Synopsis of TBD and ANCES Theoretical Framework underlying models of neural stress, dysautonomia and consequences within neurocybernetic networks including cardiovascular and gastrointestinal subsystems

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Preface

This is intended as an informal memo providing an introduction to the underlying theoretical and biophysical models that are involved in what is presently known as the Neuroplex-C Project. We begin with elementary foundations leading from topological orders in physics to those in biomolecular systems, and then we proceed to new theoretical and practical investigatory steps forward for understanding the etiology of dysautonomia and arrhythmia-type diseases. Thus, we present a set of logical steps proceeding from elementary physics and chemistry into biology and medicine. We further make remarks on how such models can lead to improvements in diagnosis and treatment for certain types of diseases, particularly linked with autonomic neural dysfunctions that ultimate create disabling and life-threatening diseases in the cardiovascular and gastrointestinal systems (particularly but not only so). We note that progress within new diagnostics and therapeutics does not depend upon the "proof" or even widespread acceptance (or confirmation) of the fundamental theoretical framework, but upon the effectiveness of analytical procedures, including interpretation of biometrics such as derived from cardiovascular and other organ-system signal monitoring, which can lead to effective forms of medical treatment, both prophylactic and therapeutic.

Section {1} (in particular {1.1}) is provided as a brief introduction to "underlying foundations". It is recommended that one either read through it at the beginning and then again, after completing a reading of the whole document, or come back to it after reading sections {**2}** and others thereafter.

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Schema for Section Divisions, References and Notes

{1}, {1.1}, {2}... --- formal sections within the document text

[1]... [n] --- bibliographic references, listed in {5} References

[a], [b], [c]... [z], [aa], [bb]... --- references for figures, and other graphics, listed after papers and articles in {5} References

[A.1], [A.2]... --- references to subsections within the Appendix (various text excerpts)

{1} TBD foundations

TBD (topological biomolecular dynamics) derives from underlying primitives and basics within fundamental physics. These pertain strongly to geometry and topology being underlying mechanisms for the derivation of order, structure and complexity, such as do lead to self-organizing and self-sustaining energy systems that are generally described as "living" systems with self-reproducing, order-perpetuating, negentropic attributes.

It is necessary to at least minimally remark about these underlying foundations, given the name of reflexive topological dynamics (RTD), albeit only very briefly.

{1.1} RTD

"UrGrund" Fundamentals

The RTD theoretical framework begins with geometry and action that leads into the emergence of space and thus time. This is relevant to molecular biology and the transmission of energy and information in molecules and cells. Why is this so? Topological ordering and patterning is present not only at the quantum behaviors at the Planck scale, but also (one of the central claims within RTD) in geometrically transformed ways at much larger scales including those of molecular and cellular biology and intracellular communications. Therein, at such a relatively large scale (in comparison to that of particle physics and the structure of space itself) we enter into the logical space of neurocybernetic (control) mechanisms – precisely such as are instrumental in the efficient management of organs such as heart, lungs, and the gastrointestinal tract – and consequently of importance in the disorders within such very macroscalar and "seemingly-far-from-quantum" systems.

Thus some mention of these "UrGrund" fundamentals is important, in the least (here, in this informal document) in order to demonstrate that there is a path of reasoning from the "simpler" to the "highly complex", and one that, moreover, offers cause for deeper reflection and investigation with regard to causal relations – the etiologies – linking various phenomena both "healthy" and "dysfunctional". Our premise - one may even call it an "axiom", at least loosely – within RTD is that it naturally, simply, logically and inevitably leads to higher complexity and "life itself" through the medium of such things as "topological orders" that involve coherence, symmetry, and interdependence and which exist at all scales of Nature.

Very briefly and cursorily for now, we offer that the roots of RTD are found in causal dynamical triangulation and variants of quantum gravity. [1] [2] [3] [4] [5] Refer to Figures 1-5 below. We view this as being the physical foundation for emergence of strings and string-nets, which are field-like, composite-like, pre-particle (pre-fermionic/bosonic), a liquid state of "pre-matter", and described variously as a superfluid or hypercrystalline vacuum (aka dark energy, quantum vacuum, quantum flux, superfluidic ether). [6] [7] [8] [9] [10] [11] [12] Refer to Figures 6-10 below.

This memorandum not the place for going further into the physics and mathematics; thus we provide here only a few highlights and some provocative words and images. We aim to show only that there is a connection between such physics and the biology which ultimately gives rise to the type of structures – and their dynamic behaviors that – found in the very much more "macro" and "tangible" world of nerves and muscles and which give rise to the cybernetic processes by which organs such as the heart can do exactly what they are so optimally designed to do.

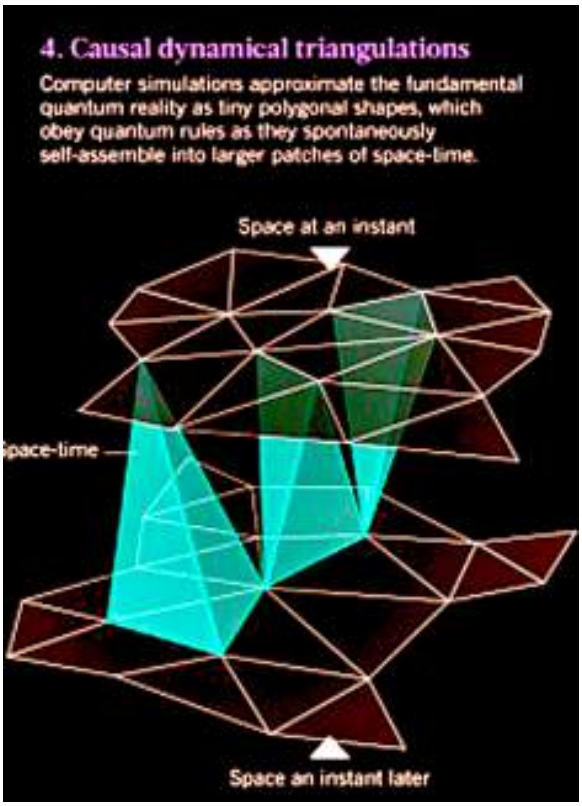


Figure 1 – Causal Dynamical Triangulation (CDT) (1) [a]

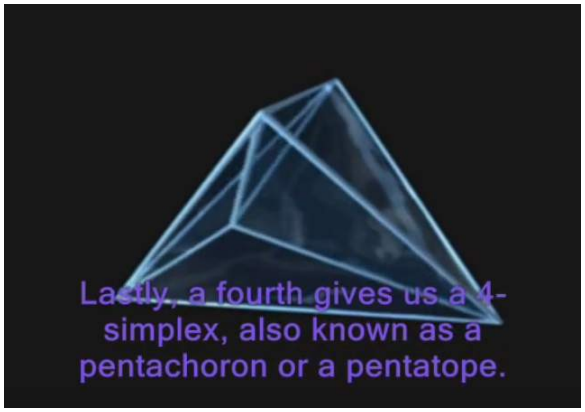


Figure 2 – CDT (2) [a]

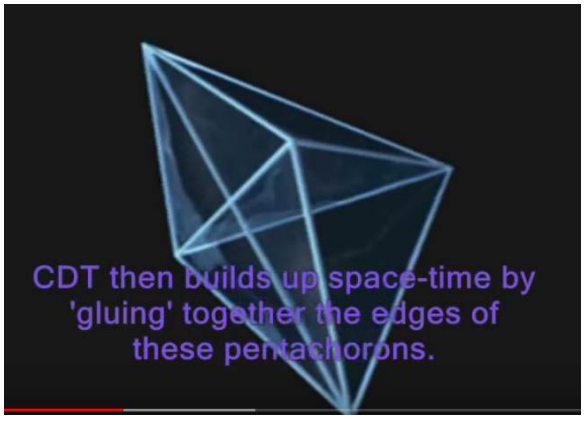


Figure 3 – CDT (3) [a]

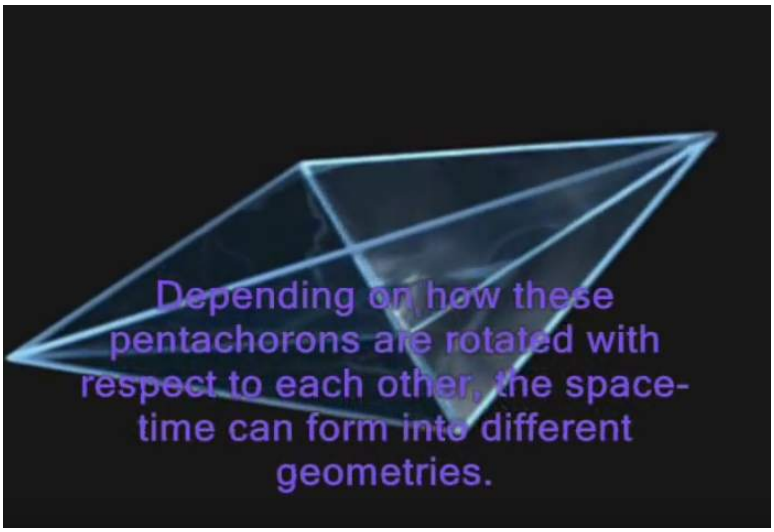


Figure 4 – CDT (4) [a]

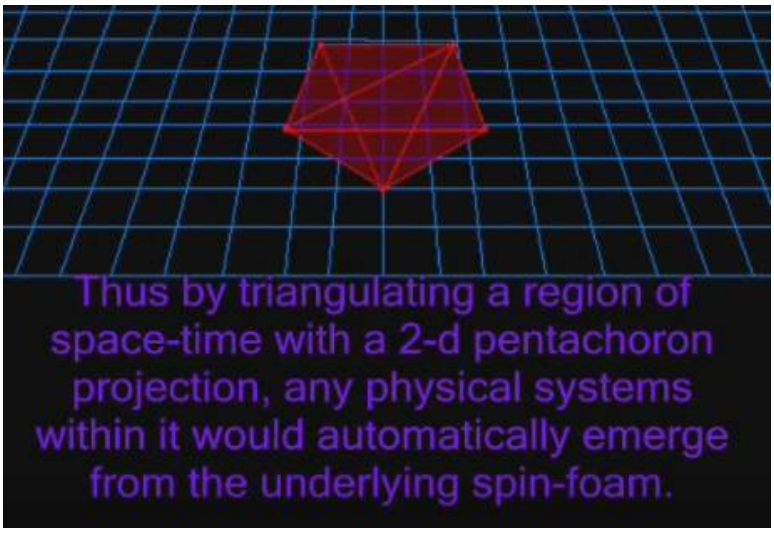


Figure 5 – CDT (5) [a]

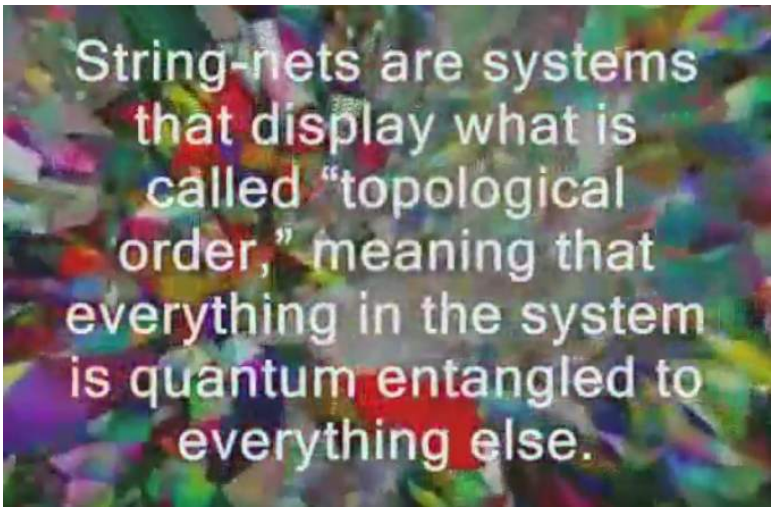


Figure 6 – String-Net Liquid (SNL) (1) [a]

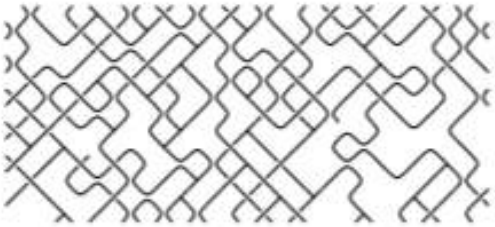


FIG. 3 A typical string-net configuration in a string-net condensed state. The fluctuations of the strings correspond to gauge bosons (such as photons) and the ends of strings correspond to fermions (such as electrons).

