsky proposed a distinction between physics and biology whereby:

> *"...while physical phenomena are the manifestations of the metric properties of the four-dimensional universe [following Einstein take on the pseudo-Riemann metric of spacetime as the basis for physical phenomena such as gravitation], biological phenomena may perhaps reflect some local topological properties of that universe".*

Thus, Rashevsky suggested a differentiation for modelling Nature: geometry as metrics for a quantitative model of physics, with topology to model biology qualitatively. The case to be expounded here is that there is a *geometry and related topology common to both physics and biology (as well as to chemistry, perception and cognition) associated to the non-orientability of torsion geometries and number systems*, rather than metric geometries and topology as separate formalizations, the former for physics, the latter for biology. They are further related to non-dual logics as the ontological (and epistemological) basis for a logophysics of Nature, physics, chemistry, biology and the unlinked sciences being nothing but particular cases (Rapoport, 2013, 2014b).

This dismissal of persuing a geometrical approach restricted to metrics was suggested for physics by the eminent mathematical-physicist E.T. Whittaker who put it thus:

> *"Since the notion of metric is a complicated one, which requires measurements with clocks and scales, generally with rigid bodies, which themselves are systems of great complexity, it seems undesirable to take metric as fundamental, particularly for phenomena which are simpler and actually independent of it".*
> (Hehl and Obukhov, 2003).

Metrics, i.e. the articulation of distance and its algebraic abstraction, is merely descriptive and numerical, rather than qualititative; it does away with processes and interactions as primary. Furthermore, geometries based on metrics are ontologically based on dualism - the distance of two objects as each exterior to the Other -as we shall discuss below further. However, the light-cone as defined by the zero- distance locus of the Minkowski metric already embodies a non-dual ontology and actually gives the setting for the study of interactions and distinctions in relation to this locus. Thus, metrics can hardly serve as a basic principle for *relational* biology, nor for physics, not in terms of a non-dual ontology for that matter. Neither a metric nor curvature are primal as we shall see next.

1.1. The Torsion Geometry of Physics, Biology and Cognition: Time Operator, Morphomechanics, the Relational Paradigm and Topology.

It is a subject of current debate whether biology is reducible to physics (Shanta and Muni, 2016), either in the framework of the Newtonian paradigm as examined by Rosen (Rosen, 1985, 2000) or of quantum physics, just alike molecular biology deemed biology as reducible to chemistry.

Yet what has been disconsidered is the possibility that biology, physics, chemistry, cognition and perception may be *all* integrated *non-reductibly* as a logophysics based on trans-dual logics, as we shall expound in the present article following previous contributions (Rapoport, 2009, 2011a, 2011b, 2011c, 2011d, 2012, 2013, 2014 a, 2014b).

Thus for a start in this article we shall introduce the torsion geometry since it is relevant for the conceptualization of the forthcoming theory vis-à-vis the modellization of biology, in terms of geometry and topology, which in this article we shall keep in quite elementary terms. Yet, these issues are basic to physics, chemistry and cognition, as we shall see.

In distinction with the metric geometry of General Relativity (Misner, 1973), torsion geometry is primal with respect to curvature, the latter being a derivative the (so-called covariant differential) of the former, or in simpler terms, a *derivative* of the torsion field

(Rapoport and Sternberg, 1984; Shipov, 1998; Goenner, 2004; Kobayashi and Nomizu, 1996; Vargas, 2014).

While torsion involves first order partial derivatives –and thus is related to gradient fields, as the differences that arise from differences in the Batesonian sense- and as such operate as information fields, curvature involves second-order partial derivatives. Thus curvature is not primal but derived from torsion. (For example electromagnetism, where the trace-torsion differential one-form stands for the electromagnetic potential and the differential of this as a curvature gives the electromagnetic field itself which actually can be null though in the highly non-trivial case such as the Aharonov-Bohm potential) (Rapoport, 1997, 2000, 2009, 2010a). Or still in fluid-dynamics where the velocity field and the torsion field are identified, while the differential of the former is the vorticity field as the associated curvature (Rapoport, 2002a, 2005a, 2005c).

This is embodied by the so-called Bianchi equations in differential geometry, which set out structural relations for spacetime frames (i.e. the "observer"), torsion and curvature (Kobayashi and Nomizu, 1996; Vargas, 2014).

The Bianchi equations may actually provide for the structural equations for the geometry of the fundamental interactions without recurring to an extraneous stress-energy tensor as a non-geometrical matter source and thus all the relevant information of a self-sufficient theory (Shipov, 1998).

A *geometrical* theory of spacetime structures and processes, be that of physics or biology, cannot have other source than geometry, otherwise inconsistency is the case. However, we may need to reveal the geometry of genomics to do so, as it actually will turn out to be the case.

Already in biological morphogenesis vortices the elementary torsional motions- and other dissipative structures are deemed to be important to development; they are acknowledged as preparatory at supramolecular and cellular levels with respect to the morphomechanics of development which is described by curvature (Beloussov, 2015).

Hence, it is torsion which ontologically preceeds curvature in morphogenesis at these integrated levels of organization; on the other hand tissue differentiation is associated to a tensegrity cellular structure which embodies a torsion geometry (Rapoport, 2011c, 2011c, 2014a).

The shearing motions in morpho-mechanics produce curvature from folding and are thus related to torsion rather than curvature. The latter we recall was introduced by Einstein as an imaginal-symbolical representation of matter which curves the otherwise flat matter-devoided spacetime. These shearings motions further create rotational motions which are the basis for morphogenesis, not only restricted to morphomechanics. Indeed, viscous fluids whether magnetized -as is the case of plasmas or electric chargeless- or not, produce shear, and in doing this they produce vortical motions crucial to turbulence which is considered the signature of complexity in fluids. In account that the latter are the most pervasive state of matter, we see that torsion geometry is indeed universal at the material level. Torsion geometries are equivalent to Brownian motions, which already the biologist Brown identified as the motion of life (Rapoport 1991, 1997, 1998, 2002a, 2002b, 2005a, 2005c).

Hence the Brownian motions in the scale of biological systems can be considered to be small-scale vortical structures which are considered to be random, but at the physical level they encompass the microscale from quantum vortical fluctuations to cosmological structures of charged plasmas and difusing galaxies. These quantum vortices appear to be the case of ordered water domains, since they have a Möbius strip topology- as we shall see, which are believed to be crucial to organisms' integration and coherence (Del Giudice, 2013); they are further suggested to be the basis for the communication of the body operating as an harmonic system (Petoukhov, 2016).

Remarkably, morphomechanics acknowledges non-linearity –which has

vortices for its source- as crucial to the feedback processes of self-organization, the so-called 'circular causality' of parametric regulation, i.e. by relatively slow and spatially smoothed evolution. Embryonic development is ruled by non-linear equations, which in turn is crucial to the reliability of this kind of dynamical regulation. It is non-linearity which ensures precise results despite the non-precise input; it further provides for the appearance of novelty and to the reduction of symmetries concomitant with the increase of complexity as development advances (Beloussov, 2015).

Still, it is non-linearity which allows for the transition from determinism to self-organization. We shall later discuss these issues in terms of the divergent (blown-up) solutions of non-linear evolutions, their chaotic attractors and the non-dual logophysics that produces them.

There is still another example that captures the primal importance of torsion; namely its relation with symmetries, actually the so-called Lie groups of symmetries. Indeed, for non-commutative Lie groups there is a canonical invariant geometrical structure which has non-null torsion and null curvature. In this structure, both the curvature and the metric are expressed in terms of the torsion, rather than being primal.

However, Lie groups also possess a geometry which has null torsion and non-null curvature defined in terms of their geodesics (Rosenfeld, 1997).

So non-commutative Lie group symmetries elicit a superposition of structures in terms of their torsion and the derived curvature.

A geometry as elementary as the 2-sphere is one such example -a knowledge which allowed the great Portuguese sailors to navigate the globe (Rodrigues and Capelas de Oliveira, 2007).

This property of a duplicitous structure will later appear in chemical configurations as certain molecules may have configurations which can be both orientable and non-orientable. In the former structure with zero curvature and non-null torsion, the latter defines –up to a minus sign- the *positional relations* which characterize the symmetry itself, the so-called structural coefficients of the symmetry appearing in the expansion of the *commutator* of two infinitesimal symmetries in terms of all of them.

These symmetries are fundamental to physics, chemistry and biology, and to the active construal of visual perception as a gestaltic integration (Giurfa and Menzel, 1997, Wagemans, 2015). Beloussov's account of morphomechanics also highlights the importance of symmetries and shape, which is not restricted to:

"…be input but also output in a feedback cycle" (Beloussov, 2015).

In biology they appear in the so-called Pasteur-Curie principle, which deals with the *dialectical* relation between symmetry and asymmetry (broken symmetry, usually by localization, as a form of contextualization, pervasive even to physics).

As well known this principle followed the discovery of molecular enantio-morphism and the observed symmetry breaking with the preference of one particular chirality which appears to be crucial relation to life (Hoffmann, 1997).

Succinctly expressed this principle claims that both symmetries and dissymetries are causally conserved and in a causal relation there can be no more symmetry in the effect than those already present in the cause (Mainzer, 1996).

Lima de Faria developed a theory of evolution in terms of self-organization puts it thus: "symmetry creates form, the asymmetry creates the phenomenon" (Lima de Faria, 1988).

This *dialectics* of symmetry and asymmetry, which –cursorily expressed- is that of shape and phenomenon, was called 'synsymmetry' (Rosen, 2008); it is crucial to molecular recognition as in the ligand-receptor binding. The importance of this cannot be overstressed in regards to biological evolution.

Indeed, *"molecular recognition provides a profound inertia to evolutionary innovation because it demands conservation of forms of proteins and hence of the encoding genes"* (Garcia-Bellido, 1996).

This dialectics is the case of both DNA and RNA; particularly, with respect to the

symmetry given by the palindromic secondary structures of single stranded RNA to be unveiled in this article as generated by the Klein Bottle logic, they are responsible for the stability and molecular recognition features of RNA molecules (Garcia-Bellido, 1996).

Molecular recognition operates differently to the dual logic of symmetry usually attributed to this class of phenomenon –the 'key-hole mechanism'.

The latter cannot account for the cognitive tasks performed by biological systems, particularly those attributed to meaning-making (Neumann, 2008).

Yet, the metaform of the synsymmetry dialectics has been identified as the Klein Bottle (Rosen, 2008).

We retake Rashevsky's pledge for topology in biology.

Indeed, observing the two topological identifications that create the Klein Bottle as in fig. 1.II.C –see Part II, the X-cross identification of two of the sides (drawn in blue) oppositely oriented vis-à-vis the other 'straight' identification of the two sides equally oriented (drawn in red), we learn that it embodies a *fusion of asymmetry and symmetry*, respectively, *relative to them*.

In distinction with the real projective line for which both opposite sides have *opposite* directions identified and the Möbius strip which only two opposite sides are identified with the *same* direction; see fig. 1.II.D & 1.II.A respectively, in Part II.

Thus, the real projective line embodies only (cross) symmetry, while for the Möbius strip partial (cross) symmetry is the case as the seemingly two sides of it merge continuously into a single side with a single boundary that contains it in a process of *dimensional creation*, since this surface exists embedded in Euclidean 3d space in terms of which appears as if contained in it.

The present ontology is related to the creative operations of the synsymmetry dialectics, be that of meaning, shapes, space and time, rather than an ontology for static identities and a static Being.

Morphomechanics has upholded the Pasteur-Curie principle for understanding development, to claim that non-linearity cooperates with it.

Also, in the setting of a theory of evolution based on self-organization, this dialectics has been identified as the very principle for evolution, no less because the symmetries found to be valid in physics carry on to chemistry and to biological shapes (Lima de Faria, 1988; Bell Pettigrew, 1907).

Thus, torsion as associated to symmetry as well as synsymmetry is crucial to 'circular' causality, which in turn is also the case of heterarchies albeit notably 'complexified', both issues to be discussed below.

In the setting of metric theories of spacetime a dualistic conception places a categorization of physical symmetries into Interior and Exterior symmetries.

This requires invoking additional degrees of freedom as extra dimensions to account for the Interior symmetries, to be later invoked a compactification of them to account for the impossibility of attaining physical evidence of them.

However, in the case of torsion geometry this categorical divide of symmetries is surmounted (Rapoport and Tilli, 1986).

Physical symmetry –and its localized form- of fields and particles is associated to torsion as it manifests as spacetime structure.

In morphomechanics the development of the embryo is related to the changes of symmetries, decreasing sequentially in symmetry order with development but for some case in which the reverse appears to be the case; they are also defined as symmetry breaks starting with the symmetry of the sphere.

The same dissociation between External and Internal symmetries claimed in physics for pointlike particles and their fields but now relative to the organism's boundary or that of a tissue, has been purported to be the case of development of embryos. In this setting Exterior agencies operate producing symmetry breaking. However this Interior/Exterior categorical divide has found to be wanting (Beloussov, 2015).

Still, the dynamical changes in symmetries which are embodied by the

developing embryo, actually show that the succession of changes is related to topological operations. As noted by Beloussov, these occur as in liquid crystals –which are examples of a torsion geometry with a Möbius strip topology (Bouligand, 1978), producing vortical instabilities through folding.

Hence the fundamental operations of embryological development are 1) the foldings of tissues, 2) the densification 'convergence' of the number of cells in a particular loci, 3) the shearing motions of layers of cells with the ensuing breakage of continuity as intercalation, and 4) the creation of a singularity by self-penetration –the latter two being the so-called Volterra operations of the geometrical torsion theory of crystal dislocations to be discussed below.

These operations *cannot* be primarily associated with metrics: metrics do not represent relatedness but a measure of the distance of a mere Exteriority of objects as if passively and neutrally contained in space and in time, which exists per-se, and us such unaccountable processwise.

This self-penetration with the creation of a singularity is the case of the blastopore invagination.

However, this invagination does not follow the Interior/Exterior divide – endodermal cells are produced from Exterior embryonic cells, and a third layer the mesoderm is involved, through the operations already alluded. Indeed, torsion folding through the previous operations embodies the *three*-layered (ectoderm, mesoderm and endoderm) tissue formation of the blastopore invagination of the ovum, i.e. gastrulation.

Gastrulation as the singularly most important early event that triggers embryological development towards maturity can be naturally seen as the turning Outside-Inside and Inside-Out of the ovum. Thus it operates as in a sphere's eversion (i.e. turning Inside-Outside and the reverse) transforming the sphere to a final topology, that of a 2-torus with a single hole, which is the shape of organisms that have an intestinal conduct joining mouth and anus (Rapoport, 2011c, 2011d; Isaeva, 2014, Jockush and Dress, 2003).

This is a non-dual logophysics manifesting a Klein Bottle self-penetration (Rapoport, 2011c, 2014b) which is kept embedded in the resultant torus as a 2:1 harmonics, to be extensively discussed below with relation to perception and the architecture of the dynamical genome.

In fact, morpho-mechanics acknowledges an integration of Exterior and Interior along development through timing, with periods of the organism being indifferent to Exterior perturbations, and highly sensitive to them in another periods (Beloussov, 2015).

Yet, there is still one another relation which sets up the primality of torsion with respect to curvature. Namely, while metric geometries as chosen by Einstein for the basis of a theory of gravitation, are merely quantitative, torsion geometries embody a distinctive quantitative and qualitative nature.

There is more to this primality.

Indeed, on a still more basic conceptual level, the space or spacetime of metric geometries is perfectly homogeneous, isotropic and continuous (Ashtekar and Petkov, 2014).

Hence it is an abstraction detached from the physical world of materials: they are inhomoge-neous.

This stands at the basis of the stalemate for achieving a reconciliation of Einstein's General Relativity with Quantum Mechanics, the latter requiring discontinuities due to the discrete nature of quanta (Rovelli, 2008) and their jumps, both related to torsion geometry (Rapoport, 2009, 2010a, 2011d; Ross, 1989).

Thus in its impossibility of treating the discrete nature of the quantum and the discontinuities brought up with it, metric geometries of a continuum fail to account for quantum phenomena, while torsion geometries indeed encompasses them in its very foundations (Rapoport, 1991, 1997, 1998, 2005a, 2005b, 2007a, 2007b, 2009, 2010a).

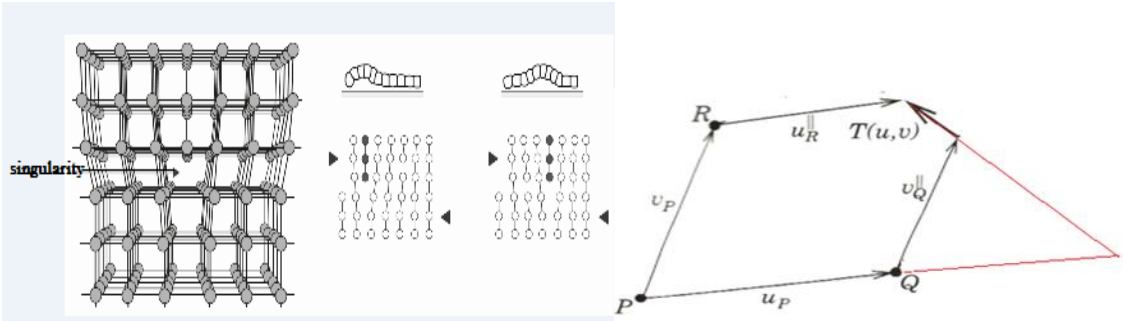

Fig. 1.I. Left and Centre*: Torsion in an 'edge dislocation' of a crystal due to shear motion.* We introduce non-null torsion by shear in a crystal lattice, say an elastic deformation (Kleinert, 2008) which are crucial to biological morphomechanics. In the central figure is depicted a "caterpillar's" shearing motion (i.e. the relative motion of two planes) in the surface of a perfect crystal. In the lhs figure we have a perfect periodic lattice (drawn in grey) –actually an idealization difficult to encounter or achieve-, but for the centre where the periodicity is altered by a so-called edge dislocation. The periodic structure is the case of a discrete space-time rendering of the homogeneous spacetime of General Relativity. But in the central area a dislocation as a singularity, a vacancy, is the case, though added material –either by spontaneous creation or as introduced by an agency as if Exterior, may alternatively be the case. As we shall see, either the singularity or the inhomogeneity become the source for non-linearity in Nature. These are the so-called Volterra operations of condensed matter physics (Kleinert, 2008), already identified in morphomechanics.We see in the left figure the transition from parallelograms that close by default (null torsion as in General Relativity) in the periodic loci, to non-closing and the formation of a fifth side, the torsion field,forming thus a pentagon, clearly depicted at the centre of the figure, showing the meaning of torsion; see first paragraph of note no.4.

Central figures: Torsion introduced by shear (i.e. think of a 'caterpillar' which moves a lattice a step at a time, and the shear produces the torsion of the crystal; this shear produces a vortical motion on the normal (i.e. perpendicular to the) to the shearing plane under the mixing of layers. Alternatively, this vortical motion can be produced by a "screw dislocation", with the torsion being normal to the plane (Kleinert,2008), either case prompting for the topological identifications to be discussed below. Yet, this is not about an Exterior agency, here the 'caterpillar', but relational dislocations produced by either a singularity or an inhomogeneity. Another analogy is that of a rug, moving in the perfect background of the homogeneous crystal; local changes affect the whole structure; the analogy strikingly applies to the crease (the folded rug) formation in the gastropore invagination in Embryology (Rapoport,2012); it can also be produced by a hole in the surface, producing an embryological expansion wave that reaches the boundary of the crystal. Thus, it is a relational action-mediated geometry, introduced in terms of either singularities or inhomogeneities spontaneously produced –say, quantum fluctuations of the vacuum or thermal fluctuations of the lattice, elastic deformations or by the subject. Notable examples are the electromagnetic potential (Rapoport, 1997, 2009,2010a, 2011d), spinor structures (Rapoport, 1998, 2005b, 2009; Shipov, 1998) the electroweak potential (Rapoport and Tilli, 1986), the viscous fluid's velocity field (Rapoport, 2005a), the logarithmic differential of the Schroedinger field (Rapoport, 2007a, 2007b), the mean velocity of a Brownian motion (Rapoport, 2005a), the morphogenetic field (Beloussov, 2015), the biophoton field (Volodyaev and Beloussov, 2015), etc. **Right** from (Rapoport, 2013): Representation of torsion as the completing element of a dislocated infinitesimal parallelogram. Thus, despite the non-closure of the parallelogram formed by the vectors u_P and v_P at P and their parallel transport –in the sense of an affine connection introduced in note. No.4, $u_R^{\parallel}$ at R and $v_Q^{\parallel}$ at Q, a fifth side T(u,v) closes the infinitesimal vectors producing thus a pentagon. Torsion is anticommutative: T(u,v) = -T(v,u). Thus the non-commutativity property, which is the formal proto-property of cognition (Musès, 1977) as already appears in quantum mechanics (Aerts and Gabora, 2005; Conte, 2009; Khrennikov, 2010; Haven and Khrennikov, 2012), is the case of torsion, as the expression of the non-null commutator in Lie algebras or Matrix Logic (Stern, 2001; Rapoport, 2011a). Prolonging T(u,v) to the line joining P and Q, we have the trapezoid whose completion is depicted in red. Assimilating the direction of the upper side to that of the torsion T(u,v), i.e. leftbound-directed we can now topologically identify the upper and lower sides, and the left and right sides of the parallelogram depicted in red, and we obtain the Klein Bottle; see fig. 1.II.C in Part II. Would we take the direction of the upper side to be rightbound-directed, and we now proceed to make the topological identification of the sides with this choice, we get the 2-torus. Both choices are natural, and equally legitimate. Yet, the 2-torus is the so-called double covering of the Klein Bottle and the Möbius strip, which are in-built (Rapoport, 2013). This double-covering relation is the one that holds the 2-torus shape of all metazoans, and particularly, humans (Rapoport, 2012); i.e. non-orientability is "hidden" yet crucially operating with regards to physiology, perception, cognition, action, etc., as we shall discuss below. *Left and central figure, by Tania Rapoport, ©, courtesy of the author. Right figure, from (Rapoport,2013) CC.*

Accordingly, Rovelli (2008) claimed that the putative spacetime to embody such a reconciliation, is dynamic and "...can "fold" and "strech" like a rubber sheet. In other terms which are proper to phenomenology after the philosopher

Merleau-Ponty, a spacetime that can be *fleshed*, as is the case of the geometry of development of actual organisms as in morphomechanics conceived in terms of torsion geometries.

Indeed, torsion geometries stand for heterogeneity, dislocations and singularities, which certainly are attributes of physical systems (as is the case of fluid systems, and liquid crystals) but most conspicuously is also the case of biological systems as already discussed in relation to morphomechanics of development.

Liquid crystals do indeed stretch and fold as Möbius strips (Bouligand, 1978, 1999).

They are crucial to the integration of body functioning through collagen molecules, which forms the major part of tissues like bone, cornea or tendon, where they organize into ordered fibrillar networks (Giraud-Guille, 2008).

Furthermore, liquid crystals through their non-orientable topologies in principle they can self-penetrate, such as in the Klein Bottle which is the case of genomics to be elaborated in detail in the sequel (Rapoport, 2011b, 2011c, 2014a, 2014b).

Already, light is found to embody very diverse topological configurations, such as Möbius strips (Freund, 2010).

Other experimentally realizable configurations of light are such that the electric and magnetic field components form closed loops, with knotted and intricate linkages (Irvine and Bowmeester, 2008; Irvine, 2010), which are pervasive to DNA (Bates and Maxwell, 2005) and molecules (Flapan, 2010), in the setting of the topological theory of electromagnetism and chemistry, respectively.

A fleshed geometry and topology indeed, which only presently Quantum Gravity starts to consider for its modelling of spacetime, but only as a *hope for a potential theory-to-be*, as highlighted in (Rovelli, 2008).

Rashevsky is thus reivindicated by eliciting the unity of geometry, topology, ontology and phenomenology, in a non-dual logophysics applied to science, to be expounded in this article, but particularly applied to elucidate the structure of genomes vis-à-vis the environment, and further extended to biological evolution.

For closing this initial discussion on torsion and curvature, it is interesting to notice that whereas in the usual understanding in the double helix model of DNA the folding of DNA and its curvature are conflated, studies on the plurality of codes in genomes show that curvature and folding, the latter to be associated with torsion and non-orientabilty, are *not* processwise identifiable (Trifonov, 2011).

Thus genomes appear to process them distinctly. Accordingly, there is –among others- a "shape-code" for DNA curving, and a chromatin code for 3D protein folding which is binary (Trifonov, 2008).

In the present logophysics the very generation of genomes in terms of the Klein Bottle logic is the primal coding as folding.

1.2 Relational Science, Closed Loops and Proto-Semiosis

In this article we shall follow the proposal of Rashevsky, departing from an abstract formulation which does not requires an intricate formalization, but rather a most elementary presentation.

This stands in sharp contrast with other formal systems approach to biology, such as category theory as in (Rosen, 1985, 2000).

However, we shall relate to another approach of this author, albeit one which has been laid to rest in oblivion, despite Rosen's stress of its importance.

The reason for doing so is that it bears a close relation to the geometrical foundations of the present approach as applied to classical mechanics (Rapoport and Sternberg, 1985) later extended to quantum physics, thermodynamics and fluid-dynamics by this author, and to the topological setting as well.

The former foundations, though it lacks the simplicity of the present approach, it has its own conceptual simplicity in regards to allow the avoidance of the teleological formulation of classical mechanics in terms of variational calculus which is believed to be basic to theoretical physics at large (Lanczos, 1970; Basdevant, 2007), yet

which is unnecessary both for physics inasmuch it is so in the present ontology.

These foundations which fuse topology and analysis on geometrical space (i.e. manifolds), allow us to place Rosen's proposal for its reformulation in a more comprehensive setting and further relate it to a topological approach to physics which has been mostly neglected, perhaps due to its success in doing away with the notion that metrics -and even space are basic.

As we shall see in the most basic conceptual terms, Rosen's suggested approach was largely realized prior to the laying out of his proposal.

Again, all this points out to a science of relations which are naturally non-fragmentable, rather than one of objects, and dynamical at that matter, rather than static, even with respect to *identity, the latter being impossible for the dual ontology of classical logic;* in the sequel we shall see that this is indeed the case discussing further another notion related to torsion geometries, namely that of a relational logophysics already propug-nated by Rashevksy and Rosen, instead of the action-reaction dual logophysics of Newtonian physics, which science has taken already in biology for its basic paradigm (Rosen, 1985, 2000).

This dualistic ontology even permeates governance, politics and management (Foley, 1990), not to mention psychology and cognition as the metaphysical background for the ascription of properties of an individual (Wilson, 2004).

This science of relations will be expounded in terms of a most fundamental form of relation which operates as indication, reference, and more fundamentally, self-reference. Torsion geometry has an ontological grounding which is universal, as is the case of self-reference- and its extension to other-reference (hetero-reference), and applies to physics, chemistry, biology and cognition, as elaborated in the works of the author.

Indeed, torsion appears as what produces and embodies the *closure* of an infinitesimal parallelogram which is *open* due to inhomogeneities or the existence of a singularity around which the parallelogram-to-be winds around, thus establishing a *closed loop*; see figure 1, above.

In other words, to be able to posit the notion of locus, a dislocation is necessary.

This stands in stark contrast with metric-based geometries for which space or spacetime is perfectly homogeneous, and the notion of locus is but an abstraction, due to its lack of distinctiveness. Its neutrality is such that it cannot bear, in principle, cognition, but as an alleged objectivity of an observer.

However it requires a communication in terms of light for its assessment, which has no objective character, but a self-referential one instead.

Indeed, light is not seen, but seeing. Remarkably, light is a torsion field (Rapoport, 2010a) which in addition of the Möbius strip configurations already alluded, produces intricate *closed* knots derived from its torsion structure (Irvine, 2010) (see Irvine fig.2, there coinciding with fig.1.I, right, above).

It further sustains quantum jumps as the most elementary difference producing differences (Rapoport, 2009, 2010a).

We shall later connect this with the relational paradigm.

Certainly, for organisms the neutral notion of space of Einstein's vintage is precisely *not* the case, since morphoge-nesis eventuates through the meaning that a precise locus plays at a certain time of development, which notions such of morphological gradients have attempted to capture (Beloussov, 2015).

This speaks out for *contextuality*, which is already the current conception of the "genetic program" of development of an organism, in which the localization of symmetries play a crucial role as regulatory closed loops (ibid.).

Such a processual understanding of space and time is anything but absent in theoretical physics at large.

It is somewhat implicit in the transactional interpretation of quantum mechanics (Kastner, 2012), and to quantum field theory (Greenberger, 2009); for an exception see (Cahill, 2005) and the Vajxo interpretation of quantum

mechanics in terms of contextual probabilities (Khrennikov, 2010).

However, this notion of space as contextuality arising from interactions or self-interactions is not exclusive to biological organisms; indeed we have proposed it to be the case of physics (Rapoport, 2013) associated to torsion as vortical motions, which may appear in flat Minkowski spacetime (Rapoport, 1991, 1997) of the physical vacuum see (Shipov, 1998).

Here we use the term 'contextuality' in its etymological sense of 'weaving', rather than a metaphorical situation with regards a physical or conceptual *container* in terms of which the system is related.

Thus the notion of contextuality through its etymology indicates a non-dual logic: a weaving cannot be undone without breaking loose the elements being related and the myriad meanings that this unity performs.

In this relational ontology, the properties of systems arise from interactions.

The notion of an essential property is in some extent a figurative appeal to the categorical Interior/Exterior divide and its surmountal.

Indeed, the Klein Bottle has an Inside-Inside state, to which essences can be ontologically attributed.

Thus this notion of essentiality is valid –also to a certain extent- as an *invariant* of interactions which are produced in terms of a non-dual logophysics, rather than intrinsic, and dually so.

In fact, theoretical physics has developed in the last one hundred years in terms of the Lie group symmetries, established as the invariance of certain defining processes, following Felix Klein's (discoverer of the homonymous Bottle-surface) Erlangen Program.

This invariance of interactions is claimed to be the case of mass upon eliciting the vortical motions that embody gravitation (rather than Newton's linearity) (Lin, 2002; Wu and Lin 2002), which are the basis of the geometry of quantum mechanics (Rapoport, 1997, 2005a, 2009, 2010), for which closed spacetime loops may play a crucial role (Steane, 2007). Already in quantum field theory properties such as the mass and charge of the electron depend on which interactions are taken in account, self-interactions being particularly important (Wikipedia /Renormalization, 2016).

As we shall discuss later this turns also to be the case of the mass of the electron, as the kinetic energy of rotation of the electromagnetic field on the spin-plane of a Dirac-Hestenes spinor operator field (Rapoport, 1998, 2005b); this shows that –under certain conditions- a metamorphosis of a massless (electromagnetic) field transforming into a massive electron is the case, and viceversa, which certainly violates the principle of identity of dual logic.

In this take, the Newtonian idealization of the isolated point-particle is about objects which in principle bear no relation between them, but each of them being *exterior to all the others as well as to the subject*.

Furthermore, time far from being a linear external parameter, will appear to be related to a *logophysical* operator associated to the Klein Bottle's non-orientability.

With respect to time being assimilable to a closed path rather than a linear parameter, the Gödel solution of the Einstein's equations of General Relativity elicit a Möbius strip topology of closed time-like geodesics describing a *rotating* Universe which is non-orientable (Boeyens, 2010).

The bottomline for this is that in compactified Minkowski spacetime, viz. Minkowski space plus a 2-sphere at infinity, closed paths along the Möbius strip surmount continuously the hyperbolic discontinuities of pseudocircles with null radius.

We shall later see that a non-orientable surmountal of an irremovable discontinuity allowing for a continuous path is very much a universal property of the evolution of non-linear equations as time-irreversible creative or renewal cycles as evolutions in the Riemann 2-sphere, i.e. compactified complex plane.

Torsion as a closure winding around a singularity - as depicted by the closed path in fig.1.

I above, enacts as a primal signature that of selfhood, but yet upon neglecting otherness, which requires an hetero-penetration which the simple closure does not distinguish.

Thus, a torsioned space is not that of an abstract location as is the case of the space or spacetime of metric geometries which do not support dislocations, but one which arises as a dialectics of continuity and discontinuity, establishing an interrelation between them, in distinction with metric geometries which, *in principle*, are only continuous.

This dialectics rests on a surmountal of the Cartesian Cut which is embodied as the self-penetration of the Klein Bottle and its hyperextensions: the whole reifies through this imaginal hole of self-penetration which itself creates the wholeness. As already introduced, light appears to be a primal example of a torsion field.

For metric geometries infinitesimal parallelograms close by default: they have null torsion, or in other words, they have a trivial self-referentiality which thus cannot be assigned to singularities, the primal one being selfhood. See note no. 4.

The relevance of this self-referential logophysical-closed-loop-producing-action (viz. torsion) with respect to *semiosis* (i.e. sign activity, occurring through self-organization) is relevant to the present theory.

