

Surmounting the Cartesian Cut: Torsion, Klein Bottle, Stereochemistry, the Biomechanics of the Cell Splitter in Embryogenesis and Bauplans

Diego Lucio Rapoport

Universidad Nacional de Quilmes, Buenos Aires, Argentina

E-mail: diego.rapoport@gmail.com

Abstract: We introduce logophysics at the foundations of biology and stereochemistry, and discuss its bearing in biomembranes and quantum torsion tensegrity structure for cell biology, proposing a unified logophysics paradigm integrating topological chemistry and cell biology. We discuss the relations with the differentiation waves in embryogenesis, and a quantum geometry tensegrity model for the cell splitter, proposing a codification of the embryological differentiation in terms of the Klein bottle logic of the genetic code. We propose a new understanding to evolution in terms of the hyperKlein bottle.

Keywords: Logophysics, Torsion, Klein Bottle, Time Operator, Quantum Tensegrity.

1. Introduction, The Logophysics of Life

A fundamental problem of biology is that of cell differentiation, its relation with the genetic code and evolution. Several models of the former have been proposed, both chemical and physical, yet in regards of the logic that is ascribed to differentiation and the structure of the embryo at large, they assume the Aristotelian-Boolean dualistic logic. The reasons for this may be traced back to the apparent 'exterior-interior'(E & I) dualism that is 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 two-sphere, has an E & I which are fixed, and in terms of which the formation of tissues will proceed 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 state 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. This is already the case of the blastopore invagination, which though there is an invagination of the ectoderm by a contraction producing a 'mouth', the ensuing topology is that of the 2-sphere. Yet a second stage of

evolution is possible, by carrying a surgery of the ovum. Yet, then only orientable topologies are argued to be the case [8], though two observations are in order: 1) an ideally elastic two-sphere can be smoothly transformed through eversion (*Smale's paradox* [20]), i.e. the "outside" can be transformed into an 'inside' and viceversa, though through smooth self-penetration without producing any creases (–which is not the case of the blastopore invagination where the crease is produced superposed with the invagination, showing the torsion of the geometry produced by shear; see fig. 1 in Appendix); thus topologically, self-penetration –as is the case of the Klein bottle (Kb, for short), rather than being ruled out is topologically possible and in the case of the blastopore invagination, torsion is the field that will develop into cleavage though non-orientability is not manifested; 2) 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 is similar to the so-called double covering of a manifold; see fig. 1f in [8a]. Indeed, by this secondary invagination, the topology turns to be that of a torus; yet the torus is the double covering of the Moebius and Kb surfaces, a fact that is central to complex analysis in mathematics [29]. It is quite remarkable that these studies have failed to account for these topological and geometrical features, claiming instead orientable topologies – whilst not identifying the torsion geometry for development and the formation of the embryo, and the embryo itself. The dualistic stance, despite the pluripotency of embryonic stem cells, is maintained in the different studies of embryological differentiation [5,6]. At all stages, the differentiation process is said to be *resolved* 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 of 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 (which we have called the Klein bottle logic, Kbl, for short) is multivalued and has *imaginary* transformations states [16,17]. These imaginary states (see also [30]) 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 [16,17]. 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. Indeed, in the Kbl, the Hadamard operator representation of the Kb, transforms the paradoxical superposed states into the Boolean states (say, E & I), which by further recursive 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 [16]; 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 the cell. In this article we shall see that this is indeed the case, by expounding a more fundamental-logophysical- causality, than the mere chemical or Cartesian-physical causalities, which are daily entertained by the working scientists at large, yet the latter much resisted [5,11]; remarkably, we are aware of a fusion of subjectivity and the material world, embodied in logophysical laws of economy, such as demand/supply, by