Figure 7 – SNL (2) [b]

FIG. 15: (a) Particles in liquids do not have fixed relative positions. They fluctuate freely and have a random but uniform distribution. (b) Particles in solids form a fixed regular lattice.

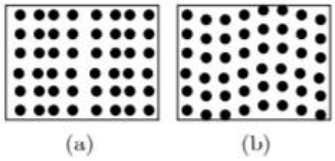


FIG. 16: The atomic picture of (a) the compression wave and (b) the transverse wave in a crystal.

Figure 8 – SNL (3) [b]

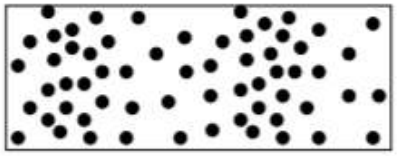


FIG. 17: The atomic picture of the compression wave in liquids.

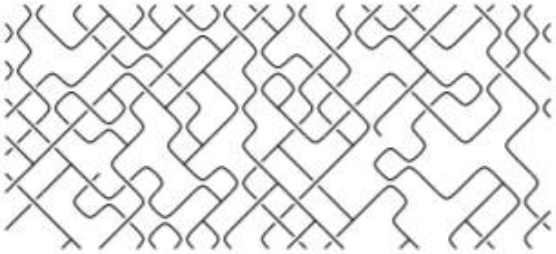


FIG. 18: A quantum ether: The fluctuation of oriented strings give rise to electromagnetic waves (or light). The ends of strings give rise to electrons. Note that oriented strings have directions which should be described by curves with arrow. For ease of drawing, the arrows on the curves are omitted in the above plot.

Figure 9 – SNL (4) [c]

FIG. 19: The fluctuating strings in a string liquid.

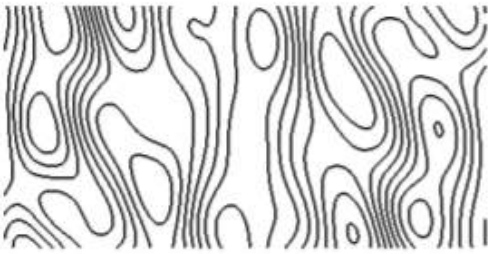


FIG. 20: A "density" wave of oriented strings in a string liquid. The wave propagates in x-direction. The "density" vector $\boldsymbol{E}$ points in y-direction. For ease of drawing, the arrows on the oriented strings are omitted in the above plot.

Figure 10 – SNL (5) [c]

Several Key Concepts within RTD and TBD

Within RTD there are certain fundamental concepts which are "mathematical-physical" and here these are simply summarized as follows:

Topological orders

involve collective entities, from the Planck-scale and larger, leading to such observed phenomena as BEC (Bose-Einstein Condensates). These involve a variety of topological order patterns (TOPs) which entail long-range entanglements, states that do not change from one into another without some type of phase transition affecting all elements in the topological structure. Generally we speak of these in terms of quantum entanglements (e.g., spin +/- configurations).

These "orders" involve consistency and coherence among what from one perspective are "parts" (observable units, such as photons, electrons (fermions), ions, atoms, molecules) but from another perspective are "wholes". (They should not be confused or limited to the topological orders discussed in contemporary literature with a focus primarily or exclusively upon architectures for qubits in certain models of quantum computing.) [13] [14] [15]

BEC (Bose-Einstein Condensates)

are such types of entities where a wave function may be derived that describes the collective entity (composed of n elements, such as atoms or ions) as a singular entity, and once again, this is on a near-macroscopic scale, for which there is evidence that the scale may be larger than "atomic" and the environmental conditions such as temperature may not be restricted necessarily to "near" absolute zero Kelvin.

Solitons

are non-dissipative (low-dissipation) waves, which manifest in a wide variety of phenomena including liquids such as flowing water [16] and in electromagnetic signals [17], and in biology. [18] [19] [20] A soliton may be described as a "self-reinforcing" wave packet. Its shape is maintained while it propagates at a constant velocity and in a constant medium (such as a channel, be that a waterway like a canal or a fiber-optic cable or a protein or nucleic acid. There is a cancellation of the nonlinear, dispersive effects and the wave continues to maintain its form. Figure 11 provides a perspective on four types of solitons.

A common equation for describing a soliton wave is given by the Korteveg - de Vries (KdV) partial differential equation:

$$u_t + u_{xxx} + u\, u_x = 0,$$

where u=u(x,t) measures amplitude at time t and position x (e.g., height of the water wave above some equilibrium level. The dispersive term is given by u_{xxx} and the nonlinear term by u_x.

The typical soliton shape can be found by direct integration of the KdV equation:

$$u(x,t) = a\, \mathrm{sech}^2[b(x-vt)]$$

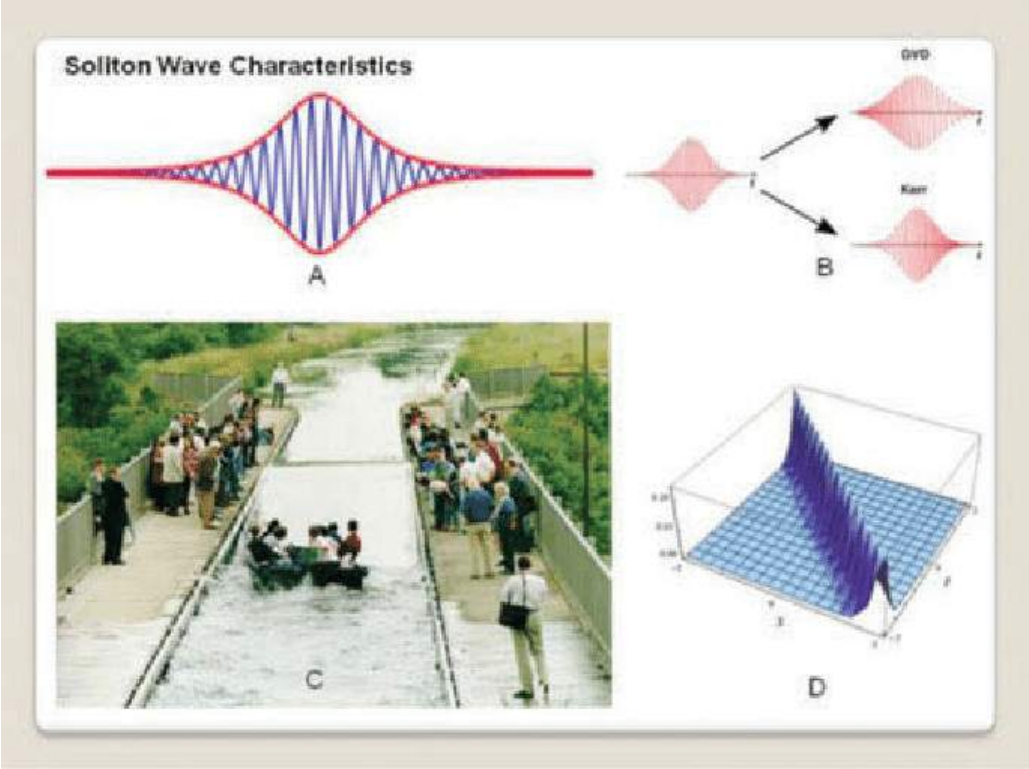


Figure 11 – Soliton wave forms [d]

A: Longitudinal soliton wave, B: Linear and non-linear soliton wave propagation, C: Union Canal in Scotland as a spot of the discovery of the solitary wave, D: Optical soliton wave representation.

Tensegrity and Tensegriton

We introduce within the RTD framework the concept of the tensegriton, which we argue can be shown to have relevance not only in subatomic and atomic physics but in biology as well, but of course with a great difference in the parameter space as we will describe in the future. A tensegriton is a model for a description of the energy composition and stability dynamics (e.g., as a vortex-knot flow within 3-space (4-space considering time as the 4th dimension), whereby the entity is "formed" by the dynamic flow of the primal superfluid quantum vacuum (SQV) in a manner that involves its complete quantum-scale environment. Tensegriton thinking is based upon actual tensegrity within geometry and classical mechanics, but also it brings in the concepts of the quantum potential and implicate order as developed historically by DeBroglie, Bohm, Hiley, Bell and others. [21] [22] [23] [24] [25].

Tensegrity concepts have a history pertaining to the biological sciences including the relatively obvious basis within anatomy and the balance of rigid and flexible (expanding-contracting) components in the skeleton and musculature of vertebrates. Figures 12a and 12b below illustrate abstract tensegrity models, and Figures 13, 14 and 15 provide a more tangible and "visceral" understanding of what tensegrity is all about in macroscalar biology. Figure 15 in particular, illustrating certain basic pelvic dynamics, has important bearing, we believe, on a number of conditions of present interest, particularly cardiovascular and relating to POTS.

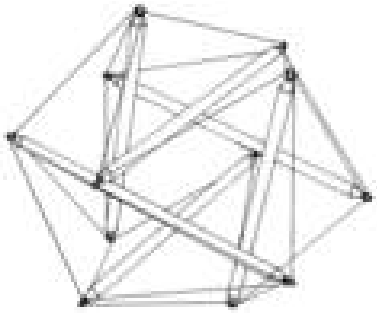


Figure 12a – Tensegrity model [e]

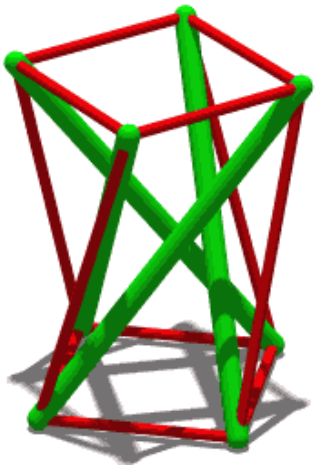


Figure 12b – Tensegrity model [e]

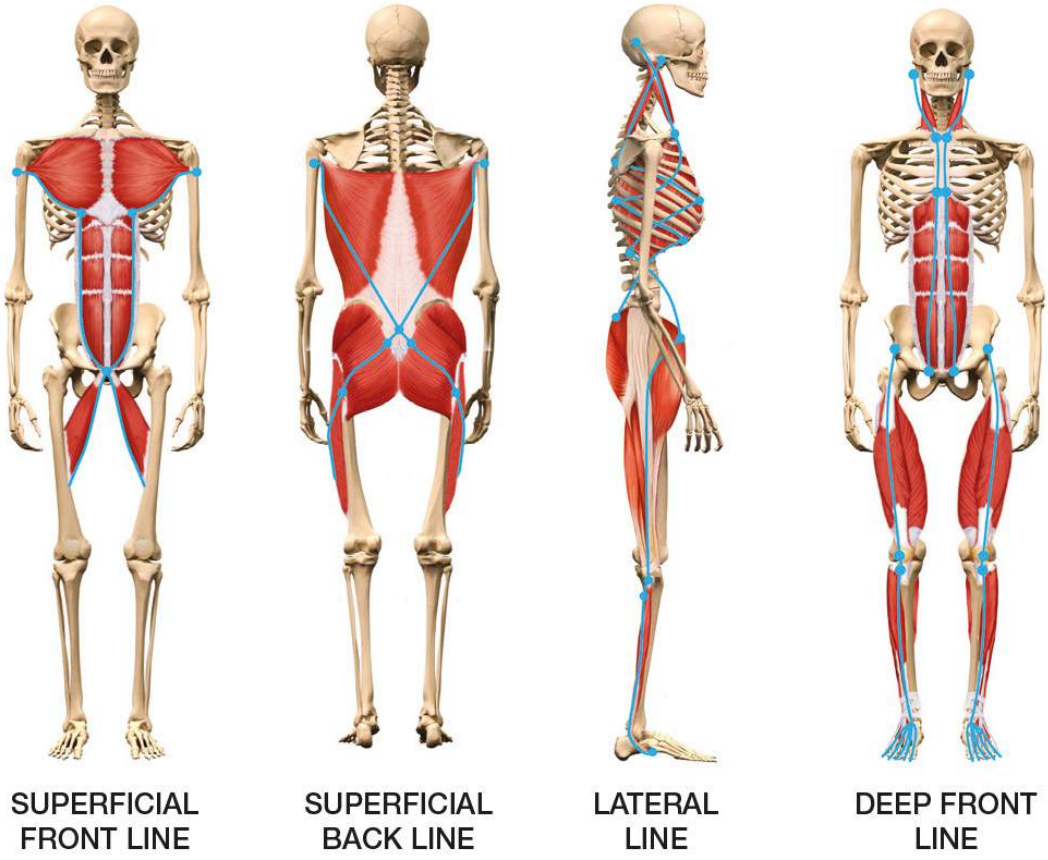


Figure 13– Tensegrity in Anatomy (1) [f]

