

# On the Fusion of Physics and Klein Bottle Logic in Biology, Embryogenesis and Evolution

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## **Abstract**

We introduce a new paradigm for embryological differentiation with its relations to the genome and evolution, in terms of the fusion of logic and physics: logophysics (LGP), associated to the ontology and epistemology of the Klein Bottle (KB). We introduce LGP through the subversion of the fixed dualistic categories of exterior and interior, basis for much of science, in terms of the eversion: turning inside-out of the two dimensional elastic sphere (ovum), which is the actual case. We propose bauplans unfolding from a 6d space in which time waves manifest through torsion fields in real space and in which the eversion is mediated by KBs. We present the torsion geometry, quantum and elastodynamical, of self-referential biology. We apply this to the problem of the physics of embryological differentiation in terms of quantum torsion-elastodynamics waves and the light tensegrity of the cell. We associate it with a topological transformation which extends the proposal by Maxwell and Poynting, founders of electromagnetics, for the interaction of the inanimate and animate worlds. We present a new conception of the world in terms of time waves and the KB, that appears in the natural number system, in cosmology, in vision recognition, in the topographic map of the sensorium, in the periodic table of elements, the genome, etc. We surmount the ancient problem of what life is, providing a LGP basis for both the inanimate and animate realms.

**Key Words:** Torsion geometry, self-reference, bauplans, self-determination, time waves, logophysics, Klein Bottle

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## **1. Introduction** **The Logophysics of Cell Biology**

Scientists usually believe that logic and physics are separate and unrelated. Logic is concerned with the laws of thought and is an instrument of epistemological discourse to argue how to face or learn about reality, either by experiment or theory, with no relation with the "world out there". In this conception, logic is not an element of reality and with no relation to physics, nor to biology. A notable exception is quantum

physics in which a quantum logic is assumed to deal with the pledged particle-wave duality, which is not the case (Rapoport, 2009b). We shall introduce the concept of logophysics (LGP), in which logic and physics are unseparable, both in ontology and epistemology, which become useable.

An example, the living cell membrane in the usual model entertained by most biologists, is a Boolean logical gate in the sense that ions, molecules, etc., are enabled to go or not to go through it. Here, a clear cut separation of the 'exterior world' and the 'interior world' is placed as a theoretical assumption. This is the dualistic logic framework in cell biology that determines the physical modelling of it, as we shall see next, and has profound implications in the biochemical model proposed for the cell, in

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accordance with this mechanical model of dual complementarity (the lock and key model of biochemical recognition). For a LGP rendering of cell biology and chemistry (Rapoport, to appear).

Of course, the cell's physiology requires its unification with the environment through the membrane, which thus cannot longer serve as an unpenetrable barrier, but rather one that requires that the membrane to be violated and with this to violate the Boolean dual assumption of 'exterior' (or 'outside') and 'interior' ('inside'); henceforth, we shall denote these states as E & I, respectively. The physics model associated to this assumption of a dual logic is the mechanical pumps models that are unseparable of the E & I logic, since they are designed to surmount the membrane's dual character by asserting itself as the solution to the integration of cell and environment. Thus, the logic and the physical model are integrated, and the physics claimed to solve the problem of getting through this Boolean context, follows from the logic. Although most scientists are unaware of this mindset, which is quite dominant not only to biology but to science at large, it actually turned to manifest as a construct for cell biology. Biophysicist Gerald Ling (2006) claims that this model of mechanical pumps is wrong and experiments appear to prove his claims. Thus, actual experiments have lead to verify that Boolean logic does not apply to cell biology, and neither trivial mechanics does.

We quote Ling, the initiator of this physicalist paradigm, very resisted by biologists of the biochemical persuasion:

"...to understand the mechanics of a complex living phenomena a biologist must begin with a hypothesis that is, first, a logical deduction from the existing laws of physics and, secondly, verifiable on a relevant inanimate model system. A failure to recognize one or both of these steps would lead us back to 19th century vitalism, according to which life phenomena fall outside of the laws of physics governing the inanimate world, and are mystical in nature." (p.320, Ling, 1992).

To resume, for Ling the physics of the inanimate world is the basis for living phenomena, logic is a mere *extracorporeal non-physical* methodological *instrument* for theoretical deduction; any principle, such as

vitalism unconnected to physics is ultimately related to the realm of Being, and thus alien to science. A similar physicalism for embryology and its unification with genetics and evolution was elaborated (Gordon, 2002; Gordon & Gordon 2011), again in criticism of vitalism, introducing a tensegrity structure unconnected to quantum physics but to continuum mechanics, a separation which is not the case (Rapoport, 2005a, b, 2007). A most important theoretical experimentally verified basis that follows from this disproof of the dual membrane as a barrier for the cell physiology and organization with its surmountal by the presupposition of communication canals, is that cell's water is not alike bulk free water, but highly ordered (Ingber, 1998). Water in the cell appears to have a geometrical structure of continuous distribution of tensions, a tensegrity structure that also is the geometry of the cytoskeleton and its extension to the extracellular matrix and the body through the connective tissue, providing the basis for body integration (Rapoport, to appear).

Tensegrity structures are basically produced in terms of geodesic paths which continuously absorb-produce tension. We shall propose a quantum light tensegrity, which still produces a form of quantum elasticity since the *wavefronts of elastodynamics* and those of the *eikonal light-rays* (Bona and Slawinski, 2011) that are at the basis of cell biology –as we shall see in *embryological differentiation*- and of spacetime are *identical*. Tension is distributed instantaneously throughout the cell and to its environment and the body through these tensegrities. We assume these shortest (i.e. geodesic) lines to be light rays (the Hamilton-Jacobi-Fermat principle of classical mechanics) producing a torsion geometry (Rapoport, 2009a, b, 2010a, 2011a, b). Thus, we shall substantiate the claim that there is a quantum geometry as a basis for the cell organization and physiology; they are essential to embryological differentiation, as we shall see next.

In the initial construction of tensegrity structures by architect and polymath Buckminster Fuller (Motro, 2006) and sculptor Kenneth Snelson (Snelson, 2011), a duality principle between tensional and compression lines was proposed, yet more

recently this paradigm has been abandoned as obsolete: Compression struts, say the body's bones can act as tensional lines, usually ascribed to the muscles's fibers, which have a self-referential geometry-topology, as they are Moebius bands and Klein bottles (Nevin and Rapoport).

## 2. Introduction to the Torsion Geometry of Biology

We recall that tensegrities are constituted by geodesic (i.e. *shortest*) lines, and thus they are usually associated to a geometry defined by a Riemannian metric as in General Relativity (GR). Yet, in proposing a theory of gravitation, Fock based it on the identity of the wavefronts of the equations of electromagnetism and of GR (Fock, 1962). The metric derived geometries of GR have a null torsion, by default; yet torsion is prior to the notion of an absolute geometry defined by a metric (i.e., one where the relations between the points of spacetime are characterized by a distance). In mathematical physics this appears as the Bianchi structural equations, in which curvature is derived from torsion, and thus curvature has no primeval role in constituting a geometrical distinction, and thus of physical causality. We may have geometries with null curvature and still with non-zero torsion; an example is a dislocated Minkowski space, with the dislocations produced by light (Rapoport, 2010).

To incorporate angular momentum and spin to spacetime geometry which GR kept unaccounted for, Einstein together with geometer Elie Cartan (who had introduced torsion in geometry, in the first place, as well as the current approach to Lie symmetry groups) attempted to give a theory of gravitation based on torsion and its derived curvature (as well as that of the metric): the Einstein-Cartan theory (Goenner, 2004; Hehl *et al.*, 1995). In taking torsion in account, cosmology does not require an alleged primeval singularity (big bang), nor inflation (Poplawski, 2010).