which the production/destruction of merchandise is regulated. In the logo-physical causality logic and topology (or still logic and topology blend to become topo-logic) together with physics determine the real world structure and viceversa, the material world is integrated into the subjective, that 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 and environment, etc., are transcended and are immanent to the non-orientable K_b and its 4-state logic K_{bl} . The latter can be constructed from the paradoxical lifting -due to Kauffman and Varela- of the calculus of distinctions due to Spencer-Brown [30,31], as proved by Rapoport [16]. Remarkably, this calculus proceeds from the notion of a primeval cleavage on the otherwise ideal homogeneous state, which we interpreted as the semiotic codification of the primeval self-referential geometry defined by a torsion field. The fixation of this frontier-skin-membrane for a system thus defined by this semiotic codification -say a cell, through the establishment of its membrane-, establishes a world. Indeed, an organism is defined by this cleavage and the ensuing motions through it, and more important, the time motions that are associated to the imaginary logical values [30] that are produced by the self-containment of a form produced by this skin: the K_{lb} . Time waves (and a consequent Time Operator which is logophysical and cognitively produced by distinction of logical values, and physically by a ninety degrees rotation in either the cognitive or complex planes) are associated to this self-containment, which as we already disgressed with respect to the ovum, in logophysical terms it can self-invaginate, so that the logic is the paradoxical one that arises from the self-containment of the form (manifested by self-invaginations transforming E into I and viceversa, which we shall see in the course of this work to manifest as a bauplan of embryological differentiation and its relations to the genetic code also establishes the self-development of the ovum to a full organism. 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 Time Operator which we linked to intention-will [17]; this operator appears from identifying opposite points on shearing surfaces -which we currently know that produce torsion and thus the five-fold Fibonacci structure appears -see Appendix; the reader is urged to read the forgotten monograph by McDougall, especially page 212 [35]. The periodic table of elements -on including the nuclides-, has the topology of the K_b arising from the torsion 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 which appears to generate their order [32], in the case of developmental embryology it was intuited -and dismissed due to the rejection of intention-teleonomy- the possibility that the differentiation waves, that produce this development has for ultimate basis a similar standing wave as a time pattern which comes to manifest as evolution; see page 1197 in [5]. Standing waves produce the floret structure of sunflower [33], a basic example for Fibonacci's sequence, from which the natural numbers surge [34] as well as the Mendeleev table [32]. Natural numbers can be generated from an original 8x8 revolving matrix, following a Fibonacci structure, which allows to identify the primes [34]; concurringly, we have predicted that the prime numbers can be generated by a

standing wave [35]. Thus, rather than the undescribed attribution of the *emergence of complexity* as a counterproposition to the fracture due to the Cartesian Cut, we are here suggesting the notion of space gestalts –bauplans-(*design* plans) unfolding from time waves, as is already the case in the Kbl and the examples just mentioned; more examples and anatomical-physiological-perceptual issue, see [17].

2. NON-ORIENTABILITY IN CHEMISTRY AND MEMBRANES

For the biologist prone to advocate chemical mechanisms as if they would exhaust possible explanations of biology, we note that the non-orientable Mb and Kb surfaces are fundamental to stereochemistry, which examines the spatial relations between atoms and groups within a molecule and also between different molecules: i.e. the conformational geometry of molecules. These spatial relations turned out to be minimalistic and based on topology, since already the concept of bonding between atoms turned out to be of topological nature. Not surprisingly, stereochemistry appeared through the tetrahedron and its ability to represent enantiomers through its 2d representation initiated by Emil Fischer. In an early review [25], it was claimed that "...The examination of topological structures is not only intrinsically of great cognitive interest, in the sense of the opportunities for realising mathematical entities in a material, molecular form. It is no less significant that the actual properties of molecular systems may cause behaviour which is *topologically indeterminate* but nevertheless almost the same as for a topologically ideal system." We notice that this is essentially the same thesis we are claiming for biology! One of the forms of topological isomerism deals with the same issue that cells do, the E & I which arises from the real non-pointlike character of atoms, namely, the set of spheres formed by the van der Waals radii of chemically non-bonded atoms in a molecule effectively create a closed surface. As a consequence, an atom or a molecule in the inner region is unable to pass into the outer region, since it is of finite size. Here we find at an atomic level the issue of penetration of biomembranes. The proposed topological hypothesis makes no demands on the size of the species to be transported (the migration of large molecules across membranes are known [25]). The main idea is that, at least in some cases, no real penetration takes place *through* the membrane, which is a *one-sided non-orientable* surface, say Mb or Kb. The suggestion was that if a particle Z is firmly attached to a site on the 'outside' of the membrane, induces a change in the conformation of the surface due to its bonding or some other cause, the site may move 'inside' in the sense of a Kb invagination (Fig. 3b [25]), where the particle is removed from the membrane. Thus the apparent result is the penetration of Z through the membrane, which is actually a consequence of the conformational change in the surface which *becomes non-orientable*—a special kind of the allosteric effect, which is conceptually predominant in biology. Biophotons emission due to change of conformation by re-organization of chemical bonding is known in biology as *chemiluminescence*; it is to be noted that chemiluminescence is recognized to be the basic process for syntropic (in distinction of entropic) organization of organisms using stored energy of chemical machines, and that is the resonant energy communication of quantum entanglement in organisms as argued in [41,46]. Most remarkable is the fact that the Kbl, which includes quantum, fuzzy and