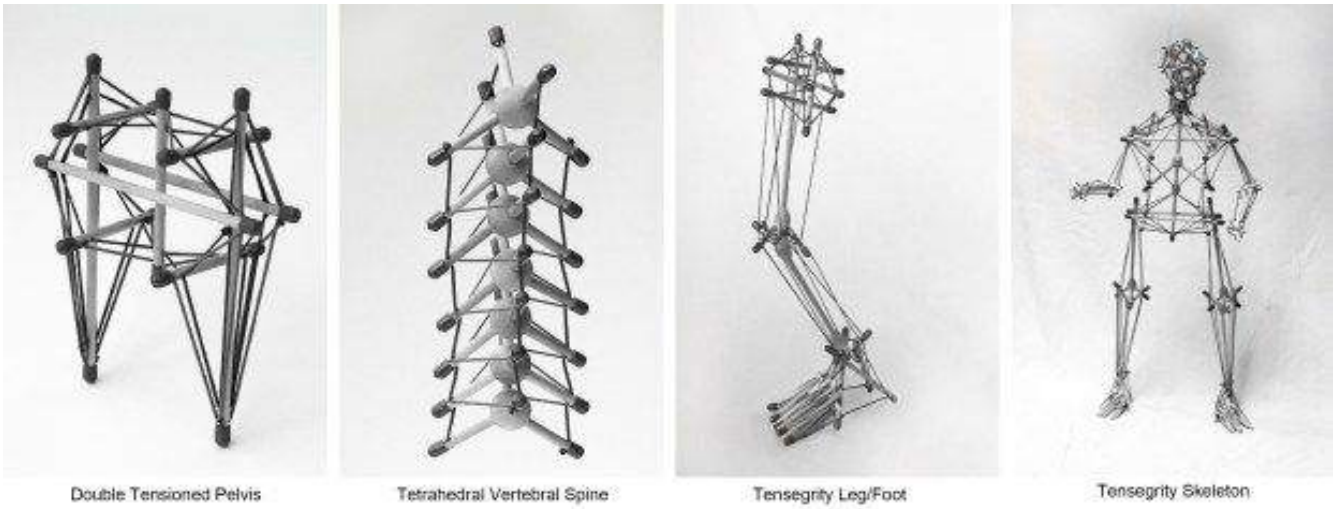


Figure 14– Tensegrity in Anatomy (2) [g]

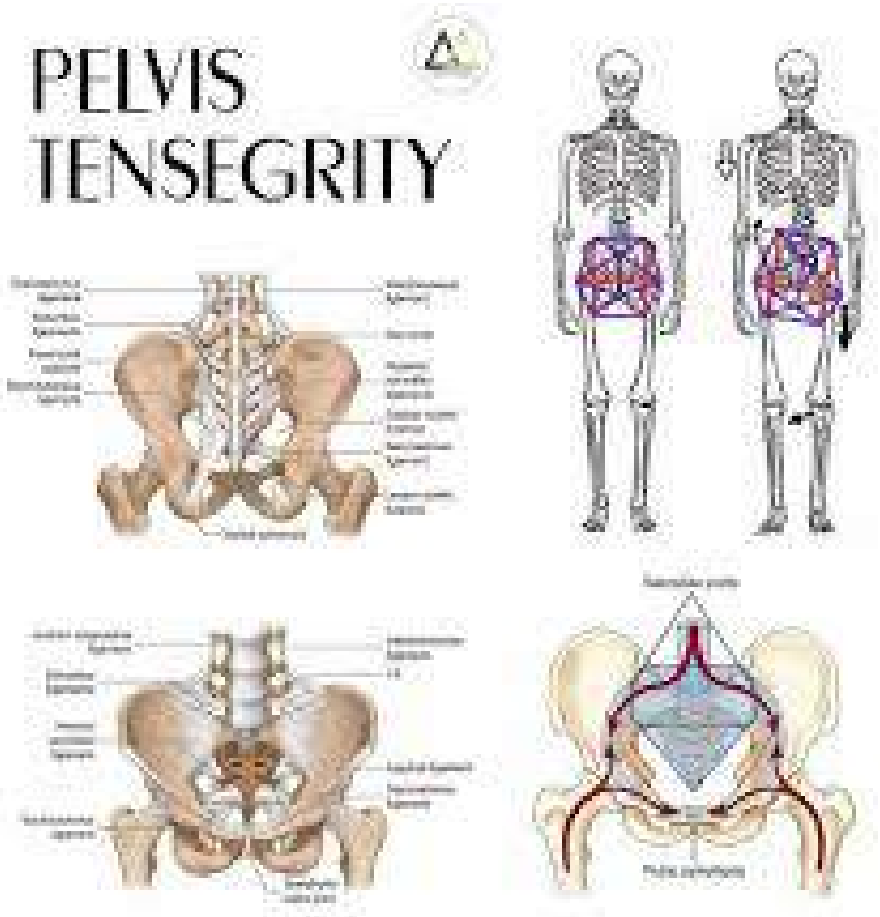


Figure 15– Tensegrity in Anatomy (3) [h]

Tensegrity has been applied to describe numerous phenomena observed in molecular biology. [26] As one example which pertains directly to neurological communications and dysfunctions (e.g., multiple sclerosis and Alzheimer's, and probably others including Parkinson's and ALS) there is clear tensegrity at work in defining, preserving (including for intracellular identification functions!) and energetically conserving cell morphology. A primary structural mechanism is the cytoskeleton, assembled of microbulin and other macromolecules which operate in a constant self-assembly/disassembly form of rearrangement and reconfiguration. This pertains to cellular reactions to applied external or internal pressure, interactions with substrates, and such internal changes, introduced by both genetic and epigenetic actions, such as very likely can be shown to include changes that ensue during viral infection and replication. [27]

While this is a point to be retained and remembered for "later", perhaps it may have significance "sooner". Consider the implications for treatment of both several infectious diseases with high-inflammation risks and also several autoimmune diseases, if progress can be established in certain areas of medical research. For instance, establishing causal pathways between tensegrity within cells and the processes of (a) endocytosis and viral entry through cell membranes and (b) cytokine interactions (e3.g., IL-1β, IL-6, and TNF-α) involved in the modulation of immune response and regulation of inflammation, could lead to new advances in therapeutics within both areas of medicine.

There are geometric patterns found throughout nature (DNA helix, volvox forms similar to geodesic domes, the carbon-complex Buckminsterfullerene, for instance – and several viral structures including that of SARS-Cov-2 and other coronaviruses) which may also be understood in terms of tensegrity principles. [28] Refer to Figures 16, 17, and 18 below. Such understanding may enable research along the lines of VESID (Viral Entry Structural Integrity Disruption) [29] to better understand and identify local "strong" and "weak" points in a viral envelope, spike structure, and other key topological features, enabling production of novel prophylactic agents and treatments which can significantly reduce the risks of viral infection.

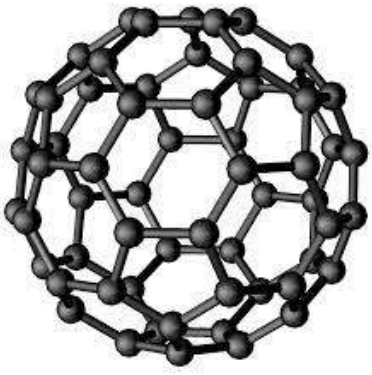


Figure 16 – C60 (fullerene) molecular structure [i]

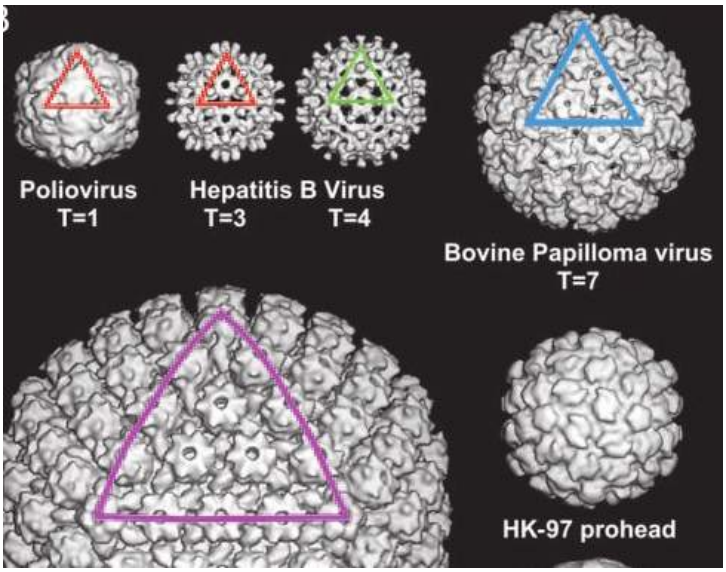


Figure 17 – Viral icosahedral structures structure [j]

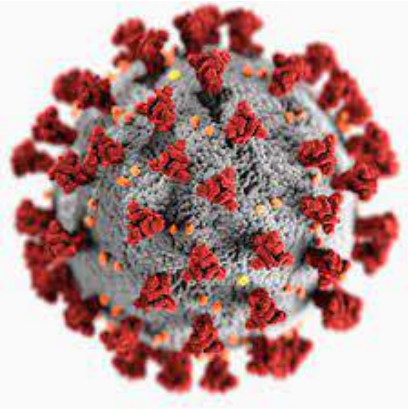


Figure 18 – SARS-CoV-2 viral structure [k]

Once again, energy efficiency and the same underling "principle of least action" demonstrates itself, in this case in the mode of tension-compression interactions. An architecture of tensegrity minimizes the molecular material needed to define and to preserve stability and also to provide structural resiliency. [30]

As Donald Ingber explains:

> *The tension-bearing members in these structures – whether Fuller's domes or Snelson's sculptures – map out the shortest paths between adjacent members (and are therefore, by definition, arranged geodesically). Tensional forces naturally transmit themselves over the shortest distance between two points, so the members of a tensegrity structure are precisely positioned to best withstand stress. For this reason, tensegrity structures offer a maximum amount of strength.* [31]

There are further avenues for future investigation that can lead into new medicine as well. Richard Gordon suggests tensegrity factors as being instrumental in embryonic stem cell differentiation. The topology of nearest-neighbor structure, involving the cytoskeleton as the defining element, beginning with the first single-digit mitosis events of the fertilized embryo, may be the primary controlling force for the subsequent differentiations that lead into a complete living organism. [32] [33]

Gravity as Unity and Entanglement

RTD introduces a reinterpretation of gravity as distinct from the particle-to-particle interactions ("forces") known as EWS (electromagnetism, strong, and weak). Gravity is the fundamental underlying unity which is responsible for observed phenomena of superposition and entanglement in quantum (Planck-scale) physics, and the "attraction", as classically described by Newton and later Einstein in general relativity, is a manifestation of what may be considered as a "spring-like" pull between two points of space-time that are, from a different topological perspective, essentially the "same source" but "stretched" as space itself expands. [34] [35] This is mentioned here for some sake of "completeness" in what is obviously a very "incomplete" understanding of the actual mechanisms of the geometry involved, or rather, certainly, an incompleteness on the part of this author in adequately expressing this in words or formulae. However, an understanding of gravity that brings out its role in what we see, within topological orders at many scales, as both superposition and entanglement states, does form part of the foundation for what later builds-up in biology. This is so because biology, within the TBD theoretical framework, involves relationships between parts and processes that may at first glance seem to be disconnected and without any obvious controlling (cybernetic) influence upon each other. This apparent disconnect is what then leads to what we see as a "disconnect" in an understanding of neurological control relations and their dysfunctions in a variety of disorders, syndromes and diseases. [36] [37]

We note that this differentiation sets gravity - being "quintessential" for the actual emergence of matter from space (as superfluid "dark energy" quantum vacuum) into the manifest form of matter-particles - as very distinctive and unique from the electromagnetic-strong-weak interactions which govern those inter-particle relations. [38] The latter are all precisely interactions that are point-centric (particle-particle interactions), whether intro-nuclear (e.g., strong force within baryons such as protons and neutrons or among nucleons within an atomic nucleus, and weak force relating to transformation ('decay") of certain massive particles in nuclear configuration), or extra-nuclear (e.g., electromagnetic interaction between charged particles (e.g., proton and electron).