Already Rosen established that the forward closed *loops*, the functional cycles of an organism, say either communicating, physiologically or ecologically, produce an *"...anticipating agency [which] stand as the general model to which most organisms sign processes in living systems conform..."* (Kull, 2011); see note no. 5.

Indeed, we recontextualize our previous discussion: In the torsion geometry we encounter a proto-action,which is both physical and *cognitive-like* (better said, semiotic) due to self-reference being the principle that supports it.

It construes a cycle as an infinitesimal space or spacetime closed parallelogram (Rapoport, 2013, 2014b), or still in the cognitive plane of Matrix Logic (Rapoport, 2011a).

Although this infinitesimal parallelogram should close by default (as parallelograms in Euclidean space or metric geometries do), due to the dislocations it only does so by the action of closure due to the torsion.

So we find in this a primitive form of *indication* (or reference) through a completion of a singularity or an inhomogeneity, which establishes the closed loop as a proto-semiosis, in particular in biology.

Yet this protoform of semiotic agency does not operate through the Exterior/Interior categorization, nor in particular through an independent agency, but through self-reference as a principle. Biological systems as integrated measuring systems would fall into a cognitive infinite regress unless a Klein Bottle logophysics sustains their unity-in-coordinated-diversity, as we shall discuss below.

Self-reference usually is not conceived as a principle but in its operational form of recursion, and keeping the Exterior/Interior divide as in (Goetzler, 2013).

As for the underlying logophysical agency supporting this closure it can be identified with the TIME operator –to be introduced below in note no.11.

This operator can further be associated with the action of self-control to return to the identity (Rapoport, 2011d) so it is linked to intentionality, as self-adaptive response -basic to the 'Geometry of Meaning' (Young, 1976) which from empirical studies of olfaction has been rendered as the basis for the neurosciences (Freeman, 2000, 2010).

This relational character is evidenced upon considering that torsion has for primal dynamics the self-organizing vortex, as is the case of the topology of vortical waves of light (Irvine, 2010) actually Möbius strips (Freund, 2010), and sound waves (Ruane, 2015), or in fluid and plasma dynamics (Rapoport, 2002a, 2005a) where they become the basis for a plasma cosmology which claims the banality of the Big Bang model (Peratt, 2015).

Ultimately, the Big Bang is the epitome of the obliteration of all contextuality, a singular event which is environment free, an isolated singularity which is not a dislocation, and yet it purports that the Universe is its outcome.

This stands in stark contrast with the linear motion upholded by the Newtonian paradigm as the basic kinematics, and inherited in the theory of General Relativity (GR) as the geodesic principle of the shorter paths joining two points.

This principle is normative rather than contextual, and unrelated to self-reference but for rendering it trivial since GR by default assumes null torsion. Indeed, the vortex produces a contextuality of the physical system vis-à-vis itself and the environment, as a structured non-pointlike spacetime entity, very much in distinction with the Newtonian idealization of the (un)physical point particle being submitted to linear forces operating through a dualistic action/reaction logophysics (Rapoport, 2013).

Yet, we need a more twisted contextuality, that of heterarchies to be introduced below.

Yet, since curvature is a derivative of torsion –which can be non-null even in Minkowski space whose curvature vanishes- and of the non-dual logophysics which decurs from its generation of non-orientability as is the case of the Klein Bottle (Rapoport, 2013, 2014a, 2014b), then metrics and their curvature as *descriptors* of the morphomechanics of organisms should be also derivable from the present logophysics, rather than being primal.

This is crucial for this logophysics to be able to provide for a basis for biocomputation, which is believed to be operated mostly through genomes. Indeed, as suggested recently by Petoukhov, the algebraic structures of genomes in terms of Hadamard matrices (i.e. the matrix representation of the Klein Bottle) provides not only for the codification of genomes, but also for the generation of metrics for biological morphomechanics, and curvatures as well (Petoukhov, 2016).

This is crucially related to the harmonics of vibrations, as systems of *resonances*, which we shall indeed discover to be associated to the HyperKlein Bottle of genomes.

We shall do this first theoretically, and lastly through the numerical evidence of BUILD 34, and other genomes, unveiled by (Perez, 2009, 2010, 2013, 2015); as we shall see both the Mobius strip and the Klein Bottle are embodiments of a 2:1 resonance.

This association with harmonics is fully compatible with the notion that genomes rather than being controllers of development "they cooperate in producing variations on generic themes" meaning by "generic themes" the law-determined motifs", (Beloussov, 2015, quoting from Goodwin).

Here, law-determined motifs are embodied already by the structural relations of symmetries (i.e. torsion) which are physical, chemical, crystallographical and ultimately "biological" (Lima de Faria, 1988).

Yet, rather than the contextual-free determination of the Newtonian paradigm, these symmetries are open to epigenetic factors through a 'circular' causality (Beloussov, 2015), the latter which shall be identified in the sequel.

This form of causality is also the case of the operations of the brain (Freeman, 2010) and of the body as we shall discuss below upon introducing the Klein Bottle topology of the topographic maps of the sensorium.

This openness to the heterarchical environment is the nature of the HyperKlein Bottle and its coding of genomes as embodying the environment and its diversity, which we shall discuss in this article.

Thus, the ancient notion of biological morphogenesis as related to the harmonics of vibrations, as already appears in the Man of Vitruvius by Leonardo (Gyhka, 1952) and Chladni structures (Jenny, 2001), would have its origin in the present non-dual logophysics.

Remar-kably, harmonics has been proposed as an alternative principle for neurocomputa-tion (Lehar, 1999) and related to the Golden Ratio associated to

the pentagon -as in fig. 1- and further to our learning capacities and neural networks as bosonic fields (Weiss and Weiss, 2003).

1.3 The Time Operator and the Non-Orientable Foldings of Development, Space, Time and Number Systems: Torsion, Self-organization and Non-linearity

GR reframed the fundamental elements of the Newtonian paradigm in a novel geometrical setting which could not provide a putative geometrical source as the material fields that generate the metrics themselves (Ashtekar and Petkov, 2014), in distinction with the self-organizing and self-referring vortex.

Thus GR is built as a duality of matter and geometry, the latter being a manifestation of the former which itself is unaccounted for by the geometry.

In GR the elementary motion is a geodesic, i.e. the extension of a line to the shortest paths in terms of the underlying metric, rather than vortical non-linear motion.

As Einstein recognized, it was the idea of free fall that layed the foundations of GR as the Principle of Equivalence, rather than vortical motion.

In GR this is put as: "geometry tells matter how to move, matter tells geometry how to curve", a phenomenological loop-to-be, even in one somewhat ultimate case.

This is the case of the stress-energy source for the Einstein equations for the metric is defined in terms of the electromagnetic field, the so-called Einstein-Maxwell theory (Misner, 1973); however, this field cannot be associated with a metric, but rather with torsion (Rapoport, 1997, 1998, 2010a).

GR claims a 'circular' causality which does not actually close upon itself since matter is being introduced 'by hand', as it were (Misner, 1973).

In other terms, GR's account of spacetime fails to incorporate self-organization, nor timing for that matter; the bottomline is that in GR time is a mere parameter.

Hence, already in the failure to produce a closed loop embo-dying the relation between matter and geometry it is elicited that self-reference is not the principle underlying GR, for which an *extraneous* source for the gravi-tational field derived from the metric is invoked.

This lack of identification of the nature of the source for the metric geometry was acknowledged by Einstein as the 'muddy' basis for GR.

However, in the torsion geometry of the physical vacuum, the Bianchi structural equations do form a phenomenological closed loop proving that there is no duality between torsion geometry and matter, and that the former itself is a *source* for matter (Shipov, 1998).

Thus matter distribution and torsion geometry constitute a somewhat superposed *non*-dual logophysical relation of self-organization with its prototypical vortical form –either of physical space as in spiral galaxies or organismic morphomechanics, rather than the unfounded superposed duality between curvature and mass distribution posed by the metric-based GR.

Thus torsion is associated with self-organization, and the generic metaform for its physical self-organization is the vortex, the eddy, or the spinning current, rather than the non-self-organized curvature of metric geometry.

Furthermore, the logophysical metaform of torsion that fuses the physical, imaginal, temporal, semiotic, cognitive and logical levels is the Klein Bottle or still the HyperKlein Bottle(s).

Indeed, it further leads to a logophysics based on these non-orientable surfaces, and as we shall see, to the overlayed folded structure of organisms having the topology of the 2-torus with the built-in Klein Bottle.

In fact, this has been claimed to be the case upon modelling the architecture and growth of conchoids (sea-shells) by Illert.

This mathematical modellization, the first ever complete analytic formalization of conchoid development, requires torsion and curvature though in a 6d space; otherwise a breakdown in development occurs.

Furthermore, time itself can be interpreted with relation to the torsion geometry and matter distribution in similar terms, i.e. as a substantial phenomena (Wu and Lin 2002, Lin, 1998, 2002, 2008) as pioneered in the work of Kozyrev (Kozyrev and Nasonov, 1980; Johansen, 2008; Levich, 2003).

Rather than time being an additional dimension of space as in GR, conchoids appear to embody their material self-organization as following and supported by a temporal non-linear logophysics related to non-orientability.

This elicits a non-linear time structure as the basis for their development (Illert, 1987), which is anticipative: it appears as if behaviour with foreknowledge would be the case (Illert and Santilli, 1995).

One of the corresponding notions of such an operator-time is that of substantiality, a 'metabolic time' (Levich, 2003), in which time arises with the vortical structure produced by inhomogeneous matter distributions (Lin and OuYang, 2010) and of space and time themselves.

For the phenomenological study of time, the identification of the 'process' or 'carrier' in the material world, whose properties might be identified or put into correspondence with the properties ascribed to the time phenomenon, was associated to the archetypical generating vortex.

Thus space appears as a manifestation of the primeval time vortices, which in the most elementary form appear as the chirality of the torsion geometries of the physical vacuum (Shipov, 1998).

However rather than pointing to a presumed hierarchy of Nature in terms of which the sources of the time phenomenon are categorized as either External or Internal (Levich, 2003), we claim that an heterarchical HyperKlein Bottle logophysics is the case, as a pluri-self-and-hetero-penetrating depth, with depth being associated to the primal protodimension of time, to be discussed below.

As we shall see upon discussing heterarchies as early introduced (McCulloch, 1945), the 'circular' causality which produces such a 'metabolic time' already introduces a logophysical operator time.

We have identified it as the TIME operator which decomposes as the sum of two terms, both vortical, of the matrix representation of the COGNITION operator associated to the Klein Bottle's non-orientability (Rapoport, 2009, 2011a), to be introduced in note no. 11.

As for its 'metabolic' operation, we shall see that is indeed the case in terms of the growth to infinity of the entropy of non-linear systems, to reenter themselves through the non-orientable topology of the complex number systems at infinity, reproducing themselves as renewed systems undergoing a transitional stage (Rapoport, 2013), and more generally of non-linear systems, to be discussed below.

This generic reproduction as a novel phase or structure of systems modeled analytically by non-linear equations, follows their inevitable divergence to infinity. In doing so the production of a singularity occurs which indicates the breakdown of the analytical modelling which simultaneously elicits the underlying non-dual logophysics as the *reentrance* of the system on itself.

On doing so the non-linear system – which is the generic case, rather than being exceptional- undergoes a transitional transformation through a change to nonorientability of the values of their dynamics (Rapoport, 2013).

Remarkably research in ecology and development somewhat non-ontologically formulated suggest related ideas, claiming a Möbius strip continuity of an adaptive four-phase cycle of exploitation → conservation→ release → reorganization → exploitation →... (Gunderson and Holling, 2001), though they invoke hierarchies rather than heterarchies.

Thus there is a breakdown of the analytical modellization that by necessity becomes a figurative qualitative model (Lin and OuYang, 2010; Lin and Forrest, 2013), wherein a change of orientability to non-orientability at infinity (the North Pole of the Riemann sphere) gives place for a renewal of the system, to be discussed below (Rapoport, 2013).

For instance in the case of the Einstein non-linear field equations of GR, they may

develop singularities which are claimed to be an indication of the breakdown of the physics of GR where the physical quantities appear to be undefined; of course, this contradicts the initial assumption of continuity of space and time, so whether these singularities are actual or only a consequence of the analytical formula-tion is an issue which is setup in the background of dual logic –or still dual logophysics- which is at the basis of this hypothesis.

Furthermore, in terms of the dual logic this problem appears to be unsolvable: we need to surmount it.

Despite the analytical background of the well-posedness of the non-linear equations, i.e. existence, stability and uniqueness of their solutions, due to the 'blow-up' of the solutions as they diverge to infinity*, non-linearity sets up together with discontinuities; morphologically, these are associated to vortices*.

With them the analytical method based on the notion of a continuum which is assumed to be infinitely differentiable (smooth, in mathematical parlance) is no longer able to characterize the evolutions of non-linear systems.

Ashtekar puts it as: "singularities are our gates to go beyond general relativity.

Presumably, quantum space-time continues to exist and real physics cannot stop there.

To describe what really happens, once again we must dramatically revise, our notions of space and time.

We need a new syntax" (Ashtekar, 2005).

In physics the unability to identify this 'syntax' in terms of the imperating dualism has been and will continue to be the case.

As introduced already, torsion appears as a manifestation of either a singularity or an inhomogeneity, to the effect of their completion, establishing continuity fused with discontinuity in doing so, through vortical fields, non-linearity.

So it is about a *dialectics* of the particular and the general, the singular and the plural, the Inside and the Outside, the discontinuous and the continuous, which is a non-dual logophysics to be explicated in this article.

Thus, we claim that what fails –in a sense to be precised below- with the analytical approach based on the continuum on applying it to non-linear equations, is the dual logic in terms of which mathematical analysis -and GR- has developed, as already claimed by the intuitionistic school led by Brouwer concerning its failure to provide a finite-step constructability (Kleene, 2009; Lin and Forrest, 2013).

Indeed, the analytical models based on the hypothesis of a continuum implicitly disconsider the non-dual logophysics which is very much the case of systems whose evolution is regulated by non-linear equations.

These models are based further on the notion that analysis is all about numerical schemes which erase irregularities.

Furthermore there is an implicit assumption: that the actual physical non-linearity that arises with physical irregularities of materials and systems in general –all these issues being disconsidered, are appropriately charac-terized by *this* numerical approach.

Thus numbers as *unstructured* quantities are consider to embody the relevant information of evolving systems.

Actually this conception underlies much of the present sciences as developed in quantitative terms.

This is the setting for the so-called theory of chaos, which started its development 50 years ago (Alligood, 1996).

A chaotic system is non-linear and such that any two solutions, given by the quantities x & y which are roughly equal, then x – y becomes a computational uncertainty involving large quantities with infinitesimal increments as the system evolves in time.

For chaotic systems, notable big differences of the solutions are produced by small differences of the values of the initial conditions.

Hence, small initial differences produce diver-gent solutions. Indeed the presumed infinite resolvability of a real number in its *binary* expansion –as actually implemented in digital computers -that is at stake in the computation of

non-linear systems as they diverge producing a singularity, is effectively carried out as a finite precision computation truncating parts of the tail of this expansion.

Hence, a finite-difference recursion is implemen-ted to compute a discrete model of the original model, the latter based on the continuum hypothesis, the former associated with a discontinuous space and time.

Thus, the presumed-to-be solution provided by the computational scheme with which the integration of the non-linear equation is carried out yields a result, which critically viewed is a computational artifact.

Otherwise the equation itself is claimed not to be an adequate model of the non-linear phenomena.

One such equation is the Lorenz non-linear equation of climatology, which itself is a simplification of the equations of fluid-dynamics (Alligood, 1996), the latter being a crucial example of torsion dynamics (Rapoport, 2002a, 2002b, 2005a).

Yet, as we shall see, the truncation is not merely about numerical precision which is crucial for the validity of the mathematical non-linear model, but of the non-dual logophysics which itself manifests in the binary expansion of real numbers as the paradoxical oscillation that the tail of the expansion embodies.

In other words, there is a non-dual logophysics embodied in the truncation error, rather than being unstructured unaccountability.

The evolution of error follows a non-dual logophysics, indepen-dently of whether the mathematical continuous non-linear model or its discontinuous discretized version is the case. Furthermore, it transpires also in the blow-up of these solutions. Let us examine both in the sequel.

As already said, the numerical analysis of either the analytical continuous model or its discretized model based on inherent discontinuity of time and the other possible variables ignores the non-dual logophysics which operates in such systems, which is particularly notable in chaotic non-linear evolutions as described in the theory of blown-up systems.

The latter are non-linear systems which diverge to infinity with the increasing time-parameter as they approach the boundary of definition of the solution (Wu and Lin, 2002; Lin and Forrest, 2013).

Consider a system which we describe by u = u(t;t_0, u_0), with t the time variable satisfying a non-linear -either ordinary or partial- differential equation depending on t, say du/ dt = f(t,u); here t_0 is the initial time and u_0 the corresponding initial state of u.

Assume that the corresponding solution of the initial value (Cauchy) problem is defined for t in the interval [t_0, T), which further satisfies that $\lim_{t\to T}$ |u | = +∞; then we say that the solution blows-up (at T), or it is a blown-up system.

Typically, the discontinuity at T of u is of hyperbolic form.

Similarly, we can introduce the definition for systems depending on other variables, say spatial variable x or still thermodynamical variables, which may develop a blow-up in the partial derivative of u with respect to x.

An example of these initial-value problem is given by the Einstein field equations for GR, for which additional constraint conditions are given (Isenberg, 2014).

Despite the widespread contradict-tions in claiming the existence of singularities, and whatever the arguments for resisting the breakdown of continuity of spacetime in GR may be either in general terms or in specific cases, in terms of the non-linear quality of its field equations they appear to be inevitable.

This is so though for logophysical reasons which the implicit dualism is unable to grasp. Remarkably, we shall see that the collapsing star Cassiopeia A (CasA) followed by a supernova explosion event actually produces a singularity as a vortical turning Inside/Outside of which the Outside is the visible Universe of which are very bodies are made of.

Models of gravitation that include torsion (the Einstein-Cartan theory) conclude that the singularity (points of spacetime with infinite curvature and matter density, in distinction with the previous sense) is prevented by torsion

(produced by the spin density of quarks and leptons filling the Universe), however precluding the existence of a Big Bang initial singularity.

Yet, this singularity is associated with the naissance of another Universe as the Interior of a collapsing black hole (Poplawsky, 2010) which presumably would be the case of CasA, so the visible result of the turning Inside/Outside of the supernova explosion would be such an Inside, our Universe.

This issue of naissances following the development of singularities which we have already introduced will surface again several times in the following.

The question of this transition that takes place upon the production of the blow-up is what the meaning of ∞ is, as the mathematical indeterminacy that the real numbers unboundedness already poses.

In the usual analytical modellization - as in GR- this is interpreted as a breakdown of the analytical formalization, as if a limit to knowledge would be the case; in other words, an issue of epistemics and its limits.

The equations cease to be valid.

The problem is with ∞, the incertitude which brings computations to a halt upon attempting to integrate a discrete model of the continuous one.

As we shall see, the interpretation of it requires to consider non-dual logophysics, in its many manifestations, as associated to non-linearity and morphogenesis, to the paradoxical character of the continuum, and their relation with the Klein Bottle logic.

Thus, rather than being a problem of epistemics, it sets us back to its relations with ontology, as associated with a logic (see §1.7 below) which, we recall, is already the case of the mathematical analysis of the continuum.

Indeed, the latter claims the dual logic as its implicit ontology (Lin and Forrest, 2013).

Actually it does so not even mentioning it, as a transparent assumption which already the intuitionistic school of mathematics disputed (Kleene,2009).

In performing the mathematical analysis and carrying out the computations of the solutions of the discretized model of the non-linear equations, the actual infinity of the divergent solutions embodies a transitional stage by which the evolution is completed in a particular temporal cycle to give birth to a novel cycle or structure.

This is already the case of the morphology corresponding to the initial state of a system which upon non-linear evolution transforms to a novel structure which is of vortical shape and thus presenting singularities which may have not been the case of the initial structure.

Thus blow-up systems *"reflect not only the singular transitional characteristics of the whole evolutions of nonlinear equations, but also the changes in old structures being replaced by new structures"* (Lin and Forrest, 2012).

This divergence of the paths of the evolutions of the blow-up systems represents a transformation of the dynamics of the system, which is associated to the non-orientability of the complex number system in terms of which the numerical values of the system are modelled (Rapoport, 2013), as we shall introduce below in fig.2.I. Still:

> *"...the essence of nonlinear evolutions [is the] destruction of the initial-value automorphic structures and appearance of discontinuous singularities, and provides a theoretical analysis tool for studying objective transitional and reversal changes of materials and events. What's more important is that the concept of blown-ups not only puts a brake on that of continuity, but also points out the various limitations of non-structural quantitative analysis science, developed in the past 300 years on the basis of particles since the time of Newton. It can also be said that at the beginning of a new era, the study of nonlinearity has led the science to the direction and territory of materials' structural, figurative evolutions, which possess more objectivity and scientificality"* (Wu and Lin, 2002).

It is pertinent to contrast this with the predominant consideration of waves in the sciences, as the non-linear deformation of an intrinsically linear structure in any dimensions, and their further decomposition in terms of Fourier or wavelets expansion.

Indeed, both linear and non-linear waves as they arise in quantum mechanics in the Schrödinger and Dirac equations (Rapoport, 1998, 2005b 2007), are also instances of torsion geometries, though this is largely ignored.

So torsion appears as a common basis for both the paradigm of linearity and non-linearity, as originally introduced in (Rapoport and Sternberg, 1985), through the notion of soldering-form.

The latter is a linear structure which introduces a point-to-point identification of a linear space with a non-linear one, keeping linear contact between them, so that the former becomes a model space for the non-linear dynamics on the non-linear space, to first approximation.

Torsion arises as the (covariant) differential of this soldering.

In terms of material structures, waves that are solutions of linear equations can be seen as arising from reciprocal motions as identified already in (Wu and Lin, 2002; Lin and OuYang, 2010).

However, would we invoke the non-orientable protoform of Newton's Third Law of the equality of action and reaction - discussed in fig. 4.II in Part II- which underlies this kind of motions, we can identify the non-linear non-dual logophsics common to both paradigms of linearity and non-linearity.

As a particular case, the morphomechanics of biological development follows the same creation of morphologies, since non-linear dynamical regulation (Beloussov, 2015) and particularly non-linear elasticity which is crucial to embryological development will also blow-up through singularities (Wu and Lin, 2002; Lin and Forrest, 2012).

As noticed already by Bell-Pettigrew, vortical structures are conspicuous in biology and in the human body as well (Bell Pettigrew, 1907).

In the case of the evolution of non-linear thermodynamical systems, the singularity produced by the blow-up is tantamount to the unbounded increase of the entropy of the non-linear system to further reenter through negative entropy in a new regime (Rapoport, 2013), through the connection of $+\infty$ and $-\infty$ which is established by this transition; see fig.2.I, centre and right, below.

This is due to the 180º Möbius twists at these points of the compactified complex plane.

Thus Schrödinger's association of life with aperiodic crystals (say the 5-fold symmetrical lattices –quasicrystals- which are examples of the torsion geometry as introduced in fig.1.I) and the capacity of living systems for self-organization despite the growth of entropy by a transition to negative entropy (Schrödinger, 2002), is the *generic* case of the present non-dual logophysics.

However, this is the case free of the limitation of being exclusively the case of biological systems: non-linear thermodynamical systems operates likewise, independently of their biological, chemical, physical, cosmological or whatever nature the said thermodynamical system may have.

For instance, Walter Freeman's experimental work in the neurosciences led him to propose that consciousness is associated with the non-linear chaotic dynamics of mesoscopic domains of the brain.

In this theory related to synergetics which also develops blow-ups (Wu and Lin, 2002), these domains perform as an order-parameter entraining neural networks at smaller scales, producing thus the 40Hz oscillation that is believed to be the physical signature of consciousness (Freeman, 2000, 2007).

In this setting, the topology of connections is modelled by networks of excitatory and inhibitory populations of neurons; the dynamics is approximated by piecewise linearization of nonlinear ordinary differential equations (Freeman, 2007).

Furthermore, non-linearity is crucial to the active *creative* construal of percepts as closed self-organizing loops having non-periodic attractors.

More recently, a model which surmounts the indefiniteness of the cortical hypercolumn in certain areas of the brain, has proposed that at a most fundamental scale, neural networks have a multitwisted Möbius strip topology (Wright, 2014), thus substan-tiating the non-orientable nature of the topology envisaged by Freeman.

To discuss these issues in more detail,we recall for a start that mathematics as built from its foundations on set theory assumes by default that dual logic is the case (Lin and Forrest, 2013).

In particular, probability theory generalizes dual logic under uncertainty, the so-called Cox theorem (Cox, 1961; Jaynes, 2003).

Thus, the commonplace recourse to advocate a modellization in terms of probability distributions falls short per-se of being able to elicit the non-dual logophysics which is the very principle of non-linear evolutions.

This dualistic setting fails to acknowledge that the incertitude is embodied already in the very non-dual logic of the real numbers as they appear in the infinite tail of their dyadic expansion once that dual logic is abandoned as the ontology for mathematical analysis (Hellerstein, 2010).

Indeed, there is a still deeper level of the non-dual logophysics which is not acknowledged in the current paradigm based on non-structured quantitative analysis nor in the pioneering critique of the blown-up theory of non-linear evolutions for that matter, though it recognizes the role of dual logic in enforcing this quantitative analysis.

Rather than the cursory characterization of infinity as manifesting the breakdown of analysis as a quantitative description of non-linearity based on the notion of the continuum as claimed by theorists of GR, it is the manifestation of a non-dual logophysics which the analytical model does not incorporate.

Indeed, the latter implicitly assumes a dual logophysics of observe-control, in other words a first-order cybernetics (Wu and Lin, 2002; Lin and Forrest, 2013). Furthermore, there is an identity of the non-dual logophysics that sustains the incertitude associated to the divergence of non-linear blow-up systems, both in morphogenesis *and* in the actual structure of the numerical representation by analytical methods, or still, they discretized modelling.

This is, we claim, a deeper ontology than the critiques offered so far, which are mainly epistemic.

The problem lies in the assumption of the continuum which already the existence of quanta has shown not to be fundamental, and its implicit association with dual logic.

The continuum is somewhat ambiguous.

On the one hand it is continuous, while the logic which is used for the representations of the real numbers is discrete, as it appears in their binary expansions.

As Hellerstein puts it in the setting of the multivalued 4-state Delta logic: *"the continuum is "semi-countable"; countable listings are possible, but they all contain paradox bits"*.

Indeed, in this setting it appears that the real numbers are actually finite-terms Boolean bits followed by an unending paradoxical tail of transitions of the form true→ false→true→false→.... The latter is a standing time-wave (Hellerstein, 1997) which we shall later encounter in the Klein Bottle logic of genomes.

In this setting the Cantor number of the (in)famous anti-diagonal construction of a 'proof' of the continuum of the real numbers is an attractor (Hellerstein, 2010).

Actually, in terms of the latter, the infinite oscillation is given by the transitional states of the Klein Bottle, Outside-Inside and Inside-Outside, which are the signature of its non-duality, as presented in fig.3.II part. II.

Thus, in the binary expansion of a real number we have a finite Boolean part which identifies it, which is followed by the infinite sequence Outside-Inside → Inside-Outside → Outside-Inside→ Inside-Outside →... .

So, would we understand the continuum as infinite divisibility in terms of dual logic, upon taking a four-state non-

dual logic, this infinite divisibility actually shows an infinitely never-ending paradoxical process, which blends both continuity and discontinuity.

This process is that of the reentrance of the Klein-Bottle on itself, as alternatively carried from the two dual states, Outside-Outside and Inside-Inside, which this sequence connects by subverting the boundary-associated-duality.

If the notion of the continuum is to survive, it definitely has a non-dual logophysics which so far the geometrical spacetime models of physics have all but ignored.

This is an infinity which the real number system has built-in, and thus it is also the case of the complex number system, as well, and all other division algebras, i.e. quaternions and octonions.

But this is only revealed by assuming a non-dual logic at the very foundations of the number theory upon which analysis is constructed.

This is one aspect of infinity which has been so far totally neglected. It begs for its investigation.

With respect to morphology, the evolution of blow-up systems as they diverge upon blowing up, is that they characterize not only a distinctive feature of the limitations of the analysis of non-linear systems *in terms of an unstructured real number system*.

The latter founded on the hypothesis of the continuum fails to acknowledge that such systems inexorably produce discontinuities.

To be more precise, nonlinear evolution models are the singularity problems of mathematical blown-ups of uneven formal evolutions due to the inhomogeneity of real material structures or torsioned spacetime; thus, the usual conception based on the continuum and an unstructured quantitative analysis fails.

This failure has been considered as the contemporary crisis of mathematics (Wu and Lin, 2002; Lin and Forrest, 2013), introduced with Newton's notion of linearity, differentiability and pointlike objects that invite the continuum hypothesis which cannot avail for singularities as the natural evolution of inhomogeneous structures as the blow-up.

The previous crisis of mathematics was prompted by the attempt to formalize mathematics as a semantics-free symbolic systems which banquishes self-reference and semantics, which we shall discuss later.

The present crisis is related to the failure to identify the torsional geometry of non-linearity and its non-dual logophysics, and the shortcomings of the differential calculus to deal with singularities in terms of unstructured quantitative analysis on the complex plane, for which a figurative mathematics has been proposed (Lin and Ouyang, 2010; Lin and Forrest, 2012).

Furthermore, this logophysics does incorporate creativity and renewal, in the non-orientable structure of the compactified complex number system, representing the cycles of dissolution-renewal; these are not present in the linear paradigm.

But also we suggest that the Klein Bottle reentrance tail of the real numbers is intimately connected to this crisis.

To resume so far: We have already seen upon discussing the non-orientability of the compactified complex number system as represented by the Riemann sphere and the blow-up of the solutions of analytical non-linear equations, that there is an identity, which is crucial to nonlinear evolutions.

It is the non-dual logophysics that sustains the incertitude associated to the divergence of non-linear blow-up systems, both in morphogenesis *and* in the actual structure of the numerical representation by analytical methods (-which we already identified in terms of the Klein Bottle self-penetration), or still, they discretized modelling. So, in this setting infinity is an actual structure, rather than a potential one.

In fact, the relation between infinity, vortical singularities, the discontinuities of the analytical solutions of the non-linear evolution equations and the non-dual logophysics requires to examine this relation upon abandoning the plane for the non-linear Klein Bottle or Möbius strip surfaces, as we shall further discuss below.

Actually, already the consideration of the Riemann sphere will do for a first understanding of how non-orientability operates in these regards.

Indeed, more generally, it has demonstrated by elementary figures that the hyperbolic discontinuities –as is the case of many blown-up solutions of non-linear equations, become continuous when appropriately represented in these non-orientable surfaces or in bounded domains of the projective plane for which infinity is realized as the equator of a 2-sphere (Rapoport, 2013).

The plane must be abandoned for discontinuities in the solutions to be realizable as continuous paths, a point shared in (Wu and Lin, 2002; Lin and OuYang, 2010).

Yet this continuity is realized by the non-orientability, and in the case of the Klein Bottle, its self-reentrance as a superposition of continuity and discontinuity.

Following the Daoist non-dualistic tradition, Shoucheng OuYang (Lin and OuYang, 2010) proposed to introduce 'the second stir' as the primal concept –instead of the Newtonian 'first push'.

In the terms of the present non-dual logophysics, this means that torsion fields as vortices, eddies, spin fields, associated to non-orientability, as in the Möbius strip or the Klein Bottle, are the sources for non-linearity.

These are the sources which linear analysis cannot grasp nor identify as such on the grounds of homogeneity or the absence of discontinuities at its basis.

So we have identified the basis for the phenomenon of non-linearity, which is the non-dual logophysics of these non-orientable surfaces.

As we shall see in fig.1.II Part.II, actually Newton's Third Law of the identity of action and reaction (or if wished, of 'first push' and its dual reaction) can naturally be conceived in terms of this non-dual logophysics, rather than being primal.

In other words, the 'second stir' is primal vis-à-vis the 'first push'.

The Newtonian paradigm cannot identify the primal torsion sources of non-linearity since it does not deal with it but in the terms provided by the differential and integral calculus.

Calculus assumes continuity and regularity, all points being indistinctive, but for the discontinuities; while complex analysis is tailored to deal with them, real analysis fares unwell.

In this setting, discontinuities are considered as exceptional nuisances, rather than the natural outcome of the unlimited growth of non-linear evolutions through blow-up as they curl vortically.

These shortcomings are notorious in quantum field theory, where several infinities appear which have to be regularized to yield finite results (Renormalization, 2016).

However, non-linearities cannot be apprehended in terms of this calculus as the outcome of the integration of analytical non-linear models with initial conditions, say as in fluid-dynamics, unless the torsion geometry is acknowledged already in the formalism (Rapoport, 2002a, 2002b, 2003, 2005a); so the outcome of the non-linear evolution reveals the non-dual logophysics which operates as the basic ontology.