Boolean logics as subcases, is essentially an entanglement topologic due to the non-orientability of the Kb, so that the quantum coherence of living organisms has in Kbl a logophysical operator and biochemiluminiscence a manifestation of quantum (topo)logical entanglement associated to stereochemical changes, which we shall further associate to the tensegrity structure of the cell's matrix. Remarkably, a molecule that can switch both topologies *without* breaking any chemical bonds, orientable and Mb topologies has been devised [11], a Moebius topology has been revealed in Inorganic Chemistry [28], while the analysis of 'simple' molecular conformational data reveals that cyclo-octane rings have a Kb topology [22]. Furthermore, the issue of non-orientable stereochemistries is the core of aromatics [9]. Sokolov's prophecy has been proclaimed as new paradigm for stereochemistry [52]; also, the genetic code is based on the Kbl, as we elaborate in [44]. Therefore, we find already in stereochemistry (and in the Mendeleev periodic table of elements [32]), the logophysics we are claiming for biology. Thus, we suggest that it may be possible that bindings of molecules at the membrane can produce conformational changes without chemical bonds breakings, that transform its topology from two-sided orientable to one-sided non-orientable, as well as that of the molecule (we shall retake this issue below), with the production of bioluminiscence. Yet, the interior of the membrane as a vacuous interior to a non-orientable bilayer lipid would be identical to a massless quantum surface interface that appears in the Kb structure of the periodic table of elements, and thus associated itself to a boson field [43], which we associated to the torsion photon field [16,17,18]. Alternatively, we could think of the bilayered membrane undergoing a stereochemical transformation induced by adhesion to its boundaries of *integrine* molecules. Thus, would a stereochemical transformation through binding at the surface of the membrane occur, it would be accompanied with photon emission of both the membrane and the adhered molecule, which would produce an electromagnetic signal that would lead to non-local effects both E & I, which under the topological change from orientability to non-orientability, would lose the dual distinction. The extracellular matrix as a tensegrity (i.e. in which tension is continuously distributed to the whole –say, a spider's web) structure (fig.5, p. 13, [13]) coincides with the tensegrity structure of the Kb proposed by de Jong [10]. This matrix is connected with the cytoskeleton -through molecules known as integrines in adhesion sites of the membrane [36] which we proposed to modify the membrane's topology; this holonomic system: connective tissue, cytoskeleton, nuclear matrix, has been termed the *living matrix* [37]. Hence, it is natural to conceive, unless we introduce the E & I duality, that the tensegrity structure for the living matrix has the Kbl. This matrix does not only carry energy, but also information, and quantum phenomenae are at its roots; we shall return to this later on examining a new paradigm for the cell. This radiation field might be associated with the mitogenetic field discovered by A. Gurwitsch [7], which lead to biophotonics as well as to the studies of the torsion phantom effect discovered by Gariaev [18]. In our conception, the photon is a universal objective-surjective gestalt, which cells have proved to be able to self-organize in terms of their 'perception' [1]; we can venture – following [1]- that the cell's tensegrity *living matrix* is the gestalt in question and that the signaling to which it responds are electromagnetic waves carriers of biophotons. We

have identified in the bioresonance through biophotons, the source of selfhood [17], which is identified as the quantum coherence of living organisms in syntropic self-organization [17,41].