In distinction with the curvature field derived from a metric as a basis for a theory of gravitation, which has not been able to be unified till today with quantum physics, a theory of spacetime based on torsion is inherently a quantized spacetime. It leads to

quantum mechanics (Schrödinger and Dirac equations), electromagnetism, the strong interactions, fluid-dynamics, Brownian motions and statistical mechanics as theories of spacetime torsion fields (Rapoport 2005 a, b; 2007; 2009a, b; 2010a, b; 2011a, b, d). The reason for torsioned spacetime being quantized, is that torsion introduces a fundamental non-commutativity of spacetime –infinitesimal parallelograms don't close up to torsion, introducing thus an essential dislocation which actually defines spacetime, rather than occurring on spacetime. Thus, torsion in distinction of being a derived field on spacetime, as is the case of curvature in Einstein's theory, is primitive. It further introduces self-referentially a locus. We shall discuss this further in Appendix, in which we shall see that torsion can be introduced by shearing motions that introduce the dislocations, from which the notion of locus is derived rather than being primeval. A result is that vortical motions are associated to torsion; for a viscous fluid, the velocity field is the torsion produced by the shearing of the fluid, and vorticity is derived from it (Rapoport, 2005a).

Returning to the relevance to torsion to biology, already it is the case of liquid crystals which are torsion geometries (Kleinert, 1998); we recall that living cells are essentially liquid crystals (Ho, 1994, 1996). Vortical structures and processes are conspicuous in biology, at all scales (Chouaieb *et al.*, 2006, and references therein). They can be introduced by torsion shearing motion of elastic rod-like structures and to effectively model growth (Goriely *et al.*, 2010). An important case of torsion geometry is that of molluscs (Illert, 1990, 1992), trees and a myriad of biological structures (Cook, 1914; Galloway, 2007), and anatomical structures as the iteratively folding Moebius band structure-process unveiled in the mammal heart (Torrent-Guasp, 2005), as well as in muscles –though unacknowledged as such (Myers, 2006) and human gait (Nevin, 2010). Double helices arise from torsioning *single* structures, in distinction with the notion that DNA is essentially a dualistic structure-process.

Torsion defines the structure of continuous (named after Sophus Lie) symmetry groups which are not only

essential to physics but to biology and chemistry as well: Rotational, radial, helicoidal, hemilateral, symmetries are at the basis of morphologies of biological and chemical systems (de Faria, 1998). Returning to the issue that torsion appears from the non-commutativity of two infinitesimal vector fields on the geometry, i.e. the commutator (as in quantum mechanics) of them is not null, it is the torsion, we note that this is also the case of the continuous symmetries we have mentioned to establish a continuity that unfolds from physics, to chemistry and further to biology. Indeed, as in Appendix, Lie groups arise from the self-referential development of the Lie commutator,  $AB - BA$ , of two arbitrary infinitesimal symmetry generators A and B (playing the role of the infinitesimal vector fields on spacetime) into an expansion of the *whole basis* of infinitesimal generators, mediated by a set of coefficients which encode the symmetries, the so called structure coefficients (Sternberg, 1995). The torsion tensor coincides with these structural coefficients that determine the symmetry structure (Schouten, 1951).

Molecules and chemical reactions are determined by the symmetry structures of atoms and molecules related to their integration vis-à-vis the environment, i.e., the electromagnetic fluctuations of the vacuum, Apeiron (Boeyens, 2005). The latter are Brownian motions produced by electromagnetic torsion fields as a background second-order cybernetic system (Rapoport, 2005a, 2007) which interact with the molecules defining a shape and controlling thus chemical reactions (Boeyens, 2005).

Thus, there is a continuity between the symmetries of physics and those of chemical and biological systems, which places spacetime symmetries of physics at the very basis of the processes which we associate with life. In fact, biological evolution is proposed to be associated to these symmetries and their homologies through species, which further appear in chemical systems that constitute the homological biological structures. Thus the notion of biological periodicities can be rooted in periodicities that appear in the periodic table of chemical elements but already occur as spacetime symmetries. This

is the core for a theory for evolution, which certainly differs from a Darwinian theory (de Faria, 1995), yet which incorporates in its basis the torsion geometry of symmetries. Yet, the logic of it is not the bottom-up physical causation with its *Anthropocentric* Principles 'top'-down dual, but one of Klein Bottle Logic (KBL) causation which we shall introduce in the case of embryological differentiation below. It is remarkable that the self-referential theory of DNA and its isomorphism with the Dirac algebra of quantum mechanics, points out to DNA being related to physical symmetries, and thus while DNA may be crucial to evolution, this is to be traced to its relations with the symmetries of quantum physics (Rapoport, 2011c). Furthermore, the periodicities that are the core of the Mendeleev table, when considering the stable nuclides, show that there is a self-referential topology that sustains the Mendeleev table (Boeyens, 2005): the KBL which we shall encounter next as the topology of biology as well.

The KB is unseparable from its logic, as condensed in Figure 2. It is a one-sided surface (Poltier, 2003) that has no E nor I, it is both continuous and discontinuous, it is self-contained by self-penetration, *not contained in space*. It is non-orientable: a normal vector seemingly placed at one side, transforms by motion through the surface to its opposite, and thus we have the prototype of Newton's Third Law, which is no longer about dual forces.

Therefore, the abandonment of the dualistic principle for cell membranes that we chose for our first example of LGP, opens us to a new holistic conception of biology in which torsion plays a fundamental role. It further reappears in conceiving a self-referential KB topology for the cell membrane as a quantum boson surface, and its integration with the cytoskeleton and the extra-cellular (Rapoport, to appear).

We have proposed that this primeval dislocation produced by torsion, is identified with the primeval distinction, as in (Spencer-Brown, 2010): a cleavage/distinction/boundary which establishes a world, in this case, biology's unit, the cell, the cleavage being the membrane. This distinction, which fuses with the one who poses (and is posed by) it, cleaves the world of all potentialities, the

vacuum, or the Plenum, not to be confused with the Void (Varela, 1979; Kauffman, 2010). The logic of this calculus of forms contains Boolean logic as well as its surmountal by imaginary motions that subverts the cleavage-boundary. The motions either through the membrane, or the imaginary motions subverting it, are the generators of its physiology and organization, in embryological development and differentiation.

### 3. The paradoxical development of the embryo and the KBL

Several models of the embryological differentiation have been proposed, both chemical and physical. The logic that is ascribed to differentiation, and to the genetic code and evolution (Gordon 2002; Gordon and Gordon, 2011) and the structure of the embryo at large, is the Aristotelian-Boolean dualistic logic already discussed. As in our first example to introduce LGP, the reasons for this may be traced back to the apparent 'exterior-interior'(E & I) dualism ascribed to biology in terms of membranes and the fact that the formation of the embryo, appears to undergo in *each* step, a differentiation which takes two possible developmental states: say, endoderm and ectoderm.

Already the ovum, conceived as a two-sphere, is conceived as an E & I which are fixed, and in terms of which the formation of tissues will precede repeating this logic. This is somewhat contradictory with the fact that stem cells, i.e. those cells which are related to the primeval mother cell, have the factual possibility of regenerating organs and tissues, thus showing a pluripotency denied by the dualistic conception. Indeed, if development unfolds according to a dual-state logic, how is it possible that at a later stage of development a multivaluedness of possibilities arise?

Topological studies of embryological differentiation, that have rightfully returned to the basics of morphology - though in neglecting its connection to geometry, physics and chemistry- have pointed out that from the two-state character of the ovum's membrane, only orientable manifolds can be conceived as the geometries of life structures (Jockusch and Dress, 2003; Maresin and Presnov, 1985). This is already the case of

the blastopore invagination of the ovum, which though there is an invagination of the ectoderm by a shearing motion of its cell, producing a contraction, the "mouth". We stress that the topology of the ovum is the 2-sphere; would a smooth invagination be produced, this in principle, is reversible, yielding the originally sphere. Yet a second stage of evolution is produced through surgery of the ovum. Still, only orientable topologies (a unique normal vector is the case) are proposed, though two observations are in order.