In the case of metric-based GR, though metrics which result as solutions of initial value problems for the metric may have singularities, since the torsion of these geometries is null, the metrics do not suffice to completely describe the non-linearity of gravitation that GR purported to characterize: torsion needs to be considered also.

GR is incomplete, actually inconsistent due to its implicit assumption of dual logic that underlies the continuum hypothesis. For a discussion of a non-orientable non-dual cosmology based on the Golden Mean and 4-dimensional projective space which is measurement independent see (Boeyens, 2010).

However, as usual, the actual analytical computation of the solutions of these equations appear to be untractable unless a discretization of the continuous model is used instead (Rapoport, 2002a, 2002b; 2003a, 2003b, 2003c; 2005a, 2005c).

Furthermore, while the evolution of non-linear systems have led to conceive these evolutions as associated to the lack

of determinism as randomness, torsion geometries actually generate Brownian random motions, and the converse is also the case (Rapoport, 1991, 1997, 2005a, 2005c).

Thus, the primal torsion geometry of non-linearity does generate a random process that coexists with the non-linear deterministic evolution, and hence morphology can be associated with the notion of 'randomness', which we already mentioned that if it exists at all, it appears associated to palindromic structures assimilable to Möbius strips.

But this is related to relinquishing the assumption of infinite differentiability of paths of evolution for their mere continuity, as is the case of Brownian motion, keeping thus the assumption of the continuum.

This renders the presumed duality of determinism and 'randomness' flawed, since Brownian motions are equivalent to torsion geometries: there is a 'geometry of randomness', as Pascal himself intuited (Godfroy-Génin, 2000), here associated to the non-linear evolution which is deterministic but for the paradoxical tail.

The initial conditions do not allow to determine the exact solutions of the analytical non-evolution equation but only their *generic form, their attractor*.

Yet, upon considering the torsion geometry of non-linear systems such as the Navier-Stokes equations of fluid-dynamics, the general form of the analytical solution is obtained, due to the equivalence of random Brownian motions and torsion geometry.

This independence of the outcome of the non-linear evolution embodied by the chaotic attractor as the generic outcome, is the case of morphomechanics, as already argued.

Thus the differential calculus of real functions as implemented in terms of a purely quantitative formal approach to deal with evolutions of systems, assumes implicitly the primacy of linear structures, and the consequential methodology of treating non-linear evolutions as a purely unstructured quantitative problem of growth.

We shall later see, that this differential calculus for several variables as applied in contemporary physics, gives rise to a topological setting for physics, chemistry and biology.

Hence, this demonstrates that despite its association with linearity as implicit in the notion of differential, it naturally admits surmounting the limitations of the calculus to treat non-linearity and a relational paradigm which surmounts the Newtonian conception incorporating singularities from the outset.

But this does not require the consideration of the evolution of non-linear systems, but the existence of integral invariants of topological nature instead, as discussed in note no. 6.

Indeed, the discontinuities that arise in the modellization of non-linear systems by the differential calculus manifest as associated to spinning currents, vortices and eddies.

This manifests a present crisis of mathematics that stems from the failure to acknowledge the *qualitative* –and we can add ontological-appearance of vortices, spin currents and eddies, as the sources of non-linearity, which arise from the inhomogeneities of materials as extended structures (Rapoport, 2013; Wu and Lin, 2002; Lin and Forrest, 2013).

In contrast, the Newtonian dualistic paradigm treats non-linear evolutions as a formal unstructured quantitative problem, which is kept in the present ontology for the sciences, which further extends to politics and economics.

Thus this vortical morphodynamics can be considered in cognitive terms, arising as differences created from differences, *information fields*, in the sense of the cybernetist and anthropologist Gregory Bateson (Bateson, 1972).

These are the sources of non-linearity, torsion, which GR could not account for, since torsion is assumed by default to be null in that theory.

These vortices appear associated to the rotational motions associated to inhomogeneous structure of the evolving system, say spacetime for which they are associated to quantum fluctuations (Rapoport, 1991, 1997, 2005a, 2005b).

In distinction with GR, torsion geometry in the case of the so-called geometry of teleparallelism identifies the

stress-energy tensor already in the Bianchi structural equations for the geometry as constructed from torsion (Shipov, 1998).

So these sources self-organize non-linearly, as the evolution in time of the interactions of these inhomogeneities, which can be both spatial, temporal or both, and thus we are back to dislocations without which the very sense of a locus could not stand by itself.

These interactions of inhomogeneous material distributions, as in dislocated crystals and particularly liquid crystals, is the case of non-abstract point-like structures (which GR dismisses for its foundations).

The latter are the abstract basis for the dual logophysics, rather than extended structures, the real physical and biological material organizations.

These vortices are far from being closed systems since they exchange matter, energy and information with the surroundings and with smaller scale structures and quantum fluctuations. The general case is that of fluid or magneto-fluid-dynamics which are torsion geometries (Rapoport, 2002) or still of Brownian motions, which though formally random it is also a torsion geometry (Rapoport, 1991, 1997, 2003).

Through this exchange, the duality Outside and Inside is surmounted, and thus these systems operate a non-dual logophysics which integrates Outside and Inside.

In this phenomenology the evolution of systems as *wholes* is what matters, and wholes upon non-linear evolution develop singularities, i.e. discontinuities.

The most fundamental case of this which actually supports and embodies this logophysics is the self-penetration of the non-linear Klein Bottle itself.

It embodies the superposition of continuity and discontinuity, and in doing so thus, it is the signature of its own non-classical logic *(fig.2.III, part.III)*.

Furthermore, the manifestation of the singularities of the non-linear system as a *whole* evolves unboundedly, follows from the non-dual logophysics of infinity and the infinitesimal.

Indeed, upon truncation of the precission of the outcome of the computational finite-difference recursion model, what is being erased is the trace of the reentering of the system on itself, as represented by the non-countable section of the expansion of real numbers, which thus is only binary in a countable approximation.

Yet, this paradoxically produces the traces of this non-dual logic associated to the infinite oscillatory paradoxical sequence: what is dismissed is reasserted. (Just like the 'unconscious', or consciousness upon repression).

The negation operator of this non-dual logophysics in general produces no trivial reflection of what is the case; we shall return to this below.

Thus the attractor sets of chaotic non-linear evolution systems rather than being the resultant of the breakdown of the validity of the blown-up solutions of the initial-value non-linear equations due to the lack of infinite determination of real numbers elicited by the non-linear dynamics, they are the manifestation of a non-dual logophysics in two complementary aspects, the morphological as vortices and the paradoxical tail of the real numbers.

Yet it is the non-dual logophysics which resignifies the unstructured quantitative analytical approach, not in diminishing their cognitive bearing because they develop errors but precisely because the non-dual character of error which has been unacknowledged so far.

This demonstra-tes a *novel meaning of non-linearity and error*.

Thus chaotic attractors elicit the non-dual logophysics acting on the presumably infinitesimal level, and in the inverse character of incertitude as the singularities themselves, which in its ontogenesis we have identified as the singularity of the Klein Bottle.

As noted already by Hellerstein, in practice all real numbers are finite Boolean, up to their paradoxical tail (Hellerstein, 2007).

To finally resume: On the one hand this non-dual non-linear logophysics operates already as the very structure of the real numbers since they already possess a finite dyadic expansion yet with

an infinite paradoxical tail which stands for the Klein Bottle reentrant oscillation.

Thus, indeterminacy is associated to non-dual logic as undisociable from vortical processes and the reentrant Klein Bottle infinite tail of real numbers, rather than merely being the problem of truncation of numbers as unstructured information, as the usual approach to chaos sustains.

The error produced by truncation upon carrying computations of non-linear systems, involves both some of the finite Boolean terms of the expansion of real numbers *and* the full paradoxical tail of reentrance of the Klein Bottle.

Thus the relation with morphogenesis is elicited and further established the identity of the non-dual logophysics of the infinitesimal tail of the divergences and of the singularities.

This is the non-dual structure of the chaotic sets –sets for which with probability 1 an initial point will generate a chaotic orbit.

Furthermore, this is the case of the infinitely points that serve for initial conditions, from which are generated many periodic orbits which are embedded in them. Indeed, they also diverge due to their instability under perturbations (Motter and Campbell, 2013).

This non-dual logophysics is further evidenced by the fact that the attractors of these systems continuously transform Inside to Outside and the converse, as is clear in the figure 8 or ∞ lemniscal pattern –the projection of a Möbius strip or longitudinally of the Klein Bottle on a plane) that they embody, say in the Lorenz attractor (2016).

This appears to be the case of the attractors of several chaotic systems, some even displaying a seemingly non-orientable Möbius like pattern as in the three-dimensional quadratic, cubic and quartic ordinary differential equations (Sprott, 1993); all these are examples of blown-up systems.

Rather than calling the Lorenz chaotic attractor as "the error spiral" (Wu and Lin, 2002; Lin and Forrest, 2013) if not recalling the non-dual structure of error, it seems more appropriate it to call it the paradoxical attractor, since the truncation of computational precission affects this paradoxical tail, or still the re-entrant attractor due to its connection with the Klein Bottle. It is precisely ∞, the quantitative *and qualitative* infinity which embodies the indeterminacy of the blown-up solutions of non-linear evolutions, which was identified as a change of orientability to non-orientability of the compactified complex number systems represented on the (Riemann) 2-sphere for which the North and South poles stand for the number (Rapoport, 2013).

Actually this transition eventuated at +∞ and -∞ -identified as a single point in the Riemann sphere- as a change of orientability to non-orientability through a 180° twist, is supported by the TIME operator of this non-dual logophysics, which as a 90° rotation from the real axis to the imaginary axis of the complex plane upon raising it to the Riemann sphere connects the real axis to the imaginary axis; see fig.2.I.

Thus ∞ rather than being a mere allegory of indeterminacy that occurs when a non-linear system develops a singularity associated to a vortex, on the one hand this transition indicates a non-continuous transformation to another novel structure of the inhomogeneous material system.

On the other hand it identifies this transition as the vortex of 180° twist at ∓∞ which is a transformation of orientability to non-orientability –due to the introduction of the opposite orientation at those points- of the (one point compactification) complex number system later reverted under a second 180° twist but after transiting at the South-Pole/origin back to the North Pole.

Thus, the blow-up of the solutions with the appearance of the incertitude, ∞, comes with a double twist in the North Pole.

This indicates a reentrance of the system on itself following a *transitional change* in which by passing through these two Poles, the system also undergoes a *change in direction* and a transformation from the real to the imaginary axis mediated by a change of orientability to non-orientability of the Riemann sphere at those two points.

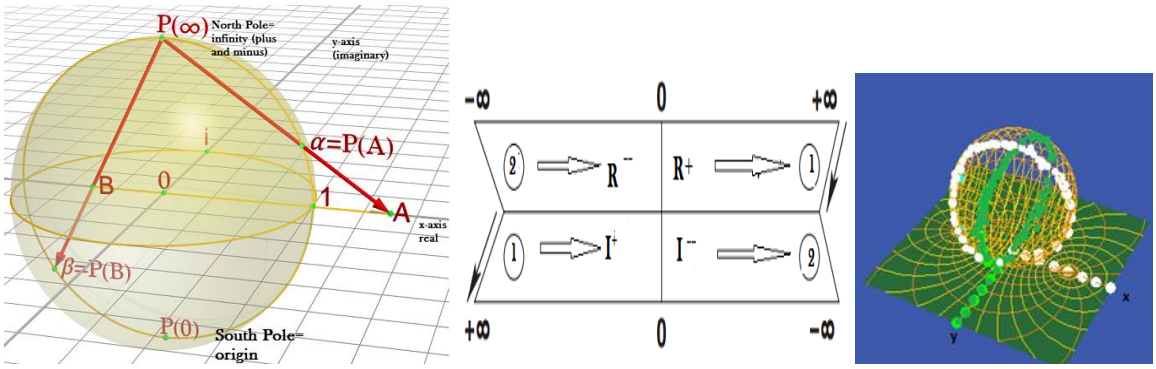

Fig. 2.I. Left*: The Riemann sphere as the one-point (∞ = +∞ = -∞ =North Pole) compactification of the complex plane obtained by the stereographic projection, P, of the former (figure modified from Leonid 2; Riemann sphere1.svg, CC; Wikipedia). Already this identification of the two infinities as a single point, shows that a non-dual logic is the case, rather than the duality invoked in analysis and physics.*
Centre*: Unfolded double cover of a Möbius strip, modelling the relation between the imaginary axis and the real axis; say, the continuation of the positive reals at +∞ through a 180º twist at +∞ followed by a path (1) that along the imaginary axis runs from +∞ to -∞, to again, through a 180º twist reenter the real axis at -∞ to continue through path (2) to the origin, etc. (Modified from (Boeyens,2010)).*
Right*: We represent the non-orientable topology of the complex plane presented, as the 2:1 fundamental octave on the Riemann sphere, lifting the discontinuity of hyperbolic singularities. (Reproduced from (Rapoport, 2013), CC). The complex plane as a non-orientable plane can be represented as a Möbius strip on this sphere, whose unfolded double cover coincides with the central figure.The positive imaginary axis can be obtained either as a 90º rotation on the complex plane or as a continuous path on the Riemann sphere. It is produced by moving (along a band on the meridian drawn as pointed white dots) from the South Pole/origin along the East meridian which corresponds to the positive real numbers until reaching x= 1, y= 0 , and up to the North Pole/infinity ; on reaching the North Pole we give a 180º turn (for which we have two choices, an East-ward or a West-ward pointing twist, i.e. a choice of chirality) to this strip, to continue with a different orientation (drawn as green dots) to the imaginary axis along the corresponding meridian, which now continues to the point x= 0, y= 1 (being that the interval (0,1) is homeomorphic to the reals), corresponding to i=√-1 to further return to the South Pole/origin, thus completing the percourse of path (1). This is the first half-octave of the 2:1 harmonic of the Möbius strip and the Klein Bottle; the motion further rises following the meridian corresponding to the negative imaginary axis, up to the North-Pole/infinity. Upon reaching the North Pole, we give a second 180º twist to the band, which returns to its original orientation/coloured surface, to follow now the West meridian corresponding to the negative imaginaries; upon reaching 0, this is path (2). This yields the second-half octave and the completion of the 2:1 resonance. Since an even number of twists on the band have been produced, this indeed corresponds to the double covering of the Möbius strip, since the latter requires an odd number of turns. It is important to remark, that the 90º rotation on the complex plane on S that transforms +1 to √-1, corresponds to a 180º rotation from the South Pole to the North Pole followed by a motion (another 90º) to the point corresponding to √-1, and thus the 360º rotation on the complex plane corresponds to the 720º rotation and the motion South Pole-real axis-East-real axis-North-Pole-imaginary axis-South Pole-imaginary axis-North Pole-real axis-West-real axis-South Pole. We clearl y see in this geometrical representation the 4π rotation of the double covering group of the Lorentz group, yet furthermore associated to the 2:1 resonance intrinsic to the Möbius strip and the Klein Bottle, as the transformation of the non-orientable topology of the complex plane, indicated by the figure , to the two sphere, whose local orientation is inverted twice. It is rather remarkable, that these characterizations have avoided recognition prior to (Rapoport,2013). The change of orientation at ∞ allows to establish the continuity of the transformation between the real and the imaginary numbers. This continuity also lifts the hyperbolic discontinuities, as already mentioned.*

All in all, this is associated with the 720º symmetry of spinors, as the fundamental symmetry of physics: the double covering group of the Lorentz group of rotations on Minkowski spacetime (Rapoport, 2013).

However, there is a different interpretation of the blow-up that does not contemplate the 180º twists as a transition from orientability to non-orientability of the complex plane as represented in the Riemann sphere; it rather conceives the blow-up as a determinated transition in the constantly curved sphere as originally proposed (Wu and Lin, 2002, Lin and Ouyang, 2010; Lin

and Forrest, 2013), priorly to the discovery of this torsion of the compactified complex number system.

Yet, we subscribe to "the traditional view of singularities as meaningless indeterminacies has not only revealed the obstacles of the thinking logic of the narrow observ-control (in this case, the Euclidean space), but also the careless omissions of spatial properties of dynamic implicit transformations (bridging the Euclidean space [the coordinate space for the evolution of the blown-up system] to a general curvature space [the Riemann sphere, which has a constant curvature]" (Lin and Forrest, 2012); as we said, the non-dual logophysics requires the plane to be abandoned.

This corresponds to the appearance of singularities in the analytical non-linear models which are indeed *continuous paths* from + ∞ to - ∞ or of ∞ to itself-depicted in white and green in the rhs fig. 2.I in the Riemann sphere, but connected by the non-orientability.

In this setting, the system self-organizes rather than Exterior forces acting upon the system being the case. As a rule indicated by Yi Lin Forrest and Shoucheng Ouyang (Lin and Óuyang, 2010), it is necessary to keep without obliterating the irregular information of the system's evolution –usually disconsidered as the by-product of noise-, since they are the signature of the developing transition already indicated.

Precisely this is what the team at the Institute of Biophysics, Moscow, leadered by Simon Shnoll did to discover the palindromic nature of the histograms of seemingly random experiments (Shnoll, 2012).

Furthermore, and as elicited in Kozyrev's astronomical experiments, this vortical self-organization is anticipative (Levich, 1996).

In fact it is used to predict irregular events (Lin and OuYang, 2010).

It furthermore appears in the palindromic structure of the histograms of random phenomena elicited by the team leadered by Shnoll (2012) associated to cyclical processes which are purportedly related to cosmological factors.

Thus time is not an additional dimension but the primal dimension as in Heidegger's phenomenology (Heidegger, 1972) which Merleau-Ponty associated with depth (Merleau-Ponty, 1965).

Furthermore, it is an operator, as is clearly the case in embryological development and the physiology of the cell.

The Klein Bottle through its self-penetration embodies this primal dimension of depth (Rosen, 2008).

However rather than being an extensive dimension as in GR, it supports them.

Another most remarkable example of a chaotic system which produces a *lemniscal* figure ∞ family of solutions, but not open as in the Lorenz attractor in which trajectories do not retrace themselves, appears likewise as an approximation to a general non-linear dynamics.

It is the n-body problem of celestial mechanics, n > 2, with all bodies lying on a plane and with equal masses though this hypothesis is suggested to be an unnecessary restriction (Alligood, 1996; Montgomery, 2010).

Remarkably the numerical indeterminacies of the analytical non-linear equations as their solutions diverge, in physics appear as the untractable computations of quantum field theory in Minkowski space with its hyperbolic metric.

Upon practicing the 90º (so-called Wick) rotation of the real time axis to an imaginary-time axis, the so-called analytical continuation of time, t →it, obtaining thus Euclidean spacetime, these computations are rendered finite and realizable (Rammer, 2007).

In the Riemann sphere of the rhs. fig.2, replacing t in x, this amounts to the first half white path followed by turning y-wise with the first half green path.

Furthermore, the Big Bang singularity in the real-time parameter, is removed by this transformation (Hamber, 2009).

So this rotation whose prototype is the action of the TIME operator, rather than being only a purely physical transformation as rendered by an Exterior observer, it supports a cognitive bearing

which is the case of blow-ups as conceived on the Riemann sphere, in this case manifesting the computational outcome of non-linear interactions and particularly self-interactions.

1.4 The Notable Non-Orientable Morphomechanics of Development

Returning to the vortical foldings as the sources for non-linearity given by torsion further associated with depth, we expect this to be the case of biological morphomechanics, in particular in relation with the toroidal shape of metazoans, in particular mammals (Maresin and Presnov, 1985; Jockush and Dress, 2003).

The 2-torus, we recall, is the double covering space for both the Möbius strip and the Klein Bottle topology (Rapoport, 2013) which longitudinally are embedded twice on the 2-torus –the 2:1 harmonics.

The latter means that by identifying two antipodal points of a centre-symmetric two-torus, it collapses to the Klein Bottle, while two copies of the Möbius strip properly glued give the cylindrical strip.

Thus, in principle, the human bodyplan as a 2-torus topology has a built-in Klein Bottle bodyplan. We shall return to this below.

The main point with respect to development as epithelial layers fold producing the continuity of superposed layers of cells latitudewise, an increased density ('convergence') of cells occur in the latitudinal transversal directions which have a tension which *doubles* that of the equatorial meridians, the former contracting and the latter expanding (Beloussov, 2015).

This anatomical architecture for the 2:1 harmonics appears to be the basic solution to the highly non-linear elasticity torsion morphomechanics of development of organisms.

This extends to the fusion of action and perception, and to genomes, as we shall elaborate below.

Indeed, this superposition appears also to be the case of the mammal heart as a Möbius strip in the Torrent-Guasp model (Rapoport, 2013) and in the so-called Anatomy Trains of bands of connective tissue in the human body fusing with the skeleton,eliciting ∞ figures as projections of the Möbius strip (Myers, 2014).

Thus, the human heart and the overlayed architecture of the connective tissue which structurally is a liquid crystal which is crucial to body integration, may be considered as higher-order harmonics of the previous one.

As in our discussion of the generation of vortical instabilities as the curvature produced by a torsion gradient curling upon itself as in fluid-dynamics, the organismic toroidal forms of metazoans are interpreted as arising from the tendency of epithelial layers "to curl around free margins and to minimize the surfaces of the arisen folds by making them circular.

The most known example is the lip of the blastopore", the latter being an intermediary state in the turning Inside-Outside of *Volvox* (Goldstein 2015, Hohn and Hallman 2011; Hohn, 2015).

1.5 On the remarkable linkage between analytical and topological modelling

Einstein attempted to circumvent the inconsistencies of GR for which he collaborated with the founder of torsion geometry, the mathematician Elie Cartan (Debever, 2015).

They aimed to formulate a theory of gravitation in terms of torsion geometry.

However this attempt did not prosper due to their failure to identify the rotational and more generally vortical motions proper to these geometries, and ultimately, to consider spin fields.

Furthermore, torsion geometries naturally lead to the non-orientable *topologies* introduced in this article which are not only basic to physical phenomena but also to biological processes and to higher-order than-one cybernetics, proper of heterarchies and non-dual logophysics, to be discussed below (Rapoport, 2009, 2010a, 2010b 2011a, 2011b, 2011c, 2011d, 2013, 2014a, 2014b).

There is more to the link between torsion geometries, non-orientable surfaces, non-dual logophysics and relational logophysics.

In the last chapters or appendix of the works by R. Rosen (1985, 2000) he

proposed the mathematical modelling of processes through *parameter-dependent* generic ordinary differential equations which he wrote in terms of the *calculus of differential forms* that arises in differential geometry which he suggested to link to information hierarchical networks; this parameter dependence embodies in principle bifurcations and instabilities, which are very much generic to Nature.

As noted in morphomechanics this parameter dependence is related to 'circular' causality (Beloussov, 2015).

The calculus of differential forms is the basic calculus of multiple variables for classical mechanics, extendable to thermodynamics and to theoretical physics at large, whenever a geometry describing the configuration of a system is invoked at the very basis of the model, a space or spacetime structures, or a phase space (Abraham and Marsden, 1987; Misner, 1973; Tu, 2008; Vargas, 2014).

Torsion itself appears pervasively as a differential form in classical mechanics (Rapoport and Sternberg, 1985), quantum mechanics (Rapoport, 2005b, 2007a, 2007b; 2010a), fluid dynamics (which by far are the majority of physical dynamics) (Rapoport, 2002a, 2002b, 2003a, 2003b), statistical thermodynamics (Rapoport, 2000) and Brownian motions (Rapoport, 2005a) as a basis for a geometrical theory of physics.

Rosen further claimed that this approach was

> *"...very revolutionary. Their revolutionary character lies in the questions they raise about the class of mathematical systems which can be the images of natural systems"* (Rosen, 1985).

The importance of this, according to Rosen, lies in that

> *"...what is essential to science is the establishment of a correspondence between percepts and the relations which link them, and the ingredients which make up a formal or mathematical system. This correspondence must match what we call the causal properties of the natural system with the inferential properties of the formal one."* (Rosen, 1985)

Thus, formal models are central to the activity of making science, for which Rosen pointed to the differential forms of the calculus on manifolds and the possibility of being linked to a relational network as a basis for a 'revolution'.

In fact, the topological model to be introduced here stems already from perception, and from the author's works on torsion geometries and physics, and provides for Rosen's call for a paradigmatic change in terms of formal models, which will take a most primitive topological setting, though they stemmed from the differential calculus which Rosen identified as the basis for a 'revolution' in formal modellization, as we shall elaborate below; see note no. 6.

1.6 Heterarchies, the Hyper Klein Bottles, Metacybernetics and Metamathematics

The present theory proposes a logophysics which is *common* to physics,chemistry and biology, which also comprises perception and cognition –or in the converse order, which is further associated to non-dual multi-valued logics, as embodied in the Klein Bottle and the Hyper Klein Bottles.

In doing so, it will turn out that contextualization is the case of both physics, chemistry and biology, rather than the notion than the sciences admit a taxonomy which divides them into a non-contextual physics and semiotics (Kull, 2007). Yet, as observed by Kull:

> " *... living systems consist of many regular processes that are independent local rules, and these rules appear as simple logical operations of the form IF a THEN DO b*" (Kull, 2015)

Also, as observed by Kull in the latter contribution, already Peirce in his matured work claimed that semiotics is generalized logic. See note. no.7.

However, the ordering of biological processes invoked above is not linear-sequential (or, in other words, does not

abide to the rules of computation of a Turing machine).

It rather invokes *closed* self-referential loops for which the transitivity rule of logic breaks down. In general though not necessarily being always the case, multiple contexts which can be of *different kinds* are involved–say, pertaining both to subjectivity and material organizations, as is the case of culture.

This is already the case of the brain which is *not* hierarchically but rather heterarchically organized, yet subsuming hierarchies, as a plurality of relations (McCulloch, 1945).

Presently, the feedback between the higher and lower is recognized to be an heterarchy, but 'simplicity' is invoked to call it a hierarchy.

Indeed, the multi-scale K-sets introduced by Freeman to describe the chaotic behaviour of neural networks in the mesoscopic domain is called a 'hierarchy' (Perlovsky and Kozma, 2007), however, it is recognized as 'fuzzy' and thus inadequate for a dual logophysics.

On the other hand, the architecture of intelligent systems is claimed to be a 'heterohierarchy' (Perlovsky, 2001), meaning by this a hierarchical anatomical architecture with the heterarchical nature of its feedback processes connecting higher and lower levels, plus their penetration by emotions, memories, and the myriad of subjective domains, particularly the imaginal.

We shall propose that the HyperKlein Bottles also provide for hierarchical relations however not necessarily restricted to Matrushkas-like recursive dualism, and still the full subjective domain.

These heterarchical organizations with their associated non-dual logics disrupt the principle of non-contradiction or still of the excluded middle, which is only valid when the whole is ideally reduced to a single context, say the environment.

This further closed upon itself and vis-à-vis the environment which becomes unaccountable as a context integrated with the system –the 'weaving' as a metaphor of integration with which contextualization is about.

These are the settings in the theory of autopoiesis which claims an 'operational closure' of a system in relation to the environment (Varela, 1979).

Particularly, heterarchies are the case of societies (Kontoupulos 1993; White, 1995; Bondarenko, 2007); they are applied to ethnography and organizational management (Stark, 2009).

It is remarkable the coincidence of figs. 3.II B,D,E,F in Part II, with the notion of heterarchy proposed by archeologist Carole Crumley, characterized as:

> *"the relation of elements to one another when they are unranked or when they possess the potential for being ranked in a number of different ways"* (Crumley, 1995).

Heterarchies are experienced as *paradoxical* in the individual and social states and events organized as liminal, such as the sanctioned states in which wilderness and civilization are superposed.

This is the case of rituals of passage, war or festivities associated to temporal cycles such as the precession of the equinoxes (Duerr, 1985), in which a changing superposition of contexts is the case, thus disallowing dualism.

Von Bertallanfy introduced self-regulation as a key process in systemics and pondered about non-dual logic in contemplating Cusanus' coincidentia oppositorum (Von Bertallanfy, 1968).

Self-regulation appeared as heterarchies, which were introduced in the sciences of cognition with Hofstadter's strange loops. They were recently described as:

> *" [a] "strange loop" is ... not a physical circuit but an abstract loop in which, in the series of stages that constitute the cycling-around, there is a shift from one level of abstraction (or structure) to another, which feels like an upwards movement in a hierarchy, and yet somehow the successive "upward" shifts turn out to give rise to a closed cycle. That is, despite one's sense of departing ever further from one's origin, one winds up, to one's shock, exactly where one had started out. In short, a strange loop is a paradoxical*

level-crossing feedback loop" (Hofstadter, 2007).

This characterization retrieves McCulloch's original characterization of heterarchies as the level crossing of hierarchies that operates co-ordinating them (McCulloch, 1945).

However, Hofstadter's definition misses the breakage of hierarchy indicated by Crumley as well as her indication of the possibility of organizing the different domains according to different 'ranks', as in the Hyper Klein Bottle.

Perhaps this may serve as an example of contemporary science: the specialist cannot grasp the richness of the relations if not by trying to adjust them to the current paradigm, whereas the outsider-insider -in this case an archeologist- is capable to acknowledge the phenomenon afresh, on the grounds of the 'privilege' of being free of preconceptions (so ignorance may be creative and virtuous, at times).

For a similar situation concerning anthropology we recommend (Kohn, 2013).

Thus, a strange loop can be related to the hetero-penetration of the Hyper Klein Bottle.

The latter, though locally may appear to partially operate as hierarchical upon disconsidering the penetrations, however the most Exterior or higher level may turn to be linked to the most Interior or lower level as in fig. 3.II B,D,E & F, where this inter-penetration of the higher/outer level into the most interior/lower and the converse is evident.

At this stage we recall our discussion that in the framework of the sciences of cognition it has been proposed that exploring the significance of the Interior/Exterior categorical divide would lead to a project of unparalleled relevance.

However, already Wittgenstein elaborated a critique of this categorical divide (Hark, 1990) while the present considerations far surmount it.

As for our motivation to discuss them in this article, we borrow from Günther's eulogy to his mentor, McCulloch, towards placing metaphysics at the very foundations of cybernetics due to the :

"lack of fundamental ontological orientation that characterized - and still characterizes - the pursuit of cybernetic theories" (Günther, 1975).

The effects of that ethical stance are all too obvious, exceeding cybernetics.

In Hofstadter's take, the levels of the strange loops are "tangled" –rather than twistedly interpenetrating forming an heterarchy retrieving our present sense of this concept as diverse inter-penetrating and self-penetrating domains, rather than a Matrushka-like hierarchy operating through a recursive dual logic (Rapoport, 2014b).

As Crumley puts it, heterarchies are neither unranked or can be ranked in different ways.

In systems's theory, Matrushka-like hierarchies only allow for ranking, and fixed at that matter.

Neither connection of the levels is established if not as an 'emergent' property.

Thus, only top-down or bottom-up relations can be incorporated into this hierarchical ontology (Salthe, 1985).

But rather than HyperKlein Bottles being ascribable to second-order cybernetics, where the controller of the system is no longer an Exterior agent as in first-order cybernetics but is integral to the system (von Foerster, 2003), a higher-order cybernetics is the case, due to the plurality of contexts which may actually be qualitatively different and both self-penetrating and interpenetrating as in figs. 3.II B,D,E & F.

Instead of being limited to the cybernetics of cybernetics, it is the mutually interpenetration of the participant and the world, where several domains are juxtaposed, operating already at a semiotic level.

In anthropological terms it produces a symmetrization of the roles of the agent and the environment, as a real ecology in which the *imaginal* reifies and in turn *is* reified by the subjects (Kohn, 2013).

The imaginal also operates in evolution as related to epigenetics where cultural elements may be crucial, say through diet (Oyama, 2000; Distin,2011).

The imaginal domain establishes what, in principle, may be realized: the domain of possibilities.

The imaginal domain is one of the ontological loci for the Klein Bottle Logic (Rapoport, 2014b), but is neglected by the imperating dualism.

This is so to the point that despite the critical revision of dualism framed in terms of the non-dual logics of the imaginal, as already elicited by dreams, the identification of Rationality with the dual logic of Aristotle and Boole is the case (Durand,1994).

It is hardly conceivable that Mathematics or the Arts could exist if not primevally existent and operating in this domain, which it is keenly intertwined with phenomenology.

Particularly, the imaginal and its manifestations is related to the experience of light, and with the precessional cycles of the equinoxes as the crucial cognitive setting in ancient traditions (Corbin, 1969, 1983).

These cycles have been related to the biological temporal cycles –chronomes, which are the subject of chronoastro-biology (Halberg, 2004).

Furthermore chronomes appear as associated to processes which appear as having a palindromic structures as elicited in the histograms of the experiments that led to the discovery of the Shnoll effect (Shnoll, 2012).

The imaginal and the precessional cycles associated to the so-called Platonic year in which the rotating Earth's axis returns to point to the same direction of the Zodiac have been claimed to be related to the cycles of history and creativity in ancient traditions such as the Yugas according to the Vedas , and rediscovered by Páleš (Páleš, 2009) and others.

Certainly, the imaginal appears to be interwoven with different domains altogether operating heterarchically.