3. ON NEW PARADIGMS TO CELL BIOLOGY: PHYSICS AND LOGOPHYSICS

Recent studies on the physical-chemistry basis of life have contested the current paradigm centered on the assumed continuity of biomembranes: "If a continuous barrier envelops the cell and is consequential for function, one needs to explain why breaching the barrier is not more consequential than the evidence indicates. On the other hand, if we entertain the possibility that the barrier may be non-continuous, so that creating yet another opening makes little difference, we then challenge the dogma on which all mechanisms of cell biological function rest, for the continuous barrier concept has become axiomatic. Is there an escape?";[22]. The proposed solution, which as we have argued already, we will integrate through the dynamics of the living matrix to the possible change of orientability of the topology of membranes due to adhesion discussed before, is to propose that the cytoplasm is not aqueous –liquids demand a membrane for contention- but rather a gel, i.e. soft solid materials formed by the fibrous aggregation of low molecular weight gelators in solvents; for the relation to bioresonance see [41]. Furthermore, phase transitions in the cell [15] would occur for the living matrix as a tensegrity structure embodying the transformations of it and the logophysics. Physical distortion of load-bearing molecules can directly alter biochemical activities [3,37,39]. Thus, both changing the level of the tension in the cytoskeleton and chemically modifying cytoskeletal architecture can significantly impact cell form and function. Indeed, it is through these varied functions of the cytoskeleton that living cells can exhibit behaviors that are far beyond anything observed in man-made materials. Water molecules assemble into higher order *geodesic* tensegrity structures, because their dipole charge distribution exhibits a tetrahedral form much like the electron clouds of carbon [3]. Already here the torsion geometry is the issue, since we it is possible to realize these *shortest* (i.e. geodesic) paths by the torsion geometry produced by the (eikonal) *light rays* propagating as electromagnetic fields, from which the tensegrity structure of the living matrix is generated. Thus, we may think of non-null torsion to be related to the biomechanics of cell division and to the change of topology of the cell membrane and yet to the tensegrity structure of the cytoskeleton, as we shall argue below. To resume, the integration of the living matrix as a tensegrity structure through the integrines and adhesion has been highlighted [38] and from our previous discussion this can produce a stereochemical modification in the membrane, changing its topology and establishing thus a continuity of I & E rather than proposing a loss of continuity of the membrane, if not by self-penetration. We can further relate this geometry to cognition and the Kbl, since the twistor representation of this light geometry leads to the generation of the eigenstates of the null operator of Kbl, providing thus a basis for all logical operators [21]. Thus, the quantum tensegrity structure of the living matrix could serve as a quantum computer operating with the Kbl [48].

The physical gelation of liquid crystals, the so called liquid crystal gels leads to the formation of a variety of self-organized structures. The underlying liquid crystal structure of the collagenous matrix of cells and extracellular organization, on which polymers interact, which have remarkable properties for the transmission, storage and processing of information essential to physiological regulation (see [37] and references therein, and [13]), which is also the case for liquid crystal gels. An important constituent of this tensegrity is collagen which has remarkable electro-optic properties; it is a semiconductor whose conductivity increases a million-fold in presence of water, so endogenous light (electromagnetic torsion whose singularities are the photons) communication may use it as a scaffold, alike fiber optics. In fact, these structures which are fundamental constituents of connective tissues, may play a fundamental integrative role of the whole body [39]. So liquid crystal gels can be the physical basis for this new paradigm as the ultimate physical structure of cells and their extension to their environment [11,23] and furthermore, their geometry is related to torsion fields which present the singularity K_b structure [17]. Yet, due to conservation of the topological charge of these singularities, they end on other singularities -creating thus a network-, and on the surface of the crystal, creating thus the physical dynamics for an (e) invagination of the membrane seen from an "internal" perspective. So the appearance of discontinuities at the surfaces is not needed to be contested, but rather is essential to the appearance of singularities producing topological charges, very much alike the Aharonov-Bohm non-local effect (providing thus the physical basis for biophotons), which can be also deduced from propagating electromagnetic fields that are carriers of extended singularities, i.e. photons, producing thus a torsion field and as well, Brownian motions which appear as the basic background self-referential logophysical geometry produced by them [18]. It was proposed that the topology of these singularities is that of the K_b , which is self-penetrating [16,17,43].