How this novel differentiation enters into the picture within biological processes is something yet to be examined, but there are considerations to be explored regarding one particular area – the role of quantum entanglement at the scale of BEC-type collective entities, in organic macromolecules, and how such entanglements can affect – and be affected by – very low-energy fields and wave dynamics of bioelectromagnetic signals. Here we suggest yet another avenue that needs to be explored more both theoretically and experimentally – the mechanisms by which superficially-seeming weak and inconsequential electromagnetic fields introduced into an organism externally or generated internally

by the biology, can exert significant actions within the protein and nucleic acid metabolism of the organism. [39] [40]

Coherent Quantum Entanglement Resonance (CQER)

This term refers to much of what has been presented earlier, here, and it is a comprehensive concept that brings together macroscopic quantum entanglement with the matter of resonance actions across "substantive noisy distances" within an organism (such as the human or any vertebrate body). Within TBD there is consideration given to the possibility that a type of harmonic resonance can exist between different organ subsystems and at more microscopic scales such as among muscle fibers (all types) in manners that are not conducted through macroscopic channels such as the nerve fibers or blood vessels. [41] [42] This does not challenge any classical physics, chemistry or biology. Among the implications, however, that may follow from a better understanding of how such apparently "non-local" (in the macroscopic sense) communications may occur, is that we may understand how there is more resonance and also dissonance – a complex of constructive and destructive interference – within muscle tissue involve in both voluntary locomotion and also involuntary processes such as the coordinated four-chambered human heart. We assert that biology does not work exclusively like a digital machine composed of a discrete array of processors connected by channels, in spite of the successes in modern technology for emulating biology with such machines. [43] [44] Consider for a moment the resonance between human bodies and musical instruments like the violins in Figure 19.

Figure 19 – Violins resonating in a room [l]

Torus topologies and stable/semi-stable non-dissipative waves, vortices and knots

TBD is a theory based upon dynamical processes and both the stabilities and instabilities that are generated by what are fundamentally a large number of interacting and interfering waves. As in water waves in a sea or river, there are a variety of stable and semi-stable forms that can and do emerge. TBD is about how these forms have certain topological attributes and how these contribute to

efficiency of the overall system. Common topologies involved are describable as twists, vortices, knots, and toruses. This is a class of phenomena that seems to run through the landscape of Nature at whatever scale we point out telescopes or microscopes.

We are familiar and accustomed to the principle of least action – simply stated, for an object traveling from one point to another, the average kinetic energy less the average potential energy is as little as possible. The integral for the path of motion will be the minimal:

$$\int_{t_1}^{t_2} \left[\frac{1}{2} m \left(\frac{dx}{dt} \right)^2 - mgx \right] dt.$$

$$\text{Action} = S = \int_{t_1}^{t_2} (\text{KE} - \text{PE})\, dt.$$

We make a conjecture which we believe has the potential for being demonstrated more strongly, perhaps in the form of a theorem that can then be put to the test experimentally:

> Stable Vortex Wave Conjecture
> *There are 3D (4D) forms of motion such as certain toroidal or vortex behaviors, which maintain some degree of stability similar to the behaviors of soliton waves, and the parameters for such stable "closed" wave systems are such that these are consistent with the same basic principle of least action as observed in classical mechanics of singular objects in motion. Dissipation of energy within the structure, and thus degradation of its integral geometry and mechanical behavior, are minimized according to principles deriving from the simpler mechanics of objects in motion. In other words, there are objects whose dynamic properties constitute swirls, vortices, knots, and torii, and some of these may be highly energy-conserving and non-dissipative. This will have strong implications for a wide range of phenomena ranging from elementary particle physics to tornadoes and typhoons and back down the scale to cells and multi-cellular complexes including among others the mammalian heart, which are among physical structures that exhibit behaviors of such stable 3D (4D) vortices.*

{1.2} RTD → TBD

Topological orders and macromolecules

Topological order patterns (TOPs) involving BEC-type configurations and CQER-type dynamic entanglement relations (not necessarily quantum spin entanglements but orientations that may include molecular symmetries) manifest in the collective organization of molecular groups. These TOPS increase in compositional (i.e., chemical makeup) and topological complexity (shape) from

elementary inorganic compounds into crystalline structures (including what are potential natural mineral examples of string-net-liquid topological ordering, such as herbertsmithite) [1] and then into the more complex structures of polymers. [45]

These increasingly complex "CQER" structures proceed in complex to a large class of organic molecules including amino acids, polypeptides and nucleotides, then further in complexity and structure including topology, to the organic polymers, the macromolecules, such as proteins, polysaccharides and nucleic acids. Figures 20a – 20d give snapshot illustration of some of the relationships being discovered and explored involving topologically ordered structures, in particular loops and knots, within large biopolymers such as DNA and proteins. These point to what we believe can be affected, destructively, by what we term stressor agents, which by electrochemical actions disrupt the formation of the proper topologies required for molecular action that sustains the organism, be it cell or a larger assembly of cells such as an organ like the heart.

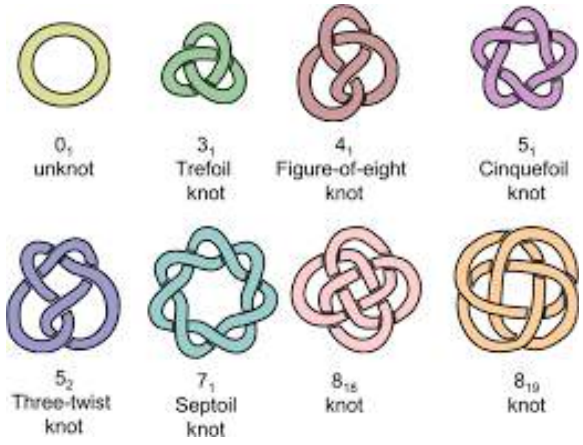


Figure 20a Knots in chemical formations[m]

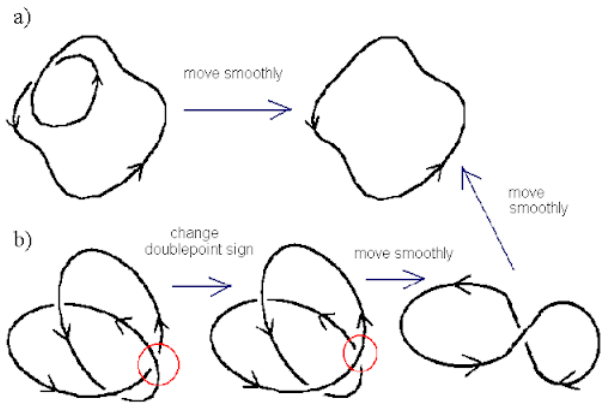


Figure 20b DNA and knot theory [n]

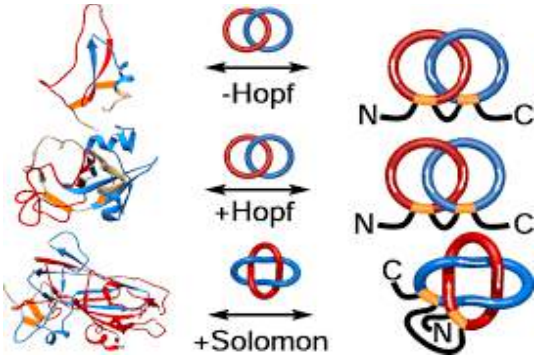


Figure 20c Proteins and knot forms[o]

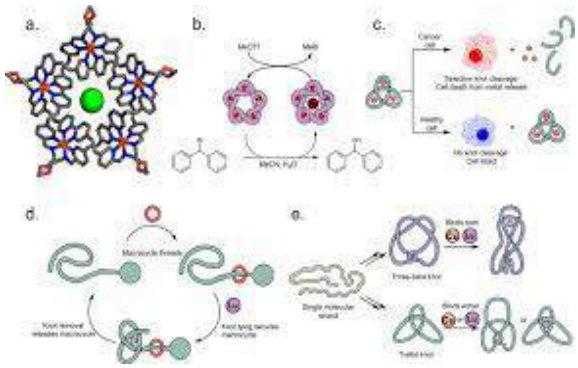


Figure 20d Functional chemistry and knots [p]

1 Herbersmithite ($ZnCu_3(OH)_6Cl_2$) in both natural and synthetic forms is one example of interest. [xxx]

We suggest that such "scalar evolution" of quantum entanglement, deriving in fact from gravity ("ur-gravity" as a relation of unity-first, attraction-later-at-a-distance, as mentioned in {1.1} above), is

(1) responsible for the ability of polymers including all organic macromolecules of interest as the substrate of life forms, to actually form and retain structure as molecular entities
(2) inevitable to occur, within appropriate environments wherein there are sufficient concentrations of the "base material" chemicals (i.e., simpler compounds both organic and inorganic) and sufficient "operating environments" (temperature, pressures, presence of "matrix" liquids such as H_2O) [2]

We conjecture that knots and macro-twistor conformations ("pretzels"), deriving from fundamental torus-vortex dynamics, are the most stable (self-protecting against decoherence within the local "entanglement network configuration) and also versatile – in terms of information storage content for retention and also combinatorics ("computing") - of structures that can be assembled in an almost limitless variety of ways.

Consider as one interesting example "Rubik's Snake", a device (invented as a toy) that is constructed, akin to a polymeric molecule, from a chain of linked isosceles triangular prisms which can be rotated but not disconnected from adjoining neighbor prisms. Refer to Figure 21 below. Given the basic architecture of the toy as designed, with 24 prisms and thus 23 turning areas, each having 4 positions possible, there are hypothetically 4^{23} = 70368744177664 (≈ 7×10^{13} or 70 trillion) shapes. Given that some configurations are spatially impossible (because they would require multiple prisms to occupy the same region of space), there are 13535886319159 (≈ 1.4×10^{13} or 14 Trillion) positions possible when prohibiting prism collisions, or passing through a collision to reach another position. Restricting the possibilities further to elimination of mirror images (defined as the same sequence of turns, but from the other end of the snake) are counted as the one position), there are still 6770518220623 (≈ 6.8×10^{12}) possibilities. [46]

We consider the possibility that within DNA and proteins there may be additional information, encoded in the form of specific conformations that are "energetically sensitive" to signals that are solitonic in nature, dependent for activation upon the transmission (completion) of such signals through some segment of the length of a chain of the macromolecule. The conformation may be in the form of a specific knot, twist or loop within the macromolecule that (for example) under "normal, healthy" conditions will allow a solitonic wave to propagate from some point a to some point b. Such information may be relevant to genetic activation and deactivation, and within proteins, relevant to protein metabolism and in particular enzymatic reactions. This information may exist as a type of "meta" code that is not "visibly" coded in in the "traditional" form (e.g., nucleotide sequences in DNA, or peptide sequences or specific conformational patterns within a protein). [47] [48]

Two simple analogies may be suggested as illustrations of this principle of this topological meta-code. A chain composed of elliptical metal links may have a kink in it. This kink may prevent the smooth

2 This last point has certain very interesting implications for questions of exobiology and the existence and development of living organisms on other planetary bodies throughout the universe, but obviously this is a "topic for another day"

unwinding or winding-up of the chain around a reel. Jams can result in a pulley or winch system from the seemingly minor kink. Another example is with an ordinary garden hose. A kink develops, and the flow of water is blocked, as well as a normal winding or unwinding from a spool. In both cases there is a path for the flow of energy or an energetic substance (e.g., water). In both cases, a seemingly minor adjustment to the conformational structure of the chain or hose has a major effect on the dynamics of the chain/hose and what flows through it or what can be done using the apparatus. In both cases the energy required to create the active disruption is relatively small and also, in both cases, the energy required to reset the chain/hose to its proper topological formation is also relatively small. Is it possible that, within the chains comprising the informational data (genes) and the computing processors (proteins) of biological organisms, there could be such equivalent kinks and knots which can radically disrupt their normal behavior? If so, might it be that such disturbances can be created by a variety of electrochemical "noise" - stressors that act upon the molecular chains in question – in manners that reduce the efficient metabolism of those molecular chains? This points us in the direction of what we believe may be one of the links between this TBD framework and the pathogenesis of a variety of disorders and diseases including those which specifically involve arrays of neurons acting in control of muscle tissue arrays, as in the heart and GI tract. Figures 21 and 22 are not so far apart when it comes to the mechanics of how one can move from smooth transitions to blockages, whether in a chain of prisms, or a garden hose, or a nerve complex.