Yet it plays a crucial role in enacting closed loops which are claimed to be likely realizable at certain times and associated to rotational celestial cycles.

Closed loops associated to hetero-reference and self-reference appeared early in the attempt to establish a purely syntactic semantic-free formalization of mathematics and in logic, the impredicativities.

But only self-reference was involved in this; hetero-reference was disconsidered.

This formalization required definitions, say of a set, invoking the very set being defined.

Thus rather than being amenable to a hierarchical or linear layout and as such predicative, self-referential invocations are unpredicative.

This was the Vicious Circle Principle, as called by Henri Poincaré and Bertrand Russell, which establishes that no object or property may be introduced by a definition that depends on that object or property itself.

Naturally, a purely syntactic formalization for mathematics, such as a computers would later be made to operate with, means that it would become a wholly closed on itself and constructively realizable language, with no exterior agency acting through contextualization nor inter-penetration (semantics is all about meanings).

But then self-reference would need to become the generative principle - however it had been banquished in the first place- to attempt to do away with semantics as 'extraneous subjectivities' (Rosen, 2000), by adding more syntax.

Rosen argued that this contextualize-tion is not the case of physics while we have already argued that upon abandoning the Newtonian paradigm it indeed operates in physics (Rapoport, 2013, 2014b; Dubois, 1999), but exclusively of biological systems.

Yet, since he identified the impredicativities of biological systems as associated to their material organization, Rosen defined complexity of a system in terms of the 'inherent impredicative loops in it'.

In the formalistic program persued by Hilbert and others, self-reference was to be banquished from the foundations of mathematics, as well as paradoxes which are generated by it. This was implemented by keeping a single context rather than repositioning them in terms of heterarchies. Instead of the latter Russell offered - as a way out to such "viciousness"- the theory of types,

producing logical hierarchies rather than heterarchies (Coquand, 2014).

However, Russell's construct of 'paradox' such as the one associated with his introduction of the class-of-all classes was somewhat induced by the practice of language-games in terms of image-schemas, namely CONTAIN.

The latter image-schema posits a dual categorization, an insideness defined by belonging to.

Indeed, Russell's construction posits the problem whether this class-of-all-classes that do not belong to themselves, call it R, is a member of itself.

If *R* is not a member of itself, then its definition dictates that it must contain itself, and if it contains itself, then it contradicts its own definition as the set of all sets that are not members of themselves.

Thus, Russell's Paradox was created.

However, Musès noted that the second term usage of 'class' in 'class-of-all-classes' is legitimate in that it denotes a selection of properties in terms of a distinction, while the first term in 'class of all [classes]' *obliterates* the primal consideration of classes as distinctions, leading to the distinctionless 'class-of-all-classes'.

Musès: *"The concept of "all classes"* simply means *"everything without distinction" and is not a class at all anymore"* (Musès, 1985).

Thus this self-referential evocation is a destruction of the possibility of meaning that distinctions and classes produce. It is operated by introducing the universal quantifier 'all', suggesting a cognitive closure which is not realizable, nor assessable, but a mere seduction of reason.

It suggests a complete knowledge that cannot be verified that is so.

Rather than the affirmation of self-reference as a creative principle, this universal quantifier erases contexts by erasing hetero-reference.

Without the latter meaning ceases to be created (Rapoport, 2014b), and self-reference only elicits an oscillation between true and false which we already encountered in the semicountable nature of the continuum.

For further elaboration of the usage of 'all' in composite contradictory paradoxes see (Lin and Forrest, 2013).

This will appear in the fundamental matrix for the generation of genomes from the Klein Bottle.

However, upon re-expansion by self-multiplication (Kronecker or tensor) it recovers a multi-distinction phenomenology which is embodied in the polysemic nature of genomes generated as the superposition of several codings introduced in the said process, though they appear to be digitally representable (Trifonov, 2011).

For example, the Liar Paradox: "the statement I am now in the process of making is false" places the (model of the) subject, the 'I', as fused with the suggested statement in the making, projecting contexts as a single one: the actual process of suggesting that a statement is being done. Language-games induce realities, as a sense of them.

In other words: Paradoxes such as the Liar, though unacknowledged as such, create a paradox as associated to Boolean logic.

Indeed, as identified lately, the evaluation of self-referential propositions may violate the laws of identity and of contradiction (Lin and Forrest, 2013).

Hence the *problems associated with paradoxes lie upon the assumption of dual logic for what is non-dual* (Hellerstein, 2010; Lin and Forrest, 2013).

But this paradox is created by a projection of a non-dual logic which surmounts the dual categorization of CONTAIN.

This non-dual logic (actually the Klein Bottle) reifies as the oscillation already mentioned, which is interpreted as a standing time-wave, which as we elaborated in note. no. 4, is the re-entrant of a distinction by subversion of the plane.

Indeed self-reference may play a generative *ontopoietic* role (Rapoport, 2014b) the meaning of this to be explicited below- independently of the Vicious Circle Principle.

The latter is but a rather specific and context-erasure instantiation of self-reference to fit it into dual logic plus an oscillation; we have encountered already

this oscillation in the very structure of the real numbers as semicountable.

Of course, the representation of the Paradox of the Liar as a *planar* re-entrant circuit (Hellerstein, 2010) projects the re-entrant character of the paradox on a *single context* - a planar Ouroboros, as chosen by (Varela, 1975, 1979), thus missing to embody its *heterarchical* character, making of it a paradox. (Heterarchies as first introduced by McCulloch are associated with a non-planar reentrance of different levels, to be discussed below).

Intuitively Russell proposed a multilayered *hierarchy* of types, capturing thus the non-planar dimensionality but still representing it as stacked rather than re-entrant, not much of an heterarchy at all!

Though some of the most competent mathematicians and logicians were involved in the attempt of construing a purely syntactic formal system representation of Mathematics, the project foundered with Gödel's theorems (Bartlett, 1992, 2015; Smulyan, 1994; Kleene, 2009).

What was left of self-reference was largely formal and as a merely *descriptive* representation of Being which as such contemplates the subject as a rather ambiguous participant/descriptor though somewhat detached if not symbolic (Varela, 1979; Kauffman, 2002, 2005; Goertzel, 2013; Hoftstadter, 1979), or indicating a layout of an ontology that transcends dualism (Spencer-Brown, 1969), which was later identified as the Klein Bottle logic (Rapoport, 2011a).

1.7 Cognitive loops, the Boolean logic of measurements and the logics of a sense of reality.

There are cognitive closed loops which operate framing and operating our conception, perception and enaction of a world, conforming an heterarchical non-dual HyperKlein Bottle inter-penetration, in which measurement plays a crucial role.

In this heterarchical ontopoiesis, which also produces our sense of reality though it may not be acknowledge as such, the basic conceptual and operative elements are: 1) the role of the observer, and 2) the notion of the observables as attributes inherent to a system as defined by the description of an apparatus.

They establish a dual reduction of what is an extremely interpenetrated enaction of our reality.

However, the context given by the setup of the apparatus for the measurement is only an element of these interactions which far exceed the contextuality which nowadays is being proposed to be the case of quantum mechanics (Khrennikov, 2010).

Our very sense of reality as facticity is made out of the contrast between our predictions and the outcomes of the experiments we produce.

They are a crucial element of enaction of our reality. As remarked by Ruhnau:

> *"A completed measurement is the registration of the final outcome of a yes/no inquiry, not the superposition of possible results. The truth values of propositions referring to observables are determined by measurements. The logic of measurement and observation is the classical two-valued logic (Primas, 1981). Therefore, the compatibility of scientific results with their classification by binary logic is not contingent because, in the realm of the exact sciences, facticity and two-valued logic are mutually dependent. To test the truth or falsehood of predictions, measurements have to be made. Measurements produce facts. Predictions are about possible future events. Facts are constituted in the present and are, retrospectively, described as past events with respect to instants which have already passed"* (Ruhnau, 1997).

However, this attribution of a truth value placed by an observer upon carrying out a measurement, who operates in terms of dual logic, is the case for an observer whose measurements do not incur himself as being the subject participant of this cognitive cycle.

Furthermore, the attribution of truth value demands a second observer, equally detached, and so on: infinite regression is invited.

However, organisms can be thought as a unified myriad of observers which themselves are the subject of others' observations (Neumann, 2008).

Thus regression is not the case for organisms constituted as a unified Klein Bottle of several HyperKlein Bottles.

Indeed, for such organisms the observed and the observer flow as a unified self, incorporating a myriad of coordinated systems which mutually carry measurements and of themselves.

Altogether this is an heterarchy, rather than a system operating as a dual logic, albeit we are unable to recognize it as such.

However, during the enaction of a sense of reality this collapses to a dual logic.

This is the case even although measurements are carried out mediated by signs as a practical construal of meaning, as is the case of biological systems (Neumann, 2008).

Certainly, the construal of meaning does not operate in terms of dual logic: paradox -in some contexts- and ambiguity are an inevitable if not necessary element of this.

Thus we have encountered an operation of dual logic that controls the highly non-dual heterarchical phenomenology of cognition, enaction and perception.

A major subversion of non-duality is at the basis of our usual sense of reality in terms of measurements establishing the facts about the material world which are operated as a dualistic ontopoiesis despite their non-dual enaction.

This, we remark, operates on the grounds that the observer's stance is that of detachment from the observed, which produces an infinite regress unless a Klein Bottle unification is the case, as already discussed.

But the facts that the observer (participant) make up upon practicing observation, are indeed an invention (Neumann, 2008).

Already Primas –following Feyerabend- made the point that *" 'facts' are not inescapable data of existence but always dependent of the observer, his culture, theories and preconcepts"* (Primas, 1981), which are in fact transparent to our enaction and reification of events as facts.

This sense of reality is demolished upon transversing to states of enhanced consciousness, which elicit the non-dual logic underlying our enaction of reality and our participation in an HyperKlein Bottle which cannot be circumbscribed by our sense of reality (Shanon, 2003).

There is more to it.

As argued further by Ruhnau, the conception of linear time relies on the basis of 1) facts, 2) dual logic, 3) the ideal of a pointlike Now, and 4) the distinction between future and past in terms of an order, which in turn enforces the linearity, an hetero-referential process that returns and penetrates all the domains involved.

But the dual logic, the pointlike Now and the time ordering are transparent assumptions that are incorporated to a formalism, while the the distinction between past and future and the reduction of observability to facticity, are derived within that formalism, as argued by Ruhnau.

Already Heidegger proposed the notion of a phenomenological time, which is non-linear (Heidegger, 1972) and was further associated by Merleau-Ponty to depth as the primal variable entwined with time (Merleau-Ponty, 1965; Rosen, 2006, 2008).

We have already argued that non-linear time operates as the logic of integration of organisms and corresponds to the association of time with torsion fields evidenced in the superposition of matter fields and vortical motions.

Ruhnau intimated a deconstruction of this dualistic basis for the time construal based on surmounting the dual ontology, the ordering of past and future, and the introduction of possibilities, the latter proposed as a dualistic ontology in (Kauffman and Garre, 2015; Raju, 2003) on the physical "tilt of time" and the introduction of order as the basis of ethics. We shall discuss this later on.

With respect to quantum mechanics and measurements, which were *first* introduced in terms of self-adjoint

operators and quantum states as vectors of a Hilbert space, clearly the Boolean logic of yes/no propositions relative to the properties ascribed to quantum systems are such that *"...the contingent propositions do not refer to properties of the physical object but to our knowledge of them"* (Primas, 1981).

We recall that observables whose spectra consist of at most the two values 1 and 0 are called *projectors,* they represent yes-no questions, indicating whether or not some event has occurred. However these projectors do *not* form a Boolean algebra, but rather a lattice structure where the distributive law of Boolean logic fails globally (Primas, 1981). Or in simpler terms, according to the initial take on quantum mechanics associated to the classical logic of measurements, it can not be associated to an ontology, but merely to epistemology. This is an example that classical logic cannot recognize itself as an ontology.

Actually classical (dual)logic is a by-product of a non-dual logic as is the case of Matrix Logic associated to the Klein Bottle logic (Rapoport, 2011a; Stern, 2001) or still of the Klein Bottle logic, by disconsidering its self-penetration. Matrix Logic (Stern, 2001) not only has classical logic as a projection, but also quantum logic and fuzzy logic as particular cases.

Yet, as Primas put it:

> *"Boolean logic is the basis of mathematical logic, but it does not apply to everything. To say that classical logic is universally valid is stupid; it is clearly restricted to a right and proper application (whatever this precisely means)".*

This (derogatory) comment about the implicit claim of classical logic as *the* ontology in terms of inadequacy, elicits that the latter operates as if purely descriptive.

The classical logic is about the knowledge *of*, rather than the *knowing* process itself, breaking the unity of the knower, the known and the heterarchical process that interrelates them.

Dual logic is ontological, in the mode of fracturization, despite our incapability to recognize it as such.

This is a far cry from Nagarjuna's Madhyamaka (Middle Way) (Westerhoff, 2009), and of the non-dual ontologies that surmount the Cartesian Cut (Rapoport, 2009, 2011a, 2011b, 2011c, 2011d, 2012, 2013, 2014a, 2014b).

In other words, the construal of a sense of reality, is a paradoxical process.

On the one hand it integrates a myriad of subsystems which mutually measure themselves and make up a model of the Self.

This unity as well as the subsystems are active in the construal of meaning and facts.

Finally, the Self reduces all these highly contextualized operations to assert the hegemony of a single context, which we experience as our sense of reality, to which, the model of the Self, the I, identifies with, and yet all integrated paradoxically as a dual logic what in fact operates as a HyperKlein Bottle.

This is the epitome of 'complexity', as a Hyper Klein Bottle.

As characterized by Crumley, the linkage of these relations can be modified.

Still, they can partially be ranked or they are unranked at all, but somehow the sense of reality manages at most times to rank itself as dominant of all the others, until health (a cognate of wholeness) is compromised.

Or retaking our previous discussion of time as an operator which integrates organisms, a major modification of its holistic performance is the case.

How and why this operates thus is a major mystery.

1.8 Biological Order, Heterarchies, Neural Networks and Hyper-non-dual Logophysics

The relevance of Rashevsky's ideas for the foundations of mathematical biophysics was further elaborated by Walter Pitts in a seminal article co-authored with the neuroscientist Warren McCulloch, which later became extremely influential for research on cybernetics, computer science, artificial intelligence and artificial neural networks.

Indeed, this work developed a theory of neural networks associated to the Aristotelian-Boolean dual logic which

provide an architecture for the computation of propositional (classical) logic (McCulloch and Pitts, 1943).

In this work closed loops played a crucial role yet assimilated to dual logic and not acknowledging self-reference as their underlying principle.

Yet, while this article stemmed from the reduction of the analogical character of neuronal phenomenology in terms of thresholds to a purely dual logophysics of firing/non-firing associated to excitation/inhibition (see note no.8), later on McCulloch would introduce the notion of heterarchies as associated to a non-dual logophysics of closed loop neural networks and their 2-dimensional toroids (McCulloch, 1945).

An Ouroboros which is forced to leave the plane.

In McCulloch's setting, uncoordinated hierarchical neural circuits, each performing a task, lie as concentric closed paths which do not intersect among themselves; so hetero-penetration is inexistent in the uncoordinated hierarchical case.

McCulloch further introduced the inter-coordination which surmounts the hierarchical disposition by posing a connection between the most Exterior-higher-level with the most Interior-lower-level, and noticed that this may be possible if this connection lies on a torus, thus abandoning the plane.

In doing so, the *co-ordination* of levels suggested by McCulloch is the case, rather than the disconnected levels of hierarchies.

Yet, the 2-torus surged upon considering the plane as an orientable container of the neural circuits, disconsidering the possibility of non-orientability of these neuronal circuits which in the case of the cortical visual and somatosensory modes have lately been proposed to be the case (Wright, 2014).

The 2-torus, we recall, is related to the Klein Bottle and Möbius strip as its double covering space, both of which are embedded in a 2:1 harmonics inside the latter (Rapoport, 2013).

This *integrates* both sides of the developed human body as a two-torus and as we shall see it is further related to the coexistence of both chiralities, each corresponding to one sided of the vertical symmetry along the centre of the 2-torus.

But the relation of heterarchies with a non-dual logophysics is not embodied by the 2-torus as the double covering orientable surface of these non-orientable surfaces which appear as the chaotic attractors of the solutions of non-linear elasticity problem of development discussed in §1.4.

Indeed, this relation intimates a higher-form of cognition which requires multiple interpenetrating contexts, to the effect of this heterarchical embodiment, namely the HyperKlein Bottle.

McCulloch referring to heterarchies:

> *"Circularities in preference instead of indicating inconsistencies [as in the Liar Paradox] actually demonstrate a consistency of higher order than had been dreamed in our philosophy. In organisms possessed of this nervous system…is sufficiently endowed to be unpredictable from any theory founded on a scale of values [as is the case of hierarchies]"* (McCulloch, 1945).

Indeed, as required by the plurality of contexts which produce the breakage of transitivity –the non-transitivity- to be introduced below, and being the case that these contexts are not necessarily of the same kind (Kaehr and von Goldammer, 1988), we shall more adequately characterize heterarchies by the interpenetration of hetero-referentiality and self-referentiality, as in the HyperKlein Bottles (figs.3.II B,D,E & F), rather than solely by self-reference as embodied by the Klein Bottle.

Indeed, the latter misses the *plurality* of contexts –and in doing so also misses their qualitative distinctions- reducing it to the *single* self-reentrant system by self-penetration.

In other words, the environment fused dynamically with the system through the Klein Bottle, is rendered itself as a *single contexture which is not that of the objective world*, as in dual logic associated to the single true value; see note no. 9.

Rather this fusion of system and undistinct environment is non-dual.

Each contexture *indistinctly* being either penetrating by (if subjective) or incorporated into the other (if material), totally or partially, yet not necessarily closed nor open, rather than the system being projected into the context.

But still the Klein Bottle unity of system and environment does not represent the plurality of *multiple distinctions* that an environment embodies as diversity.

However, ecologies are considered as nested hierarchical systems (O'Neill, 1986), while the Klein Bottle basic nature of environmentalization of ecology has been identified as related to non-dualism (Cubitt, 2015).

In the former setting, nested hierarchical systems are considered an example of complexity (Wu, 2013), which we shall rather claim to be the case of HyperKlein Bottles.

If self-intersection was the case assumed for the uncoordinated neural systems, it is the case upon abandoning the plane which enables to establish the coordination, by making of each partial system an environment of the others, indistinctly of the possible difference in their *kind*.

We note that on *erasing* the self-penetration as well as the hetero-penetration of the HyperKlein Bottles we get a *hierarchical* system, like a Matrushka system or Chinese Boxes hierarchy which may embody a 'circular' causality at each level yet rendered as a dual logophysics as first intimated (McCulloch and Pitts, 1943).

For a discussion on hierarchical systems -as a conceptual tool- which may present heterarchical behavior yet unrelated to the (Hyper)-Klein Bottle see Salthe (2012).

The hierarchical system thus produced by these erasures at each level operates as a monocontexture through the dual logic but with *partial containments* due to the interpenetrations which though cancelled as re-entrances, they are still actual as traces of them.

These are the partial inclusions suggested for the relations between genomics and epigenomics, and still the action of culture (Oyama, 2000; Distin, 2011).

Furthermore, these hierarchical partial inclusions may embody the '*higher*' element of the hierarchy as well as others, which may appear as fractured and further as partially contained in the '*lower*' elements (figs.3.II B,D,E & F).

So the *subversion* of the hierarchy is *kept* despite the erasure of these penetrations, but producing partial fractured containments which cannot recognize the subversion, losing thus the integrality of the original HyperKlein Bottle, as we just explained.

Certainly, the dual logophysics is incapable to restate the wholeness that its fracturing has already produced, notwithstanding the enaction of a sense of reality might be operating.

This dual logophysics certainly keeps the Inside/Outside categorical divide as suggested in (Goertzel, 2013) for the basis of a major investigation towards a paradigmatic change, which is nothing but more of the dualistic fragmentation. See note. no. 10.

Due to their pervasive role, the relation between self-reference, hetero-reference and neural networks deserve further exposition.

This endeavour will dawn us to their hidden Klein Bottle and Hyper-Klein Bottle logophysics of other-penetration: hetero-penetration, revealing the non-dual logics of heterarchies at a formal level.

Important notions here are those of transitivity and non-transitivity, exposed by McCulloch (1945) yet in different terms than the current exposition.

As Kaehr and von Goldammer puts it:

> *"nervous nets are systems characterized by: 1) by the topological distribution of different interacting centers and interacting circularities; 2) by non-transitivity of nervous activities; and 3) by self-referentiality of their organization"* (Kaehr and von Goldammer, 1988).

The transitivity rule can be summarized as a network *on a plane* which verifies: if A entails (or implies) B, and B entails C (implies), then this entails (implies) that A entails (implies) C.

Symbolically, this is written as: ((A →B) ∧ (B→C)) → (A →C).

Yet, as observed in Kaehr and von Goldammer (1988) this:

> *"... reflects the validity of the transitivity law of the classic-logical implication postulated for a hierarchy of values or processes which only admit a notion of super- or sub-ordination but no co-ordination. This, however, contradicts observations of neural processes such as the coordination of visual, tactile and/or acoustic perception".*

Indeed, the validity of the Klein Bottle topology with regards to visual, tactile *and* music perception, indicates that a *synesthesic co-ordination* of Klein Bottles is the case, rather than dual logic; more about this in the sequel.

This coordination based on closed loops is non-transitive, which can be stated as ((A →B) ∧ (B→C)) → ((C ←A)∨(A←C)), the last term (A←C) being incorporated by these authors to symmetrize the (C←A) term introduced by McCulloch (1945).

Remarkably, the appearance of the counter-implication, symbolized as ←, together with the implication, →, introduces into these closed loops the TIME operator of Matrix Logic.

Indeed, one of the many different representations of this operator, namely TIME = → - ←, was introduced by Stern in his extraordinary work on the Matrix Logic which is based on the Klein Bottle (Stern, 2001; Rapoport, 2011a).

The network representing the non-transitive rule *must* leave the plane being irrealizable there, which inevitably must be represented as an HyperKlein Bottle.

They are more general than the Klein Bottle, not only in terms of the plurality of them but mainly due to the possible *different* quality of the domains –some may be imaginal, other material- being logophysically connected), with the "lowest" node C turning to the 'highest' node A; see figs. no.3.II B,D,E & F. As already argued, McCulloch (1945) showed that the Ouroboric reentrant nature of the neural networks of the brain forces their abandonment of the 2d plane.

He was anticipated already by Peirce in his topological studies of logic, who had encountered the same phenomenon (Peirce, 1958; Murphey, 1961).

Notably, Spencer-Brown upon introducing his Calculus of Distinctions with imaginary values, noticed the unacknowledged imposition of the 2d plane (Spencer-Brown, 1969), and alike McCulloch, he indicated the 2-torus as the metaform of this process (McCulloch, 1945); see note no. 11.

The transitivity rule is valid for computation in terms of the Turing-Church thesis, while instead the non-transitivity rule proper of heterarchies (von Goldammer, 2003), which is the nature of the Hyper Klein Bottles, corresponds to the superposition of hierarchy *and* heterarchy which is processual, as can be observed from figs. no.3.II.

Certainly, the recursive dual logic which was rooted in organicism (Brooks, 2014) and is embodied by the hierarchical Matrushka-like (or Chinese boxes) metaforms (Pattee, 1973) only repeats what occurs at each single closed contexture.

In each level of a hierarchy the dual logic is the case, but in no way it can embody the processual interrelation between the levels.

The need of surmounting this recursive hierarchical conception is especially felt in the Physiome Project (Noble, 2010, 2015), the current international system biology project for physiology.

It aims to provide *"the quantitative description of the functional behaviour of the physiological state of an individual of a species. In its fullest form it should define relationships from organism to genome".*

However, as already discussed in relation with the vortical shape of non-linearity, a quantitative description in terms of dual logic fails to grasp the non-dual logophysics of a non-linear system which restarts after reaching a vortical or eddy singularity).

Indeed, according to this project, organisms operate as non-hierarchical

relational networks; however, the logic of them has not been identified.

In simpler terms, the hetero-penetration and self-penetration of these networks and their non-dual logophysics have not been recognized at the foundations nor in developments of this project.

For instance, the mammal heart appears anatomically to be a Möbius strip up to the valves integrating it with the whole organism, following the Torrent-Guasp model (Rapoport, 2013); this model is under research at the Auckland Bioengineering Institute where the Physiome Project was initiated.

Moreover, the human cardio-vascular system as a whole has the lemniscal form (Furst, 2014), ∞ (the one-dimensional projection of the Möbius strip on a plane).

This is clearly heterarchical and reveals that the same non-dual logophysics is found at different levels of organization with some differences which beg for further investigation.

Let us return to the plurality of contextures incorporated as heterarchies which due to their hetero-penetration is associated to the surmountal of the reflexivity of the classical negation operation (i.e. true and false inter-transform under the negation, which makes of one of them a trivial reflection of the other).

While McCulloch stopped short of going beyond the formalization of 'circular' causality in terms of Boolean logic, Gotthard Günther, a pioneer of cybernetics and Hegelian philosopher working at the Biological Computer Lab, Illinois, considered the necessity of doing so.

The consideration of this will further open us to the modellization in terms of heterarchies as plural coordinated contextures of a whole (the Hyper Klein Bottles (Rapoport, 2014b) in terms of hyper-trans-dual logics with plural non-dual negation operators, as introduced by Günther (1962, 1967, 1969, 1971).

Indeed, to characterize heterarchies he introduced the notion of polycontextures, systems of many-valued (or many position) logics which embody the formalization of different ontologies with an increasing combinatorial complexity.

They are characterized by a multiplicity of non-reflective negation operators, in distinction with the classical Aristotelian-Boolean logics with its single dual (merely reflective) negation.

Günther claimed that this non-reflective operation of the plural negations is the signature of subjectivity (Günther, 1962).

Certainly, in distinction with the mere reflexive character of the negation of dual logic, these systems of plural non-reflective negations which include *partial negations* allow thus for a protoform of *discernment*.

There is no ontological loci for discernment in dual logic, but for Absolute Objectivity.

The matrix representing the relations between the elements of the logical system is related to the *positional* –relative to the matrix- valuation, which is purely combinatoric.

This proposal by Günther, which he acknowledged to have drawn from discussions with his peers, von Foerster and McCulloch.

Classical (Boolean) logic, is nothing but a particular case of the Klein Bottle Logic, that given by disconsidering the self-penetration, producing thus a two-positional logic; Inside-Inside and Outside-Outside; see fig.1.III in Part III.

The latter provides a single context, towards which everything is refered to as pure positivity, an ontological locus for Absolute Objectivity.

In doing so, now the dual logic is identified as *the* ontology, producing the world of facts and that given by a *sense of reality* as a most elementary epistemic state (d'Aquili and Newberg, 2000).

Thus, subjectivity has been banquished, yet with a paradoxical outcome described by Schrödinger in his Tarner Lectures:

> *"The reason, why our sentient percipient and thinking ego is met nowhere within our scientific world picture can easily indicated in seven words: because it is itself that world picture. It is identical with*

the whole and therefore cannot be contained in it as a part of it" (Schrödinger, 1959; Günther, 1962).

Yet as already acknowledged by several authors, this is a by-product of the transformations enacted in the Renaissance with its instauration of perspective and 3-dimensional space of a detached ego, but was not the case of Western Medieval culture for which the world was interwoven with meaning; furthermore, a turning Inside-Outside and Outside-Inside of our sense of reality was enacted with the Renaissance (Foucault, 1970; Rosen, 1994).

Thus the Self identifies with the world of facts enacted as his sense of reality.

The projection to the dual ontology, prompts up the already mentioned CONTAIN image-schema, as an operation of the ego, who on the one hand is conflated with the world picture.

Yet in doing so, a privileged point of reference is setup to assess this Absolute Objectivity.

It further conflates this world picture with the primary epistemic state of a sense of reality, making of this operation a most transparent association.

Thus, by banquishing subjectivity from our world picture, the latter becomes the very sense of what is real, to which we identify ourselves.

What is ontologically denied is reaffirmed. In this setting, paradigms may change but if framed in the dual ontology, no radical transformation is possible.

Furthermore, this is projected as a state of affairs to which *everyone,* whatever her/his own sense of reality may be, has to abide to this 'order of things', and compulsary at that.

It becomes a matter of hegemonics.

In the dual ontology there is no room for subjectivity as such, nor for interpretation nor semantics, nor for higher-order-than- one learning (Kaehr and von Goldammer, 1988).

In the theory of artificial neural networks, fuzzy logic is envisaged to describe adaptive learning (Perlovsky, 2001), but this logic is a particular case of Matrix Logic, which is based on the Klein Bottle (Stern, 2001; Rapoport, 2009, 2011a).

This is relevant to the notion of ecological systems operating as a learning unsupervised network, which self-organize without an Exterior agent being in control (Power, 2015).

The corresponding logophysics is the dual logophysics that decurrs from it and particularly, from the image-schema CONTAIN that categorizes this world into Exterior and Interior, for which both space and time are mere containers of the objects of the world and of their processes (Rapoport, 2014b).

1.9 Heterarchies and Computation. Surmounting the Cartesian Cut.

In terms of non-Turing computation, the Klein Bottle and Hyper Klein Bottle logophysics surmount the paradigm of sequential Turing computation which operates in a single context: heterarchies are intracontextural rather than intercontextural, while for a single *closed* context vis-à-vis others, dual logic operates reductively as a dual logophysics which is the imperating logic of the sciences for which the Outside/Inside dual categorization appears to operate transparently (Rapoport, 2014b).

This notion of polycontexturality can serve to explain the paradox in the theory of autopoiesis imposed by the dualistic notion of operational closure, where the consideration of volition becomes necessary to restate self-reference which is rendered non-effective in this theory (Kaehr and von Goldammer, 1990).

It is this unseparability of volition and cognition which was dismissed by Varela's instatement of the operational closure, under the spell of conceiving living systems as a kind of machine, self-regulating and self-producing vis-à-vis the environment.

Indeed,the freedom of a living system –the latter defined by a boundary or a distinction (Spencer-Brown, 1969) to interpret the environment and act upon it requires a non-dual logophysics which is "ecological" in the sense that it operates through a plurality of contexts *volitively (intentionally)* (Günther, 1967), and it further wholly symmetrizes the

interrelation with the environment (Kuhn, 2013).

Thus the Self manifests as distributed through the Other.

This not only surmounts the Cartesian Cut in its several guises. It also identifies the metaforms of such polycontextures as Hyper Klein Bottles, and further indicates their symbolic formalization by the pluri-negational non-dual logics introduced by Günther, or still the tensor algebra of Stern's Matrix Logic which is based on the Klein Bottle (Stern, 2001; Rapoport, 2011a).

1.10 Heterarchies, Cognition and the HyperKlein Bottles. Systems of Logic as Ontologies.

The importance of the choice of a system of logic, say the Aristotelian-Boolean logic, cannot be overstressed, and remarkably it begs us to do so.

It was Günther who made a point that has been almost completely ignored : the *choice of a system of logic is tantamount to the choice of an ontology*, i.e. it puts up a theory of Being, yet mostly unacknowledged as such (Günther, 1962; Kaehr and von Goldammer, 1988, 1989; Rapoport, 2014b).

Still "If there seems to be a need for a new logic a new concept of ontology must be formed and *viceversa*" (Günther, 1962).

This understanding has *not* been put to operate in the sciences at large, nor in philosophy, but almost exclusively through the dual logophysics and unacknowledged as an ontology (Rapoport, 2014b), yet developing the present non-dual ontology.

A remarkable work on the phenomenology of time and its non-dual logophysics, and its actual experimental verification in quantum mechanics is (Ruhnau, 1997).

Other rare exceptions are the work in (Primas, 1981) and (Mittelstaedt and Weingarten, 2006), on quantum logic and ontology related to quantum probability (Wilce, 2012) and some occasional glossing by the very few authors who have dealt with (some) of these issues in the setting of cybernetics (von Foerster, 2003).

To verify that Günther was and still is much ahead of *our* time see Malinowski and Pietrusczak (2006), which do discuss this observation.

Remarkably, Primas observed that:

"...the wholeness of nature implies that its temporal logic is not Boolean" (Primas, 1981).

One such example is that of biological systems which undergo processes of metamorphosis, say through symbiogenesis.

Another important example is the life/death unending cycle which is a particular case if not the most general expression of the temporal logic, but as well known it also extends to non-biological systems.

Indeed, while this is the case of biological cycles, it furthermore appears to be the case of the very diverse physico-chemical processes on Earth, which despite their seemingly random character present notable palindromic events related to astronomical cycles (Shnoll, 2012), which as assimilable to a Möbius strip.

Thus, biological evolution if not all evolution must, by necessity, embody a non-dual logophysics, which as we shall elaborate below, appears to be the case.