It is important to remark that there are notable physical effects, in one hand that these fluctuations cannot penetrate these singularities due to the infinite character of their torsion, and the fact that it has been known that liquid water behaves differently from bulk water in the region of interfaces, showing that colloidal and molecular solutes are excluded from extensive regions next to many hydrophilic surfaces [23]. "Surrounding many biological tissues is a zone of extremely slow diffusion extending up to hundreds of micrometers from the surface. Studies of these aqueous "exclusion zones" reveal a more ordered phase than bulk water, with local charge separation between the exclusion zones and the regions beyond. The present studies make clear that the buildup of this more ordered near-surface zone involves charge separation and that the underlying energy source is incident radiant light. Interestingly, the wavelengths most responsible for building this zone are the very wavelengths most strongly absorbed by water. Hence, in a more general context, it may be that a good fraction of the electromagnetic energy absorbed by water is used to build order and separate charge"; [2,12,14]. Thus, the building of these ordered low entropy areas of the cell are related to the torsion geometry produced by light, that already sustains the most infinitesimal level of dynamics of cells as active media, the cell's Apeiron, as we had digressed in

our theoretical studies of the appearance of life as related to the Time Operator associated to these geometries and the appearance of syntropic processes [17]; for the genetic role of Apeiron, see [43]. The aggregation phenomenae is traced back to Feynman's *paradoxical* principle [4], 'like-likes-like through an intermediate of unlikes', to explain with excellent agreement between theoretical expectations and experimental observations, the phenomenae of colloidal -and possibly down to the nano and molecular levels- coalescence, which would have important implications for self-assembly aggregations and "complexity".

Therefore, the paradigm of a liquid crystal gell, for the physical basis of the cell's dynamics, is associated to self-referential quantum torsion geometries, acting as logophysical fields, and naturally, the self-penetration which this paradigm claims to surpass the continuity of biomembranes, is already the case due to the singularities that these fields carry. Yet, somewhat in disagreement with this paradigm, rather than exclusively playing down the role of the membranes, the conclusions that we arrive from these observations, lead us to stress the fact that their loss of continuity is not to be taken as secondary [43], but rather defining the self-referential self-penetration topology of cells and the multivalued Kbl of their functioning, and that torsion fields are fundamental in this. So, we are upholding a logophysical understanding of the membranes, instead of looking for a physical basis of the functioning of the cells, disregarding the Kbl; already the gell paradigm concedes to paradox, as explained before [23]. We quote Ling, the initiator of this -very resisted- physical paradigm - "...to understand the mechanisms 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"; page 320, [11]. To resume, the physics of the inanimate world is the basis for living phenomena, logic is a mere *extracorporeal non-physical* (in contrast with the Kbl ontological embodiment) methodological *instrument* for theoretical deduction; any principle, such as vitalism unconnected to physics is ultimately related to the sphere of Being, and thus outside of the realm of science; for differing takes see [16,17,43]. A similar physicalism for embryology and its unification with genetics and evolution was elaborated by Gordon [5,6], again in criticism of vitalism, introducing a tensegrity structure unconnected to quantum physics but to continuum mechanics; yet, they are related through the torsion geometries of Brownian motions and fluid-dynamics, electromagnetism and quantum physics [48].