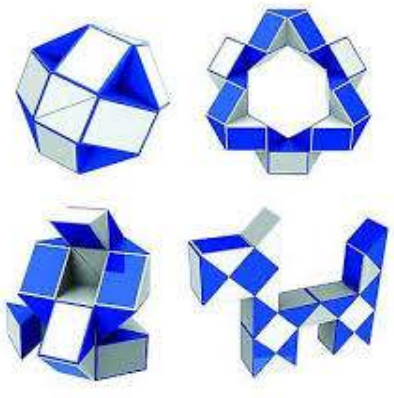


Figure 21 – Rubik's Snake [q]

Figure 22 – Kinked Hose [r]

We introduce another conjecture which we believe has relevance to topological transformations within biological structures at the molecular and also cellular scales, and perhaps this may in the future take the form of a theorem that can then be put to the test experimentally:

Topological Transformation and Conservation of Curvature Conjecture

The transformation of a "perfectly" closed manifold (e.g., 3-sphere, 3-torus) will preserve (conserve) a measure of the total curvature involved within the manifold. By "perfectly closed" we assert that the transformation ("deformation" from the original topology) is without creation of any rips, tears, nor any topological "surgery" (e.g., cuts

and reconnections), nor any considerations for an internal "pressure" within the structure. This "conservation of curvature" (C) is a value that may be compared to an integral of the entire surface or even the entire volume (∯∯). It is further conjectured that there is a set of operations that can be performed on this manifold which behave in a group-theoretic manner, providing a kind of symmetry, such that any changes in the manifold, occurring in sub-regions where curvature changes locally, retain at the global level the constant C. This could be employed as a measure of constancy in the behavioral dynamics of an object with such a manifold as its representation. Any departure from that constant C would be an indication of a break from the integrity of the behavior – topologically speaking, it would imply a rip or tearing action. This could represent a jump from coherence into decoherence within a BEC-type topological order, or a phase transition in such an order within a qubit array or within a protein molecule. Such a deforming action could include a split into two or more closed manifolds, a splitting that results in two or more distinct manifolds, each with a new C measure.

Quantum Computing, non-Turing style

As a passing remark, this is why in related research development undertaken by members of TETRAD Institute, pertaining to design and implementation of a quantum computing machine based upon a "non-Turing" architecture (i.e., simply expressed, not employing a binary schema of qubits and instruction sets, but based upon topological arrays for information representation and field-principle computation), the choice of "substrate" for combined data representation and computation has been in the domain of protein-polymer conjugates (PPC). These molecules are also capable of stable operation at higher temperatures ("room temperatures" of @ 0 C to 50 C), rather than supercooled configurations of (typically) ions or atoms in a variety of fixed-architcture arrays. [49] [50] [51] Moreover, they automatically lend themselves to vastly more possible configurations than qubits for representing data states with their segmented configurations. More importantly, they are capable of literally match-fitting recognition with other PPC, either individually or as part of a massive array. There are really incredible possibilities for new forms of computation and computers, if one will take the time to consider "quantum computer" designs that arguably have been proven well over a evaluation and testing period of more than 2 Billion years![3]

Biosolitons

Molecular communications in organic macromolecules, in keeping with principles of least action, energy conservation, and minimal complexity, optimize conductivity of signaling and transmission. The mechanism of choice within biological systems is solitonic propagation. This should hardly be surprising given that the operating environment consists of long-chained polymers in a fluid environment.

3 Anecdotally speaking, not a small number of virologists have given at least tacit albeit unpublished assent to the concept that viruses, including the highly adaptive (for endocytosis purposes) Ebola virus, are among the most advanced form of quantum computer yet to be "implemented" on Earth. This is, of course, a topic for another time and setting.

A biosoliton is a soliton that propagates within an organic molecule or array of molecules such as proteins and nucleic acids. Solitons in protein and DNA have been studied at length since introductions by Davydov and Schrodinger. [47] [52] These are related to low-frequency collective-unit motion in proteins and DNA. Biosolitons are also suggested as a mechanism for near-lossless neuronal signal transmission. [53] [54]

More recently, studies by Brizhik and colleagues have led to models for how biosolitons function in protein chains. [55] [56] The combination of relatively weak hydrogen bonds with strongly one-dimensional polypeptide chains points to a role of electron-lattice interactions [57] which can lead into local deformations along the chain through electron transfer. The resulting state involving a bound electron and a lattice deformation behaves according to the classic nonlinear Schrödinger equation

$$i\hbar\frac{\partial\Psi(x,t)}{\partial t}+J\frac{\partial^2\Psi(x,t)}{\partial t^2}+2Jg\left|\Psi(x,t)\right|^2\Psi(x,t)=0,$$

which has a soliton solution presenting the propagation along the polypeptide chain of the deformed lattice:

$$\Psi(x,t)=\Psi_s(x,t)\equiv\frac{1}{2}\sqrt{g}\,Sech\left[g(x-x_0-Vt/a)/2\right]\exp\left(im_eVx/\hbar+i\varphi_s(t)\right),$$

This is represented in Figure 23 as a propagation of a soliton within DNA.

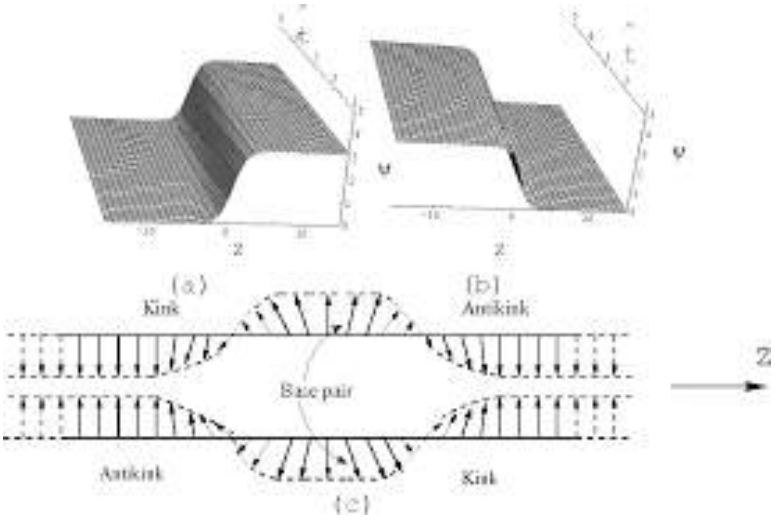


Figure 23 Biosoliton [s]

With biosolitons as the mechanism for conducting information through molecules, there is a robust system that can withstand many variations and even with degradation, achieve the desired goals of delivering energy and communication information. However, this type of system, like any, has its limits and bounds for performance. This brings us closer now, following this admittedly lengthy "introduction", to the topics of healthy operations, noise and stress, and situations where system

degeneration and failure is the outcome from a combination of both acute and chronic stress factors. This leads us from the theory of TBD into the practicals of biomedicine and the analysis of processes that can be predictors of system degradation (disease) and breakdown (death), and thence to questions of how to find those predictors and create, synthesize, corrective therapies to avoid the breakdowns.

{2} TBD resilience – normal conditions and manageable system stress

The model as presented thus far is one that provides for resilience, stability, and frequent "returns" to equilibrium dynamics – meaning: patterns of metabolic process, including neuronal signaling and muscular actions (both somatic and autonomic control), that when pushed out of equilibrium will function almost "gyroscopically" (metaphorically speaking) – the out-of-equilibrium behaviors will return to some set that is within the bounds of equilibria that are sufficiently efficient and minimal in losses and risks of system collapse. From a medical perspective, this is "health" in a broad sense – namely, being able to function within a range of state-spaces that allow, enable and are naturally gravitating toward stability that is sustainable.

Abstractly, we can consider that the topological orders involved in collective organization within macromolecules such as proteins and nucleic acids are not being disrupted and pushed into irrecoverable decoherence. If there is some degree of decoherence, there is a return to some steady state. This is because the system as a whole reinforces that "return".

> Metaphor: Push a classic pendulum ball lightly to one side and it will move in a path that is not within its natural harmonic, but eventually it will return to that harmonic. Push it with an extreme force and it may not be able to return to that harmonic at all.

> Metaphor: Generate a soliton wave in water within a fixed-parameter channel that can be altered by lifting or transverse movements; e.g., a sluice-pipe, analogous to the canal in John Russell's first observations [xxx] but in some way flexible (like a long trough). Maintain generation of such waves on a periodic basis. Disrupt the channel apparatus slightly and the soliton waves will be disturbed but then future waves will restore to their previous harmonics.

> Metaphor: Walking on a pedestrian rope-suspension bridge, create some noise by jumping around, then settle back down and proceed to walk normally. The bridge will reflect the noisy jumping and then restore itself to its normal harmonic.

Figure 24[t]

It so happens that in a number of studies on topological orders within inorganic and synthetic settings, such as atomic and ionic arrays (the context being Turing-format quantum computing architectures), there is evidence of what may be termed a disposition to maintaining the order in spite of elements or segments of the array in question being disrupted. In fact, this is one of the reasons for attention to TOPs with regard to quantum computing. [58] [59] [60].

In biomolecular operations, for instance within neurons and muscle cells, there is a constant "drive" to optimize conductivity of signaling and transmission, and the mechanism is through biosoliton wave propagation. We can view this as one of the innate "built-ins" within living systems. This is what living things do – they strive to keep things in balance and thus "stay alive".

Given the ideas presented as foundation-elements for TBD, we now can direct questions and make inquiries into finding how such processes as biosolitons and topological orders (TOPs) can play central roles in the maintaining of health within living organisms. Our goals, ultimately, from the medical perspective, are concerning cardiovascular and gastrointestinal system stabilities. Our challenge is to identify how those are maintained, in terms of neural communications and muscular processes, [4]and to identify how these processes for maintaining harmony and equilibrium are disrupted, kicked out of balance, and pushed into biochemical and ultimately anatomical disorderly states that subsequently prevent or greatly hinder any natural return to equilibrium and indeed can often lead to severe breakdown and death for the organism.

Ultimately, these matters all concern *control*. On/off, up/down, in/out, and in many different state-spaces, it is all about maintaining *control and order*.

{2.1} Neurocybernetic Functions

Cybernetics is all about functions of steering, navigation and, simply put, control. [5] The central nervous

4 As always, it should be pointed out, this is not to the exclusion or omission of other important subsystems such as that comprised by endocrine glands and the whole, in fact, of the central nervous system, but we are simply aiming to keep some focus on a particular set of physiological processes.

5 "cybernetics" --- "theory or study of communication and control," coined 1948 by U.S. mathematician Norbert Wiener

system and all its branches and "subsidiary" components are fundamentally all about keeping control over whatever the organism is doing. Automatic, autonomously-operating control of many functions. Voluntary control, involving actions within the brain that are classed as "conscious acts", for certain others.[6] Many mechanisms, such as involving various muscles throughout the body, are generally considered to be under somatic, voluntary, intentional control, but clearly there are instinctive and automatic reactions which are generally associated with self-protection and survival. With proper training and discipline, there are ways that several autonomic, involuntary processes can be subject to voluntary control (e.g., heart rate).

Virtually all actions we do are derived from a basic set of algorithms which govern control and restoration. Arguably (and perhaps it can be demonstrable in the future), our emotive and cognitive functions - our "psyche" both conscious and unconscious – is all centered upon achieving control of the things within and around us as individual organisms and as members of a collective organism – our society – in order to achieve objectives which are either instinctive or acquired and modified (such as through education, habit, acculturation, other methods). This points to more commonality of functional design within many more components of the brain and central nervous system than only those which we historically and culturally describe as autonomic and involuntary. Once again, there is plenty of "food for thought" here, above and beyond the scope of what Neuroplex-C as a project undertakes to discover, delineate and refine.