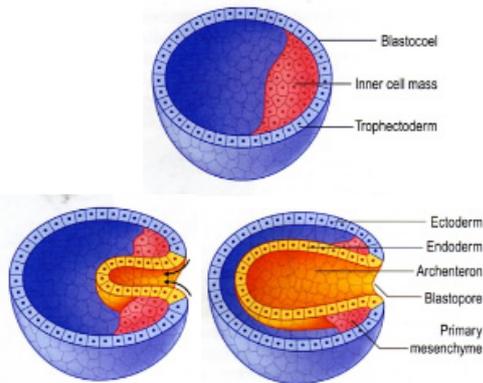
Firstly, an ideally infinitely elastic 2-sphere can be smoothly transformed through eversion (*Smale's paradox*), i.e. E & I are exchangeable (Levy, 1985; Peters, 1984, 1994), through smooth (i.e., no sharp edges produced in the process) self-penetration, without producing holes nor any creases.

The latter condition is not the case of the blastopore invagination in which the crease (a folding which is not about curvature, but a shearing torsion motion) is produced superposed with the invagination, showing the torsion of the geometry produced by shear; see Figure no.3 in Appendix).

Thus, through topological (i.e. continuous invertible) transformations, self-penetration -as is the case of the KB, rather than being ruled out is indeed the case of the blastopore invagination, torsion is the field that will develop into cleavage though non-orientability is not manifested in the process nor the end result. Yet, the eversion of the 2-sphere is realized through mutually interpenetrating KBs (see especially 0:21 and 1:06, and 5:16 to 5:46 in <http://www.youtube.com/watch?v=bGiVPj2P19s&feature=related>), that mediate/partake in the process of eversion, to create orientable sections of the 2-sphere. It is the superposition of the outward and inward motions that produce after self-penetration of the caps (which undergo each one a  $2\pi$  rotation, each cap in a direction contrary to the other one) this KBs. Far from being only virtual; we shall propose that they are fundamental to the development of the body as a bauplan.

Thus, the blastopore invagination may be related to the actually non-infinitely elastic 2-sphere-ovum eversion. Indeed, in

the actual completion of the invagination, with the formation of the mouth, the development front of the shearing will indeed push the inner side of the ectoderm to face outwards by pinching the North cap, as shown in the Figure 1 below.



**Figure no. 1.** The Sea-Urchin gastrulation. The Exterior/Interior duality is clearly not the case through the in-formation of the double bag invagination which will produce the bilateral symmetry. This in-formation proceeds by shearing motions, i.e. torsion. The geometry of the gastrulation is self-referential: as a process the developed embryo is not contained in space as in the Cartesian take, rather self-contained. In the first stage some cells of the blastoderm invaginate to form the archenteron.

In the second stage more blastoderm cells ingress to form the primary mesenchyme and other cells further elongate along the sides of the archenterone. The final stage will produce the turning inside-out with the formation of the mouth from the penetration of the ectoderm by the archenteron in the animal pole, we have the formation of the mesoderm by mesenchyme cells, and of the anus of the mature animal in the vegetal pole. This self-penetration by the ovum occurs through a secondary invagination. Indeed, through a surgery of the ovum, say in the case of metazoans which share with animals a bilateral symmetry, with the formation of a secondary invagination (a gut and a digestive system) which joins the original mouth of the blastopore, yet producing by this a duplication of the body that topologically is the so-called double covering of a manifold, in this case, the manifold being a 2-torus; see fig. 1f in (Jockusch and Dress, 2003). Indeed, by this secondary invagination, the topology turns to be that of a torus by actually the retraction initiated with the

blastopore invagination pinching the ectoderm and thus E & I becoming one as occurs in the rhs of Figure 1, in a final stage which we have not depicted. Thus the eversion comes to be. We shall discuss further below, the torsion double-bag model and the eversion as a general bauplan for development.

The eversion manifests through the double bags of the amnion and yolk sac, and the manifestation of the non-dual logic is the appearance of the mesoderm sandwiched between the ectoderm and mesoderm. The ectoderm, in contact with the amniotic sac and fluid, will form the nervous system and skin, the neural net. The endoderm, in contact with the yolk sac, will form the linings of all our circulatory tubings (veins, arteries, capillaries, microcapillaries), along with the glands; it is the primary source for the fluid vascular net. The mesoderm in between the two, which as discussed is a manifestation of the KBL of the eversion of the fertilized egg, will form the muscles and connective tissues, as well as the blood, lymph, kidneys, most of the genital organs, and the adrenal cortex glands. Thus, the eversion is associated with the formation of three in-formation systems of the matured embryo: neural net (ectoderm), the vascular system (endoderm), the connective tissues which form a unitary net, which has been largely disregarded until more recently in the work of body and motion therapeutics (Myers, 2008; Oschman, 2000). All three systems contain the shape of the body as a whole: the body of shape (Varela and Frenk, 1987).

The importance to the unitary bauplan for the body regulation, from the cell level to the whole macroscopic integration of the fibrous fascia net, and its relation with the auto-origami folding and refolding torsion action of the embryo, is worth of further attention. It installs the initial cellular specialization within the embryo, and occurs at about two weeks' development. It installs the difference that produces the differences, in the sense of Bateson (Johansen, 2008), which is produced by the eversion and the torsion folding: Until the initial step of the eversion, in which E & I are the only mainly manifested two states, the formation of the mesenchyme heralds the in-formation of spatial relations in the egg, which in the egg

were not evidenced. So the appearance of the mesenchyme brings the manifestation of anticipation since it is imperative that the spatial arrangements, in the background of the increasing specialization, be maintained while keeping motions, so that the ongoing complexity and growth of the embryo, is the case.

Thus, the process of in-formation of the connective tissue, as well as the processes of in-formation of the neural and vascular systems associated to the three logical states, need to unfold according to the logic that sustained the eversion in the first place, and furthermore, it needs to keep the in-formation of the shape (viz.) of the whole body, since the logic is of integration. This turns actually to be the case: Each of the three systems contains the shape of the body, as before. The egg is a whole developing by this logic and the three states (ectoderm, mesenchyme and endoderm) and the three unitary shape systems (neural, vascular and connective) unfold from it.

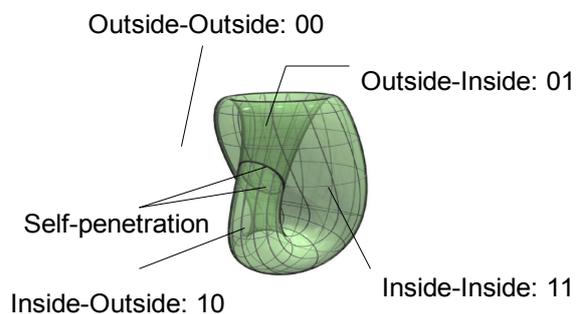
Returning to the issue of the appearance of the bilateral symmetry of the body and its double torus topology, we note that the torus is the double covering of the Moebius Band (MB), a fact that is central to complex analysis (Cohn, 2003); it is also a double covering manifold for the KB (Frankel, 2003). It is easy to visualize this in the case of a MB: We cut it with scissors perpendicularly to the boundary to unfold into a surface twice as long as the original MB (if squeezed onto a plane).

It is quite remarkable that these mathematical studies of embryology have failed to account for these topological and geometrical features, claiming instead orientable topologies, whilst not identifying the torsion geometry for development, the formation of the embryo and the embryo itself, nor identifying the relation between the double covering torus, MB and KB. In fact, the development plan of the embryo (the embryological bauplan) is through the physical agency of torsion which goes all the way to produce the self-invagination of the exterior of the ovum which is embodied in the self-penetration as the end result of the torsion field retraction.

We must remark that before the eversion is terminated, three *potential*

spaces are formed together in this double-bag produced by the invagination as in Figure 1:

- A: The inner space of the inner bag;
- B: The space produced by the holomovement of invagination, a retraction of the environment that will finally pierce through the inner space; finally we have
- C: The environment, the outside of the ovum, whose fate is to move together with B to achieve self-penetration by piercing through the boundary of A. Remarkably, this parallels the KB as described in Figure 2.



**Figure no. 2.** The KB has a natural logic of 4 states (the Klein Bottle Logic, KBL for short) which has two digits representation: Inside-Inside (represented as 11), Inside-Outside (represented by 10), Outside-Inside (represented by 01) and Outside-Outside (represented by 00). The mediation states arise from self-penetration, absent in the mechanical-dual-membrane, and are paradoxical states associated to time waves. From it, appears the genome (Rapoport, 2011c).