4. TORSION, DIFFERENTIATION WAVES, KLEIN BOTTLE LOGIC & EMBRYOLOGY

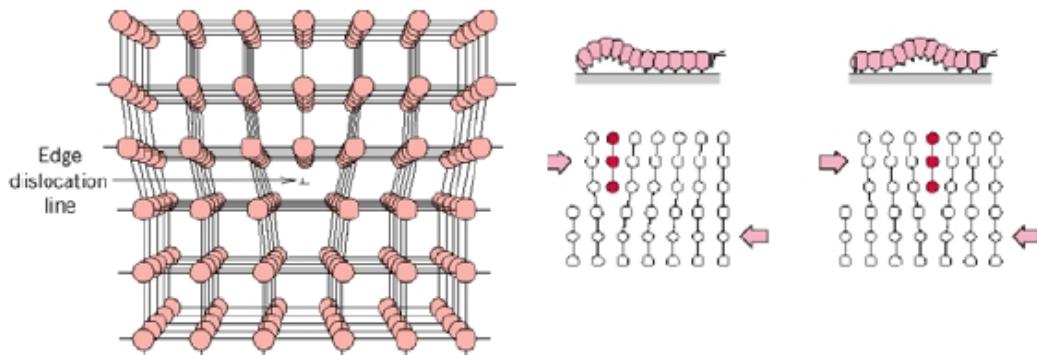
Gordon proposes a mechanical model of the cell as a physical active media, on which a boolean logic of differentiation *emerges* from the mechanics of differentiation; in this take, the logic of the embryo is *deduced* from the physics; it is merely epistemic, rather than being a generator of organization. "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] 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''; [5]. 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 [16,17,30,31]; 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.'' ; see [5]. To resume, Newtonian mechanics determines both genetics and phenotopics (p. 1058,[5]), while a fundamental role of logic is eschewed though explicit already in the departure, and the dual evolution is conceived to be a by-product of the mechanics, not a fundamental causality operator, though the topology of cells and organisms is assumed from the start to be orientable; see page 1, [5]. 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 logophysical generator, that integrates cell and environment, as currently proposed [16,17].] 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 [5]. ``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 [5]. Thus, to avoid vitalism and teleonomics, a return to Newtonian physics & mechanicism 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 [16,17,43]. Thus, the ever mysterious preconceived distinctions between ``animate and non-animate'' are futile, since intention related to self-referential-control-determination is a fundamental action of the Time Operator, which is universal [17]. For a start, a very important issue is that the differentiation waves follows the *shortest* paths in the cell as an active substrata (see p.276. [5]), with which they interact; in other words, they behave as light rays, satisfying the eikonal equation of light [18], alike the wáter tensegrity in cells [3]. Thus, they produce a quantum tensegrity structure. 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 [18]. 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 cykoskeleton's tensegrity structure, producing a *kind* of tug-of-war 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 logophysical model of embryogenesis, 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. 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, closing the differentiation by expansion; both states are produced by a self-entrant logic similar to the transitions considered by Maxwell-Poynting [36] (see Appendix below), 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

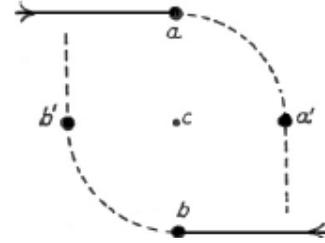
transitional states which we denote as 01, 10, embodying the transition of expansion to contraction and viceversa, respectively, corresponding to the imaginary values in a 4-state logic. We shall find these states in the topological representation of the Kb from which the genetic code can be constructed in a most simple way obtaining a planar fractal structure; for the details see [44]. Thus, the differentiation process, rather than being a ever two-valued Boolean branching tree, is a path on this fractal structure, which stands as a bauplan for differentiation, which appears at each step of differentiation as a two-valued non-Boolean branching tree. This is the ‘memory’ intuited in [5,6] 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 [44]. 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 [51].

6. APPENDIX. We introduce the figures already mentioned, and their explanations.



The first figure 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; 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 “mud”-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. Torsion can be introduced by shear (i.e. the relative motion of two planes) as the second figure shows. In this case, a caterpillar moves a lattice a step at a time, and the shear produces the torsion of the crystal. Another analogy is that of a rug, which moving in the perfect background of the homogeneous crystal; local changes affect the whole structure. 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; [5,6]) extending innerwise as a tube, say an adhesion molecule in the membrane that changes the topology to be nonorientable, the Kb, and thus we have an expansion wave; alternatively, an adhesion molecule is removed (say, of the apical microfilament

ring in a cell, producing the embryological contraction wave [5,6]), the topological change to is to orientability due to the closing of the self-penetration, and we have a contraction wave; chemiluminescence is the case, as explained already. 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 [47]; 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, ψ either a linear, non-linear Schrodinger or Dirac field [47], or still a propagating field satisfying the eikonal equations for light rays [18]. Notice that torsion stores energy, thus giving rise to syntropic processes; they are the signature of life [17,41,46]. Furthermore, above the slip plane 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 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' . 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. 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; see [45]. 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 Pontyng [37] to exert 'animate' control – the logophysical action of 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 [17,21,43,47]. 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; [17].



7. CONCLUSIONS We have presented an integrated paradigm of cell biology in terms of the Kbl (also as a possible basis for quantum biocomputation [48]) and quantum torsion geometries, integrating the cell's living matrix tensegrity structure, stereochemistry and the genetic code, in distinction with the prevailing separate paradigms. This approach has proposed a common basis for "inanimate" and "animate" structures in terms of the Kbl, 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 [17]; see also [41]. 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 of Dubois [42], in which the bauplan holds the information 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"; [41]. 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,[5]). Yet, this *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 [49]; essentially, it is an *epistemic* categorization rooted in the Kb ontology. 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, as a paradigm of the hyperKlein bottle [17]. 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 Kb approach 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 Kb genetic code, which we shall present in [44]. 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, may account for environmentally sourced variability (the *directed non-random mutations* [50]), 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.