Cardiac Cybernetics

Let us return to the "heart of the matter", specifically, the cardiovascular-pulmonary network. It has a central control function: to keep all parts of the organism (ideally), or the most life-critical parts (consider hypothermia reactions over prolonged exposures), supplied with oxygen and nutrients, and simultaneously, to have CO_2 and other waste chemicals removed. It may be simple enough to state things this way, but it is far more challenging to describe the state-spaces involved in determining what actually happens in the end-effectors of all this, namely, the striated muscle fibers of the atriums and ventricles. We can identify, easily enough, and measure the electrochemistry of the sinoatrial node, internodal tracts, atrioventricular node, Bachmann's bundle, and the whole of the cardiac nervous and arterial networks. But what is the state-space of parameters that are driving these firings and pulses? Can we find insights into the metrics of this state-space by examining other systems even outside the realm of biology? [61] [62]

The entire living organism, as a unitary system, has a complex state-space and there are several regions within this multidimensional space that are suitable for short-term or long-term duration (as a state-space over time). There are many borders which describe the limits of performance and endurance, and survivability. These are the places where it is "OK for awhile" but that cardiovascular-pulmonary network must work to move things out of these border-regions into the "safe/normal" regions. Finally, there are regions which are to be avoided at all costs because they result in acute

(1894-1964), deriving from Greek κυβερνητικός (kubernētikós, "good at steering, good pilot"), from κυβερνάω (kubernáō, "I steer, drive, guide, act as a pilot").

6 Here we speak mainly in terms of the human organism but much of this can apply to other species.

deterioration and death. These are the regions for that control network to "get out of" as rapidly as possible. There may be relevance to understanding cardiac harmony and arrhythmia from such seemingly-afar disciplines as the study of highly nonlinear systems [63], turbulence [64], and catastrophe theory in particular. [65] [66] Figure 25 below provides an abstract view into such spaces.

We suggest that the overall neurocybernetic processes in the body (human, but extensible to many other species) operates within some type of similar state-space where there are such regions of stability, divergence, and sudden jumps. We suggest that a healthy organism is one that "knows" how to maintain its heart and other autonomically governed subsystems (e.g., gastrointestinal, endocrine) in the regions of stability (ref. To Fig. 25), but that prolonged, sustained, chronic pushing of the system to its limits, into the border regions of instability, lead to the diseases we find such as arrhythmias.

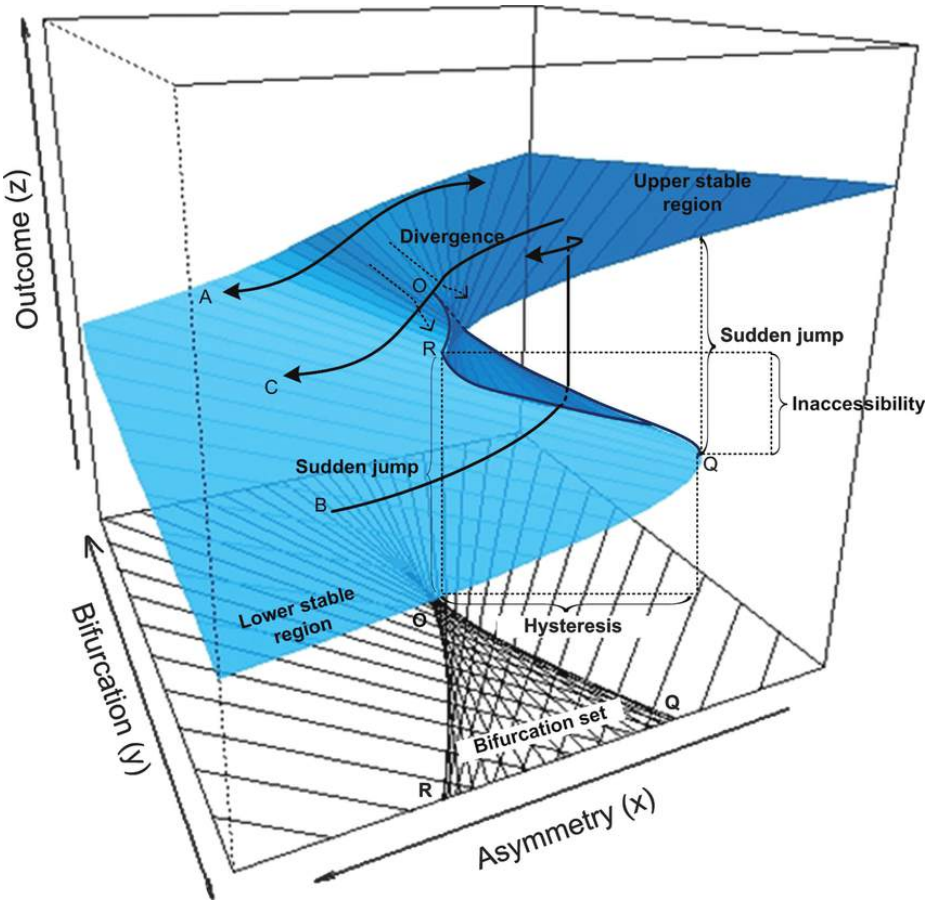


Figure 25 – Catastrophe state-space [u]

A Symphony and Chorus of Neural Control

It must be kept in mind that the neurocybernetic (control) network does not receive its commands in any simple, linear manner. There are inputs from many subsystems into the control network that generates the signals being fired by neurons in heart muscles which produce contractions and

relaxations of those four chambers. These inputs compute an algorithm, essentially, albeit one that is hardly linear or simple. That “cardiac pumping” algorithm draws upon blood pressure, oxygenation and carbon dioxide levels, indicators of nutrition and a “chorus” of signals that cross over the spectral range between what can be classed as unconscious/involuntary and conscious/voluntary. But these indicators are not variables being “read” by a discrete sensor apparatus. Rather, they are being approximated and blended together in an informational “score” (again, the music metaphor, but no pardons requested). This “score” may be for just a measure or several in sequence or an entire page. What matters is not only what are the specific notes but how does it “fit” in sync with the rest of the symphony.

The last point is important. What we measure in any quantifiable way about virtually anything is involving a sampling over some type of space and often across a temporal dimension. We measure many quantities of physiological performance by taking readings at specific locations, over some window of time. We learn a lot from a simple reading of pulse or one of blood pressure. We can learn “more and different” from an EKG, and from an echocardiogram, and differently, from an MRI, a CT, an fMRI, and so on. We may be able to learn more by expanding the time-series of measurements, or by bringing different observables together into a map and seeing where there are “convergences” in the sense of the border-region boundaries that are in the overall state-space.

This does not mean that the body – the cybernetic-central organism-within-an-organism, involving especially the CNS, endocrine, and cardiovascular subsystems – is making control decisions in the same way. Our suggestion here is that biology is more “naturally attuned to the music” - and here the metaphor is perhaps more literal than symbolic (but that is a further topic for “later discussion”.

The point for right here and now is that signal patterns which vary, not only in parameters such as amplitude and frequency, but in how certain blocks or sets of signals may fit in with the “key”, the “tonic”, the “tempo”, the “scale”, that is dominant in the context of the organism's basic “steady-state” of metabolism and also its systematic psychophysical activities. Some things fit in, some things don't. How the cybernetic network of the body handles the “misfits” is one thing that can help us as researchers and as clinical practitioners come to some better understanding of how the body maintains its dynamical equilibria, and also how it fails to do so, and perhaps, hopefully, we can in this process of looking farther and wider, across different boundaries of measurement, achieve understanding of how to correct inbalances more effectively, even before they get the body involved to those border-line regions of state-spaces which are putting the body at risk of breakdown and final failure.

For instance, consider what else is going on besides what a person is doing when laying down, sitting, walking. There may be “hunger-pang” rumblings, and the activity within the brain in response to seeing, smelling, or tasting a “favorite food”. There are muscle strains and regional hyperlactatemia following exertion in some physical work or exercise, and such conditions can arise from simply thinking about muscles, workouts, fatigue, or any other “calorie-burning” activity. There are a myriad of inputs that can affect the collective aggregate of primary and critical quantities that measure,

internally, the overall oxygen and nutrient delivery process which depends upon moving sufficient quantities of oxygenated blood out past the aortal valve.

The point here is that there is a "chorus" of inputs that have influence, ultimately through neural transmissions and a variety of biochemical levels, that affect the nerves and blood vessels and ultimately the muscle tissue of the heart. Together they "sum up" their inputs and through the not-only-so-symbolic "cardiac rhythm" algorithm; they provide the signals that are responsible for muscle contractions and relaxations in the respective atrium and ventricle.

Ideally, this is a "chorus" and it produces good music. That depends upon the sum of each member of the chorus, and the musical conductor, and the acoustics of the auditorium, and many other factors. But sometimes it is less of a chorus and more of a "heavy metal" concert or even a frenzied riot. The same singers, the same orchestra, the same auditorium, but now it is not music but noise, cacophony, and it makes the audience look for the exit. Some of those critical inputs that are intended to keep the heart and the whole body within those upper and lower stability regions (cf. Fig. 25 above) are coming to the neurons instead in the form of degraded information because of damage that occurs to those neurons and others up and down the line. Some of this degradation may be unavoidable through the aging process. Other forms may be the result of literally too much noise, internal and external. It all translates into biosolitons conducting the messages, and some of those are not getting through properly. The overall system works to compensate, if it can. This may result in spurious nerve fibers and the development, literally, of knots and tangles. This is what the cardiologist finds and must deal with, if things degrade enough.

How does this happen, how can it be avoided? How can the problems with the orchestra, the chorus, be detected in advance of the concert, as signs that something is awry and getting worse? How can a precursor to turbulence be noticed in time and corrected so that we will have a proper performance and not a stage disaster?

This may seem like yet another offbeat metaphor to describe what some readers might prefer to remain in formal anatomical terminology. But here we are beginning to sail and swim into some uncharted new waters, and sometimes it can be beneficial to draw upon symbols and signs that are familiar and rich with meaning, from other walks of life, with the intention that these more familiar images and cognitive constructs can lead to a good path forward into these uncharted waters.

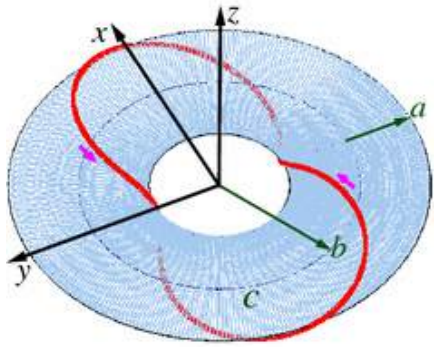
We are striving right now to understand how a truly vast variety of biochemical events, and some stranger-than-classical-chemistry configurations of molecules and cells also, keeping company with each other in some strange "topological orders" that seem to defy the way we have usually thought about molecules and cells, are able to accomplish a veritable miracle in communication and control – in the *Incredible Cybernetic Act*, of doing things like the following, most of which we simply take for granted, as humans, as physicians and nurses, as scientists, but these are truly remarkable that they can and do occur – both the "healthy and desirable" and also the "unhealthy and diseased":

- maintain a fairly constant (single-digit variation) pulse and blood pressure while moving from a reclining position to a vertical position and then simply walking or even running forward
- going into a near-shock stage from a sudden fright or a big "Boo!" on a Halloween or a surprise birthday party, then rapidly settling back into normal/average pulse, pressure, and breath rate
- engaging in the "roller coaster" of muscular activity with different parts of the body and dramatic changes in breathing, definitely, during activities like: sex, extreme-sport cycling or rollerblading, playing a solid nonstop game of soccer or rugby
- doing hatha yoga and then simply getting up and heading to the pool or shower
- and...
- going into hyper-overdrive tachycardia when simply getting out of bed and trying to stand up, much less walk anywhere

{2.2} Heart as Torus in Constant Motion

We have previously, in {1}, touched on the topics of vortices, toruses, twists, knots, and a variety of both ordered and disordered motions and configurations. We have briefly discussed principles of least action and minimization of expense (cost) of energy, mostly in the more elementary context of particle physics and classical mechanics. Now we turn to how some of these principles are present, albeit in radically different "garments" of form and structure, in the biological world, and in keeping with our primary focus ("Neuroplex-C" project), with the cardiovascular-pulmonary system that is the central cybernetic engine of the body.

Our claim is that toroidal vortex motion provides optimized efficiency in terms of energy required to perform 3-axis rotational flow of some fluid with minimal expense in movement of the fluid and minimal stress upon the mechanism that is the vessel in which this flow occurs.