Hence, following Lima de Faria's theory of evolution through self-organization that starts from physics and chemistry noting that the symmetries that appear in material systems and their metamorphosis are also encountered in biological systems (Lima de Faria, 1988, 1995), then we can conceive Nature as enacting a non-dual logophysics of heterarchies, embodied as Hyper Klein Bottles.

Yet this logophysics has cognition as an indivisible element (Rapoport, 2014b), be that physical, chemical, biological or sociological, yet encompassing astronomical and cosmological scales, based on self-reference and hetero-reference, rather than a derivative notion of agency.

If the Self, the reality enacting conscious agent is actually a *model*- in which action creates perception rather than passive perception being the case (Freeman, 2000, 2007a, 2007b) which is transparent to our cognition/perception (Metzinger, 2004), then Günther's observation of the distributed Self

indicates a model which is not different; see note no. 12.

For instance, the choice of the dual logic due to Aristotle and Boole is the underlying logophysics of the reductive approach to the sciences based mostly in material processes, but eradicating time as an operator, as well as self-reference, hetero-reference and the imaginal domain, as formalized in terms of the Newtonian paradigm; see note no. 13.

Thus, in this article we have chosen to surmount the reductionist dual logophysics by introducing the Klein Bottle logophysics and the HyperKlein Bottles logophysics as the embodiments of self-reference and hetero-reference respectively, or in terms of contextures, the consideration of system with the environment as single for the former, and the further consideration of plural environments or plural contextures for the latter, respectively.

1.11 The Klein Logophysics, Cognition and Genomics: the subjects of this article.

Having completed the basic overall conceptual background to the present article, we finally state that its main subject is the logophysics of the Klein Bottle and of the Hyper Klein Bottle.

Yet, we shall elaborate on its relation to an image-schema that intermediates Outside and Inside *integrating* them by leaving out of the plane and back to it through the Klein Bottle self-penetration. This mediation is *not* an in-between.

It was Günther who pondered about place-logics to extend dual logic in his eulogy of McCulloch (Gunther, 1975).

Upon its reduction to a categorical divide by disconsidering the self-penetration of the Klein Bottle, this produces a categorical Inside/Outside divide, which has been qualified as a "system of belief" (Goetzler, 2013), actually a most basic image-schema. Already, the life of a cell is all about the interrelation between its Interior and Exterior, as mediated by the cell membrane; this is also the case of organisms, but as distributed entitities. Self-reference is crucial to the Klein Bottle and the Möbius strip which can be considered as embodiments and signs of self-reference.

Self-reference is basic to metamathematics and computer science as in Lisp recursive function theory (Odifreddi and Cooper, 2012) that led to the theory of algorithmic complexity due to Chaitin (1987, 1989, 1999), and in studies on cognition and consciousness (Hoftstadter, 1979; Rapoport, 2011a, 2009; Stern, 1992, 2001).

We shall further discuss the relations with the evolution of genomes and further to relate them to a novel topological conception of complexity.

Yet, shape and locus is associated to logic, and still to a dynamics which altogether conform the Klein Bottle logophysics (Rapoport, 2011a, 2011b, 2012, 2013); see note no. 14.

The latter has been applied to embryological development and tissue differentiation (Rapoport 2011b, 2014); topological models of embryological developments have also been elaborated in a series of works (Maresin and Presnov, 1985; Jockush and Dress, 2003; Isaeva, 2014), and still to a unified conception of remarkable simplicity for the unification of science (Rapoport, 2009, 2011a, 2011b, 2011c, 2011d, 2013).

The study of metapattern, as the pattern of patterns, will be addressed repeatedly, as well as the logophysical aspects of this model of genomics as related to quantum phenomena and harmonics.

Conflicts of Interest

The author declares no conflict of interest.

References

Abrams L. Black Holes: the legacy of Hilbert's error. Can J Phys 1989; 67: 919.

Abrams L. The total space-time of a point charge and its consequences for black holes.Int Jour of Theor Phys; 1996, 35,12: 2661-2677. DOI 10.1007/BF02085771.

Abraham R and Marsden J. Foundations of Mechanics. Addison Wesley, 1987.

Aerts D and Gabora L. A state-context-property model of concepts and their combinations II: A Hilbert space representation. Kybernetes 2005; 34(1&2), 192-221.

Alligood K, Sauer T and Yorke J. Chaos: An Introduction to Dynamical Systems.Springer, Berlin,1996.

Antspamacher H and Dalenoort G.Inside Versus Outside Endo and Exo-Concepts of Observation and Knowledge in Physics, Philosophy and Cognitive Science. Springer-Verlag, Berlin,1994.

Arkani-Hamed N, Bourjaily J, Cachazo F, Goncharov A, Postnikov A and Trnka J. Scattering Amplitudes and the Positive Grassmannian. arXiv:1212.5605, 2012.

Ashtekar A and Petkov V. Springer Handbook of Spacetime. Springer, Berlin,2014.

Bartlett S. Reflexivity: A Source Book in Self-reference. Elsevier, 1992, republished 2015 as ebook, http://repub.eur.nl/pub/78707.

Basdevant JL. Variational Principles in Physics. Springer, Berlin,2007.

Bateson G. Steps to an Ecology of Mind. Aronson, London,1972.

Bates A and Maxwell A. DNA Topology; Oxford University Press: Oxford, UK, 2005.

Bauer T, Banzer P, Karimi I, Orlov S, Rubano, A, Marrucci L, Santamato E, Boyd RW, Leuchs G. Observation of optical polarization Möbius strips. Science 2015; 27 February: 347; 6225 pp. 964-966. Doi: 10.1126/science.1260635.

Bell Pettigrew J. Design in nature; Longman, Green, and Co.: London, UK, 1908.

Bell Pettigrew J. Animal locomotion or walking, swimming, and flying with a dissertation on aeronautics; Henry S King & Co, London ,UK, 1973

Beloussov L. Morphomechanics of Development. Springer, Berlin, 2015.

Ben Jacob, Eshel. Bacterial self-organization: co-enhancement of complexication and adaptability in a dynamic environment. Phil Trans R Soc Lond A 2003; 361, 1283-1312.

Bennet M and Hacker P. Philosophical Foundations of Neuroscience. Wiley Blackwell, London, 2003.

Blekhman I. Vibrational Mechanics: Nonlinear Dynamic Effects, General Approach, Applications. World Scientific, Singapore, 2000.

Boeyens JC. Chemical Cosmology.Springer: Berlin, Germany,2010.

Bohm D and Hiley B. Wholeness and the Implicate Order. Routledge-Kegan, London,1980.

Bonchev D and Rouvray D. Chemical Topology: Introduction and Fundamentals. CRC, Boca Raton, 1999.

Bondarenko D. Approaching "complexity" in anthropology and complexity studies E:CO, 2007; 9, 3 2007: 62-74.

Bouligand Y. Liquid Crystals and their Analogs in Biological Systems. In: Liquid Crystals. Liebert L, editor; Academic Press, New York, NY, USA, pp 259-293, 1978.

Bouligand Y. Defects and Textures. In: Physical Properties of Liquid Crystals; Demus,D, Goodby J, Gray G, Spiess H, Vill V; editors, Wiley VCH: Weinheim, Germany, 1999.

Brooks D. The Concept of Levels of Organization in the Biological Sciences. Ph.D. thesis. Bielefeld Univ., 2014.

Buccheri R and Buccheri M. Evolution of Human Knowledge and the Endophysical Perspective. In: Endophysics, Time, Quantum and the Subjective. R. Buccheri et al (eds.). World Scientific, 2005.

Burch R. Valental aspects of Peircian algebraic logic. Comp Math Applic 1992; 23, 6-9: 665-677.

Carlsson G, Ishkhanov T, de Silva V and Zomorodian A. On the Local Behavior of Spaces of Natural Images .Inter Journal of Comp Vision January 2008; 76, Issue 1: 1-12 .

Carlsson G. Topology and data. Bull AMS 2009; 46, 2: 255-308.

Cahill R. Process Physics: From Information Theory to Quantum Space and Matter. Nova Science, New York,2005.

Carmeli M et al. The SL(2,C) gauge theory of gravitation and the quantization of gravitational field. arXiv: gr-qc/9907078.

Chaitin G. Algorithmic Information Theory, Cambridge University Press, 1987.

Chaitin G. Thinking about Gödel & Turing, World Scientific, Singapore, 1997.

Chaitin G. The Unknowable, Springer Verlag, Berlin, 1999.

Cohn, H. Conformal Mapping on Riemann Surfaces. Dover, New York, 2010.

Conte E , Khrennikov A, Todarello O, Federici A, Zbilut J. Mental states follow quantum mechanics during perception and cognition of ambiguous figures. Open Systems and Information Dynamics, 2009; 16, 1–17.

Coquand T. Type theory. Stanford Encyclipedia of Philosophy. 2014. http://plato.stanford.edu/entries/type-theory/ ; accessed April 14, 2016.

Corbin H. Creative Imagination in the Sufism of Ibn 'Arabi. Princeton University Press, 1969. (Re-issued in 1998 as Alone with the Alone.)

Corbin H. Cyclical Time & Ismaili Gnosis. KPI, 1983.

Cornish-Bowden A, Cárdenas ML, Letelier JC, Soto-Andrade J. Beyond reductionism: metabolic circularity as a guiding vision for a real biology of systems. Proteomics. 2007 Mar;7(6):839-45. PMID:17370262.

Crothers S. General Relativity: In Acknowledgement of Professor Gerardus 't Hooft, Nobel Laureate. http://vixra.org/pdf/1409.0072v6.pdf. Accessed April 17,2016.

Crumley C. Heterarchy and the analysis of complex societies. In: Heterarchy and the Analysis of Complex Societies, Ehrenreich R and Levy J.1995; 1-5.

Cubitt S. The information environment. In Ubiquitous Computing, Complexity and Culture. Ekman U et al. Routledge, London,2015.

Cytowic R and Eagleman D. Wednesday is Indigo Blue: Discovering the Brain of Synesthesia MIT Press, Cambridge, 2009.

d'Aquili E and Newberg A. The neurophysiology of aesthetic, spiritual and mystical states.Zygon, 2000; 35:39-51.

Debever R. Elie Cartan and Albert Einstein: Letters on Absolute Parallelism, 1929-1932. Princeton Univ Press, Princeton, New Jersey, 2015 (second edition).

Del Giudice E, Preparata G and Vitiello G. Water as a free electric dipole laser. Phys Rev Lett 1988, 61, 1085–1088.

Distin, K. Cultural Evolution. Cambridge University Press, Cambridge, 2011.

Dubois D. Computing Anticipatory Systems with Incursion and Hyperincursion. Computing Anticipatory Systems with Incursion and Hyperincursion. Computing Anticipatory Systems: CASYS First International Conference, Published by The American Institute of Physics, AIP Conference Proceedings 437, pp. 3-29, 1998.

Dubois D. Review of incursive, hyperincursive and anticipatory systems-foundation of anticipation in electromagnetism. AIP Conf. Proc. 517, 3 (2000); http://dx.doi.org/10.1063/1.1291243 .

Duerr HP. Dreamtime: Concerning the Boundary between Wilderness and Civilization. Blackwell, London,1985.

Durand G. L'Imaginaire. Essai sur les sciences et la philosophie de l'image, Paris, Hatier, 1994.

Fink B. Lacan To The Letter: Reading Ecrits Closely. Univ. of Minessota Press, 2004.

Freeman W. How Brains Makeup their Minds. Columbia University Press, new York, 2000. Freeman W (2007a). Intentionality. Scholarpedia, 2007, 2(2):1337. http://www.scholarpedia.org/article/Intentionality. Accessed March 08, 2016.

Freeman W (2007b). Proposed Cortical "Shutter" Mechanism in Cinematographic Perception. In: Perlovsky L. and Kozma R. Neurodynamics of Cognition and Consciousness, Springer, 2007.

Freund T. Multi-twist optical Mobius strips. Optics Letters 2010; 35, Issue 2: 148-150. doi: 10.1364/OL.35.000148

Foley M. A Government of Laws Men and Machines: Modern American Politics and the Appeal of Newtonian Mechanics. London: Routledge, 1990.

Foucault M. The Order of Things: An Archaeology of the Human Sciences. Pantheon, 1970.

Frieden BR. Science from Fisher Information: A Unification. Cambridge Univ. Press, 2004.

Freedman D and van Niewenhuizen P. Scientific American 1978,238, 126.

Frith C and Wolpert D. The Neuroscience of Social Interaction: Decoding, imitating, and influencing the actions of others. Oxford Univ. Press, Oxford, 2003.

Furst B. The Heart and Circulation: An Integrative Model. Springer, Berlin,2014.

García-Bellido A. Symmetries throughout organic evolution. Proc Natl Acad Sci USA December 1996; 93: 14229–14232.

Giurfa M and Menzel R. Insect visual perception: complex abilities of simple nervous systems. Current Opinion in Neurobiology 1997, 7:505–513

Ghyka M. The Geometry of Art and Life. Dover, New York, 1952.

Giraud-Guille M, Belamie E, Mosser G, Helary C, Gobeaux F and Vigier S. Liquid crystalline properties of type I collagen: Perspectives in tissue morphogenesis. Comptes Rendus Chimie 2008; 11, 3: 245–252.

Godfroy-Génin A-S.Pascal!: La Géométrie du hasard. Math. & Sci. Hum 2000, 150: 7-39.

Goenner H. On the History of Unified Field Theories. Living Rev. Relativity, 2004, 7, 2.

Goertzel B. Chaotic Logic: Language, Thought, and Reality from the Perspective of Complex Systems Science. Springer Science, Berlin, 2013.

Goldstein RE. Green algae as model organisms for biological fluid dynamics. Annu. Rev. Fluid Mech 2015; 47: 343.

González-Díaz P and Alonso-Serrano A Observing other universe through ringholes and Klein Bottle Holes, In: Towards New Paradigms, Proc of the Spanish Relativity Meeting (29 August–2 September) AIP Conf. Proc. 1458, pp. 311-314;Springer, Berlin.

Greenberger D, Hentschel K and Weinert F (eds.). Compendium of Quantum Physics: Concepts, Experiments, History and Philosophy, Springer, 2009.

Gunderson L and Holling C. Panarchy: Understanding Transformations in Human and Natural Systems. Island Press,2001.

Günther G. Cybernetic ontology and transjunctional operations. In Yovits, M.C., Jacobi, G.T. and Goldstein, G.D., Eds., Self-organizing Systems, Spartan Books, Washington DC, 313-392, 1962.

Günther G. Cybernetics and the Transition from Classical to Trans-Classical Logic. Illinois University Biological Computer Laboratory BCL Report 3.0. Urbana: Biological Computer Laboratory, University of Illinois, 1965.

http://www.vordenker.de/ggphilosophy/gg_bcl-report-no-30.pdf

Günther G. Time, Timeless Logic and Self-referential systems. Annals of the New York Academy of Sciences. Volume 138, Interdisciplinary Perspectives of Time pages 396–406, February 1967, DOI: 10.1111/j.1749-6632.1967.tb55000.x.http://www.vordenker.de/ggphilosophy/gg_life_as_polycontexturality.pdf

Günther G. Natural Numbers in Trans-Classic Systems. Part I, Journal of Cybernetics Vol. 1, 1971, No. 2, p. 23-33; part II: Journal of Cybernetics Vol. 1, 1971, No. 3, p. 50-62. In: www.vordenker.de (Sommer-Edition 2004), J. Paul (Ed.).

Günther G. Number and Logos: Unforgettable Hours with Warren St. McCulloch, 1975, retrieved from http://www.vordenker.de/numlog/numlog1.htm, March 17, 2016.

Günther G. Cognition and Volition. A contribution to a cybernetic theory of subjectivity. In Beiträge zur Grundlegung einer operationsfähigen Dialektik", Band 2, Meiner Verlag, Hamburg, 1979, p.203-240. http://www.vordenker.de/ggphilosophy/c_and_v.pdf.

Günther G. Life as Contexturality.Beiträge zur Grundlegung einer operationsfähigen Dialektik", Band 2, Meiner Verlag, Hamburg, 1979, p.283-306.

Günther G. Beiträge zur Grundlegung einer operationsfähigen Dialektik, Vols 1-3, Felix Meiner.Verlag, Hamburg, 1980.

Gunther G and von Foerster H. The Logical Structure of Evolution and Emanation in Interdisciplinary Perspectives of Time, R. Fischer (ed.), New York Academy of Sciences, New York, pp. 874–891 (1967).

Haken H. Advanced Synergetics: Instability Hierarchies of Self-Organizing Systems and Devices. New York: Springer-Verlag, 1993.

Hall M. Quantum Theory for Mathematicians. Springer, Berlin,2013.

Hamber W. Quantum Gravitation - The Feynman Path Integral Approach, Springer, 2009.

Hark M. Beyond the Inner and the Outer: Wittgenstein's Philosophy of Psychology.Kluwer, Dordrecht, 1990.

Haven E and Khrennikov A. Quantum Social Science, Cambridge University Press, 2012.

He M and Petoukhov SV.Mathematics of bioinformatics: theory, practice, and applications, John Wiley & Sons Inc , New York, NY, 2011.

Hawking S. Information Preservation and Weather Forecasting for Black Holes. www.arXiv:1401.5761V1 ; 2014.

Hawking S. The Beginning of Time.http://www.hawking.org.uk/the-beginning-of-time.html. Accessed June 14,2016.

Hehl F and Obukhov Yu. Foundations of Classical Electrodynamics: Charge, Flux, and Metric. Springer Science, Berlin,2003.

Heidegger M. On Time and Being. Stambaugh J (translator). Harper and Row, New York, 1972.

Hellerstein N. Delta: a paradox logic. Knots and Everything Series vol. 16, World Scientific, Singapore, 2010.

He M and Petoukhov S. Mathematics of Bioinformatics: Theory, Methods and Applications. Wiley, New York, 2011.

Hilgevoord J. Time in Quantum Mechanics. Studies in History and Philosophy of Modern Physics 2005, 36: 29–60.

His W. Unsere Körperform und das physiologische Problem ihrer Entstehung Briefe an einen befreundeten Naturforscher. Leipzig :F.C.W. Vogel,1874.

Hofstadter DR. Gödel, Escher, Bach: An Eternal Golden Braid, Basic Books, NY, 1979.

Hofstadter DR. I Am a Strange Loop. Basic Books, New York, 2007.

Hoffmann, R. The Same and Not the Same; Columbia University Press: New York, NY, USA, 1997.

Hoffmeyer J. Semiotic freedom: an emerging force. In: Information and the Nature of Reality: From Physics to Metaphysics. Davies P (ed.), Cambridge Univ. Press, 2010.

Hoffmeyer J. Semiotic freedom: an emerging force. In: Information and the Nature of Reality: From Physics to Metaphysics. Davies P (ed.), Cambridge Univ. Press, 2010.

Hohn S and Hallmann A. There is more than one way to turn in a spherical cellular monolayer inside out: Type B embryo inversion in Volvox globator, BMC Biol 2011; 9, 89.

Hohn S, Honerkamp-Smith A, Hass PA, Khuc Trong P and Goldstein R. Dynamics of a Volvox embryo turning itself inside out. Phys Rev Lett 2015; 114, 178101.

Hubel D. Eye, Brain and Vision, Scientific American Library, NY, 1988.

Hwang U, Laming MA (2012) Chandra X-Ray Survey of Ejecta in the Cassiopeia A Supernova Remnant. Astrophys. J. 746 . doi:10.1088/0004-637X/746/2/130.

Illert C. Formulation and Solution of the Classical Sea Shell Problem. I. Seashell Geometry.

II Nuovo Comento 1987; 9D: 791-814.

Illert C and Santilli RM. Foundations of Theoretical Conchology (2nd edition). Palm Harbor, USA: Hadronic Press, 1995.

Irvine W and Bowmeester D. Linked and knotted beams of light. Nature Physics 2008; 4:716-720.

Irvine W. Linked and knotted beams of light, conservation of helicity and the flow of null electromagnetic fields. J Phys A: Math Theor 2010; 43: 385203 (9pp) doi:10.1088/1751-8113/43/38/385203.

Isaeva V, Kasyanov N and Presnov E. Topology in Biology: Singularities and Surgery Transformations in Metazoan; Development and Evolution. Applied Mathematics 2014; 5, 17:2664-2674. doi: 10.4236/am.2014.517255.

Isenberg J. The initial-value problem in General Relativity. In: Ashtekar A and Petkov V. Springer Handbook of Spacetime. Springer, Berlin,2014.

Jablonka E and Lamb, JM. Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral and Symbolic Variation in the History of Life. MIT Press, Cambridge, Mass.,2005.

Jockusch H and Dress A. From Sphere to Torus: A Topological View of the Metazoan Body Plan. Bull Math Biol 2003, 65: 57–65.

Jaynes E. Probability Theory: The Logic Of Science.Cambridge Univ. Press, Cambridge, 2003.

Jenny H. Cymatics: A Study of Wave Phenomena & Vibration , 2001, 3rd ed. Macromedia Press.

Johansen, SE. Outline of Differential Epistemology. Translation of the Norwegian edition, University of Trondheim, Trondheim, Norway, 1991; to appear.

Johansen SE. Basic considerations about Kozyrev's theory of Time from recent advances in specialist biology, mathematical physics and philosophical informatics. In: Time and Stars: The centenary of N.A. Kozyrev (russisk og engelsk). Shikhobalov L (ed.), St. Petersburg, Nestor-History, 652-703, 2008.

Kaehr R and von Goldammer E. Again Computers and the Brain. J Mol Electronics 1988, 4: S31-S37.

Kaehr R and von Goldammer E. Models of Brain Functions (Cotterill R, ed.), Cambridge University Press, 1989, p.483-497.

Kaehr R and von Goldammer E. Problems of Autonomy and Discontexturality in the Theory of Living Systems . In: Analyse dynamischer Systeme in Medizin, Biologie und Ökologie: 4. 4. Ebernburgerer Gesprach Bad MOnster, 5.-7. April 1990. Springer, 1991.

Kaehr R. Placed-valued Logics around Cybernetic Ontology, the BCL and AFSOR. ThinkArt Lab Glasgow, 2007. http://www.thinkartlab.com/pkl/PDF-Overview/PDF-Overview.html, accessed March 18, 2016.

Kauffman L. De Morgan algebras, completeness and recursion. In: Proceedings VIIITh International Symposium in Multiple Valued Logics. IEEE Computer Society Press 1978;: 82-86.

Kauffman L. Imaginary values in mathematical logic. Proceedings of the Seventeenth International Conference onMultiple Valued Logic, May 26-28 (1987), Boston MA, IEE Computer Society Press 1987: 282-289.

Kauffman L. I am a Fibonacci Form. Cybernetics And Human Knowing 2002; 11, 3: 101-106.

Kauffman L. Eigenform. Kybernetes 2005; 34.1 & 2: 129-150. DOI 10.1108/03684920510575780.

Kauffman L. Non-commutative worlds. New J Phys 2004, 6: 173 doi:10.1088/1367

Kauffman S. Home in the Universe: The Search for Laws of Self-Organization and Complexity. Oxford University Press, Oxford, 1994.

Kauffman S and Garre A. Beyond Descartes and Newton: Recovering life and humanity. Progress in Biophysics and Molecular Biology 119(2015) http://dx.doi.org/10.1016/j.pbiomolbio.2015.06.003.

Kastner R. The Transactional Interpretation of Quantum Mechanics: The Reality of Possibility. Cambridge University Press, 2012.

Kelso J A S. Dynamic Patterns. MIT Press, Cambridge, Mass., 1995.

Khrennikov A. Ubiquitous Quantum Structure: from Psychology to Finances. Springer, 2010.

Kiehn R. Periods on manifolds, quantization and gauge. J.Math Phys 1977; 18: 614.

Kiehn R. Non-Equilibrium Systems and Irreversible Processes, Vol 3: Wakes, Coherent Structures and Turbulence. Lulu, 2003.

Kiehn R. Non-Equilibrium Systems and Irreversible Processes, Vol 6: The Universal Effectiveness of Topological Thermodynamics. Lulu, 2009.

Kleene S C. Introduction to Meta-Mathematics. Ishi Press, New York, 2009.

Kleinert H. Multivalued Fields In Condensed Matter, Electromagnetism, and Gravitation. World Scientific, Singapore,2008.

Kobayashi S and Nomizu K. Foundations of Differential Geometry, Vol.1. Wiley, 1996.

Kohn E. How Forests Think: Toward an Anthropology Beyond the Human. California Univ. Press, Berkeley,2013.

Kontopoulos, K. The logics of social structure. Cambridge University Press, 1993.

Koonin E and Wolf Y. Evolution of microbes and viruses: a paradigm shift in evolutionary biology? Frontiers in Cellular and Infection Microbiology, 2012;September, 2, 119.1-15.

Koonin EV.The Logic of Chance: The Nature and Origin of Biological Evolution. FT Press Science; New Jersey, USA, 2012.

Koulakov A, Enikolopov A and Rinberg D. The structure of human olfactory space. https://arxiv.org/pdf/0907.3964.

Kozyrev A N and Nasonov VV. On some properties of time discovered by astronomical

observations. Manifestation of Cosmic Factors on the Earth and Stars, 76-84 (in Russian). Moscow-Leningrad. In: Institute of Time Nature Explorations: Library of Electronic Publications. http://www.chronos.msu.ru/eelectropublications.html

Kull K. Biosemiotics and Biophysics-The Fundamental Approaches to the Study of Life. In: Introduction To Biosemiotics, Barbieri M, 2007, Springer, 167-177.

Kull K. Semiosis stems from logical incompatibility in organic nature: Why biophysics does not see meaning, while biosemiotics does. Progress in Biophysics and Molecular Biology 119 (2015) :616-621.

Kull K, Emmeche C and Favareau D. Biosemiotic Research Questions. In: Towards a Semiotic Biology: Life is the Action of Signs. Kull K and Emmeche C, eds. Imperial College Press and World Scientific, London and Singapore, 2011.

Lakoff G and Nuñez C. Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being. Basic Books, New York,2000.

Lakoff G and Johnson M. Metaphors we live by.The University of Chicago Press , Chicago (IL),2003.

Lavrentiev MM, Yeganova, IA, Lutset MK & Fominykh, S. On the registration of substance respond to external irreversible process. Doklady Physical Sciences. 1991; 317 (3): 635-639.

Lavrentiev MM and Eganova I. N. A. Kozyrev's Method of Astronomical Observations: Information from True Positions of Stars, Stellar Systems, and Planets. In: Instantaneous Action at a Distance in Modern Physics:"Pro"and "Contra" . Chubykalo A et al (eds.) Nova Science Publishers, New York,1999.

Levich AP. On the Way to Understanding the Tiùe Phenomenon. In:The Constructions of Time in Natural Science. Part II. The "Active" Properties Of Time According To N.A. Kozyrev. World Scientific, Singapore, 1996.

Levich AP.Paradigms of Natural Science and Substantial Temporology. In The Nature of Time: Geometry, Physics and Perception. Buccheri R et al (eds.), 2003,Springer, pp.427-436.

Lima de Faria A. Evolution without Selection. Form and Function by Autoevolution. Elsevier: New York, NY, 1988.

Lima de Faria A. Biological Periodicity: Its Molecular Mechanism and Evolutionary Implications. JAI Press Inc., Greenwich, Connecticut, 1995.

Lin Y (Guest Editor). Mystery of Nonlinearity and Lorenz's Chaos. A special double issue of Kybernetes: The International Journal of Systems and Cybernetics,1998; 27, 6 & 7: 605 – 854.

Lin Yi. Systemic Yoyos: Some Impacts of the Second Dimension. CRC Press, Boca Raton, Fl USA, 2002.

Lin Y. (Guest editor). Systematic Studies: The Infinity Problem in Modern Mathematics. Kybernetes: The International Journal of Systems, Cybernetics, and Management Science, 2008, 37, no. 3 – 4: 387 – 578.

Lin Y and Ouyang S. Irregularities and Prediction of Major Disasters. CRC Press, Boca Raton,2010.

Lin Y and Forrest B. Systemic Structure Behind Human Organizations: From Civilizations to Individuals. Springer, Berlin,2012.

Lin Forrest Y. A Systemic Perspective on Cognition and Mathematics. CRC Press, Boca Raton,2013.

Lorenz System. In: Wikipedia, https://en.wikipedia.org/wiki/Lorenz_system; accessed June 14,2016.

Logothetis NK. Single units and conscious vision. Phil Trans R Soc Lond B 1998, 353:1801-1818.

Louie A. The Reflection of Life: Functional Entailment and Imminence in Relational Biology. Springer Verlag, Berlin, 2013.

Machon T, Alexander G. Knots and nonorientable surfaces in chiral nematics. PNAS 2013; August 27,110;35:14174–14179. doi: 10.1073/pnas.1308225110.

Mahner M and Bunge M. Foundations of Biophilosophy. Springer Verlag, 1997.

Mainzer K. Symmetries of Nature: A Handbook for Philosophy of Nature and Science. Gruyter, Amsterdam, 1996.

Malinowski J and Pietruszczak A. Essays on Logic and Ontology. Rodopi, Amsterdam, 2006.

Mamlouk A and Martinetz T. On the dimensions of the olfactory perception space. Neuro-computing 2004, 58–60: 1019–1025. doi:10.1016/j.neucom.2004.01.161.

Maresin VM and Presnov E. Topological approach to embryogenesis. Jour Theor Biol. 1985; 114, 3:387-398.

McCulloch WS and Pitts W. A logical calculus of the ideas immanent in nervous activity.The Bulletin of mathematical biophysics. December 1943, Volume 5, Issue 4, pp 115-133

McCulloch WS. A heterarchy of values determined by the topology of nervous nets. Bull Math Biophys 1945, 7: 89-93.

Merleau-Ponty M. Trans: Smith C. Phenomenology of Perception . London: Routledge & Kegan Paul, 1965.

Metzinger T. Being No One: The Self-Model Theory of Subjectivity . MIT Press, Cambridge (MA), 2004.

Mezey P (1993) Shape in Chemistry: An Introduction to Molecular Shape and Topology. VCH: New York, NY, USA.

Misner C, Thorne K and Wheeler J. Gravitation. Freeman, San Francisco,1973.

Mitchell E. Quantum Holography: A Basis for the Interface Between Mind and Matter, Bioelectromagnetic Medicine, Marcel Dekker, New York, 2003.

Mittelstaedt P and Weingarten PA. Laws of Nature. Springer Verlag, Berlin, 2005.

Montgomery R. N-body choreographies. Scholarpedia 2010; 5(11):10666. doi:10.4249/scholarpedia.10666.

Motter A and Campbell D. Chaos at fifty. Physics Today 2013;66,5: 27-33. doi: 10.1063/PT.3.1977.

Murphey M. The Development of Peirce's Philosophy. Harvard Univ. Press, Cambridge, 1961.

Musès, Charles A. Applied hypernumbers: computational concepts. Appl. Math. Comput 1977; 3 (3): 211–226. doi:10.1016/0096-3003(77)90002-9

Musès C. Destiny and Control in Human Systems Studies in the Interactive Connectedness of Time (Chronotopology). Kluwer, Amsterdam, 1985.

Myers T. Anatomy Trains: Myofascial Meridians for Manual and Movement Therapists. Churchill-Livingston,2014. https://www.google.com.ar/search?q=myers+anatomy+trains&client=firefox-b&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwi7tP3jiIbOAhXLGJAKHVrlDy0QsAQIPg&biw=1366&bih=657.

Neuman Y (2008) Reviving the Living: Meaning Making in Living Systems, Elsevier, Amsterdam, Holland.

Noble D. The Music of Life: Biology Beyond the Genome. Oxford University Press, 2010.

Noble D. Physiology is rocking the foundations of evolutionary biology. Exp Physio 2013; 98.8: 1235–1243

Odifreddi P and Cooper B. Recursive Functions, The Stanford Encyclopedia of Philosophy (Fall 2012 Edition), Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/fall2012/entries/recursive-functions/>.

O'Neil R, De Angelis D, Waide J and Allen T. A Hierarchical Concept of Ecosystems. Princeton University Press, 1986.

Oyama, S. Evolution's eye: A Systems View of the Biology-Culture Divide. Duke University Press,Durham and London, 2000.

Páleš E. Seven Archangels. Rhythms of Inspiration in the History of Culture and Nature. Sophia, Bratislava, 2009.

Pattee H. Hierarchy theory: the challenge of complex systems. George Brazillier, New York,1973.

Peirce C. The Categories (MS 403 of 1893). Abridgement of "On a New List of Categories", Proceedings of the American Academy of Arts and Sciences 7 (1868), 287–298. Presented, 14 May 1867. Reprinted (Collected Papers, vol. 1, paragraphs 545–559), (The Essential Peirce, vol. 1, pp. 1–10), (Chronological Edition, vol. 2, pp. 49–59).

Peirce C. Collected Papers, Vol. -t, Bk. 2, (Hartshorne C,Weiss P and Burks A, (Eds.), Ilarvard University Press, Cambridge, Mass.,1958.

Penner C, Knudsen R, Miuf M and Andersen C. An Algebro-Topological Description of Protein Domain Structure. PLoS ONE | www.plosone.org 1 May 2011; 6 , e19670. DOI: 10.1371/journal.pone.0083788.