Acknowledgements: My gratitude to Prof. Stephan Praets, Dr. Istvan Diénes, Craig Nevin & G. de Jong, for crucial references, to Prof. Dr. Daniel Dubois, Dr. Salvatore Santoli and Dr. A. Grapone, for their invitation to contribute to the pioneering Session "Physics and Logic of Anticipation in Biosystems", CASYS' 11. My wife Sonia, and my children, Tania and Tsafir, made this work possible with their love.

References

- [1]Albrecht-Buehler, G. (1992), *Proc Nat. Academy of Sciences USA*, 89, 8288–8292.
- [2]B. Chai, H. Yoo, and G. H. Pollack (2009), *J. Phys. Chem. B*, 113, 13953–13958.

- [3] Donald Ingber (1998), 48-57, Scientific American, January, 1998.
- [4] R. P. Feynman et al (1963), The Feynman Lecture on Physics, Addison-Wesley, MA, ch. 2, p. 2.
- [5] R. Gordon (2002), The Hierarchical Genome and Differentiation Waves, World Sci., Singapore.
- [6] N. K. Gordon and R. Gordon (2011), Embryogenesis Explained, World Sci..
- [7] Gurwitsch, A. G. (1911), *Archiv fuer Entwicklungs Mechanik der Organismen*.
- [8] a. H. Jockusch & A. Dress (2003), *Bull. Math. Biol.* **65**, 57–65; Maresin, V. M. & E. V. Presnov (1985), *J. Theoret. Biol.* **114**, 387–398.
- [9] R. Herges (2006), *Chem. Rev.* 106, 4820-4842; H. S. Rzepa (2005), *Chem. Rev.* 105, 3697-3715
- [10] Gerald de Jong, <http://www.darwinathome.org/blog/default/2009/09/10/Tensegrity-Cylinders.html>
- [11] G. Ling (1992), A Revolution in the Physiology of the Living Cell, Krieger Publs. Co, Malabar, Fl.
- [12] E. Nagornyak, H. Yoo & Pollack, G. H (2009), *Soft Matter*, 5, 3850–3857 | 3855
- [13] A. Pischinger (2007), The Extracellular Matrix and Ground Regulation, North Atlantic Books.
- [14] Gerald H. Pollack (2003), *Adv. Colloid Interface Science* 103, 173–196.
- [15] Pollack, G.H (2001). *Cells, Gels and the Engines of Life*; Ebner and Sons, Seattle, 2001.
- [16] Rapoport, D.L. (2011), *Found. Phys.* 41, 1, 33-76.
- [17] D.L. Rapoport (2011), in *Quantum Mechanics*, J. Groffe (ed), Nova Science, NY.
- [18] D. Rapoport (2010), in *Proceedings CASYS'09*, Daniel M. Dubois (ed.), AIP Conf. Series, Springer.
- [18] Berezin, A.A., Gariaev, P.P. (1996), *Laser Physics*, 6, no. 6, pp. 1211-1213;
- [19] T. F. Shklyar et al (2008), *Biophysics*, 2008, Vol. 53, No. 6, pp. 544–549.
- [20] <http://www.youtube.com/watch?v=sKqt6e7EcCs&NR=1>.
- [21] D. Rapoport (2009), in "Ether, Spacetime and Cosmology vol. 3: Physical Vacuum, Relativity and Quantum Mechanics", M. Duffy and J. Levy (eds.), pags. 389-457, Apeiron Press, Quebec, Canada.
- [22] H. Rzepa (2008), *Inorg. Chem.*, 2008, 47 (19), pp 8932-8934
- [23] Gerald H. Pollack et al (2009), *Int. J. Mol. Sci.*, 10, 1419-1429
- [24] Simanonok, K.E (1983), *Biomaterials, Medical Devices & Artif. Organs* 11:83-92, 1983.
- [25] V.I.Sokolov (1973), *Russian Chem. Rev.* 42 (6).
- [26] M. Stapien et al, *Angewandte Chemie*, Volume 119, Issue 41, pgs. 7859-8047, 2007;
- [27] R. Van Wijk (2001), *Journal of Scientific Exploration*, Vol. 15, No. 2, pp. 183–197, 2001.