Thus, before completion of the ovum's eversion, the space A is paralleled by the Inside-Inside, the retracting space B coincides with the Outside-Inside, and the environment is, of course, the Outside-Outside. The latter, on completion of the eversion, by self-penetration in which space B becomes the Inside-Outside simultaneously fusing with Inside-Inside and Outside-Outside, completing the holomovement and states of 4-space-state KBL. Thus, eversion is only possible through the mediation of the environment E and the inside I of the ovum, by the spaces-states 10 & 01. We see very clearly that the physics (and other systemics, say genetic, chemical, etc., must conform too) and the logic of this process are unseparable; the logic is clearly non-dualistic. The self-construction of the

cell is not independent of the construction of the cell' environment nor of the holomovement that determines them as an in-between. Thus, we have a paradigm of space which does not comply with the Cartesian take of a structure-process contained in space. Rather the cell is self-contained, and still, in this self-determination process which is-makes the cell, the environment also is self-contained. This self-contained environment (which is no longer a mere container, think of the extracellular matrix is realized through the agency of the mediation by self-penetration, by the spaces-states  $10$  &  $01$ , which in the KBL, are time-waves. They correspond to imaginary (*i.e.*, associated to the square root of minus 1) logical states. Thus, cell's space is a realization of/by time.

So, the exchange of E and I as in Smale' Paradox yet regarding the ovum as non-infinitely elastic, rather than being a purely theoretical construct is actually reified as a *non* linear eversion transformation of the ovum. The resultant of this process is the actual buildup of the body's bilateral symmetry through the formation of the canal going from the mouth to the anus. So, we propose for a theoretical organizing principle, that the blastopore invagination up to the formation of the anum-guts-mouth invagination process is the manifestation of a *virtual* (imaginary) eversion of the elastic ovum with a crease. For a physicist this should be no reason for scandal, in thinking on the vacuum and its infinite virtual photons, electrons, etc., as the source for the world: Apeiron (of the presocratics). In this last respect this is distinct to the Smale's Paradox which assumes an ideally infinitely elastic sphere which is not the case of the ovum, while keeping it as the virtual process of differentiation, since this requires a mutual penetration of the animal and vegetal poles through the intermediate agency of KBs.

It is important to recall that the nervous central system, which includes the brain and the spinal cord, arises through development from the ectoderm. Thus, what is conceived in the Cartesian Cut framed neurosciences to be the anatomical basis for thought, as the deepest *interior* world of a human being, is from the understanding which considers the body in terms of the

embryological development which as we saw exchanges E & I, is not related to the interior at all nor the exterior, per se. Rather the brain and the central nervous system partake of the KB holomovement that transforms-integrates both the world and the body through the nervous system that has been interiorized by the logophysics from which the embryo develops in the first place, and the embryologic (!) unseparable to this holomovement.

Consequently, the topographic maps of the sensorium studied by neuroscientists, are not related to what in the Cartesian Cut is believed to be representations of the exterior world through the sensorium (having the skin as its ectodermal gestalt) to the (ectodermal) nervous system, but rather representations that are constituted coherently with the logic of development which as we saw, is not dualistic, exchanging the world with the interior of the body qua processes, not mere objects. In terms of the LGP of embryological development, these topographic maps, who have the KB topology (Werner, 1968; Rapoport, 2011a, b), are the cognitive bauplan that is superposed with the embryological development, and in the sense of its history, stand for representations of E on E!

#### **4. The Klein bottle, Logophysics, Embryology, Chemistry, Time Waves and the Surmountal of the Cartesian Cut**

At this point perhaps the reader may have noticed that the KBL essentially fuses the environment (the exterior) with the system in which it is placed, Yet this placement is not in the Cartesian sense of a form-system occupying space: Space and objects exist as in the Russian Matrushkas, their relation is realized by this contention which fuses space with the objects it contains, yet the former rather inert, while neglecting the existence of the subjects defined and defining the boundary-distinction and the self-referential holomovement of self-contention, in the HyperKlein Bottle (HKB); see Figure 4 in Rapoport (2011c).

This stands in sharp contrast with the logic of the definition of a system by its boundary, as the primeval distinction envisaged by Spencer-Brown, and in the

theory of autopoietic systems due to Varela (Varela, 1979). This author contemplated the reentrance of the form produced by subversion of this distinction by a single time wave producing thus a 3-valued logic; he noticed en passant that this reentrance of the form is the KB yet reduced his theory of autopoietic systems to Boolean logic, separating E & I. By doing this, the subject embodied in the definition of the system as the sign of distinction establishing its functionality, is rendered superfluous, and the system follows first-order cybernetics, rather than its functionality produced by the subversion of the boundary, that fuses the subject with the system. We recall, this is the case of second-order cybernetics, i.e. the cybernetics of cybernetics by which the subject becomes embodied in the system.

The fixation of the boundary (which can be ideative), say a membrane, defines a cell. This is the first step in constructing a world according to Spencer-Brown, now applied to biology. Indeed, an organism is defined by this cleavage and the ensuing motions through it, and more important still, by the time motions that subvert the boundary, associated to the imaginary logical values (Kauffman, 1978, 1989; Rapoport, 2009, 2011b; Spencer-Brown, 2010; Varela, 1979) that are produced by the self-containment of a form produced by this skin: the KBL. Time waves (and a Time Operator which is logophysical and cognitively acts by computing the difference of logical values, and physically by a ninety degrees rotation in either the cognitive or complex planes (Rapoport 2011a, 2011b) are associated to this self-containment, which as we already commented with respect to the ovum in LGP terms, it can self-invaginate.

Thus, the logic for an organism defined by a boundary, is the paradoxical one that arises from the self-containment of the form, and it manifests essentially by self invaginations, transforming E into I and viceversa, which we have already encountered in the eversion of the blastopore, and will re-find it in the course of this work, as a bauplan for embryological differentiation and its relations to the genetic code, establishing the self-development of the ovum to a full organism. In the case of an organism that has arisen from this logic, the latter has operated at all instances of

manifestation of the bauplan for the organism and across its evolution. In fact, the bauplan, its unfolding and its KBL become unseparable.

For example, let us examine the current paradigm. The dualistic stance, despite the pluripotency of embryonic stem cells, is maintained in the different studies of embryological differentiation (Gordon, 2002; Gordon and Gordon, 2011). At all stages, the differentiation process is said to be resolved (i.e., a hidden logophysics, which is assumed to be Boolean-Newtonian) by the establishment of determinate type of tissues, say endoderm and ectoderm. It is apparent that though the said resolution takes place, the logic that is associated to embryological differentiation, is far from being dual: Indeed, if E & I are not the only possible states and transformations between them are possible, as is the case of the KB, the logic of this self-penetrating non-orientable surface (KBL) is multivalued and has *imaginary* transformations states. These imaginary states which in the KBL appear associated to the transitional states Outside-Inside and Inside-Outside (here first presented) are those which produce the reentrance of the form on itself, or systemically speaking, of the system on/in itself, and thus the eversion of the blastopore is produced. These imaginary states play a fundamental role in Nature, through their association with time structures (chronomes), and thus the existence of gestalts that account for life, self-organization and self-determination (Rapoport, 2011b).

We are led to entertain the notion that the 2-state resolution of embryological differentiation is produced due to the fact that the underlying logic is paradoxical and multivalued as the already discussed bauplan shows explicitly to be the case, and thus dualism is secondary to the holonomy of the KBL. In fact, through the unfolding of the singularity of self-penetration, we have the physical embodiment of the explicate order unfolding from the implicate order, the singularity, in the sense of (Bohm and Hiley, 1980). Furthermore, the explicate order returns to itself to reproduce itself by producing the singularity. This is the topological self-referential embodiment of Bohm's holomovement, in which the two orders, implicate and explicate, become

dynamically and KBwise unseparably realized and validated.