Pensinger W and Nha Trang C. The Moon of Hoa Binh: A Novel. Foundation Autopoy; 2-volume edition, 1994.

Peratt A. Physics of the Plasma Universe. Springer, Berlin,2015.

Perez, JC. La révolution des ordinateurs neuronaux, Hermes; Paris, 1990.

Perez, JC. De nouvelles voies vers l'intelligence artificielle (pluri-disciplinarité, auto-organisation et réseaux neuronaux); Masson: Paris , 1988 and 1989.

Perez JC. Codex Biogenesis: Les 13 Codes de l'ADN. Marco Pietteur: Embour, Belgique,2009.

Perez JC. Codon populations in single-stranded whole human genome DNA are fractal and fine tuned by the golden ratio 1.618, Interdiscip Sci Comput Life Sci 2010; 2: 1–13.

Perez JC. The "3 Genomic Numbers" Discovery: How Our Genome Single-Stranded DNA Sequence Is "Self-Designed" as a Numerical Whole. App Math 2013; 4, 37-53.http://dx.doi.org/10.4236/am.2013.410A2004

Perez, J.-C. Deciphering Hidden DNA Meta-Codes -The Great Unification & Master Code of Biology. J Glycomics Lipidomics 2015a, 5:2 http://dx.doi.org/10.4172/2153-0637.1000131.

Perez JC. First music of DNA. https://sites.google.com/site/thefirstmusicofgenes/home; accessed December 2015(b).

Perlovsky L.Neural Networks and Intellect: Using Model-Based Concepts. Oxford University Press, Oxford, 2001.

Perlovsky L. and Kozma R. Neurodynamics of Cognition and Consciousness, Springer, 2007.

Petoukhov S. Genetic Code and the Ancient Book of Changes. Symmetry: Culture and Science 1999, 10, 3-4: 211-226.

Petoukhov S. Matrix genetics, part 2: the degeneracy of the genetic code and the octave algebra with two quasi-real units (the "Yin-Yang octave algebra"). arXiv:0803.3330; 2008.

Petoukhov S and He M. Symmetrical Analysis Techniques for Genetic Systems and Bioinformatics: Advanced Patterns and Applications, IGI Global, Hershey,NY, 2010.

Petoukhov S. Symmetries in Genetic Information and Algebraic Biology. Symmetry: Culture and Science 2012; 23, 3-4, 225-448.

Petoukhov SV (2012) Symmetries of the genetic code, hypercomplex numbers and genetic matrices with internal complementarities. Symmetry: Culture and Science, 23, 3-4: 275-301.

Petoukhov S. The system-resonance approach in modeling genetic structures. BioSystems 2016,139: 1–11. http://dx.doi.org/10.1016/j.biosystems.2015.11.001.

Pollack G (2013) The Fourth Phase of Water: Beyond Solid, Liquid, and Vapor; Ebner and Sons: Seattle, Washington; USA.

Poplawski N. Cosmology with torsion: an alternative to cosmic inflation. Phys Letts B 2010; 694, 3: 181–185.

Post EJ. Formal Structure of Electromagnetics.North-Holland, 1962.

Post EJ. Geometry and Physics: A Global Approach In Problems in the Foundations of Physics. Springer Verlag, Berlin, 1971, 57-78.

Post EJ Quantum Reprogramming (Ensembles and Single Systems: A Two-Tier Approach to Quanutm Mechanics). Springer Verlag, 1995.

Post EJ. Geometry and Physics: A Global Approach In Problems in the Foundations of Physics. Springer Verlag, Berlin, 1971, 57-78.

Priest G. Beyond the Limits of Thought, Cambridge University Press, 1995, 2nd expanded edition, Oxford: Oxford University Press, 2002.

Primas H. Chemistry, Quantum Mechanics and Reductionism. Springer, Berlin, 1981.

Rabounski D and Borissova, L. General Relativity Theory Explains the Shnoll Effect and Makes Possible Forecasting Earthquakes and Weather Cataclysms. Progress in Physics, 2014, 10,2,63-70.

Raju CK. The Eleven Pictures of Time: The Physics, Philosophy of Time Beliefs. Sage Publs., London and New Delhi,2003

Rammer J. Quantum Field Theory of Non-equilibrium States. Cambridge Univ.Press, 2007.

Ranicki A. Algebraic and Geometric Surgery. Oxford Mathematical Monographs, Oxford University Press, Oxford, 2014.

Rañada A. A topological theory of the electromagnetic field. Lett Math Phys 1989, 18: 97-106

Rapoport DL and Sternberg S. On the interactions of spin with torsion. Annals of Physics 1984; 158, 2: 447–475. doi:10.1016/0003-4916(84)90128-3.

Rapoport DL and Tilli M. Scale Fields as a Simplicity Principlicity. In Proceedings of the Third Workshop on Hadronic Mechanics, vol. II (Patras, 1986); Janussis A, editor, Hadronic J.Suppl. 2 (1986) 682-778.

Rapoport DL. Stochastic processes in conformal Riemann-Cartan-Weyl gravitation. Int J Theor Phys 1991, 30, 11: 1497-1515. DOI 10.1007/BF00675614.

Rapoport DL. Riemann-Cartan-Weyl quantum geometry. II Cartan stochastic copying method, Fokker-Planck operator and Maxwell-de Rham equations. Int Jour of Theor Phys 1997; 36, 10: 2115-2152. DOI 10.1007/BF0243594.

Rapoport DL. Riemann-Cartan-Weyl geometries, quantum diffusions and the equivalence of the free maxwell and Dirac-Hestenes equations. Advances in Applied Clifford Algebras , 1988; 8 (1):129-146 . DOI: 10.1007/BF03041930.

Rapoport DL. Covariant non-linear non-equilibrium thermodynamics and the ergodic theory of stochastic and quantum flows. In: Instabilities and Nonequilibrium Structures vol VI, Tirapegui E, Martínez J and Tiemann R .editors, Springer Verlag, 2000. http://link.springer.com/chapter/10.1007%2F978-94-011-4247-2_19

Rapoport DL (2002a). Random diffeomorphisms and integration of the classical Navier—Stokes equations. Rep Math Phys 49, 1, February 2002: 1–27. doi:10.1016/S0034-4877(02)80002-7

Rapoport DL (2002b). On the geometry of the random representations for viscous fluids and a remarkable pure noise representation. Rep Math Phys, October 2002: 211–250. doi:10.1016/S0034-4877(02)80055-6

Rapoport DL (2003a). Random symplectic geometry and the realizations of the random representations of the Navier-Stokes equations by ordinary differential equations. Random Oper and Stoch Eqs. 2003,11, 4: 371–401. DOI: 10.1515/156939703771891888.

Rapoport DL (2003b). Martingale problem approach to the representations of the Navier-Stokes equations on smooth-boundary manifolds and semispace. Random Oper and Stoch Eqs. 2003, 11, 2: 109–136

Rapoport DL.(2005a) On the unification of geometric and random structures through torsion fields: Brownian motions, viscous and magnetic fluid-dynamic. Found Phys 2005; (35) 7: 1205-1244.

Rapoport DL. (2005b) Cartan–Weyl Dirac and Laplacian Operators, Brownian Motions: The Quantum Potential and Scalar Curvature, Maxwell's and Dirac-Hestenes Equations, and

Supersymmetric Systems. Found Phys 2005, (35) 8: 1383-1431.

Rapoport DL.(2005c) Stochastic Geometry Approach to the Kinematic Dynamo Equation of Magneto-hydrodynamics. In Trends in Partial Differential Equations of Mathematical Physics. Rodrigues J, Seregin G and Urbano J (Eds.), Birkhauser, 2005, 225-241. DOI 10.1007/3-7643-7317-2_17.

Rapoport DL. Torsion Geometries, their Brownian Motions, and the Time Variables, Found of Phys 2007; (37) 4-5: 813-854

Rapoport DL. On the state-space and spacetime geometries of geometric quantum mechanics, In: Foundations of Probability and Physics IV, Proceedings of the Conference, Center for Interdisciplinary Mathematics and its applications, Univ . of Vaxho, Sweden, Khrennikov A and Adenier G, American Institute of Physics Conference Series , Springer, 2007.

Rapoport DL. Torsion Fields, Cartan-Weyl Space-Time and State-Space Quantum Geometries, their Brownian Motions, and the Time Variables, Found Phys 2007; (37) 4-5, 813-854.

Rapoport DL .Torsion Fields, the Extended Photon, Quantum Jumps, the Eikonal Equations, the Twistor Geometry of Cognitive Space and the Laws of Thought. In: Ether, Spacetime and Cosmology vol. 3: Physical Vacuum, Relativity and Quantum Mechanics. Duffy M, and Levy J, editors; Apeiron Press: Quebec, Canada, pp. 389-457, 2009.

Rapoport DL (2010a). Torsion, propagating singularities, nilpotence, quantum jumps and the eikonal equations. In: Computing Anticipatory Systems, Proceedings CASYS'09 , Dubois DM (ed.), American Institute of Physics Conf. Series 1303. Springer, Berlin, 2010.

Rapoport D (2010b). Self-reference, the Moebius and Klein Bottle surfaces, Multivalued Logic and Cognition. Inter J Comput Anticip Syst 2010; 23: 103-113.

Rapoport DL (2011a). Surmounting the Cartesian Cut Through Philosophy, Physics, Logic, Cybernetics and Geometry: Self-reference, Torsion, the Klein Bottle, the Time Operator, Multivalued Logics and Quantum Mechanics. Found Phys 2011; 41, 1: 33-76.

Rapoport DL (2011b) Surmounting the Cartesian Cut: Klein Bottle Logophysics, The Dirac Algebra and the Genetic Code. NeuroQuantology 2011, 9, 4, Special issue: Classical and "Quantum-like" Views of the Genetic Code .

Rapoport, DL (2011c) On the Fusion of Physics and Klein Bottle Logic in Biology, Embryogenesis and Evolution. NeuroQuantology 2011; 9, 4: 842-86.

Rapoport DL (2011d). Torsion Fields, the Extended Photon, Quantum Jumps, The Klein Bottle, Multivalued Logic, the Time Operator, Chronomes,Perception, Semiosis, Neurology and Cognition. In Focus in Quantum Mechanics,Hathaway D, Randolph E, editors; Nova Science, NY, 2011.

Rapoport DL. Klein Bottle logophysics a unified principle for non-linear systems, cosmology, geophysics, biology, biomechanics and perception. Journal of Phys: Conf. Ser 2013; 437, 012024. doi:10.1088/1742-6596/437/1/01202.

Rapoport DL (2014a).Surmounting the Cartesian Cut: Torsion, Klein Bottle,Stereochemistry, the Biomechanics of the Cell Splitter in Embryogenesis and Bauplans. Int J Comp Anticip Sys 2014; 29: 225-246.

Rapoport DL (2014b). Hyper Klein Bottle Logophysics Ontopoiesis of the Cosmos and Life. In: Phenomenology of Space and Time: The Forces of the Cosmos and the Ontopoietic Genesis of Life: Book Two, Tyminieckia, A, editor, Volume 117 of the series Analecta Husserliana pp 275-350.

Rashevky N. Topology and life: In search of general mathematical principles in biology and sociology. Bull Math Biophys 1954, 16, 317:348.

Rashesvsky N. Mathematical Biophysics. University of Chicago Press, Chicago, first edition, 1939 (republished 1961, Dover Publs., New York).

Ritter H, Martinetz T and Schulten K. Neural Computation and Self-Organizing Maps - An Introduction. Addison-Wesley,New York, 1992.

Rodrigues W and Capelas de Oliveira E. The many faces of Maxwell, Dirac and Einstein equations : a Clifford bundle approach. Springer Verlag, Berlin, 2007.

Ross KD. Planck's constant, torsion, and space-time defects. Int J Theor Phys, 1989,28,7: DOI 10.1007/BF00671851.

Rosen S. The Self-evolving Cosmos: A Phenomenological Approach to Nature's Unity in Diversity. Series on Knots and Everything 18, World Scientific: Singapore, 2008.

Rosen, S.M., 2015. Why natural science needs phenomenological philosophy. J. Prog. Biophys. Mol. Bio. 119 (3), 257e269. Special Theme Issue on Integral Biomathics: Life Sciences, Mathematics, and Phenomenological Philosophy.

Rosen R. Essays on Life Itself. Columbia University Press, New York, 2000.

Rosen R. Anticipatory Systems: Philosophical, Mathematical and Methodological Foundations. Pergamon Press, first edition, 1985, Springer Verlag, second edition,2012.

Rosen S. Science, Paradox, and the Moebius Principle: The Evolution of a "Transcultural" Approach to Wholeness. State University of New York Press, 1994.

Rosen S. The Self-evolving Cosmos: A Phenomenological Approach to Nature's Unity in Diversity. Series on Knots and Everything 18, World Scientific: Singapore, 2008.

Rosen S. What is radical recursion? SEED Journal 2004; 4, 1:38-57.

Rosen S. Topologies of the Flesh: A Multidimensional Exploration of the Lifeworld. Ohio Univ. Press, Illinois, 2006.

Rosenfeld B. Geometry of Lie Groups. Kluwer, Dordrecht, 1997.

Rossler OE. Endophysics: the World as an Interface. World Scientific, Singapore,1998.

Rovelli C, Quantum Gravity. Scholarpedia, 2008, 3(5):7117.

Ruane G, Swartzlander A, Slussarenko S, Marruccie L and Dennis M. Nodal areas in coherent beams.Optica 2015; (2) 2: 147-150. doi: 10.1364/OPTICA.2.000147.

Ruhnau E. The Deconstruction of Time and the Emergence of Temporality. In: Time, Temporality, Now. Atmanspacher H and Ruhnau E (Eds.), Springer Verlag, Berlin,1997.

Schempp W. Quantum Holography, Synthetic Aperture Radar Imaging and Computed Tomographic Imaging. In: Quantum Measurements in Optics NATO ASI Series Volume 282, Springer Verlag, Berlin, Germany, 1992, 323-343.

Schempp W. Quantum holography and neurocomputer architectures. In: The Physical Nature of Consciousness. Van Loocke P (editor), John Benjamins, Amsterdam 2001.

Schrödinger E. Space-Time Structure. Cambridge Univ. Press, 1950.

Schrödinger E. What is Life? Cambridge University Press, 2002.

Schouten J. The Ricci Calculus. Springer Verlag, Berlin,1954.

Schrödinger E. Mind and Matter. Cambridge University, Cambridge,1959.

Shanon B. The Antipodes of the Mind. Oxford Univ. Press, Oxford, 2003.

Shanta BN and Muni BJ. Why Biology is Beyond Physical Sciences? Advances in Life Sciences 2016, 6(1): 13-30. DOI: 10.5923/j.als.20160601.03.

Shipov G. A Theory of the Physical Vacuum. Moscow ST-Center, Russia, 1998.

Shnoll SE. Cosmological Factors in Stochastic Processes. American Research Press: Rehoboth, NM, USA, 2012.

Schwartz E. Afferent maps in the primate visual cortex and the generation of neuronal trigger features. Biol Cyber 1977; 28:1-14.

Schwartz E. Spatial mapping in primate sensory projection : analytic structure and relevance to perception. Biol. Cybernetics 1977; 25: 181-194

Schwartz E. Computational Neuroscience. Bradford Book, Cambridge, MA, 1993.

Shnoll SE . On the Cosmophysical Origin of Random Processes Open Letter to the Scientific Community on the Basis of Experimental Results Obtained During 1954–2014. Progress in Physics 2014; 10, 4: 207-208.

Siegelmann H. Neural Networks and Analog Computation:Beyond the Turing Limit, Springer Verlag, Berlin, 1999.

Simeonov P. Integral Biomathics: A Post-Newtonian View into the Logos of Bio. Progress in Biophysics and Molecular Biology 2010, 102, 2-3: 85-121

Simeonov P. and Cottam R. Integral Biomathics reloaded: 2015. Progress in Biophysics and Molecular Biology 119 (2015) 728e733.

Smarandache F. Unifying Field in Logics: Neutrosophic Logic, Neutrosophic Set, Neutroso-phic Probability and Statistics. American Research Press, Rehoboth (NM), 2005 (4th edition).

Smulyan R. Diagonalization and Self-Reference. Oxford Science Publications, 1994.

Snyder G. Self-organized computation with unreliable, memristive nanodevices. Nanotechnology 2007; 18: 365202. doi:10.1088/0957-4484/18/36/365202

Soto-Andrade J, Jaramillo S , Gutierrez J and Letelier JC. Ouroboros avatars: A mathematical exploration of Self-reference and Metabolic Closure. 2012. https://mitpress.mit.edu/sites/default/files/titles/alife/0262297140chap115.pdf, accessed March 24, 2016.

Spencer-Brown G. The Laws of Form. Allen and Unwin, London, 1969; Bohmeier Verlag, Leipzig, 5th international edition, 2008.

Sprott J. Strange Attractors: Creating Patterns in Chaos. M&T Books, New York,1993.

Stakhov A. Mathematics of Harmony. World Scientific; Singapore, 2009.

Stark D. The Sense of Dissonance: Accounts of Worth in Economic Life. Princeton University Press, 2009.

Steane A. Context, spacetime loops and the interpretation of quantum mechanics.J Phys A: Math Theor 2007; 40: 3223–3243. doi:10.1088/1751-8113/40/12/S21

Stern A. Matrix Logic and Mind: A Probe Into a Unified Theory of Mind and Matter. Elsevier, Amsterdam, 1992.

Stern A. Quantum Theoretic Machines. Elsevier: Amsterdam,2001.

Stewart I. The Mathematics of Life. Basic Books, New York, 2011.

Strassler M. Black Hole Information Paradox: An Introduction.
https://profmattstrassler.com/articles-and-posts/relativity-space-astronomy-and-cosmology/black-holes/black-hole-information-paradox-an-introduction/ Accessed April 24, 2016.

Swindale N. Visual Cortex: Looking into a Klein Bottle, Current Biology 1996; 6, 7:776–779.

Tenenbaum J, de Silva V and Langdorf J. A Global Geometric Framework for Nonlinear Dimensionality Reduction. Science, 2000, 290: 2320-2323.

Tanaka S. Theory of self-organization of cortical maps: mathematical framework. Neural Networks 1990, 3, 625:640. doi:10.1016/0893-6080(90)90053-N.

Tanaka S. Topological analysis of point singularities in stimulus preference maps of the primary visual cortex. Proc R Soc Lond [Biol] 1995; 261: 81–88.

Tanaka S. Information representation and self-organization of the primary visual cortex. In Natural and Artificial Computation: Proceedings of the 5th NEC Research Symposium; Waltz E (ed). SIAM, 1996, p.93-123.

Tanaka S. Topology of Cortex Visual Maps, Forma 1997; 12:101-108.

Thompson D'AW. On Growth and Form;.Cambridge University Press: New York, 1945 .

Thouless D. Topological Quantum Numbers in Nonrelativistic Physics. World Scientific, Singapore, 1998.

Trifonov EN. The multiple codes of nucleotide sequences. Bull Math Biol 1989, 51(4):417-32.

Trifonov EN. Cracking the chromatin code: Precise rule of nucleosome positioning. Physics of Life Reviews 2011;8: 39–50.

Trifonov EN. Codes of biosequences. In: The Codes of Life, Barbieri M. (ed.), Springer,2008, pp.3-12.

Trifonov E. Natural geometry of nonzero quaternions. Int J Theor Phys 2007;46 (2): 251-257. DOI: 10.1007/s10773-006-9234-9.

Trifonov E. GR-friendly description of quantum systems. Int J Theor Phys 2008; 47(2):492-510. DOI: 10.1007/s10773-007-9474-3.

Tu L. An Introduction to Manifolds. Springer, Berlin, 2008.

Turvey M. Impredicativity, Dynamics, and the Perception-Action Divide. In: Coordination Dynamics: Issues and Trends, Jirsa VK et al, editors, Springer Verlag, Berlin, 2004, DOI 10.1007/978-3-540-39676-5_1

Van Dantzig D. The fundamental equations of electromagnetism, independent
of metrical geometry, Proc. Cambridge Phil. Soc. 1934,30: 421.

Van der Helm P. Symmetry perception. In: The Oxford Handbook of Perceptual Organization. Wagenas J. Oxford University Press, Oxford,2015.

Varela F. A calculus for self-reference. Int Jour of Gen Sys, 1975, 2(1):5–24. In Oxford Handbook of Perceptual Organization, Wagemans J (ed.);Oxford Univ.Press,2015.

Varela F. Principles of Biological Autonomy. Elsevier/North-Holland: New York, 1979.

Vargas J. Differential Geometry for Physicists and Mathematicians: Moving Frames and Differential Forms: From Euclid Past Riemann. World Scientific, Singapore, 2014).

Volodyaev I and Beloussov L. Revisiting the mitogenetic effect of ultra-weak photon emission. Frontiers in Physiology, 2015 ; 6, Article 241. doi: 10.3389/fphys.2015.0024

von Bertalanffy L. General System Theory: Foundations, Development, Applications New York: George Braziller, 1968.

von Foerster H. Understanding Understanding. Springer, 2003.

von Goldammer, E., Joachim, P., Newbury, J., 2003. Heterarchy e Hierarchy: Two Complementary Categories of Description. http://www.vordenker.de/heterarchy/a_heterarchy-e.pdf. Accessed on 09.09.2015.

von Uexküll J and von Uexküll M. A Foray Into the Worlds of Animals and Humans: With a Theory of Meaning. Minnesota University Oress, Minneapolis, 2013.

Vrobel S. Fractal Time: Why a Watched Kettle Never Boils. World Scientific, Singapore, 2011.

Wagemans J. Historical and conceptual background: Gestalt theory. In Oxford Handbook of Perceptual Organization, Wagemans J (ed.);Oxford Univ.Press,2015.

Wang J. Geometric Structure of High-Dimensional Data and Dimensionality Reduction. Higher Education Press, Beijing, and Springer, Berlin, 2012.

Werner C and Whitsel BL. Topology of the body representation in the somatosensory area 1 of primates,I. Neurophysiol 1968; 31:856-869.

Werner G. The topology of the body representation in the somatic afferent pathway. In: The Neurosciences, Second Study Program. Schmitt FO, Quarton CC, Melnechuk T, Adelman G; editors, Rockefeller University Press: New York, NY, 1970, pp 605-617

Weiss H and Weiss V. The golden mean as clock cycle of brain waves. Chaos, Solitons and Fractals 2003; 18, 643-652.

Westerhoff J. Nāgārjuna's Madhyamaka: A Philosophical Introduction. Oxford Univ. Press,2009.

Wheeler JA. Geometrodynamics. Academic Press, New York, 1962.

White J. Incorporating Heterarchy into Theory on Socio-political Development: The Case from Southeast Asia. Archeological Papers of the American Anthropological Association 1995;6: 101–123.

Wikipedia.Renormalization.https://en.wikipedia.org /wiki/Renormalization, 11 July 2016.

Wilce A. Quantum Logic and Probability Theory. Stanford Encyclopedia of Philosophy, 2012. http://plato.stanford.edu/entries/qt-quantlog/

Wilson R. Boundaries of the Mind, The Individual in the Fragile Sciences: Cognition. Cambridge University Press, Cambridge, 2004.

Wright J, Bourke P and Favorov O. Möbius-strip-like columnar functional connections are revealed in somato-sensory receptive field centroids. Frontiers in Neuroanatomy. October 2014; 8 ;Article 119 . Doi: 10.3389/fnana.2014.00119.

Wu J. Hierarchy Theory: An Overview. In: Linking Ecology and Ethics for a Changing World: Values, Philosophy, and Action.Rozzi et al (eds.), Springer, 2013.

Wu Y and Lin Y. Beyond Structural Quantitative Analysis: Blow-ups, Spinning Currents and Modern Science. World Scientific, Singapore, 2002

Wynn M, Consul N, Merajver S and Schnell S. Logic-based models in systems biology: a predictive and parameter-free network analysis method. Integr Biol (Camb). 2012 November ; 4(11): . doi:10.1039/c2ib20193c.

Young A. The Geometry of Meaning. Robert Briggs Associates (CA), 1976.

Zalamea F. Towards a Complex Variable Interpretation of Peirce's Existential Graphs. In: Ideas in Action: Proceedings of the Applying Peirce Conference. Nordic Studies in Pragmatism 1. Helsinki: Nordic Pragmatism Network; 277–287..

Zenkin A. Scientific Intuition of Genii Against Mytho-'Logic' of Cantor's Transfinite 'Paradise'. Philophia Scientiæ 2005; 9-2 | 2005. http://philosophiascientiae.revues.org/532 ; DOI : 10.4000/philosophiascientiae.532.

Zenkin A. Ten Fatal Mistakes of the Cantor's Proof of the Real Numbers Uncountability (fragment of a letter to the Editor-in-Chief, Bulletin of Symbolic Logic.; 2000. http://www.ccas.ru/alexzen/papers/10_mistakes.html; accessed April 04,2016.

Zhou W and Chen D. Binarial rivalry between the nostrils and in the cortex. Curr Biol. 2009 September 29; 19(18): 1561–1565. doi:10.1016/j.cub.2009.07.052.

Zhvirblis VE. Stars and Koltsars. In (Levich, 1996), DOI: 10.1142/9789812797292_0009.

Endnotes

1. In the 1950-60s a similar project which involved several laboratories worldwide directed by Dr Giorgio Piccardi, head of the Physical Chemistry Deparment at the University of Firenze, found the same effect, mainly working with chemical reactions, which they also attributed to a cosmological factor. Shnoll's experiments are reported to have found independent confirmation-http://noosphere.princeton.edu/shnoll2.html.

2. Pettigrew was considered the world authority in animal motion of his time. With the primitive observational methods available to his epoch, he was the first to observe that the lemniscate, ∞, presently identified as the uni-dimensional projection of the Möbius strip on a plane, appears to be a universal pattern of animal gait, either natatory, flying or land displacement (Bell Pettigrew, 1878). Current gait studies are quantitative and analytically set as coupled oscillators rather than qualitative, the latter suggesting that the surfaces of self-reference introduced here may be interpreted as a semiotical signature as we shall discuss below.

3. By trans-dual, trans-classical or still non-dual logic we shall mean a logic for which any of the three rules of the classical propositional logic due to Aristotle is not valid: 1) The Principle of Identity; it states that "each thing is the same with itself and different from another". As we shall argue in this work, science as conceived in relational terms does not abide to it; properties are contextual , rather than inherent; metamorphosis is the generic case of Nature. This surmounts the image-schema CONTAIN which categorizes in terms of an Inside/Outside divide; or 2) the Rule of the Excluded Middle, Tertium non datur, that for any proposition, either that proposition is true or its negation is true; alternatively 3) the Principle of Non-Contradiction; namely that contradictory statements cannot both be true in the same sense at the same time. Since we shall not work with propositional logic but rather with place-valued logics (Günther, 1962, 1967). We shall more generally loosely call them multi-valued or multi-state logics, or we may call them multi-valued place-logics, a notion first introduced by Günther , or still, as locations defined vis-à-vis the Klein Bottle or HyperKlein Bottles. Thus, these logics are not conceived in terms as assignments of truth-value to propositions. These logics surmount the reductive usage of logic as a mere epistemological instrument, to be discussed below. It is the qualitative nature of the latter what in principle allows to assign them different names in regards of the concepts that support them. We mention the dual ontology, or still the dual logophysics associated to Aristotelian logic or its Boolean

formalization: Aristotelian-Boolean logic. Remarkably, developments of Neutrosophic non-classical logic and its applications to mathematics have surged in the work of Smarandache and of the so-called Paradoxist movement (Smarandache, 2005). From the study of the foundations of probability theory in terms of the Boolean algebra of propositions and an attempt to surmount it, E.T.Jaynes concluded that with respect to propositional logic, classical logic is the ultimate case since "n-valued logic applied to one set of propositions is either equivalent to a two-valued logic applied to an enlarged set, or else it contains internal inconsistencies" (Jaynes, 2003). In Western philosophy, the notion that a proposition and its negation can be both true is embraced in the theory of dialetheias and related to paraconsistent logic (Priest,1995, 2002).