- [28] <http://www.cs.sandia.gov/newsnotes/2009newsnotes.html#klein>
- [29] H. Cohn (1967), *Conformal Mappings on Riemann Surfaces*; T. Frankel (2000), *The Geometry of Physics*, Cambridge Univ. Press, Cambridge (UK).
- [30] Kauffman, L., in *Proc. VIIIth Int. Symp. in Multiple Valued Logics* (1978),. IEEE Computer Society Press, 82-86; Varela, F. (1979), *Principles of Biological Autonomy*. North-Holland, New York .
- [31] G. Spencer-Brown (2010), *Laws of Form*, Bohmeier Verlag, Leipzig.
- [32] J. C.A. Boeyens & D. C. Levendis (2008), *Number Theory and the Periodicity of Matter*, Springer.
- [33] R.E. Palmer and B.T. Steer (1985), *Field Crops Res.* 11, 1-12.
- [34] S. Johansen (2011), *Journal of Dynamical Systems and Geometric Theories* **8** (2), 101-171.
- [35] D. Rapoport, private communication to S. Johansen, July 2009.
- [36] W. McDougall (1922), *Body and Mind: A Defense of Animism*, Methuen, London, 4th edition.
- [37] Maniotis, A.J., Chen, C.S., Ingber, D.E. (1997), *Proc. Nat. Acad. Sc. USA* 94 (3), 849–854.
- [38] Oschman, J.L. (2000) *Energy Medicine: The Scientific Basis*, . Harcourt Brace, Edinburgh.
- [39] Chen C.S., Ingber, D.E. (1999), *Osteoarthritis Cartilage*, Jan;7(1):81-94.
- [40] Langevin H, Bouffard N, Badger G, et. al. (2005), *Am J Physiol Cell Physiol*; 288:C747-756.
- [41] Mae Won-Ho (1994), *Modern Trends in BioThermoKinetics* 3, 50-61, 1994.
- [42] D. Dubois (2000), in *CASYS'99*, Proceedings, D. Dubois (ed), AIP Conf. Proc. Series 517, 3-30.
- [43] Steven M. Rosen (2008), *The Self-evolving Cosmos*, World Sc.; *ibid.* (2004) *Dimensions of Apeiron*, Rodopi, New York; *ibid.* (2006), *Topologies of the Flesh*, Ohio University Press, Ohio.
- [44] D. Rapoport (2011), submitted to Proceedings of CASYS'11.
- [45] Mae Won-Ho (1996), in *Computation in Cellular and Molecular Biological Systems*, (R. Cuthbertson et al, eds.), pp.251-264, World Scientific, Singapore.
- [46] McClare, C.W.F. (1971), *J. theor. Biol.* **30**, 1-34.
- [47] Rapoport, D. L. (2005), *Found. Phys.* vol. 35, no.7, pags. 1205-1244 & vol. 35, no. 8, pags. 1383-

1431 ; *ibid.* (2007), *Found. Phys.* vol. 37, nos. 4-5, 813-854.

[48] Stern, A. (2000), *Quantum Theoretic Machines*, Elsevier, Amsterdam.

[49] Johansen, S.E. (2011), *Outline of Differential Epistemology*, English translation ,Trondheim,1991.

[50] Caporale , L., (2003), *Darwin in the Genome*, McGraw-Hill, NY.

[51] Szallasi, S., Stelling, J. & Periwal, V. (2006), *System Modeling in Cell Biology*, MIT Press, MA.

[52] Bonchev, D. and Rouvray, D.H. (2000), *Chemical Topology: Applications and Techniques*, vol. 6 of *Mathematical Chemistry*, Gordon & Breach, Amsterdam.

© 2011 by Diego L. Rapoport

All rights reserved. No part of this article may be reproduced, stored in a retrieval system, or transmitted or translated in machine language in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the author. The moral right of Diego L. Rapoport to be identified as author of this work has been asserted in accordance with the copyright, design, and patents act 1988