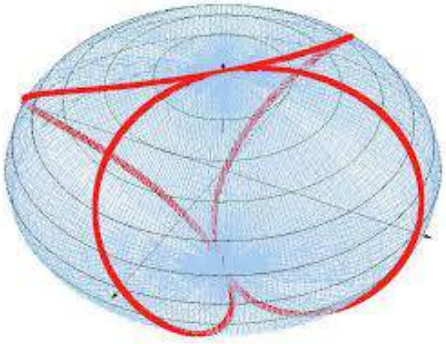


Figure 26a Toroidal vortex [7] [v] Figure 26b Topological transformation of the helicoidal ring[8] [v]

7 Toroidal vortex. Radius of the tube a = 2 and radius of the torus b = 4. The center line of the perimeter of the tube is indicated by the letter c. Pink arrows point out motion along the helicoidal ring drawn by red color.

8 Topological transformation of the helicoidal ring shown in Fig. 26a in red to the ring on the sphere. The ring is shown on the torus transformed into the double coated sphere.

We go further now and make a daring claim which we intend to demonstrate more forcefully and convincingly through mathematical modeling and computer-simulation visualization.

The vectors of motion involved in the circulation of blood by a mammalian heart can be described as toroidal vectors and the heart functions as a biologically-evolved torus engine in its circulation of blood to and from the lungs and to and from the rest of the body. The ideal engine for circulation would be a smoothly flowing torus and without moving parts. But to "build" such an engine which should approximate "perpetual motion" (i.e., not ceasing operations), out of millions and billions of parts (cells), there needs to be a different design but one that will do a similar basic function.

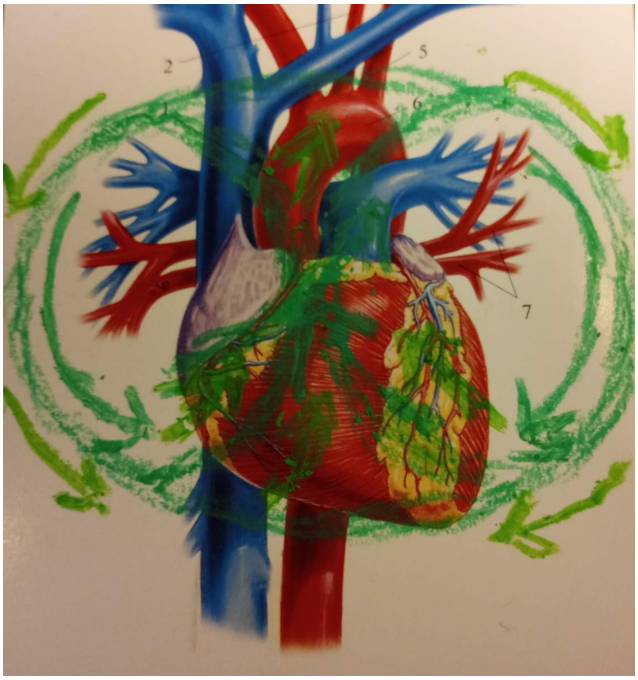


Figure 27 – Heart as embodying an abstract torus vortex flow machine [w] [9]

This comparison is not meant to be a simple metaphor. We believe that this can help us to understand better the wave dynamics involved in both healthy hearts and in those developing into different cardiac arrhythmia syndromes. If we can employ this abstract model, along with what is already well understood about cardiac wave dynamics, then we can be hopeful of obtaining some set of patterns which will constitute a "precursor set" - behaviors of the heart that can indicate a variety of early dispositions and imminent phase transitions leading to serious arrhythmia such as AFIB and other potentially deadly and certainly life-critical forms.

9 The present "primitive-resources" illustration barely conveys the important concepts. We want to express this graphically in the heart-as-torus model, both pictorially and in animated simulation:
(I) Venal flow into right atrium and ventricle like a top-to-bottom outward surface motion in torus. Then movement from right ventricle to lungs is like bottom-to-top movement in center (inner surface) motion of torus.
(II) Lungs to left atrium performs a top-to-bottom flow on the other side of the torus, on the outward surface of torus. Then aorta outflow is like center-surface toroid motion, bottom-to-top.

Here we introduce a few points about asymmetry and chaos. Both are essential within biology including in the ever-beating, ever-adjusting, ever-approximating heart. Too much, no good, of course. Too little, also not healthy. Cells need to rest and not perform the exact same operations (e.g., expand/contract) non-stop. Some variance must be within the "machine" in order that a different "mix" of neighboring cells will be activated, enabling other neighbors to rest. The biology accommodates this in what we see, for example, in the human heart:

- a separation of functions for moving low-oxygen content flow into the lungs for oxygenation and for moving the re-oxygenated flow into the main return stream for the entire body
- a network of nerve fibers that are distributing the controlling impulses for the muscle contractions and relaxations, across a field of tissue, but under normal "as designed" operating conditions, these are not all firing simultaneously, nor too rapidly, nor without periods of relaxation.

We can measure and observe visually, through electronic monitoring, the types of waves that are generated in the neuromuscular "signature" states that are considered healthy, and also the waves when there are aberrations such as arrhythmia. We can begin to look for relationships between these waves that point to how one state (healthy) transitions into another (unhealthy). We can strive to find the early indicators of such transitions, in hopes that by doing so, we can identify risks that can be expected and hopefully can be avoided.

{3} Neurocybernetic Stress → Noise and Dissonance → Disease

A variety of molecular-scale stresses and strains disrupt the optimal topological orders of neurons and the tissues they control. These stressors can be various and they may be "low-energy" from a Lagrangian standpoint but they are high-impact in the sense of how a pilot wave can strongly influence a larger physical body with significantly higher kinetic energy.[10] [22] [23]

We suggest that these low-energy disruptions cause changes in the structure and behavior of molecules such as proteins and nucleic acids. Some changes are dramatic – actual breaks. But there may also be knots, kinks, and tangling. Here we can expect to find disruptions in the transmissions that are normally, and efficiently, being transmitted, in the mechanism of solitons. What are the consequences that we can expect if the soliton propagations are being disrupted? Loss of information, loss of energy, with results that can lead to further degradation of the molecular medium (e.g., proteins, nucleic acids). [67] [68]

Consider neuronal axon sheath damage, linked with the initial development of diseases such as multiple sclerosis, and microtubule degradation within Alzheimer's, respectively. [69] [70] The implications include prospects that the origins of certain autoimmune diseases, like MS, are not in some failure of the body's immune system, genetic or otherwise, but in damage at the molecular level, caused by a variety of chemical and electromagnetic stressors, and that the immune system's response to attack such degraded cells is actually quite "normal" from the perspective of what the immune system is empowered to do – remove damaged, atrophied, dysfunctional components along with foreign biological agents. This could open up yet another "new path", not pertaining to cardiovascular health but to the approach for addressing such neural-primary diseases. [71] [72]

Stressors originate in many sources and a key point for consideration about healthy neurocybernetic operations is in the chronic aspects and the multiplicity of sources for these stressors. These are typically low-concentrations and low-energy inputs but what matters is that they are chronic, persistent and often nearly constant in the psychophysical environment. This includes "literal" noise that is acoustic, visual, and cognitive. Consider a person who is literally overloaded with multiple demands for action, for emotional interaction, for cognitive decisions, for physical movements, within home, work, and even when traveling. A constant, persistent, chronic cascade of stressor inputs which are having effects that activate sympathetic and parasympathetic signals, even if in "low level" ways. The result can be a conflict between "on" and "off" that is comparable to riding the brakes while stepping on the accelerator – over and over and over.

Noisy and conflicting signals within the ANS from conflict between sympathetic and parasympathetic can lead to interference patterns both constructive and destructive within collectively organized and usually coherent tissues, such as in the heart, and this can be one of the important origins for such disorders as different tachycardia.

10 The classic simple example is that of a small tugboat exerting its "pilot-wave" energy to adjust the vectors of a much larger and much more massive ship such as a tanker or container ship.

{3.1} Cardiac Waves, Spirals, Knots and Unknots

Can there be a way to classify patterns of wave activity within the heart in such a manner as to identify patterns that are the first stages of some form of arrhythmia? The seminal work by Sutcliffe and Maucher in knot theory has initiated investigations into the analysis of cardiac wave forms including those present in various forms of arrhythmia. [73] [74] [85] [86] This is a promising beginning for how we can identify candidate patterns of cardiac waves which are the types of arrhythmia precursors we want to find – even before one would clinically conclude, "arrhythmia".

We begin with the classic nonlinear PDE Fitzhugh-Nagumo equations which provide a model for cardiac tissue as an excitable medium

$$\frac{\partial u}{\partial t} = \frac{1}{\varepsilon}\left(u - \frac{1}{3}u^3 - v\right) + \nabla^2 u, \qquad \frac{\partial v}{\partial t} = \varepsilon(u + \beta - \gamma v),$$

In this, u(r,t) sand v(r,t) are physical fields and t = time. In a 2D space this equation yields a rotating vortex solution, which has come to be known as a spiral wave. Figure 28 illustrates this spiral wave with a vortex core. The evolution of the vortex string (shown in red) generates in 2D plane a set of spiral waves fronts that emanate from the string which exhibits a clear knot formation.

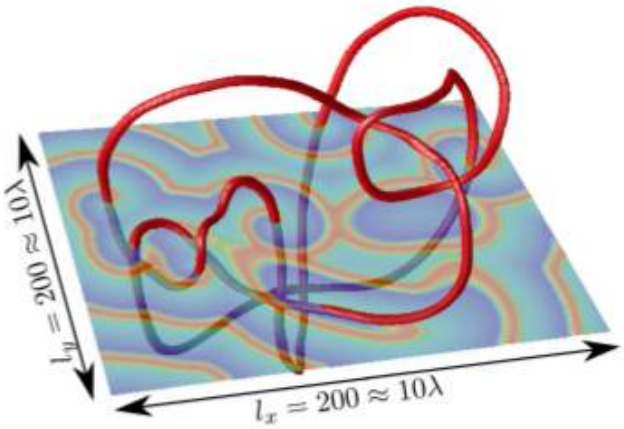


Figure 28 Spiral wave with vortex core [x]

These abstract spiral waves, following the time-evolution of the Fittzhugh-Nagumo equations, are (mathematically, if not visually) comparable to those constructed from cardiac arrhythmia data, as shown in Figure 29. The tangled knot can be untangled without cutting ("reconnection").

This is not simply a topic of mathematical interest and delight to abstract modelers of knots and tangles. It points to some possibilities for the medical challenges of both diagnostics and therapeutics. If one can think of the evolving tangle as representing the time-evolution of arrhythmia-type waves in the heart, then there may be a variety of perhaps simpler and "less tangled" patterns which can be computed from some set of initial data collected (e.g., by traditional EKG, or through echocardiography) and identified as being precursors to the dangerous spiral waves, detectable earlier than by present-day methods.

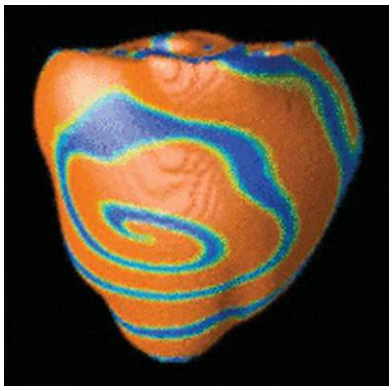


Figure 29 [y]

Now this apparent knot is really, in mathematical terms, an *unknot*. It is clearly a "tangle", but it can be untangled without cutting and reconnecting. The topology is maintained through the untangling until the apparent knot, the unknot, is untangled into a smooth circle. Figures 30a, 30b and 30c give illustrations of how this proceeds during evolutionary cycles of the basic Fitzhugh-Nagumo equations.