This may seem contradictory: That the Boolean 2-state determination of embryological differentiation is the result of higher order logic? We have already seen that this precisely of the ovum eversion as well as is the case of the membrane (Rapoport, 2012); but there is more to it. Indeed, in the KBL, the Hadamard operator Matrix Logic representation of the KB (Rapoport, 2011a, b; Stern, 2001), transforms the paradoxical superposed states into the Boolean states (say, E & I), which by further recursion, the action of it reconstructs the paradoxical states. To put it in a metacognitive perspective: dualism is an artifact of the action of the KB (Rapoport, 2011a). Yet, it is only one step of the action of a fundamental topological Hadamard operator which represents in Matrix Logic the topology of the KB; further action on the Boolean states retrieve the paradoxical states (Rapoport, 2011a). This operator is central to quantum computation (Nielsen and Chuang, 2011). It gives a representation of the genome in terms of the KBL (Rapoport, 2011c). In particular, the rendering of the embryo's history into a succession of dual events, is an artifact of the holonomy and its multivalued logic, rather than aprioris of the cell. Thus, instead of the dualistic stance that is attributed to natural problems, in the embryological development we see that this seemingly dualism is produced by the actual logic of self-penetration which is the being of the KBL.

Embryological development is related to the definition, or better said, the manifestation of the bauplan in terms of information, as the above discussion has elaborated. We remark here the crucial difference between in-formation and information. The latter is the usual business of Shannon's theory of transmission-reception of discrete data which has a dual contradictory character: Indeed, though it is purported to be a message, it requires no interpretation of the data but its actual reception is claimed to be all that there is; there is no interpreter to make of this data a message. This is another example of the already mentioned separation between physics and logic. Here the logic is Boolean (emitor and receptor being the two separate

unidentified elements), the physics is of signals whose meaning is not an issue for the information to manifest neither as a form nor as process: in-formation. In this dualism, nor the receptor nor the emitor have an inherent structure participating in making out from the data a message. This is the "it out of bit" maintained by John A Wheeler, a purportedly objective world coming out from meaningless information. No interpretation of the information is required to make the information operate. Despite its widespread use in biology, biological systems appear to be able to ascribe an intention to the physical content and organize accordingly. The message in the data is not quite such per se, since no ascription of purpose nor meaning is the case in this theoretical setting, and in-formation, the manifestation of a bauplan that actually designs an entity, in this case, the developed embryo to full maturity, is not considered.

The second characterization is that of self-determination which requires that the self-referential bauplan be self-signified, and thus the ovum becomes a sign for itself through its development. As argued by Rosen in his KB understanding of semiosis (Rosen 2004), in distinction of the postmodernists' slippage of the signifier with regards to its act of signification of the sign, which in the usual take requires a second signifier to assess this action, and thus ad infinitum, the KB -and in the present take the KBL- is the embodiment of the fusion of signifier and sign. This is the case of space self-referentially constructed through torsion, as the primeval sign. Thus the ovum, through its developmental bauplan, as a semiotic system is, in principle, the embodiment of the KBL, unless we assume that 'life' would not be self-validated nor self-contained as a cognitive process.

Yet, the process of unfolding of this cognitive process that is the maturing and matured embryo is about the *determination of shapes*, as a primal difference on the primeval difference that is the ovum's membrane, a primal shape. This determination or unfolding of shapes from a bauplan, which is not exclusive to the ovum but extends to the biology of cells as we discussed in the Introduction, and to the allosteric phenomena crucial to the cells' self-organization and still to the very

structure of the molecules that participate in this phenomena (Rapoport, 2012).

Thus, the processes that produce shapes of molecules and their inter-relations fundamental to biochemistry and cell biology, or the cells themselves, which in the development of the ovum by the torsion shear that produces the blastopore invagination and continues by shear retractions and deformations that arise from them (and as we have unveiled, is the real unacknowledged basis for a paradigm of complexity, while the present one has been born in ignoring them (Rapoport, 2012)), can be understood departing already from the quantum chemistry of molecules by Boeyens (Boeyens, 2005), which can be interpreted in terms of torsion fields and the holonomic orders that Bohm envisaged in his causal interpretation of quantum mechanics, following the treatment of the Schrödinger equation as a torsion Brownian motion (Rapoport, 2007). In this case, shapes will define those of atoms and molecules, organized already by the separation of spacetime in terms of the zeros of the wave function, in the excited states leading to the formation of the shape of atoms (Nagasawa, 2003) and more generally of molecules interacting with this quantum background.

Let us return to our first issue that this article has upheld, the unseparability of logic and physics. It has been proved that the KBL has a Matrix Logic representation derived from it (Rapoport, 2011a,b; Stern, 2001), by which quantum mechanics is derived, in sharp distinction of the usual approach that places quantum logic as derived from Quantum Mechanics. We recall here that the latter approach follows from the alleged duality of waves and particles, which the de Broglie-Vigier double-wave theory and Bohm's approaches to quantum physics, have been proved not to be the case (de Broglie, 1962; Bohm and Hiley, 1980). More closely connected to the issue of the torsion geometry of embryological development and of the cell tensegrity structure, in the light torsion geometry of spacetime, the photon and neutrino appear as the null set of the waves which can also be represented as the eigenstates of the null operator of the matrix logic representation of the KBL; they are not point like, but

extended. Thus, rather than duality, we have a fusion between light and logical states in a multivalued logic, and the latter appear from the geometrical structure of the particle. Thus, we have said that the self-referentiality of the photon is such that it is the process of seeing-thinking (Rapoport, 2009b). With respect to the neutrino, it is quite striking to observe its shape-shifting to a seemingly 8 (again) in recent experiments that have finally marked its trace (J-PARC, 2010).

In the LGP causality, logic and topology (or still logic and topology blend together with physics determine the real world structure and vice versa, the material world is integrated into the subjective, which has been associated to the surmountal of the Cartesian Cut by which the dualisms such as E & I, 'objective'/'subjective', 'being/becoming', 'signified'/'significant', 'system/environment', etc., are transcended and are immanent to the KB and its 4-state logic KBL. We have seen already that embryological development is the materialization of this logic, appearing to be the reification of an imaginary dimension of subversion of forms by self-penetration, self-determination, self-reference in all its logophysics aspects which incorporates the algorithmic, meta-algorithmic, metameta-algorithmic dimensions, envisaged by Johansen (Johansen, 2008). Indeed, LGP is not about physics as independent causation of the other forms of causality envisaged by Johansen, which are incorporated in the fusion of logic with the physical materializations of them.

We may conjecture that the growth and unfolding in anticipation of molluscs discovered in the pioneering work by Illert (Illert, 1990, 1992, 1995) which requires a torsion in 6D (formalized in terms of Hadronic Mathematics and Physics, the latter being a case of torsion geometries; see Rapoport, 2009b and the work therein by Santilli) is actually the signature of the imaginary and real dimensions of the KB logophysics, the former playing the role of the zero-time physics of the imaginary motions of the ovum's eversion as a logical algorithmic causality (Johansen, 2008). We shall prove in (Rapoport, 2011c) that the doubling of 3D space to obtain 6D is produced by the superposition of two KBs, and we recall that the eversion of the sphere is produced by the

superposition of such pairs, as discussed above. Illert's theory was successful in generating all known molluscs, the 6D are crucial, since the projection to 3D does not allow the molluscs to be: they break down due to the torsion.

The founders of electromagnetics, Maxwell and Poynting, proposed a merging of the real-physical and the imaginary-subjective realms by the action of the imaginary rotation operator, essentially the Time Operator in the KBL which we linked to intention-will and self-determined design (Rapoport 2011b). We find this operator appearing from identifying opposite points on shearing surfaces –which produce torsion and thus the five-fold Fibonacci structure appears – leading to embryological differentiation; see Appendix; (the reader is urged to read the forgotten monograph, especially page 212 in (McDougall). Thus, embryological differentiation is realized by this merging contemplated by Maxwell and Poynting.

The periodic table of elements -on including the stable nuclides-, has the topology of the KB arising from the torsion standing vortical structure of the natural numbers disposed on a plane according to a Fibonacci symmetry, and a standing wave is the expression of a chronome for the atoms and their stable nuclides. This wave appears to generate them in terms of the environment-dependent values of the atomic weights (Boeyens, 2005), which we propose to be essential to evolutionary theory as an *unfolding* of an imaginary dimension embodied in the KBL (Rapoport, 2011c).