4. Torsion, the Primal Distinction, Self-reference and the Topological-Analytical Representation of Non-dual Logophysics. The existence of singularities associated to the curvature produced by metrics as "black holes", have been lately outruled by their initial propugnator (Hawking, 2014). Furthermore, the status of the so-called Schwarzschild singularity is far from clear in regards to its genuinity; see Abrams (1996). Indeed, "black holes" have a unique status with regards to physical reality and cognition, as the epitome of paradox and of the Newtonian paradigm of the massive point particle –but for an 'event horizon', now claimed as embodying an infinite mass. Typically, the same authors claim that they have and not have their defining property (Crothers, 2014). Remarkably the analysis of their existential status is crucially related to the Interior/Exterior duality (Abrams,1989; Hawking, 2014) and the contradictions which arise from it (Strassler, 2014). However, upon transforming real-time into imaginary-time the singularity claimed by the "Big Bang" is removed by yielding the Euclidean space metric, which is singularity free, boundaryless. However, Hawking puts it as: "Instead, the way the universe started out at the Big Bang would be determined by the state of the universe in imaginary time. Thus, the universe would be a completely self-contained system. It would not be determined by anything outside the physical universe, that we observe" (Hawking, 2016). Not a word though on the relation between such a self-contained Universe and the body of self-containment: the Klein Bottle. The "black hole" which in the current cosmological mythology of ancient vintage (Raju, 2003) plays the role of a Cosmic Self. Though it is claimed to be pervasively found at the centre of galaxies, surrounding the Milky Way's centre, a 600-light-year wide Möbius strip of supercooled material has been found (Hwang and Laming, 2012), while at the centre itself is an astronomical radio source Sagittarius A, which is called a " supermassive black hole" though strongly radiative! As described in fig.1, torsion is the fifth-side closure of an infinitesimal parallelogram forming thus a closed loop in space or spacetime, which embodies a dislocation produced by a singularity –not related to the metric- or an inhomogeneity around which the closure of the dislocated parallelogram produces a pentagon (Rapoport, 2013, 2014b). The crucial notion in a geometrical setting is that of affine connections, i.e. a rule to produce a parallel transport of an infinitesimal (tangent) vector to the space or spacetime manifold. In the case of metric geometries this rule depends on their first-order derivatives of the metric, and the parallel transport of any two such non-aligned vectors emanating from a point produce a closing parallelogram (Goenner, 2004; Hehl and Obukhov, 2003; Kobayashi and Nomizu, 1996; Schroedinger, 1950; Vargas, 2014). These affine connections derived from metrics are symmetric (Levi-Civita connection), as commutativity, and with null torsion the closure of the infinitesimal parallelogram is the case without any action taking place to do so, by default, and thus they cannot account for neither a singularity, nor for a protoform of cognition nor related to self-reference, as we shall discuss below. Whereas affine connections which are anticommutative, i.e. with non-null torsion, produce an infinitesimal parallelogram which does not close, even in flat Minkowski or Euclidean space, the torsion itself producing this opening and at the same time completing the fractured parallelogram thus producing a pentagon, discussed in fig. 1. In the setting of metric geometries there are no singularities nor inhomogeneities that can be acknowledged by closed loops around them; self-reference is purely descriptive if ever mentioned, not being ascribed an ontopoietic action; it could even be contracted to collapse to a point, so even the invocation of trivial self-reference would be redundant. However, in the case of non-null torsion this redundancy is no longer possible. This is a most basic formulation required to give a coordinate-independent formulation of the physical processes, particularly of Brownian motion, and is not restricted to spacetime. This invariance of the geometrical fields under smooth (infinitely differentiable with likewise inverse) co-ordinate transformations (which represent the observers), which is both the case of the metric and torsion, is the signature of objectivity in the dual logophysics, and in the non-dual as well. As a particular important case, this non-trivial self-referential closure is also the case of the configuration space of non-linear non-equilibrium thermodynamical systems, with non-potential torsion being rotational fields related to time-irreversibility of these processes (Rapoport, 2000). In the particular case

of the five-fold symmetry of the equal sided pentagon produced by torsion, it is further associated to the Golden Ratio (Ghyka, 1952). In relation to continuous (Lie) non-commutative symmetry groups (i.e. axb ≠bxa, for any two elements, a and b of the Lie group), we recall that torsion embodies the relational positional in-formation of their structure. However, this is widely ignored but elaborated in detail in (Schouten, 1954), albeit loaded by cumbersome formalism, and quite clearly presented in (Rosenfeld, 1997). This leads to mistake the identity of torsion as curvature in the derivation of electrodynamics from the primal distinction (Kauffman, 2004). In mathematical terms, the commutator operator, [A,B]= AxB – BxA, which in the case of Lie groups, A and B are infinitesimal symmetries, i.e. elements of the Lie algebra, or still the adjoint representation is unseparable from torsion, and accounts for the unified electromagnetic and weak interactions surmounting the standard model (Rapoport and Tilli, 1986). Yet, on the cognitive 2d-space of Matrix Logic (Stern, 2001), the general case of the infinitesimal parallelogram which does not close, is produced by the commutator of TRUE and FALSE operators, which are non-dual; the torsion is given by the difference between the two operators as mediated by the Möbius strip's or the Klein Bottle twisted non-orientability (Rapoport, 2009, 2011); see note no. 9. Matrix Logic has quantum, fuzzy and Boolean logics as particular cases, and permits a conversion between cognitive states and quantum states; the importance of cognitive closed loops and their relation to physics was amply discussed in (Stern, 2001). The null state of this logic is embodied by light rays in their twistor representation, and related to spacetime propagating torsion (Rapoport, 2009, 2010a). In distinction with Hofstadter's "strange loops", the cognitive closed loops that appear in the mathematical model in which Matrix Logic is formalized are abstract and physical at the same time, even suggested to be anatomical cortexwise (Wright, 2014); they appear in the vortical closed loops and particularly Möbius structure of electromagnetic waves (Freund, 2010; Irvine, 2010) or sound waves (Ruane et al, 2015) and are pervasive to chemistry as formulated in the topological paradigm (Mezey, 1993; Bonchev and Rouvray, 2010; Flapan, 2010). In other words, through the torsion geometry the imaginal becomes physically manifest, and this is due to the imaginal being incorporated as an ontological locus of the Klein Bottle logic. We shall see this in the generation of a dynamical structure of genomes, to later identify it in the very dynamics of genomes through transposons mobile elements, crucial to biological development. Furthermore, on considering a plane, the closed loop produced by the torsion-closure as depicted in fig. 1.I, produces an Outside and an Inside. Let us follow what later we shall call the Flatland ontology. Thus on the plane we have induced a dual logic in the context of the plane, or still a dual logophysics in terms of the Outside/Inside duality –which we further associated to the CONTAIN image-schema. It is produced by the closed loop of the torsion field, as the boundary of a system; but as we shall see this dual logophysics is but a projection of a non-dual logophysics. Hence, torsion is not merely objective, as already discussed, but also subjective, on the latter as we shall elaborate below. Thus this boundary/distinction, for the case of a two-dimensional system, may be naturally associated to the primal distinction introduced by George Spencer-Brown in his Laws of Form (Spencer-Brown, 1969). It is altogether the creation of a world, signified through the action of drawing a boundary around something, here a singularity, or an inhomogeneity, thus separated from the Outside, creating that which now becomes distinct from everything else, by tracing the boundary/distinction, or signifying the crossing from one side to the other. Up to this point, this is still the dualistic Outside/Inside image-schema produced by the distinction on a plane, and indeed Spencer-Brown derived Boolean logic from this setting yet with two states only, the Void and the Mark, instead of a singularity or inhomogeneity for the former, the Mark being the distinction (the boundary). Indeed, the boundary realized by the torsion producing the closure of the infinitesimal parallelogram on the plane, as in fig.1, embodies the primal distinction but with a twist which subverts the plane,in relation to the topological generation of the Klein Bottle; of this twist we said nothing at the start. So the Spencer-Brown construction on a plane is but the projection of a non-dual logophysics produced by the reentrance by self-penetration of the system on itself –thus producing a discontinuity that stands for the original singularity. This is produced by abandoning the plane (see fig. 2.II) through the identifications of fig. 1.II. C (for which the fifth side embodied by torsion is assimilated to the upper side, as discussed in fig.1.I), and thus returning to the plane through a Klein Bottle. Thus what is produced is a non-dual logophysics rather than the dual logophysics restricted to the plane as originally proposed by Spencer-Brown, which disposed off the cumbersome thousand pages long formulation of dual logic in Russell and Whitehead's Principia Mathematica. Furthermore, the singularity around which torsion winds around to embody it, becomes both fused as the signature of self-hood, which in Spencer-Brown's terms is: *"We see now that the first distinction, the mark, and the observers are not only interchangeable, but, in their form, identical"*. More generically, the singularity (which Spencer-Brown rendered it in dualistic terms as the Void)

the torsion closure and the observer are signified as one, a singularity which is neither exclusively subjective, semiotic nor objective, but all of them together. Hence, as a primal distinction torsion has a subjective quality. In other words, this non-dual logophysics stems first from identifying the torsion-closure with the primal distinction of Spencer-Brown.The basis for this identification cannot be simpler. It is the torsion closure of the otherwise fractured infinitesimal parallelogram which establishes the primal distinction, in the first place. Without it the open fracture would leave a gap, as revealed in fig. 1.I, which was produced by the singularity or inhomogeneity in the first place. Now it is the gap which is the so-called Unmarked (Void) state of Spencer-Brown, while the primal distinction, is the torsion closure, rectifying the broken parallelogram! These are the only two states with regards to the closed loop, up to the twist producing a Klein Bottle, which subverts the dual logophysics of Inside-Outside relative to this closed loop and actually sustains it. Indeed, according to Spencer-Brown, "distinction is perfect continence", as the single semantical rule of the Calculus of Distinctions, while the primal distinction is the drawing of a boundary so that a point on one side cannot reach the other except by crossing the boundary, in other words the Inside/Outside duality, which the Klein Bottle subverts and transcends integrating it as a projection of itself. With regards to the nilpotence of the operator that stands for the primal distinction, i.e. its two-fold iteration yielding the Unmarked or Void state, the so-called Law of Cancellation (or Annihilation), i.e. with the left hand size being the Void, it has the evident correspondence in the torsion being of the exact differential form d log. Here log is the complex logarithmic function, d the differential which verifies dd= 0 upon applying it to a smooth function or differential form. Here log is applied to a complex-valued function, f, defined on whatever domain, acting on the space of values. But then nilpotence (d log)((d log)f) = 0 is the case if and only if (df)/f is nilpotent, its self-multiplication is null, a generic eikonal equation as in geometrical optics' constraint for light rays. This condition is basic to the creation of quantum jumps and the generation of the null operator in Matrix Logic in terms of twistor fields related to torsion (Rapoport, 2009, 2010a, 2011d). This torsion is indeed a co-vector field, an exact differential form but for the zeros of the function f to which d log is applied. It is called the logarithmic differential trace-torsion, and is extremely pervasive to quantum mechanics as applied to both the linear and non-linear Dirac and Schroedinger equations, for the spinor-operator field (Rapoport, 2005b, 2008), or to the Schroedinger wave function (Rapoport, 2007a, 2007b), respectively. This fits perfectly with Spencer-Brown's introduction of the imaginary values that stand for the re-entrance of the form in itself, here the Klein Bottle, as a memory of the self-referential re-entrance process. Spencer-Brown: such an expression [referring to the equation xx = -1] is thus informed in the sense of having its own form within it, and at the same time informed in the sense of remembering what has happened to it in the past". But now, the counting is of the Klein Bottle's re-entrances, as the quantitative measure of the depth variable –the primal dimension to be discussed further- embodied in the Klein Bottle as TIME, as we shall see in the discussion following fig. 1.III. The dual logophysics pervasive to science and cognition is nothing but ignoring the self-penetrating reentrance produced by abandoning the plane to return to it through the 2-dimensional Klein Bottle. This subversion of the plane, the system and the dual logophysics, was suggested to be realized by a 2-torus rather than by the Klein Bottle in Spencer-Brown (1969) and likewise suggested by McCulloch for heterarchies (McCulloch, 1945). It was symbolized as the planar Ouroboros in the theory of autopoiesis by Varela, to produce a three-valued logic (Varela, 1979). Remarkably Varela noted that the Klein Bottle could be the re-entrant non-planar Ouroboros, but actually chose the planar Ouroboros instead, hardly anything but a symbolic re-entrance, as already McCulloch's identification of neural heterarchies showed that the plane must be abandoned for re-entrance to be realized. Actually, Charles S. Peirce was the first to introduce a relation between topology and algebraic logic, (anticipating Spencer-Brown) producing two-dimensional syntactic logics based on "existential graphs" (Burch, 1992; Peirce, 1958); this system is based on conjunction and negation. In this syntax, negation is represented by drawing a simple closed curve that encloses precisely the term to be negated, alike Spencer-Brown's formalization of Boolean algebra, for which the primal distinction is the Boolean negation. As noticed by (Burch, 1992), this led to the plane being abandoned, rather than producing Flatland ontology. Drawn on a plane, this divides Inside from Outside relative to the closed curve. But, if drawn on a surface, say around the hole of 2-torus or that of a Klein Bottle, this is no longer the case. So, when the language-game of categorizing in terms of CONTAIN as the archetypical dual Inside/Outside divide is played, it is Flatland dualism where this ontology is realized. It is Flatland dualism which Spencer-Brown abandoned by considering the subversion of the plane by re-entrance through a 2-torus. The Flatland ontology breaks the self reducing it to a mere descriptor of a world made out of this description – as noticed by Schrödinger (see §1.3), an ontopoietic agent that cannot recognize itself if not as reduced to be an epistemic agent. This is why self-reference cannot be acknowledged as an ontopoietic

principle, and thus merely reduced to epistemics. A typical stance on this regard, is the thesis that epistemology is separable from ontology. Thus, concepts in terms of which theories are posited are not amenable to investigation, because theories presuppose those concepts, since they are correspond to logically different enquiries. This unacknowledged ontology as in (Bennet and Hacker, 2003,p.2) is the epitome of fracturization with its claim that this stance surmounts dualism! (Hacker is an eminent philosopher of mind and language, critical of cognitive neuroscience, and a Wittgenstein scholar). These breakages prompted us to discuss the ontological import of the image-schema CONTAIN. With respect to Kozyrev's experiments and his theory of time as an operator related to the torsion chiral structure of the physical vacuum (Shipov, 1998), the failure of this categorical divide to account for the interactions of the world as we experience them, is that there exist no actual isolated system. Furthermore, "any real object is metastable, and has definite form and structure only as far as it continuously exchanges energy with the environment" (Zhvirblis, 1996). This certainly stands in stark contrast with the principle of identity of dual logic. As just mentioned, the Flatland ontology is quite widespread, actually it is hegemonic in the sciences. A revamp of it in terms of replacing Interiorism ("Endo-ism") for Externalism is claimed to be the way for healing the Cartesian divide, and further developing a phenomenological approach to science and in particular biology (Simeonov and Cottam, 2015; Kauffman and Garre, 2015; Rössler, 1998; Vrobel, 2012; Antspamacher and Dalenoort, 1994). Endo-ism implicitly assumes dual logic; however, a review commenting on a cosmology that coheres with this conception claims that the "universe is a self-contained and self-referential quantum automaton which organizes its own evolution without a semi-classical observer standing outside it" (Buccheri and Buccheri, 2005). No mentioning of the Klein Bottle, the surface of self-contention and self-reference, alas. The mere introduction of a symbol as the self-re-entrant Ouroboros to introduce a Calculus of Self-Reference (Varela, 1975) will not suffice to realize a surmountal of dualism but only to represent it symbolically, and as we shall see the three-state logic of Varela, Void,Mark and Ouroboros, is missing its differentiation of the local side vis-à-vis the self-penetration, producing four states. Re-entrance is embodied as self-penetration. It operates as an ontology, rather than the reductive apologetics of epistemology (Varela, 1975, 1978; Kauffman, 2002, 2005; Goetzler, 2013), which is another manifestation of the forceful reduction to the dual ontology of this language-game (Rapoport, 2014b). Returning to Peirce's topo-logics and our indication of the primal distinction as being of the form d log, it has been noted that Peirce's formalism may be related to complex analysis and Riemann surfaces, for which this identification points to a deeper connection (Zalamea, 2010).

5. The functional cycle of organisms as the feed-forward loop is related –in the setting of a dualistic logophysics- to an image-schema, CONTAIN, which is extremely pervasive to our cognitive framing. In particular, this image-schema is used to the effect of describing semiosis and the functional cycles in Nature. Thus, functional cycles are "… established between both the organism's set of internal relations and the set of existing environmental relations "external" to the organism/environment interface (e.g., its membrane, skin or other boundary condition" (Kull, 2011). Yet, already semiotics as introduced by von Uexküll introduces the notion of the Umwelt of an organism (von Uexküll, 2013), in terms of which the organism participates in the making of the environment to self-organize. This is patent in the case of microbial colonies, which produce particular conditions of their spatial environment to navigate in it more fluidly through vortical motions (Ben Jacob, 2003). CONTAIN is basic to dual logophysics (Rapoport, 2014b). One such functional cycle led Rosen to introduce the notion of (M,R)-categorical systems to account for the notion of metabolic circularity, as the key element of molecular biology, given that proteins are not given from Outside but are products of metabolism, and thus metabolites; in other words, the proteome is part of the metabolome (Cornish-Bowden, 2007); for the relation of metabolic closure and self-reference (Soto-Andrade, 2012). Thus proteomes cannot be understood in terms of the dual logophysics associated to CONTAIN. Indeed, as well known, proteins being produced by an organism continually change in response to events which are usually conceived in terms of the Exterior/Interior duality.Their forms are crucially twisted as a resultant of their integration to the environment, notably water with its tendency to assume a functional cycle of formation and disintegration of ordered domains (Pollack, 2013). The topological shape of proteins as represented by a network identifies the non-dual logophysics of the metabolic cycle as a collage of 2-tori and Klein Bottles (Penner, 2011). Another functional cycle is that of intentionality as conceived in the phenomenological neurodynamics due to W. Freeman, which stemmed from his empirical work on the olfactory system (Freeman, 2000).This led him to propose that consciousness is associated with the non-linear chaotic dynamics of mesoscopic domains of the brain acting synergetically to produce a percept as a pattern by ordering the small-scale behavior of the neural networks . These domains perform as an order-parameter entraining

neural networks at smaller scales, producing thus the 40Hz oscillation that is believed to be the physical signature of consciousness (Freeman, 2000, 2007). In this setting, the topology of connections is modelled by networks of excitatory and inhibitory populations of neurons; the dynamics is approximated by piecewise linearization of nonlinear ordinary differential equations (Freeman, 2007a). Furthermore, non-linearity is crucial to the active creative construal of percepts as closed self-organizing loops having non-periodic attractors. Synergetics develops blow-up solutions and in the present case the appearance of a discontinuity in the phase of the neural wave packet obeying the non-linear evolution is crucial to the transition to a new state and the formation of a definite pattern which is identified as a percept (Freeman, 2007b). So again we retrieve the creative role of discontinuities associated to blow-ups, in this case of synergetics (Wu and Lin,2002). More recently, a model which surmounts the indefiniteness of the cortical hypercolumn in certain areas of the brain, has proposed that at a most fundamental scale, neural networks have a multitwisted Möbius strip topology (Wright, 2014), thus substantiating the non-orientable nature of the topology envisaged by Freeman. "Intentionality is the circular process of generalization/abstraction of input and specification/concretization of output by which brains achieve understanding of their environments through the cycle of prediction, action, sensation, perception, and assimilation by learning" (Freeman, 2007a). As originally introduced by Aquinas, intentionality differs from the aboutness of modern phenomenology after Brentano, which as Freeman describes it, is but the diluted version of intentionality as purported action intimated by Aquinas. This classical notion of intentionality is related to the assimilation process initiated by acting on the world, in accordance with the American school of pragmatists (William James, Dilthey, Peirce, etc.). In Freeman's phenomenological theory of the brain's creation of experience, this cycle appeared as a substitute for the arc-reflex, the functional cycle which starts by perception –conceived as a passive intake of data to further elaborate it by hierarchical partialization, the 'butcherhouse paradigm'- to be completed by action. Yet, as understood by Turvey, a late exponent of this school, the arc-reflex is supported (as an image-schema) by the topology of the Möbius strip (Turvey, 2004), rather than the uni-directional perception→action linear sequence followed by its closure through action. In fact, as elicited by the topology of the topographic maps of the sensorium, the arc-reflex embodies a Klein Bottle rather than a Möbius strip (Werner 1970, Werner and Whitsel, 1968), a non-orientable functional cycle, indeed. Both Freeman's phenomenological theory of the neurosciences and Turvey's theory of the unity of action and perception, can be modellized mathematically in terms of Synergetics (Haken,1993), which is neither top-down nor bottom-up causation, nor ontically "emergent". It is rather the phenomenon well established in several disciplines whereby a mesoscopic domain as a collective variable or order-parameter dominates a microscopic domain producing an integration which the parts cannot produce by themselves. Thus, the mesoscopic synergetically operating domain produce a functional cycle order- parameter→parts→order-parameter→…, which Turvey, quoting Kelso (1995) refers to as "semantic relational quantities that are intrinsically meaningful to system functioning" and their dynamics as context-dependent" (Turvey, 2004). Returning to action as triggered by volition, in his cybernetic theory of subjectivity grounded in his notion of polycontextures, Günther noticed that cognition and volition rather than being the purely dual extremes of passivity and activity, they manifest as a dialectical reciprocal relation. According to Günther,the Self operates as distributed 1) in the Ego as the subjective subject, which assumes a passive stance towards which our active attention is directed, 2) the Thou or Other to which our attention may be turned towards, and still 3) the environment as a mediator: This inter-penetration of self-reference and other-(i.e. hetero-)reference is embodied by the HyperKlein Bottle. Thus, the intentional cycle is more complex than the Möbius strip embodiment of the unity of action and perception, proposed by Turvey, due to the hetero-reference towards the environment and the Self qua subject. We shall later discuss this in terms of biological evolution.

6. Closed differential forms are such that the application of d , the differential operator, upon a smooth (i.e. twice continuously differentiable) differential form is null. Exact smooth differential forms are such that they can be written as dμ, with μ a differential form (Abraham and Marsden, 1978; Hehl and Obukhov, 2002; Vargas, 2014). Since under the said regularity conditions d is a nilpotent operator, i.e. dd μ= 0 for a smooth differential form μ, then an exact differential form is closed. The converse is not generally valid: a closed form is not necessarily exact, globally, yet it is valid locally. The revolutionary status proclaimed by Rosen stems from the model wherein these differential forms expression of dynamical systems can be further understood as a relational activation/inhibition information network with different hierarchical levels, which he related to complexity; see Appendix in Rosen (1985). Yet, this identification of the dynamics of systems with information networks arises whenever these differential forms are all exact, i.e. of the form df.

Here d is the differential operator and f is a differential form that embodies the information of activation/inhibition of the network (so that f will generically depend on subindices identifying the nodes of the network). Whenever this differential form is not exact at all levels of the network, it is not possible to understand this dynamics as that of an integrated information system. Since each level of it is derived from the previous one or still the integral of the next level, in this case of non-exactness the relations between the levels of the network break down and become independent. Rosen further links these considerations to a novel approach to complexity, whereby the exact differential condition at all levels embodies a different qualitative complexity than the case of the derivative levels breaking down to isolated levels. Remarkably, the present theory evolved along more than thirty years of work starting from the modellization of classical mechanics of spinning particles as a torsion geometry, where from an exact one-form the complete description of the dynamics unfolds (Rapoport and Sternberg, 1985). What is most remarkable of this is its connection with torsion geometries as relational structures, which already is the case of quantum systems as already discussed in note no.4. Also as already mentioned, the velocity one-form of a viscous fluid is generically a non-exact torsion, whose differential produces the vorticity (as the fluid's curvature). Turbulent flows are extremely complex in the sense of foldedness, which is the qualitative sense of complexity we shall expound in this article (Rapoport 2002a, 2002b, 2003a, 2003b). A particular pervasive and fundamental differential form already alluded, the d log form, has recently reappeared at the very basis of a construal of quantum field theory which prescinds of space and time as foundational concepts, which turn out to be rather derived ones. It invokes a polygonal structure and its simplicial decomposition (so we are back to topology, see more below) which allows to actually compute scattering amplitudes; they were usually computed using Feynman integrals, which in the case of closed loops were highly intractable, while with this approach they are somewhat easily obtained (Arkani-Hamed, 2012). Furthermore, this d log form appears in the mathematical modelling of vision, for which the complex logarithm in the foveal approximation gives a good analytical representation of vision as mapped to the neurocortex, and which further identifies the Klein Bottle as the topology of the topographic mapping of the visual mode (Schwartz, 1977a, 1977b; Swindale 1996; Tanaka 1991,1997). The d log form –actually d log (z-a), with z a complex variable and a complex number is crucial to the Cauchy Integral Formula of Complex Analysis, as counting the contour winding number, i.e. the number of turns of the winding path around the singularities of the function being integrated. Furthermore, this formula allows to produce information of an analytic function on the Inside relative to that of the values Outside: Indeed, that the value of an analytic function at a point can be obtained from the values of the analytic function on a contour surrounding the point, as long as the function is defined on a neighborhood of the contour and its Inside. So actually, an in-formation integrating Outside and Inside relative to a singularity Inside is indeed the case of complex analysis for an analytic function of single complex variable. Yet, what Rosen did not elaborate is widely known in differential geometry and its calculus of differential forms which is the most basic mathematical formalism of classical mechanics and physics at large (Vargas, 2014). In this context these notions of exact and closed differential forms are related to the topology of the manifold, or still of their homological simplices. (By manifold we mean the geometrical space where the system's evolution is described, which in most cases is spacetime, yet it may well be a phase space as in classical mechanics.) The former is called the de Rham cohomology of differential forms that appears already as related to the most basic formulas of calculus, the Stokes, Green and Gauss formulae (Hehl and Obukhov, 2003; Vargas,2014). The elaboration of physics in terms of the topology of spacetime started with the Dutch school of geometrical and topological methods in mathematical physics initiated by Schouten (who also introduced in topology the notion of clopen sets, i.e. sets which are both closed and open) and his assistant van Dantzig. Their work led to developments (van Dantzig,1934; Post,1962) which later appeared as the claim by Rosen's identification of the contrast between exact and closed differential forms (related to the integration of local and global phenomena), as the basis for a 'revolution' (Rosen is called the 'Newton of biology'). This does not only play a crucial role in classical mechanics in the symplectic geometry setting (Abraham and Marsden, 1976; Rapoport and Sternberg, 1985) and 'geometric quantization' (Hall,2013), but lie at the very foundations of a topological formulation of electromagnetism (Post, 1962; Wheeler, 1963; Rañada, 1989; Hehl and Obukhov, 2003) for the non-orientable case, thermodynamics and physics at large (Kiehn, 2003, 2009), quantum physics (Post, 1962, 1971, 1995, 2003; Thouless, 1998) and its foundation in terms of torsion geometries (Rapoport 1987, 2005a, 2005b, 2007a, 2007b, 2010a, 2010b). It is crucial to the so-called Aharonov-Bohm potential, actually a torsion one-form (Rapoport,2010a), which is crucial to the coherence of biological systems (Binhi, 2002). The relation of topology with the global difference between closed and exact differential forms is topologically embodied by the

manifold of the system, through the so-called Poincaré duality theorem of the cohomology of differential forms, which is valid for both orientable and non-orientable manifolds (Ranicki, 2014; Tu, 2008). It allows to study this difference between local and global phenomena and structure in terms of homology theory. The homology theory is based on decomposing the manifold by simplices made of polytope decompositions of manifolds (i.e. polygons, polyhedrons which are constructed from lines, triangles, tetrahedrons and so forth) and what matters is their connectivity (Ranicki, 2014 Tu, 2008). They stand for the relational networks indicated by Rosen. Thus, both for the homological structure as the relational network suggested by Rosen, and the de Rham cohomology of differential forms, the Inside/Outside duality is sidelined for another image-schema which is no longer dual, in the sense of this divide. It is related to the possibility of extending local relations with global ones, which lies at the very core of Rosen's proposal. Indeed, a closed one-form can always be locally written as an exact form, but the possibility of extending this to the whole, i.e. making it global rather than local, hinges on the topology of the space, viz. number of connected components, holes and twists (the latter called the torsion subgroup). In fact, Bohm and Hiley proposed a notion of pre-space in these topological terms, which fall to oblivion (Bohm and Hiley, 1980). This approach is also crucial to pattern recognition, through the revelation of patterns of higher-dimensional data (Tenenbaum, 2000; Wang, 2012), which led to the identification of the Klein Bottle as the metaform of pattern recognition (Carlsson, 2009). So it is a qualitative issue of the integration of the global and the local, not categorizable in terms of the Inside/Outside divide. Remarkably it is this approach which leads to the classification of shapes in biological organisms (Maresin and Presnov, 1985; Jockush and Dress, 2003; Isaeva, 2014). Also, as it turned out to be the case, the current paradigm of topological chemistry (Mezey, 1993; Bonchev and Rouvray, 2010; Flapan, 2010; Sokolov, 1973), in particular as applied to proteins (Penner, 2011) as well as that of pattern recognition (Carlsson, 2008, 2009) based on these simplices and the topological invariants of the homological decomposition of topological spaces. The basic developments in physics and chemistry actually preceded Rosen's suggestion of a forthcoming 'revolution', and remarkably were unbeknownst by him. Finally, for theoretical physics it is the existence of 'period integrals' embodying very elementary formulas stemming from the Stokes formula for the integration of differential forms (Kiehn, 1977; Post,1971, 1985). Yet, despite that much was elaborated priorly to and independently of Rosen's proposal, his attempt to relate it to complexity as layered –hierarchical - connectivity has not been retaken. Remarkably, contrarily to his suggestion, they actually are not layered at all. In terms of the system's space of evolution, this is the case due to the topological nature of the issues at stake which all participate in defining the shape in an equal qualitative stand. Indeed, the Betti numbers are combined to produce a topological invariant, the Euler characteristic or number of a topological space, which for the Klein Bottle, Möbius strip and 2-torus is zero. Naturally, this project would be to relate his conception of complexity as related to the obstruction for differential forms to be globally exact, to the topological Betti numbers of the manifolds. What may indeed provide a novelty so far, is that the differential forms from which Rosen departed for his proposal for a 'revolution', is that they further depend on additional parameters (which would represent cyclical developments), and thus the topology of the correspondent activation-inhibition relational networks may undergo bifurcations and instabilities (cyclically). Particularly important among them are the synergetic variables, by which an order-parameter that integrates a dynamics at a lower scale, produces novel integrated phenomena. More recent elaborations of Rosen's relational biology have all but left to oblivion his proposal and focused on his (M,R) category theory (Louie, 2013; Simeonov and Cottam, 2015), perhaps because Rosen's followers have no background in the geometric and topological methods of mathematical-physics. The theory of anticipatory system which Rosen introduced and temptatively related to differential forms was extensively developed by Daniel Dubois, yet unrelated to them (Dubois, 1998, 2000). Alike the present logophysics, Dubois elaborates upon the notion that anticipatory systems already arise in physics, rather than being exclusively the case of biological systems as claimed by Rosen (1985).

7. Contextuality, which is necessary for semiosis, is physically operated by vortical motions as the elementary motions. The latter manifest a non-linear non-pointlike dynamics which subverts the Interior/Exterior divide, in distinction with the linear dynamics of the Newtonian paradigm (Wu and Lin, 2002, Lin, 2008, Rosen, 1985). Thus the assumed taxonomical exhaustive divide of the sciences as ethics, contextuality-less physics and semiotics, the latter having contextuality as a primal condition (Kull, 2007) appears to be exclusively valid under the assumptions of the Newtonian paradigm (Rosen, 1985). Another characterization in Kull's taxonomy for science to distinguish physics (as the world of material processes) and semiosis (as the world of sign activity) is that the former abhors non-uniqueness. Presumably physics is about a single reality of a non-contextual logophysics while in Rapoport (2013) it was

demonstrated that contextuality is rather the case of physics, while meaning as produced by semiosis, is plural. Already the topological chemistry approach to chemical structure, elicits the multiple dynamical and contextual conformational activity of molecules, whereby a certain molecule embodies a topological shape (in contrast, say, with its geometrical model) which is non-unique, rather than a single geometrical structure (Mezey, 1993; Stapien, 2007). But 'hybrid' structures of molecules were early argued in quantum chemistry, as we shall further discuss. Furthermore, just like chirality generically appears as an intertransformable pair connected through a Möbius strip, a particular choice of one of the two handedness has a chemical purport –of practical paramount importance- which we may call a meaning (Hoffmann, 1995). The same may be claimed to the case of the multishapes that the topological models of molecules elicit in their interaction of the world, as plural meanings, although they refer to material organizations. In this work we shall elaborate on the idea that this is the case of DNA, and that semiosis operates already as the plural topologies of molecules, and particularly through their transformations from an orientable to a non-orientable shape, and the converse, and most basically as the self-penetration of the Klein Bottle which embodies the contextualization of system vis-à-vis the environment. The presumed division between physics as non-semiotics and semiotics is deeper than a purely epistemological nature -an issue about description. The case is that in the fractured approach that reduces science to disconnected sciences, there is indeed an implicit assumption of a unique logic: This is the Aristotelian dual logic –as a single contexture in the sense of Günther, i.e. the domain of objective Being which we associate with the Universe and with the dualistic logophysics arising from this logic. This principle produces an effect which has to be singled out. Günther: *"…such a logical principle could not generate the ontological conditions for the existence of a thinking subject"* (Günther ,1979), to further extend it, nor for the existence of life. To cognize in this dualistic setting we recur to the usage of an image-schema, CONTAIN, which given a frontier/boundary of a system, divides the world as an exhaustive Inside/Outside categorical divide (Rapoport, 2014b). In Kull's approach, this categorical divide naturally extends to the methodology: physics is studied from Outside while semiotics is studied from Inside, respectively (Kull,2007). Yet, in the so-called Vaxjo interpretation of quantum mechanics contextuality is basic (Khrennikov, 2010). Thus, a phenomenological approach to the material world is rendered impossible in the setting of dual logophysics if not by reiterating this categorical divide or reframing it as in Kull's approach but making of physics to operate from the Inside of the experienced world as an interface as in Rössler's Endophysics (Rössler,1983). In the present theory semiosis is universal, a manifestation of multiple-valued logics as the Klein Bottle and HyperKlein Bottle surfaces and their logophysics, which they further produce a phenomenological for science as a whole (Rapoport, 2013, 2014b). As we shall see, upon studying the logophysical structure and dynamical processes of genomes, biosemiotics "as the study of living systems that interprets these as sign systems, or communicative structures, and involves the description and analysis of various organic codes (e.g., epigenetic, genetic, behavioural codes, including intracellular, intercellular, and interorganismic codes)" (Kull, 2011) shares in its genomic basis the same non-dual logophysics of material systems. This stands in distinction of the contextuality-free linear dynamics based on the unreal point particle of the Newtonian paradigm as embodied by the law of action and reaction, actually an hypothesis. Or still in Newtonian gravitation as an inverse square of distance between two bodies interaction of an unidentified origin, superseded by a rotational motion in Yi Lin's theory of the blow-up of non-linear systems in which time is unseparable of the non-linear material organizations as vortical structures (Wu and Lin, 2002; Lin, 1998, 2008), as we already elaborated upon discussing the TIME operator. But contextuality is the very case of multi-valued logics such as the trans-classical logics (for which the principle of the excluded middle is no longer the case) investigated by Gotthard Günther (1962, 1965, 1967), and the Klein and HyperKlein logics introduced in this article (Rapoport 2014a, 2014b). Yet, as Günther came to learn from his last encounter with McCulloch, who made of Gunther's ideas on trans-classical logics his own –and also shared with Heinz von Foerster, this extends to an hermeneutics of number according to the cardinality of the finite system to which they belong, as he wrote in his eulogy for McCulloch (Günther,1971, 1975). In other words, there is a quality to number which depends on the quantity of numbers of the system to which it belongs; this may be of relevance to genomes and the checksum process associated to transposons and harmonics, presented in this article. In short, for Günther Number is ontologically prior to Idea, and still "…not the Finite is embedded in the Infinite but that the Infinite - be it conceived as potential or actual - is, in the metaphysical sense, only a subordinated element of Finitude".This is quite natural when considered in terms of the Klein Bottle self-return but rather than subordination of infinity to finitude they appear to enact a non-dual complementarity in which infinity enables finitude to self-organize, coherently with Günther's intuition. Indeed, as narrated by Günther, this

discussion with McCulloch led him to introduce the notion of polycontextures with their formalization as heterarchies having a finite number of non-dual negation operators. Following Spencer-Brown's formalization of Boolean logic through the Laws of Form in which the primal distinction that defines a system through its boundary which is subverted to yield the Klein Bottle self-penetration of the system, we can think of these plural non-dual negation operators as defining a HyperKlein Bottle.

8. Later on the 1950s, the seminal work of Hubel and Wiesel would also face the existence of thresholds for the excitatory/inhibition phenomena of neurons in the visual cortex. That the actual phenomenology is grounded on a non-dual logic, but unacknowledged as such, was put in the following terms: " [it is] as if you were telling the cell to fire faster and slower at the same time'', i.e. a superposition of inhibition and activation (Hubel,1988).The relation of these superpositions to the Klein Bottle was established in (Tanaka, 1997). This disconsideration of thresholds is also the basis for Stuart Kauffman's theory of the emergence of order by considering autocatalytic networks operating through Boolean logic. The rationale for such reductions is "[T]he point in using idealizations in science is that they help capture the main issues" (Kauffman, 1995). What 'main' is, is already decided through instauring the hegemonics of Boolean logic as noted in (Primas,1981); see discussion at the end of §2.2. This is done by defining a context as operating in terms of a Boolean logophysics by the shear obliteration of the irregularities which do not make the phenomena amenable to the dualistic ontology (Lin and OuYang, 2010). Thus the obliteration of the non-dual logophysics of distinction is enforced (Günther,1962; Rapoport, 2014b), which is nothing else but a reductive ontology promoted to universality, as observed in Primas (1981), whose purport is widely ignored when not dismissed.