For developmental embryology, it was intuited –and dismissed due to the rejection of in-tention/teleonomy- the possibility that the differentiation waves that produce this unfolding ding/development have for ultimate basis a similar standing wave as a time pattern which comes to manifest as evolution; see page 1197, (Gordon, 2005). Standing waves produce the floret structure of sunflower (Palmer and Steer, 1985), a basic example for Fibonacci's sequence from which the Mendeleev table by Boeyens surges. The natural numbers can be generated from an original 8x8 revolving matrix, following a Fibonacci structure, which allows to identify the prime numbers

(Johansen, 2011); concurringly, we have conjectured that the prime numbers can be generated by a standing wave (Rapoport, 2011d).

Thus, rather than the inapprehensible attribution of the emergence of complexity (complex derives from the Latin root for folding, which is produced by torsion as in the ovum's development), due to the Cartesian Cut, we are here suggesting the notion of space gestalts –i.e., contextualization is the case-, bauplans (design plans) unfolding from time waves (as the 0-time physics in the algorithmic causality level), as is already the case in the KBL; for other examples and perceptual-anatomical-physiological-cognitive-systemic issues, see (Rapoport, 2011b,c, 2012).

## 5. Torsion, differentiation waves, Klein bottle logic and embryology

Gordon proposes a mechanical model of the cell as a physical active media, on which a Boolean logic of differentiation *emerges* from the mechanics of differentiation; in this take, the logic of the embryo is *deduced* from the physics; it is merely *epistemic*, rather than being a generator of organization (Gordon, 2002). Thus we are returning to the field with which we have started this article, framing the first example of LGP which we have further expounded in discussing the biology of the cell.

“Differentiation waves lead to a simple view of development: Each embryonic tissue is split into two new tissues by two waves. One is a wave of contraction, and the other is a wave of expansion.... In epithelia, these waves seem to propagate via a cytoskeletal apparatus at the apical surface of each cell, that we call the ‘cell state splitter’... This device, somewhat akin to the spindle apparatus in its mechanical antagonism between microtubules and microfilaments, is constructed in a metastable state ready for a radial tug-of-war [Newtonian physics is upheld; our comment] between its apical microtubules and apical microfilament ring...The cell state splitter resolves this instability in one of two ways: Either the microfilaments win, greatly contracting the apical surface, or the microtubules win, flattening the cell.... We presume that a one-bit signal then proceeds to the nucleus by some sort of signal transduction, resulting in one of two readied gene cascades being

triggered...Cell differentiation is thereby conceived as a binary bifurcating process, i.e., each intermediate cell type during embryogenesis gives rise to *exactly* two new cell types. Differentiation waves give us another tree, a 'tissue lineage tree' where we define a tissue as all cells that have experienced the same sequence of contraction (C) and expansion (E) waves. This means that, if differentiation waves are the primary trigger of cell differentiation, every cell, at every stage of development, can be assigned a binary code, such as CEECECCEEE, etc., representing its history of participation in differentiation waves yet with a single value at each step. This 'differentiation code' may actually have some kind of representation in the cell, which would be its 'memory' of what it has been and now is. The concept that every embryonic tissue gives rise to exactly two tissues further on in development is only implicit in the literature, and needs further investigation. Thus, the notion that the tissue lineage tree also branches in a strictly binary fashion awaits confirmation." (Gordon, 2002).

Notice that a concession that non-duality may be the case is made, and yet the theory disregards the own warning, despite that

"...At the boundaries of and between the expansion and contraction waves that traverse a given embryonic tissue, there are likely to be some cells that do not participate in either type of wave. [Again, the issue of multivaluedness of the logic established by boundaries or distinctions (Rapoport 2010a, b, 2011a, b, c); our remark] This may be the origin of stem cells, cells that are stuck in an embryonic state, perhaps able to wait indefinitely for something to trigger them to the next stage(s) .... The differentiation code of these stem cells, insofar as a cell acts on its past, or rather its stored memory of that past, may limit the kinds of cells it can differentiate into. This would explain why stem cells are generally pluripotent rather than totipotent. Thus, differentiation waves may explain the origin of the many kinds of pluripotent stem cells that have been discovered in recent years." (Gordon, 2002).

To resume, Newtonian mechanics determines both genetics and phenotypes (p. 1058, Gordon, 2002); Boolean logic is the case together with mechanics, and the dual evolution is conceived to be a by-product of

if; logic is assumed as auxiliary, not a fundamental causality operator, though the topology of cells and organisms is assumed from the start to be orientable: 'Consider a spherical cow', i.e., a mouth-stomach-guts-anus-less non-self-penetrating being; see page 1, in (Gordon, 2002) . This is the starting point of this pioneering work and so is the starting point of the present article, to introduce the unseparability of logic and physics: LGP. Since the wavefronts of the eikonal equation for light rays, in particular for the cell tensegrity, and the wavefronts for the propagation of elasticity coincide (Bóna and Slawinski, 2011), then effectively the quantum geometry does serve as a tensegrity. Gordon considered tensegrity to be associated to classical physics, as is the usual take, and hereby we find that the tensegrity we have proposed is basically quantum, yet with wavefronts (which are crucial to the embryological development) that coincide with those of the quantum tensegrity as an elasticity dynamics.

Remarkably, the issue of the "illusory" role of DNA to self-sufficiently be a bauplan for development, is argued in terms of its failure to be self-generated, which due to the fact that the DNA in the nucleus "...is considered to be the same in each cell, something from outside the cell must specify which set of 'instructions' is used in each cell. But all what is outside each cell is other cells with the identical DNA and/or the outside world".

We retrieve here the already examined logic of separation of E & I, cell and environment, which the KBL establishes to be an artifact of its multivaluedness; if the cell's Other does not establish the genetic instructions, then the self-referential KBL must be the LGP generator, that integrates cell and environment, as currently proposed. We continue quoting Gordon:

"Thus, the existence of this DNA with its genetic code does not itself answer the question of how the cells become different from one another"; page 3 (Gordon 2002). "As we shall see, it is not simply "other molecules and structures", but the physics of the embryo, that is the essential complement to the DNA, making a genetic program possible", see page 4 (Gordon, 2002).

Therefore, to avoid vitalism and teleonomics, a return to Newtonian physics and mechanism is advocated, and a separation of logic and physics, in which the former has an epistemic non-ontological role. We shall instead apply logophysics to embryology and genetics, yet we note that the KBL upholds vitalism as logophysical, rather than metaphysical (Rapoport 2011b). Thus, the ever mysterious preconceived distinctions between ‘animate and non-animate’ are futile: logophysics sustain both. Further, intention is related to self-referential-control-determination as a fundamental action of the Time Operator, which is universal (Rapoport 2011a, 2011b).

For a start, a very important issue is that the differentiation waves follow the *shortest* paths in the cell as an active substrata (p.276. Gordon 2002), with which they interact; in other words, they behave as light rays, satisfying the eikonal equation of light, alike the water tensegrity in cells and the tensegrity structures in the cell, the extracellular matrix and the body at large. Thus, they produce a quantum tensegrity structure as discussed above, which further relates the embryo to the environment through the membrane.

Furthermore, they are propagating waves, and thus we find that consistent with our treatment of the self-referential creation of space through electromagnetic waves carrying photons as their singularities, they create a torsion geometry on the cell, identically as in spacetime, whilst they also create a random Brownian motion in the substrata, acting as the zero-point fluctuations, now of the cell’s space (Rapoport 2005a, 2007, 2009a, b, 2011b). The torsion differentiation waves (already embody contraction and expansion; our discussion on stereochemical topological transformations may explain which wave is the case; see Appendix) act on the cytoskeleton’s tensegrity structure, producing a *kind* of tug-of-war (though Newton’s Third Law is topological, as discussed already), in between its apical microtubules and apical microfilament ring, as a bioresonance coupling effect on the quantum tensegrity structure’s *modification* produced by them.

So to resume, there is a KB logophysics embryogenesis which does not end in the blastopore invagination, in which torsion plays the central role, and still, though there appears to be dual logic appearing as the resultant of this differentiation physically instanced by cells, this logic is not appropriate since it cannot account for the pluripotency of stem cells, nor can account for the actual eversion of the ovum that manifests its bauplan for development and self-constitution.

At the area of the equator of the dividing embryo (alike a door’s arch), there are cells which are not only neither side of the equator (a person standing under the arch is in superposition), yet which are in a state of transition from one side of the equator to the other. For example, a cell that in the animal hemisphere is in a state of contraction, C, it is codified as the three consecutive states: C, C→E, and E →C by which C transforms to E, to finally E transform to C, closing the differentiation by contraction. The second state is E, E→C, and C→E, E, E→C, and C→E, closing the differentiation by expansion; both states are produced by a self-entrant logic similar to the transitions considered by Maxwell-Poynting (see Appendix), in which each shearing layer has one potential type of tissue.

So rather than having only Boolean states, say 00 and 11, corresponding to contraction or expansion in either side of the equator, there are transitional states which we denote as 01, 10, embodying the transition of expansion to contraction and vice versa, respectively, corresponding to the imaginary values (time waves) in a 4-state logic. We shall find these states in the topological representation of the KBL given above, from which the genetic code can be constructed in a most simple way obtaining a planar fractal structure (Rapoport 2011c). Thus, the differentiation process, rather than being a ever two-valued Boolean branching tree (Gordon’s basis for a theory of evolution), is a path on this fractal structure, which stands as a bauplan for differentiation, which appears at each step of differentiation as a non-Boolean two-branched tree, say C, C→E, and E →C in one branch, E, E→C, and C→E, in the other. Along the lineage differentiation tree, the time waves are

always present. This is the 'memory' intuited in (Gordon 2002, 2011) embodied in nuclear DNA, given that the tensegrity structure cytoskeleton returns to a metastable state in which the differentiation is eventuated, yet in anticipation by the bauplan. The robustness of this bauplan under environmental hazards will be discussed in (Rapoport, 2011c). The KBL we have based upon this paradigm has a fused ontological/epistemological nature in contrast with the *epistemic* Bayesian inference 'logic of biology', in the systemic approach in (Szallasi, 2007).

### Conclusions

We have shown that the KB logophysics can provide a basis for embryology, which can be extended to cell biology and body integration, and to chemistry (Rapoport, 2012). In this conception allosterics is about bioresonance and KB invagination, rather than the key and lock models or its extensions.

What is maintained to be a sacrosanct metacognitive tenant that separates the world by posing fixed categories, Exterior and Interior, has been surmounted and found that Nature, already in the ovum, the cell, the body, and down to the molecular and particulate levels (Rapoport, 2012), are all embodiments of this self-reference: Semiotic signs in which we are discernable by (and discern) through boundaries which are subverted, and that actually the worlds are, by and through these subversions of the forms by themselves. We cannot but remark the universality of this self-reference, present in the structure and physiology of the mammal heart (Torrent Guasp, 2005), in the physiological organization of the body in terms of the KB topographic mapping of the sensorium (Weber, 1968; Rapoport 2011b), in the KB gestalt of human vision that has transpired from the statistical topological analysis of photographs of natural sceneries (Carlson, 2009), in the genetic code and its relations with the Dirac algebra of quantum mechanics and in the joint constitution of double 3D representation for space and momentum space (Rapoport, 2011c), in the muscle-bones tensegrity structure of the human body, and in cosmology at the centre of the Milky Way (Molinari et al, 2011). So perhaps we can intuit the notion that the

human body is also the manifestation of a time wave as the LGP manifestation of self-reference.

This is not the world as we knew it. Yet, it becomes apparent, at least to this author, that this is Nature's (so it is also ours) signature. While mathematics is considered to be the language of physics (for Galileo it was the language of Nature), the same foundational grounds have not been presented for biology usually but in ad-hoc way. The present work has attempted to modify this situation, placing logic, physics and much of biology stemming from a unified basis common to them. We have actually shown that torsion geometries are pervasive to biological structures, as a geometry for self-reference.

This approach has proposed a common basis for 'inanimate' and 'animate' gestalts in terms of the KBL and more generally the HKBL, its Time operator and chronomes, and torsion self-referential structures, the role of Time being of self-referential-control and bauplan production through time waves, and the setting of syntropic –instead of entropic- processes (Rapoport 2011b; Ho 1996).

The appearance of bauplans as in toto gestalts produced by chronomes, brings to the fore a world which appears as teleonomic, and anticipative in the sense presented in (Dubois, 1998), in which the bauplan holds the in-formation in time, as the unfolding of the time wave.

"The processes are also *catenated* in both time and space...The processes, rather than constituting the system's 'memory' as we might think, are actually projections into the *future* at every stage. They determine how the system responds and develops in times to come"; (Ho, 1994). This was also the picture proposed by Illert. We have related this to imaginary motions that actually sustain the in-formational processes as motions in real 3D space and to the duplication of 3D space that appears from a superposition of two KBs (Rapoport, 2011c)

Gordon contemplated the possibility of the cell splitter, that appears to produce the differentiation process, be erected by time waves as a prewave of synchronization, yet dismissed it due to the teleonomy implied and lacking the KBL to sustain it

(“smacks infinite regress”, (p.1197, Gordon 2002); indeed, it does; for the relation with the Myth of Eternal Return as a self-referential process see (Rapoport, 2011b). This idea of time waves generating patterns in *wholeness* as presently envisioned for embryological development is surprisingly universal. We may recall the development of the sunflower in terms of torsion shear as already described above, which seem to appear from oscillations of the homogeneous undifferentiated central extended area of the sunflower (Palmer and Steer, 1985) as well as the standing waves that generate in toto the periodic table of elements including its nuclides, which stems from the torsion Fibonacci spiral geometry for atomic waves and its decurrent KB structure of the Mendeleev table (Boeyens, 2005). Thus, here again we surmise the previous ideas of bauplans which unfold in unison through an *imaginary* 3D space in which *algorithmic causality with 0-time physics is the case, together with a 3D space structure which are their materialization*.

Yet, in regards to an alternative to the current conception -belied by biology- of time as a mere parameter, the idea of anticipation is introduced by the subject, which already starts by posing initial conditions and acts over systems with the intent of anticipation of some chosen-to-be or prefigured final conditions, in a cognitive process very much bound to ideological prefigurations, that only a *paradigm change* may bring to the fore as a self-referential unveiling *and* the revelation of self-reference, which we have submitted here. This anticipation is a natural -ontologically anchored- mode of existence of all temporary bound gestalts, in which the subject reduces the holonomy to the process between the initial and final conditions. The holonomy embodies integrated differential (imposed by a boundary, in the sense of Spencer-Brown) ontological levels of causality, which transcend the mere physical causality which might be related to the differential ontology-epistemology of Johansen (Johansen, 2008). Essentially, anticipation is an *epistemic* categorization rooted in the KB ontoepistemology. The reaching to the prefiguration of the future by incursion on

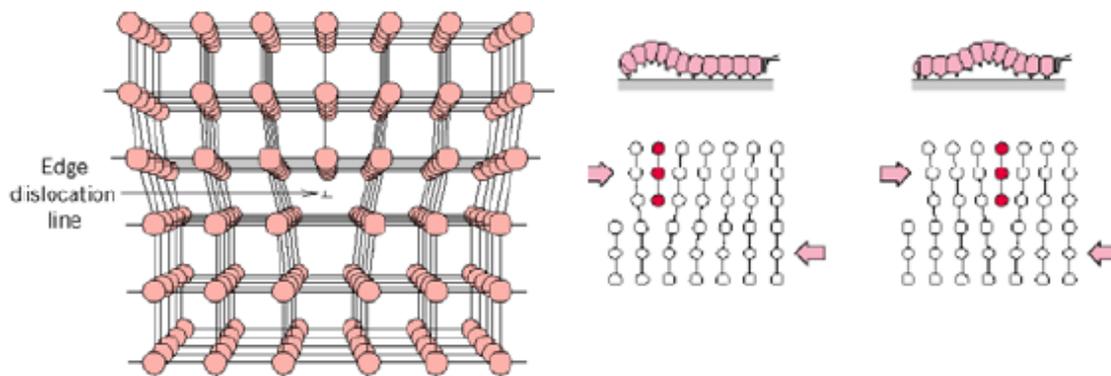
the chronome, is for the being of Time, in and by self-determination; it is the action of will, free as the chronome is in its paradoxical Being.