9. Contextures were introduced by Günther, to the effect of indicating a distinction in terms of the application of Tertium non Datur (TDN). Whereas TDN is usually applied in a distinguishable context in terms of which the positive value of a proposition can be identified, there exists instances of contexts for which the positive value cannot be established though the context might be identifiable, though partially for that matter; these are the contextures as introduced by Günther. Say, 'a sin is rhomboid or not' invokes a geometrical category as a context and an unidentifiable context which surges from its denial, opening to the whole Universe, both objective and subjective. While this may appear as abstruse, these kind of utterances are very much the cognitive core of synaesthesia , a neurological phenomenon in which stimulation of one sensory or cognitive pathway leads to automatic, involuntary experiences in a second sensory or cognitive pathway. This kind of co-ordination is the case of heterarchies, as first noted by McCulloch, and though we may not acknowledge them as such they are basic to our cognition (Cytowic and Eagleman,2009) (We recall that both the visual and somatosensory modes both share the Klein Bottle topology of their topographic cortical maps). Another example, 'a sin is permissible or not'. While it suggests social normativeness as the context for its assessment, and thus allows for the application of TND, these normatives do not constitute by themselves a closed context, would such a structure exist at all if not an idealization, or as the single contexture of the positivistic sciences. So both of the previous utterances are in principle indeterminate, nor true nor false, until further contextures are explicated. The present elaboration in which a contexture is indicated as the universal context for which there is not even the possibility of validation for TND until further distinctions are considered and even then superposition states may be the case, i.e. the HyperKlein Bottle, stands in stark contrast with Günther's conception. In Günther's take, contextures stand for the generic consideration of contexts to account for the fusion of objectivity and subjectivity, where the single contexture of the positive world of objects is the universal contexture of TND. To support the notion of the monocontexture as the domain of validity of TND, and as a subjective counterpart of this all-encompassing objectivity, he claimed that "…psychic space in which thought processes evolve constitutes a closed contexturality, and is, as such, strictly two-valued (Günther,1979). In doing this Günther actually enforced the Cartesian divide. However, psychoanalyst Jacques Lacan, already made the case, though in a quite deliberate abstruse way, that non-orientable surfaces embody psychic space (Fink, 2004), while the case was made that these surfaces are embodiments of the surmount of the Cartesian divide (Rapoport, 2009, 2011a, 2011d, 2013, 2014; Stern, 2001). Contexts are otherwise construed as domains of validity of TND, by the expedience of omitting from consideration all irregularities or incertitudes (Primas,1981), which is precisely what Günther wanted to account for. So, as an intermediation of both the objective and subjective universal mono-contextures in which TND is valid, Günther constructed the logic of pluricontextures in terms of positional-valued logics with several nonreflexive negation operators. This latter choice is the one we uphold for the HyperKlein Bottle logics as heterarchies. In this regard we disagree with the notion that the breakage of transitivity has for necessary condition the plurality of contexts, which in the present ontology is only a sufficient condition for non-

transitivity. The former take (Günther, 1973; von Goldammer, 2003) leads to enforce duality as the logic of a single context, even and particularly so would that single context be the Universe or Multiverse, for that matter (Gonzalez-Diaz and Alonso-Serrano), which the Klein Bottle logic already surmounts. Indeed, as Hawking would acknowledge, given a Universe with no total boundary, it is necessarily self-contained (Hawking, 2014), just like the Klein Bottle, and global-scale-say galaxies- material distributions show a nearly flat two-dimensional distribution. In the present ontology, and differing with Günther, only closed contextures operate through dual logic; but they are a mere idealization. Social normatives are interwoven with other phenomena which partake in the buildup of the context. In ancient societies, this was the case of cyclical natural phenomenae decurring from the precession of the equinoxes, such as the arrival of spring. In this day social hierarchies were allowed to be subverted and crimes committed by outsiders and outcasts, the impersonators of Otherness who became the rulers for a day. However, they were summarily executed on a cross –representing the two solstices and two equinoxes on the Zodiac- following the end of the festivity (Duerr, 1985). Thus it was made the point that neither dualism nor hierarchies was the case as normatives were interwoven with their cosmologies and social organization. Exceptions rather than defying the social contract, showed its validity in all circumstances either 'regular' or 'special' –the latter being no less regular than the usual ones. These circumstances though liminal, but for a day of cosmic and earthly union, were socially established, rather than being accidental disruptions of the social contract but their assertion in terms of a 'higher' grounding. It is also the case of war for its most horrendous expressions that far exceed a confrontation through arms.

10. This multiplicity of interpretations is the signature of semiosis as embodied by the HyperKlein Bottles which self-penetrate as well as inter-penetrate (or better spelled, other-penetrate; hetero is the Greek for 'other'). In doing so, they embody hierarchy albeit locally, self-reference and other-reference (see figs.3.II) Thus, Kaehr and von Goldammer proceed to describe how heterarchies are modelled by multi-valued (or better stated by Günther, multi-"placed-valued") logics with multiple negation operators (Günther,1962, 1965, 1967, 1971, 1979, 1980). As further stated in (Kaehr and von Goldammer, 1988) cybernetics, computer science, decision theory, artificial intelligence have been and continue to be dominated by the classical logic that already McCulloch, Günther and von Foerster considered to be inadequate to model thinking nor the operations of the brain, and more fundamentally unable to provide the ontology for cybernetics. This is even the case although for its consideration of fuzzy logic, though the latest knack is probabilistic and Bayesian methods, or still the nanotech design of adaptive networks to bypass Boolean Logic (Snyder, 2013), to which we can add System Biology (Wynn, 2012). For a more extensive presentation of Boolean logic, its limitations vis-à-vis self-reference, in computer science and artificial intelligence while keeping it as the basic logic see (Goertzel, 2013) who refrains of ever mentioning the reentrance of the primal form on itself nor multivalued logics but as a quick gloss. In fact, analog-like computation has returned to the fore by merely retaking the original digital neural networks associated to the modelling of Boolean logic (McCulloch and Pitts, 1943) and extending them to continuous weights, as a purely formal step. Yet while this supersedes Turing computation, and produces the attractors of the so-called chaotic systems, it stays short of mimicking natural phenomena. The bottomline is that finite precission sets in, alike in digital computers, only producing a hierarchy of neural networks (Siegelmann, 1999); heterarchies as in McCulloch (1945) are not an option already from the outset. Von Foerster introduced a calculus of recursive functionals for neural nets as finite automata, which the human genome's harmonics appears to be generated as such Perez (2009, 2010, 2013), to the effect of modellizing learning and memory, yet on keeping with dual logic (von Foerster, 2003). With respect to biological computation, he noticed that these automata are the case in which "… function and structure go hand in hand, and one should not overlook that perhaps the lion's share of computing has been already achieved when the system's topology is established (Werner, 1969). In organisms this is, of course, done mainly by genetic computations." (von Foerster, 2003). Indeed, according to Werner (Werner and Whitsel, 1968; Werner, 1970) the topology of the somatosensory system has been identified as the Klein Bottle, as is the case –as well- of the visual mode (Schwartz, 1977a, 1977b, Swindale 1996; Tanaka 1991, 1997). With respect to genomic computations, in this article we shall see it conforms with a finite automata which represents a genomic dynamical computation in accordance with a Klein Bottle logophysics, and its Hyper Klein Bottle version.

11. TIME already appears as a term in the COGNITION (or LOGICAL MOMENTUM) operator, M, given by the commutator of the non-dual TRUE and FALSE operators in Matrix Logic.Thus M = [TRUE, FALSE] = TRUE x FALSE – FALSE x TRUE= +1.TRUE +(-1) FALSE, embodying in its +1 and -1 the non-orientability of the Klein Bottle or the Möbius strip (Stern, 2001; Rapoport, 2011a); here x indicates matrix multiplication,

which we recall, is non-commutative.Thus, M is not the null matrix, as is the case of Boolean logic which is scalar-valued (say, 0 is false, 1 is true). Alike quantum mechanics to which for two-spin quantum systems is interchangeable with the cognitive states of Matrix Logic, both have for fundamental property the non-commutativity of the operators which arises from that of the matrix product. In Matrix Logic this becomes the point of departure for the whole theory by revealing the non-orientable embodiment of this logic –and of quantum mechanics with which cognitive statements and quantum statements are indistinguishable (Stern, 2001; Rapoport, 2011a). In terms of torsion in the cognitive plane, it is embodied in the representation of the non-orientability of above which can further be represented as superposition states. Now let us examine rotations, of which TIME can be alternatively represented as the 90º rotation on the cognitive plane (Stern, 2001; Rapoport, 2011a), or still the transformation of the positive real axis to the positive imaginary axis as represented in the Riemann sphere, where the former axis at reaching infinity, i.e. the North Pole, a 180º twist changing the orientation occurs, to connect with the positive imaginary axis pointing to the origin, as described in note no. 4 (Rapoport,2013). Indeed, M = TIME +SPIN, with SPIN given by the Pauli matrix of rotation in the normal direction z to the cognitive plane. Thus, M is a logophysical vortex given by the sum of two such vortices producing thus the non-transitivity of neural networks and their abandonment of the 2d-plane, as claimed by McCulloch. As a logophysical operator it generates the 'circular' causality which is pervasive to Nature. Operator TIME introduces timing as related to intentionality in the sense of Aquinas (Rapoport,2011d) into neural networks. Yet, the original model of Pitts and McCulloch in terms of dual logic, requires a global synchronization which is not the case (Legéndy, 2009). Rather than a global synchronization a dynamic task-oriented synchronization appears to be the case (Legéndy, 2009). A HyperKlein Bottle(s) logophysics appears to naturally support this, since heterarchy and partial hierarchy is their case. Kaehr and von Goldammer: "…within any domain the hierarchical principle holds and the multitude of domains are combined by the principle of heterarchy, systems structured in this way allow an interplay of coordination (heterarchy) and sub ordination (hierarchy). It is the distribution of qualitatively different domains which has no equivalent in classical logic where a single basic domain is classified in types, categories, worlds, etc. This is the fundamental difference between McCulloch´s conception of heterarchy and that of the so-called ´radical constructivism'. Under these conditions it is no longer possible to submit a nervous net (in the sense of McCulloch) to one and only one super-ordinated logical aspect or concept. That means that modeling and formalization of heterarchical structures, which have to be considered as system-wholes or complex systems, require a multiplicity of simultaneous points of view" (Kaehr and von Goldammer, 1988), or in other words, multi-contextuality is the case. Certainly the Flatland-Boolean-logic does not embody this, while the HyperKlein Bottle(s) does afford it. In particular, in this ontology, M, TIME and SPIN are indistinctly quantum and cognitive operators, which in relation with TIME is a far cry from the Objectivist time parameter of physics, either in Newtonian physics or in Einstein's Relativity. TIME can be interpreted in several ways. On the one hand as the logophysical operator of distinction between cognitive (alternatively quantum) states (Stern, 2001; Rapoport, 2011a) –a distinction creating operator, as in Bateson's sense (Johansen, 1991). In the other hand, as discussed already in fig. 2.I upon introducing the non-orientable topology of the complex plane as it changes at the North Pole/infinity, TIME operates as a metamorphical operator. It converts the positive real axis to the positive imaginary axis, and the negative imaginary axis to the negative real axis. This allows for the reentrance of the blown-up system on itself through a transition that enables a cycle of recreation of the system, and particularly, in the case of thermodynamical systems to reenter through negative entropy values following the divergence of the entropy of the non-linear evolution. As the prototypical 90º rotation which in complex numbers theory is embodied by the square root of -1, which is a key operator to quantum mechanics it also plays the role of a metamorphical operator since it transforms a massless electromagnetic field to a massive fermionic field equation. This also requires one such rotation at its very basis. Indeed, in terms of Clifford algebras, several square roots of - 1 may be the case (Rodrigues and Capelas de Oliveira, 2007). One such square root of -1, identified as the spin-plane generator, appears in both the Maxwell equations for electromagnetism and the Dirac equation –both linear and non-linear- for the electron's (Dirac-Hestenes) spinor-operator field (Rapoport, 1998, 2005b; Rodrigues and Capelas de Oliveira, 2007). This allows for an equivalence of both equations, operating a remarkable metamorphosis based upon the 90º rotation of the spin-plane generator.In other words, upon the 90º rotation of the spin-plane generator, both equations inter-transform. Under this transformation, the Interior/Exterior dual divide is surmounted, since the usually deemed Exterior electromagnetic field of Maxwell's equations becomes identified with the Interior components of the electromagnetic field of the torsion produced by the spinor-operator field, but this operates under a proviso which restricts

these components to be purely two-dimensional defined on the spin-plane, rather than being defined in four-dimensional spacetime. Furthermore,the former equation is massless, the latter is massive (Rapoport, 1998, 2005b) thus the 'metamorphosis'; more about this in note no.34 in Part III. Thus, TIME is not reducible to the parametrization of location as a container of events, as in physics in a dualistic ontology, but the phenomenological timing operation, further related to control and self-control in terms of the Planck constant of quanta (Rapoport, 2011d, Young, 1976), and to the elementary torsion dislocation of space-time (Ross,1989). Inasmuch TIME operates a metamorphical relation between quantum physics and electromagnetism, and as biological cycles of transformations. The latter appear in the cyclic transformations of genomic matrices (Petoukhov, 2015; Petoukhov and He, 2012) as construed from the Klein Bottle logic in the present article. Thus, TIME is a processual time, as is already acknowledged to be the case of biological time, and as the fundamental rotation of 90º in cognitive space, it stands for the fundamental physical two-dimensional rotation of a plane and also that of the cycle of learning in which intention is crucial, as first intimated by Arthur Young (Young, 1976). As a quantum operator it is related to the long-sought time operator in quantum mechanics, constructed by Hilgevoord (2005). TIME is related to duration in the context of the cyclical processes of senescence and rebirth of non-linear processes; there is no possibility of intimation of duration if not in the context of these cyclical processes. They are supported by TIME accompanying its self-reentrant Klein Bottle metaform incorporated into the COGNITION operator M already introduced; for a similar stance of the unseparability of time and vortical organization of non-linear processes, following the Daoist doctrine see (Wu and Lin, 2002; Lin, 1998, 2008). We recall that Musès conceived time as a self-reentrant spiral (Musès,1985), and that the Soviet astrophysicist A. N. Kozyrev, conceived time as a density having an associated chiral field, a torsion field (Shipov, 1998), manifesting through thermodynamically irreversible processes (Lavrentiev, 1991; Lavrentiev and Eganova,1999), which is very much the case of the underlying twists of the compactified complex number system at infinity already discussed. So the experience of TIME is framed in terms of these non-linear processes. Particularly what is conceived as a hierarchical layering of the experience of time as fractal Matrushkas cybernetics (Vrobel, 2012), due to the heterarchical nature of this experience which even embodies cultural aspects, emotions, memory, etc. is the case of Hyper Klein Bottles. The relation of timing to the self-referential cycle of action and cognition, and to intent –which is related to Hoffmeyer's 'interest', and to Freeman's phenomenological account of the neurosciences departing from Aquinas's notion of intent (Freeman, 2000) was discussed in (Rapoport, 2011d). Timing, as a waiting-for intentionality, a process of withholding for maduration to eventuate, was known to the Ismaili tradition studied by Corbin (Musès, 1985), of which a non-dual theodicy which recently was related to self-reference (Rapoport, 2011d) sprung thousands of years ago. In numerical systems, such as the hypernumbers introduced by Musès, the rules of multiplication as an ordering introduce already timing and crucially in relation to their non-commutativity, which Musès claimed to be the signature of consciousness (Musès, 1977). S. Rosen with deep insight associated the Klein Bottle with a hypernumber ε, which is a non-trivial square-root of +1, i.e. $\varepsilon \neq \mp 1$, though $\varepsilon\varepsilon = +1$ (Rosen, 2008). M is indeed an hypernumber (Rapoport, 2011a), which is nilpotent, i.e. its square multiplication yields the null matrix. However, the unnormalized Hadamard matrix representation of the Klein Bottle is a hypernumber equal to the sum of two different ε's, whose square is +2 rather than +1 (Rapoport, 2011a), which normalization corrects. This null matrix corresponding to the null operator in this logic can be realized by light rays in a twistor representation (Rapoport, 2009, 2011d).

12. An example of this transparency –which in Metzinger's terms is actually an impediment to meta-experience (a cognitive 'blackspot') of the association of a system of logic and an ontology, is the project of mathematization of biology and particularly of biological computation known as Biomathics (Simeonov and Cottam, 2015). This coherentwise loose assemblage of suggestions for potential research, with no identified ontological background for its development as if eclecticism would provide for them, glosses on the potential applicability to biology of several logics, such as second-order logics or still, the "logic of ambiguity". In doing so, these authors further gloss on the need of the mathematical and logical formalization of biology in terms of non-classical logics and mention the poly-contextures (Simeonov and Cottam, 2015), quoting the heterarchies introduced in (Mc Culloch, 1945) without elaborating in their significance. To these authors, following the usual approach based on dualism, logic is descriptive; they suggest the usage of non-classical logics to keep track for the relations of multiple contexts, an issue ontologically grounded on heterarchies (the HyperKlein Bottles) and elaborated by Günther's multiple negational logics. Thus, this ascription of logic to mere description is related to epistemology, a theory of knowledge, rather than of knowing, nor a generative and constitutive ontological operator,

an ontopoiesis (Rapoport, 2014b). In this take, they follow the dualistic stance. It is stated thus: *"…no fact is logically necessary; in other words, all facts are contingent. This is because logic is ontologically neutral; that is, neither logical nor mathematical laws have any bearing on matters of fact. Logical (and mathematical) laws are constructs, not objective patterns of being and becoming"* (Mahner and Bunge, 1997); notably, the second author is a panegyrist of Objectivism, as paradoxical it may seem, but actually shows the degree of coherence it may achieve. In other words, logic is purely descriptive, not an element of reality, whatever the latter may proceed from. The same detachment of logic as ontology generating the reified world jointly with the full fledged subjectivity and the imaginal domain, is the thesis of psychologism. Remarkably it coincides with the prior notion maintained by Objectivism. It was Günther that upon examining the dual logic ontology, noted that subjectivity was banquished by projecting it into the world of objects, thus being conflated with it and simultaneously absent (Günther, 1962); we recall that Schroedinger's understanding on this regard coincided with his, as discussed in §1.3 . Goertzel: *"Logic is not a corollary of other psychological functions, it is a special psychological function of relatively recent invention, one with its own strengths, weaknesses and peculiarities. But it has neither meaning or utility outside [my emphasis] of the context of the mind which maintains it and which it helps to maintain"* (Goetzler, 2013). Again, we retrieve the Interior/Exterior dual image-schema and logic pushed to the status of detachment of reality. The ontology presented in this article, proves these last statements wrong, as well as that of the "neutrality" of logic. Of course, the notion of positional-valued logics incorporated into the rules of combination of multiple negation operators as introduced by Günther, or still as embodied by the Klein and HyperKlein Bottles are quite independent of the notion of law. But as metaforms of semiosis and logophysics they are naturally compelling, though the last term is somewhat a forceful extension of the usage of "law" (see the protoform of Newton's Third Law in fig. no.4.II), although not as an Exterior agency. A discussion of the dual logophysics associated to classical logic with examples is given in Rapoport (2014b). Remarkably, Goertzel's call for surmounting Boolean logic is his "dual networks": *"a collection of processes which are arranged simultaneously in an hierarchical network and an heterarchical network"*, for which distributivity operates together with feedback control of first-order cybernetics. This is Goertzel's intended transformation of the non-dual HyperKlein Bottle to a "dual network". Actually we have identified a sense of reality as a dualistic subversion of a HyperKlein Bottle, however it does not operate as a first-order cybernetics though we recognize it as if dual. Goertzel instead proposes the notion of "emergent patterns", of which he singularizes the Exterior/Interior divide as: *"They [i.e. Interior & Exterior] are impressively, incredibly dialogical -- the amount of new pattern which they create is far beyond our conscious comprehension"*. We cannot agree more, they create a metapattern of fracturization, for that matter, and pervasive as it is, startling cognitively poor (Rapoport, 2014b). However, it is further identified as Rationality while still making a call for the consideration of the imaginal domain (Durand, 1994), which has been discussed in quantum mechanics by Primas (1981) and in the unique work by August Stern (2001), alas largely disconsidered. But rather than remarking the beyondness of this metapattern vis-à-vis consciousness, the case is of transparency, i.e. of a metacognitive impediment which makes it unacknowledgeable to our cognition, as discussed above. Thus Günther's notion of a formalization of a system of logic as equivalent to posing a world all by itself is not considered by Biomathics, nor by Goertzel's Chaotic Logic. Upon stating that *"life is hierarchically structured with complementary heterarchical inclusions"* (Simeonov and Cottam, 2015) is presented a confusion of the interpenetrating polycontextures of heterarchies with the (nested-Matrushka-life) Boolean inclusions corresponding to the dual image-schema CONTAIN, instead of the hetero-penetration of the HyperKlein Bottle as introduced in Rapoport (2014b). The works of von Foerster, Günther, Rapoport and Stern, are all but ignored, despite the leader of this project having been informed about them as off 2010 by this author. This is further evidenced, with respect to Günther, by their quotation of von Goldammer et al. (2003) and his website, where Günther's articles can be found. This also is the case of a phenomenological account of the foundations of string theories in terms of the Klein Bottle which stops short of identifying the Klein Bottle as a logic (Rosen, 2015). Varela extended Spencer-Brown's calculus of indications based on two states, for which he introduced a third state; he symbolized it by the planar Ouroboros to represent the self-reentrance of the system on itself, following the lead of Günther.In this work on the Calculus of Self-reference as Varela called it (Varela, 1975, 1980), acknowledged (Günther, 1962) but then remarkably Varela both dismisses his mentor's work in terms of being too difficult to comprehend (Varela, 1979). Not without a reason, since the operational closure assumption which is the core of autopoietic theory is nothing but the reduction of the Klein Bottle Logic by erasing the (both planar and non-planar) Ouroboric self-reentrance upon imposing this closure. Thus autopoiesis is framed in terms of CONTAIN. Von

Foerster himself, who was interested in Günther's work to the point of inviting him to work at the Biology Computer Lab, Univ. of Illinois, collaborated with him (Günther and von Foerster, 1967); this lab also hosted Varela and Maturana. Von Foerster further acknowledged the importance of Günther's work on his own (von Foerster, 2003) but merely glosses with a few words about its import (p.136; ibid.) while not mentioning their collaboration (Günther and von Foerster, 1967). On the other hand Günther states the major influence of von Foerster's ideas on his own work on multinegational logics (Gunther,1962), as well of McCulloch's (1945); there was a clear asymmetry of intent among this two pioneers about remarking the status of non-dual logics. For Varela and von Foerster, it is a merely descriptive issue, an epistemological tool as in Kauffman (2002, 2005), with no ontological entity. These omissions of referencing towards making the case for the relevance of non-classical logics, to the point of disinformation, indicates the impossibility–both at a social and individual levels- to stand out for Günther's contention that ontology and logic are entwined. It also points out to the sociological implications of the denial or ignorance of such a statement. According to Goertzel, the Inside /Outside categorical divide, operates as "an internal conspiratorial belief system", meaning by this a transparent self-referential reinforcement of it by the cognizing agent (Goertzel, 2013). Certainly, the effect of this is making transparent the implicit choice of dual ontology as a reality all by itself. In his dual network setting, Goetzler offers an explanation: *"…consciousness… has to do with the iterative strengthening of barriers or boundaries"* since as in Metzinger's account for which the self is a model, the self is a belief system, and so is reality, for which CONTAIN would be the justified but not the ultimate belief system. Upon experiencing altered or enhanced states of consciousness, some boundaries indeed break down and the principles of identity and non-contradiction are experienced as a mistake (Duerr, 1985; Shanon, 2003). For further studies on cognition and this image-schema see (Wilson, 2004). Another proposal to keep the Inside/Outside categorical division as the fundamental image-schema which is inexorably associated to dual logic is the theory of endophysics (Rössler, 1998) endo is the Greek prefix for Inside. Recently it has been extended to 'endobiology' as a proposal for a phenomenology of biology (Kauffman and Garre, 2015). However, as already argued, phenomenology cannot be grounded in the dual ontology of this image-schema, as the functional Klein Bottle cycle of action/perception proves to be the case. Yet, in the work on the phenomenology of the time perception (Vrobel, 2011), which we recall is entwined with depth, Vrobel introduces the Klein Bottle to immediately settle down with the dualistic CONTAIN image-schema- yet as iterated nestings-, following Rössler's endophysics. But the extended non-linear Now which is crucial to bind us together with the world as the Other who penetrates us as much as we penetrate it, has the metaform of the HyperKlein Bottle, as we have argued along this article. It is an heterarchy, not primally hierarchical as suggested by Vrobel. For a remarkable introduction of a deconstruction of linear time towards a non-linear Now associated to non-dual ontology see Ruhnau (1997). If time appears as if stratified, this stratification exists throughout this metaform, not cancelling it away. Depth, as the primal dimension entwined with time is embodied by the Klein Bottle (Rosen, 2006, 2008, 2015). Yet this is still superseded by the HyperKlein Bottle which incorporates the Thou and the I, as already discussed; and it is the extensions of the I to incorporate the Thou which already are claimed to be a case of stratified time perception (Vrobel, 2011). However, the reduction of the HyperKlein Bottle to the Klein Bottle is a form of self-referential solipsism, which easily collapses to narcissism. As we expressed it already, it appears that dual logic imperates transparently, or almost so, and that the very experience of intimation of the possibility of its surmountal produces cognitive blockages and intense denial, when not censorship or/and self-censorship. In the powerful and thought provoking essay and novel The Moon of Hoa Binh, by William Pensinger and Cong Huyen Ton Nu Nha Trang, it is claimed that World War II was an ontological confrontation related to the rejection of the notion of multiple identity and the surmountal of Tertium non Datur as the fundamental issues being disputed with regards to classical logic (Pensinger and Nha Trang, 1994). Constrasting with this hegemonics of dual logic, hundreds of years ago in India trans-classical logics were introduced by Nagarjuna and others and are expressed in some of the languages of this polycontextural civilization (Raju, 2003). Remarkably, after examining the impediments of Western culture to consider non-dual logic –but see (Priest,1995,2002), Raju claims that the choice of a particular logic, meaning by this dual or non-dual, is a cultural trait. In fact, centuries prior to the so-called Enlightenment of Voltaire –rebutted by Leibniz in his theodicy of Evil (which can be related to self-reference (Rapoport, 2011d)), with the conquest of the New Continent later extended to the others, the Western world put into practice what in Günther (1962, 1967) would be deemed as the natural outcome of the dual ontology based upon the perfect duality of its negation: its reduction to a single state logic, the positive state by which time and subjectivity are banquished by being projected to the material world dominated by a single true state. (Thus, Mahner & Bunge's thesis

on the nature of logic is consistent with this projection). The newcomers –as reported by Fray Bartolomé de las Casas- reduced the new world of Otherness to a mere tokenization –for plunder, and its population demoted to the condition of 'spiritless beings' superposed at times as 'agents of the Devil', for their enaction of a reality unassimilable to their own of greed. As already discussed there is an hegemonics that may come from committing a sense of reality to uniqueness. Be as it may, the still most remarkable fact is that most scientists of both West (including philosophers, for that matter) and East embrace the dual ontology alike, and quite transparently so. Thus, the hegemonics of dual logic as the ontology indicated by Günther, is still the case, yet its crisis is all to obvious, though transparency is the case, a superposition in the making of a novel sense of reality. According to Pensinger and Trang the Self identity, which already Günther argued to involve a distribution encompassing the Thou and the subject, is the cultural mark of the Orient. It is reductively operated mostly on the West through the principle of identity of dual logic, and operates most pervasively through the categorical divide embodied by the Inside/Outside image-schema, at times superposed with a perverse usage of non-dual logic. Yet, the fixation of a logic is interwoven with the primal phenomenology of a sense of reality- and thus entwined with culture-, through and with which we operate, which is also transparent (Metzinger, 2004), until some event quite literally slaps us out of obviousness. All ancient traditions, as reported by their practitioners, or ethnologists and travelers, incorporate practices to break our identification with the usual sense of reality, to give place to a novel structuration of experience. Indeed, a sense of reality is very much taken for granted and thus the claim of its transparency. It is ontologically and experientally prior to Peirce's Firstness yet interweaved with his three categories (1893); furthermore, it is considered to be a primal epistemic state (d'Aquili and Newberg, 2000). Indeed, a sense of reality is experienced as a metasensation in which (meta)cognitive elements play a crucial role, however logic as ontology is basic to it. For some individuals, and not at all uncommon among academics, experiences or intimations that may put this into question are met reactively and/or phobically, while empathy is the essence of the distribution of the Self on the subject and the Thou, as experienced in the mirror neuron phenomenology. War, for its manifold motivations, usually intends to enforce a particular sense of reality, either as a cultural, religious or economic order, as the hegemonic one, and thus it in its initial built-up manifests as character assassination of the Other, and in actual destruction all along, imposing itself as the sense of reality. A final comment on the ethics upholded by this article: we deliberatively put into practice the ethos of the empowerment to learn, not without some optimism, by indicating as far as possible -and without overextending ourselves, for keeping its length in limits- the key references for further studies and checking out the assertions presented herein, and by attempting to convey a conceptual self-sufficiency in the presentation, with the same limitations.

13. This is a far cry from the Western tradition and its critics that conflate Rationality with the dual logic (Durand, 1994), while indicating the need of consideration of the imaginal domain and non-dual logic following Corbin –of which Durand was a student, which the usage of dual logic as the single-valued positivistic ontology has banquished (Günther, 1962, 1967). The imaginal domain mediates the intellect and the material reality as an effective operator, as elaborated in the Zoroastrian philosophy of Persia and the Sufi tradition (Corbin, 1969, 1983). Indeed, the Klein Bottle logic is ontologically grounded not only in Being, but also on the imaginal domain and Time as an operator; see (Rapoport, 2011a, 2014b) following Günther. This domain already operates as the topological identifications that produce the non-orientability of the Klein Bottle or the Möbius strip. Yet, after quoting Aquinas, who in Western philosophy raised imagination to the status of primeval, Freeman developed a theory of non-linear neurodynamics based on the primacy of intentionality as adaptive creation (Freeman, 2000). This intentionality is not the diluted form embraced by the XXth century phenomenology.

14. Four-state logic (Kauffman, 1978; Hellerstein, 2010; Rapoport, 2011a, 2011b, 2011c) as inspired in the imaginary logical states introduced by Spencer-Brown's Law of Forms (Spencer-Brown, 1969) -and which shall appear in the Klein Bottle and the algorithmic generation of genomes- provides, in principle, a completely different setting to the foundations of mathematics in its relation to the hypothesis of the continuum. This is closely related in principle to Chaitin's proposal of discreteness rather than continuity as the fundamental ontological status of space and cognition (Chaitin, 1999). Indeed, the Anti-Diagonal Construction of Cantor used to prove the "uncountability" of the real number system, in four-state logic takes a completely different interpretation and ontology; this logic may provide a novel setting for mathematics atuned to computer science and to a discrete world, such as the quantum spacetime. For a remarkably unique elucidation of Cantor's horrendous 'proof' (as per Brouwer, Poincaré, Wittgenstein, Weyl, Quine, Arnold and others) of the presumed existence of transfinites and the supposed uncountability of the

continuum see Zenkin (2005); see also Hellerstein (2010). In another of Zenkin's contribution (a late senior researcher at the Computing Centre, Russian Academy of Sciences, Moscow) he elucidates that Cantor's argument is properly represented by the potentially infinite sequence true→false true→true→false→… presented here as the imaginary time-waves **i** and **j,** alternating Inside-Outside and Outside-Inside as already discussed in relation with the paradoxical tail of the real numbers. In Zenkin's terms, following Aristotle for that matter, the notion of an actual infinity is self-contradictory; there are only potentially infinite sets. Naturally, if we stick to Boolean logic, this cannot be elicited, and at times this is intentionally brushed off to avoid lifting the dual case. For a proposal of construction of mathematics in terms of potential infinities and non-dual logic see (Lin Forrest, 2013). In this setting developed by Hellerstein are resolved, in principle, the Zeno paradox as well as those paradoxes that in the present imperative Boolean logic ontology inflicted on mathematics a blow in its pretention to yield a complete semantics free formal language. For this novel mathematics, imaginal states –paradoxical to Kauffman and Hellerstein, introduced as imaginary (like the square root of minus 1) by Spencer Brown, namely the interpenetration of the Klein Bottle –to be presented below- will be crucial.