Yet, the being of organisms is not exhausted by the KBL, but by nested families of them (say, cell, organ, body, family, socio-cultural-economic-climate group, planet, cosmological realm in *mutual* self-penetration), as a paradigm of the HyperKlein bottle Logic, HKBL (Rapoport, 2011c, 2012). In contrast with the claim that the differentiation waves produce a mechanical basis for the genetic code, we have found that the dualistic approach which in the Boolean signal codification of Gordon leads to this claim by using the binary character of the generation to *suggest* that it is of the *whole* genetic code; in the KBL ontoepistemology, we have identified instead a *single* codon-anticodon pair for embryological development, which though it sets the codification for the differentiation process, it is fully algorithmically embedded in the whole algorithmic richness of the KBL genetic code, which we shall present in (Rapoport, 2011c).

This leads to the surprising finding that from the understanding of the KBL, evolution appears to be linked to the genetic code degrees of freedom *not* used for differentiation, which may account for environmentally sourced variability (the *directed non-random mutations* (Caporale, 2003), which are ‘interiorized’ through the KBL. Instead of having to claim the preeminence of either genetics or development, we have found a common integrated basis for both. Although the *algorithmic* richness of the former seems to be greater than the one of development, logophysically they unfold in unison from the KB Being. This unfoldment is far from being accidental (no Darwinian evolution), since it actually *embodies* the self-referential *perception of novelty by the organism*, perceived as *if* belonging to the environment, in displaying one further step of the bauplan for the *inter-relation of both*: an hyperKlein Bottle bauplan.

## Appendix

### Torsion and Embryological Differentiation



**Figure no. 3.** Torsion introduced by shear in a lattice; in the rhs by a caterpillar moving in the surface of a perfect crystal. In the lhs we have a perfect lattice but in the central area in which a dislocation is the case. We see then the transition from parallelograms that close (null torsion), to non-closing and the formation of a fifth side, the torsion field.

Figure 3 shows the meaning of torsion. In an otherwise perfect crystal, i.e. one free of inhomogeneities (in practice, difficult to achieve) an edge dislocation is produced, either by removal (i.e., introduction of singularities) of atoms of the crystal, as the figure shows, or by introducing extra material (Kleinert, 1998). Torsion can be introduced by shear (i.e. the relative motion of two planes) as the Figure no. 3 shows. In this case, a caterpillar 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 vertical plane to the shearing plane. Another analogy is that of a rug, which 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 we departed with. It can also be produced by a hole in the surface (or of an apical mat of microtubules oriented parallel to the apical surface, producing an embryological expansion wave; (Gordon 2002, Gordon and Gordon 2011) extending innerwise as a tube, say an adhesion integrine molecule in the membrane that changes the topology to be nonorientable, the KB (Rapoport, to appear), and thus we have an expansion wave; alternatively, an adhesion integrine molecule is removed (say, of the apical microfilament ring in a cell, producing the embryological contraction wave, the topological change is

to orientability, due to the closing of the self-penetration, and we have a contraction wave; chemiluminescence is the case (Rapoport, 2012).

We note that the above characterization of torsion in Fig. no. 3, it also the case of the non-commutativity of two generic infinitesimal generators of continuous symmetry group; the commutator is the non-closing four sides completed by the structure coefficients of the symmetry, as the torsion of the group symmetry manifold (Schouten, 1951).

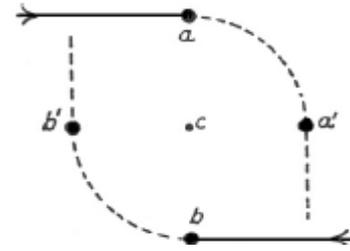
Thus, it is an action-dependent participative geometry introduced in terms of inhomogeneities by the subject, in distinction with the homogeneous situation of a Cartesian ideal geometry exterior to the subject, which corresponds in the continuum limit, to the zero torsion metric-based geometry of General Relativity (in which matter is extrageometrical; Einstein's dubbed 'clay'-energy-momentum tensor in the r.h.s. of the otherwise geometrical field equations). In short, to have loci, self-referentially dislocations are needed. Thus, the parallelograms where inhomogeneities are present do not close (while in the perfect crystal do close) and instead a pentagon is produced, the fifth new side is the torsion, completing the self-referential closure of the otherwise parallelogram. Would the fifth side be equal to the other four, we would have the five-fold symmetry typical of

quasicrystals and thus the Fibonacci sequence is embedded in this symmetry and the golden mean.

Consider now that the dislocations occur in different loci of the lattice producing a dynamic tensegrity structure; further, the lattice 'atoms' move in Brownian motion determined by the torsion geometry, and torsion is the average velocity of motions (Rapoport 2005a); the torsion covector may be an electromagnetic potential, the velocity vector of a viscous –magnetized or not-fluid, or take the form of an elasticity covector of the form  $d\psi/\psi$ , with  $d$  the differential operator,  $\psi$  either either a linear, non-linear Schrodinger or Dirac field (Rapoport 2005b, 2007,2009a), or still a propagating field satisfying the eikonal equations for light rays (Rapoport 2009a,b.2010a). Still, torsion geometries are the basis for a theory of statistical thermodynamics in which small scale fluctuations do not obey the second law of thermodynamics (Rapoport 2011d).

Notice from Fig. no. 3, that torsion stores energy, thus giving rise to syntropic processes; they are the signature of life (Rapoport 2011b; McClare, 1971; Ho, 1994, 1996). In fact the propagation of the torsion to the surface, may actually produce the breaking of the crystal liberating energy; this is a well known fact in metallurgy (Kleinert, 1998 and references therein). Furthermore, above the slip plane in Figure no. 3, we have compression while below we have expansion and thus the shearing motion produced by the differentiation wave is associated to a compression-expansion wave.

Now, as depicted in Figure no. 4, we can consider a bonding –it may be materially acted, say, by a revolving wheel on whose rim the transformation is acted upon on joining the points with spokes centered at  $c$ , or by topological identification- is established temporarily between the points of the dislocated lattice, say,  $a$ , of the upper contractive (C) and  $b$  of the lower expansive (E) layer, moving with equal velocity, by a ninety degrees rotation around the centre  $c$  in the slip dislocation plane transforming  $a$  to  $a'$ ,  $b$  to  $b'$ .



**Figure no. 4.** The imaginary motions of embryological development following the proposal by Maxwell and Poynting, to relate psyche and physis (From McDougall, 1912).

Finally the bonding is terminated on reaching the line joining  $b',c, a'$ : say, the topological identification of them is no longer considered since the entanglement has actually been produced (the MB identification has been eventuated). Now the transitions  $a \rightarrow a'$  and  $b \rightarrow b'$  are the previous  $C \rightarrow E$  &  $E \rightarrow C$  imaginary states;  $a'$  and  $b'$  lie precisely in the *boundary* between C & E, as in the self-penetration of the KB. Thus the boundary line  $b'ca'$  (the equator) between two tissues contains the *superposition* information that leads to the pluripotency of stem cells and the genetic coding of the differentiation wave.

This is the topological interpretation of the method suggested by Maxwell and Poynting (McDougall, 1912) to exert 'animate' control—the LGP *rotational* action of the Time Operator- on the physical realm *without* producing work- Yet, notable logophysical effects appear: The particles  $b'$  and  $a'$  will mutually recede in orthogonal paths to their original ones with the same velocity; and despite no work was done, this change of direction *does change the kinetic energy* of the Universe since *anisotropy* is the case (Shnoll, 2004) yet now appearing related to the non-orientable topology of spacetime. The new transitional states though imaginary (*res cogitans*), have a real (*res extensa*) manifestation. This is a surmountal of the Cartesian Cut. Finally, we note that the Time Operator is related to self-control and thus to *learning*, of importance with regards to evolution and genetics (Rapoport, 2011b)

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