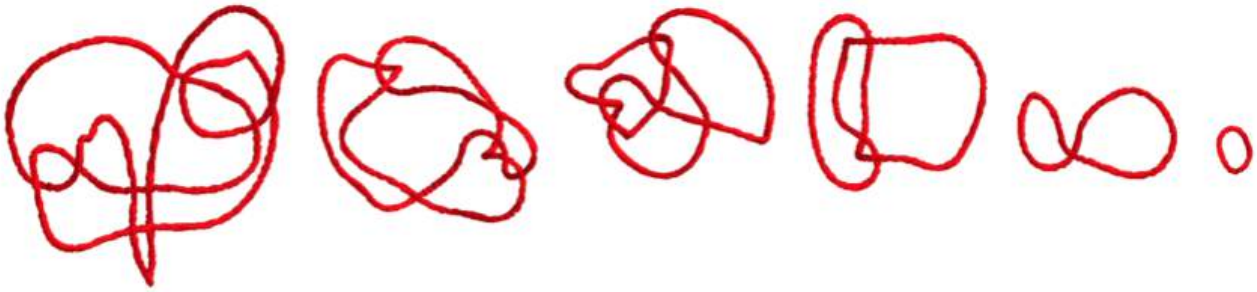


Figure 30a – Evolutions of the vortex string beginning with the "culprit" unknot (at left) [x]

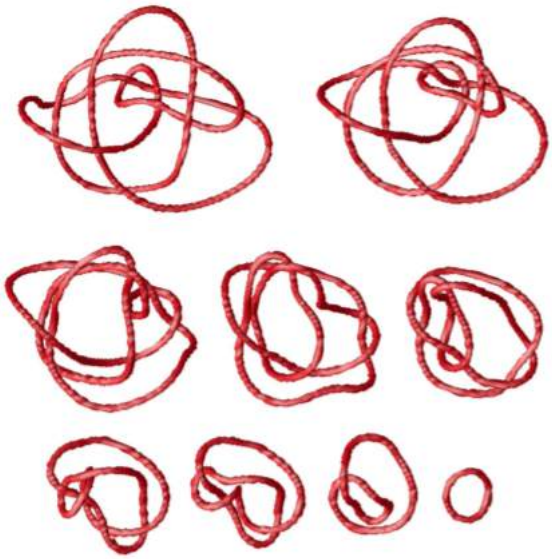


Figure 30b – Evolutions of the vortex string beginning with the a 13-crossing unknot (at left) [x]

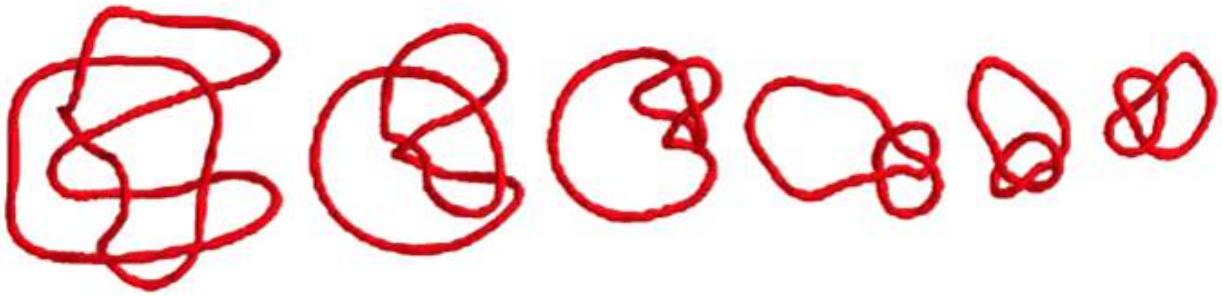


Figure 30c – Evolutions of the vortex string beginning with the a common trefoil knot (at left) [x]

{3.2} Coherence, Collision and Interference in the "Pond"

We are only at a beginning stage of understanding how each of these phases proceed:
[a] knots and tangles, figuratively speaking but also in terms of actual wave dynamics of signals coming IN to neurons and neural ganglia, the result of computational, logical, informational tangles, and how these wave collisions transform into damage and degradation of the "processing array" - the neurons at the receiving-end. We see the stressors – electrochemical of many types - and at a higher level of analysis, psychological – the full range of on/off/on/off emotions, anxieties, attention deficits and conflicts, amplified often by memories and recollections. We still are a long ways from understanding the "a → b → c" biophysics and biochemistry, but we have a good start on where and how to be looking for evidence and explanations.

[b] knots and tangles in the wave dynamics of signals going OUT from those affected neural networks to other neurons that are the end-effectors for muscular and glandular cells in organs such as heart, stomach, intestines, liver, thyroid and more. We need to be able to "translate" from wave-behaviors in neural networks into different cellular metabolism. Still at the beginning we are, but if we go back to some fundamental concepts of topological orders and BEC-type coherence, and a biological model of quantum computing that is not a Turing machine but a field of elements that "compute" by how their shapes, their topologies, fit or do not fit with one another, and how they enable or prevent flow of information-energy as solitons, then we may be some steps closer. [75] [76] [77] [78]

[c] knots and tangles in the wave dynamics of cardiac, pulmonary, gastrointestinal muscle action, and how these in turn affect those same neural networks that are the cybernetic engine, some of which are damaged from [a] and [b]. We see relationships between a tangle and its unwinding into a simple unknot, such as Fitzhugh-Nagumo provide, but how to go from there to defining reliable criteria for use in the practice of medicine? How can these relationships point to a better advance-alert or curative treatment?

We make yet another conjecture:

> *Turbulence and both constructive and destructive interference among cardiac waves may somehow "feed" the development of ganglia tangles and thus increased noise within the neurons, leading to spurious growth. One possibility is that there are "reflected" and "bounce-back" signal activity – not dissimilar from the waves generated in a pond or smaller yet, a pool or tub of water, when a rock is thrown from the shore or a swimmer jumps in. Such a mixture of interferences generated between the waves can create a type of "heat sink", and in response there is new, chaotic, noisy growth that is triggered genetically by the cells in that neighborhood – neurons and perhaps muscle cells as well. This new growth is unnecessary from one point of view but a consequence of the way neural tissues respond to such stimulation.*

How to prevent, or stop this process, and how to reverse this once it has occurred? Is this possible without resorting to invasive medical procedures or pharmaceuticals which often have far-reaching and undesirable side-effects?

Thus we embark on a quest to discover new approaches for neural (re)entrainment that can be consistent with a model that offers topological order as a key component of how biology works.

Figure 31 – Biology behaves a lot like Water... [z]

{3.3} Dysautonomia → Systemic Noise and Schizoid Conflict → Dis-Order

The basic problem we face is that mixed and conflicting signals bring sympathetic and parasympathetic into contradiction and operational conflict, generating noise that deteriorates cells within those neural networks. The organism responds and acts to compensate and adjust as best as it can. Some of this results in immune response against deteriorating tissues; e.g., MS, Alzheimer's, potentially also Parkinson's and ALS. But the noise continues and creates what can be describes as a

"schizoid" conflict situation within the neural networks and in those organ systems that they are attempting to control with now a "push-pull" situation. This is again, "riding the brakes-and-accelerator simultaneously". Not good for the automobile, not good for the human mind-body.

Figure 32 [aa]

In Figure 32 above, we illustrated the effects of destructive interference in wave dynamics involving a very macroscopic object – a suspension bridge built of steel, concrete and other materials.[11] This is the kind of dynamics taking place in a neurocybernetic network under stress from non-stop noise and conflict. Push-pull forces in all sorts of directions. This is physiological, psychological, and often terminal. In Figure 33 below, we show the follow-on to that historical incident; this situation is what we want to avoid from happening. But we need to be able to detect the precursors, the state-space parameters, before things get into the state of Figure 32 above. By then it is usually too late.

Figure 33 [bb]

Our objective in the medical domain with all of this theoretical work is to do something to avoid such situations occurring within the human body. Point blank simple. In medicine, we are working with mind-bodies born with a fixed and relatively non-adjustable set of parameters that derive mainly from the genetic array allocated at conception. We cannot redesign the bridge and build a new one. In medicine we are working with the equivalent of bridges that are subjected to a wide variety of subtle but often very significant changes in structural properties, in that people grow up and live their lives

11 The Tacoma Narrows suspension bridge collapsed during a strong windstorm on November 7, 1940

with all the psychophysical inputs imaginable, and many contribute to sustained stress processes that are comparable, at least in some functional respect, to the effects of wind and other actions upon a bridge. In medicine we can strive to accomplish two things better and better each step of our way forward as scientists, as physicians, as people:

Firstly, we can work to detect the earliest possible indicators and warning-signs that something is heading to being a problem and even a disaster with our "bridge" in the way it is being maintained, cared for, and subject to stressors of all sorts, and also, in the way some cases are simply disposed to such problems because of tings like genetic factors beyond our control or modification.

Secondly, we can work to develop better ways of dealing with problems once detected. Something to reduce the effects of the "wind storm", or something to be done, retroactive to "initial construction" (both), therapeutically, to make the "bridge" stronger.

We must strive to work in a dedicated way toward such simple goals. But that can produce a lot of good, as long as we maintain our courage, our discipline, our honor and our objectivity.

We suggest the following as an avenue to explore in the origins of arrhythmia and their sustenance:

> *Dissonance in cardiac waves lead into spiral waves and then to multiple spirals which create more and more interference and thus push the heart to beat in ways not designed for it to do. Sustained dissonance of perhaps a lower amount of interference, both constructive and destructive, will have more likelihood of creating such spiral waves that have recurrent effects on heart muscle tissue.*
>
> *This process, if sustained, exhausts muscle tissue that is meant to have time to rest, and the result can be both myocarditis and new neural forking growth and branching and then more arrhythmia. A "chreode" effect may emerge, where the repeated over-exertion and exhaustion cycle creates something in cardiac muscle tissue that is almost like scarring and adhesion in other tissues, although on a microscopic scale.*
>
> *The arrhythmia is then not limited in its effects to only the heart, but progressively it extends to create inbalance and disharmony within pulmonary functions, within GI functions such as peristalsis and basic digestion, within endocrine system metabolism. All of this in turn further aggravates the cardiac arrhythmia. Nothing minimizes the problem, it only gets worse. Positive feedback loops are almost always bad news in biology. Here we have among the worst that can be.*

There has been an exceptional amount of research in recent years from combinations of clinical findings and computer simulations, which point in the basic common directions suggested within this document and provide as a basis for what is termed the Neuroplex-C Project. Here we point out a few of these pathfinder developments, almost all of which precede and are independent from our theoretical and computational work, and so it seems, indeed, from most of each other's projects. Perhaps one of the initial values of Neuroplex-C is in bringing together many valuable "sheaves".

Wave Breaks, Collisions, and Fibrillations

Sustained dynamical instability has been linked with formation of wave breaks and continuation of fibrillation, but it such instability over time can also cause waves to extinguish, leading to spontaneous termination of the fibrillation. [79] Here there is evidence that the combination of sustained dynamical instability with changes in tissue density (mass) and geometry may work together to create and sustain fibrillations. This could point to an area for new diagnostics; the integration of EKG and CT or ultrasound imaging, coupled with appropriate machine learning algorithms, may lead to a new method of early (dispositional) detection.

Particularly relevant is the work coming from Luther, Parlitz and colleagues in Göttingen and elsewhere in Germany. One focus of research is precisely on employing both inverse modeling methods for computing variables that cannot be observed directly, or simultaneously, and also machine learning algorithms, in order to about more accurate discrimination and also prediction for chaotic electrical wave propagations. [80]

Both spatial and temporal permutation entropy (PE) models have been employed to form a new method, termed spatiotemporal PE (STPE). This STPE addresses the complexity of spatial structures and also their temporal complexity, simultaneously. This shows promise in being able to address longer-duration cardiac wave dynamics and the movement of particular wave forms across different regions of the heart. [81]

The employment of machine learning methods, including echo state networks and convolutional autoencoders (a class of feed-forward network), offers promising signs for working with impaired (noisy) and incomplete data, in order to create recovery models of the spatiotemporal pattern. These can be of potential value for diagnosis of the type of wave dynamic variations that can be used as predictors of future spiral (“rotor”) waves. In order to obtain measurements of mechanical motion in 3D, current ultrasound is the only practical means, and electrical activity cannot be measured non-invasively or in any real-time manner within cardiac muscle tissue. [82] [83]

If inverse and predictive algorithms can essentially “clean up” the data that is obtainable through external, non-invasive monitoring, and if a finer method can be developed for discrimination and distinction between wave forms that are generated in different regions of the heart, then there will be promise for the kind of “pre-rotor”, pre-arrhythmia symptom mapping that can be invaluable for earlier-stage prevention and treatment of this class of disease.

Finally, in closing this section, we draw upon the work of Goldberger and Mitrani who express several “summation themes” very clearly, in our view, in a seminal paper that addresses the prediction of future atrial fibrillation (“AF”) and related other arrhythmia. Emphasizing measurable changes in the autonomic nervous system, they point out that there is a complex of parameters that may, together, integrated with an analytical model that also introduces observable wave dynamics, aid in predicting the onset or the disposition for different arrhythmia. These include prolongation of P wave duration,

slowing of atrial conduction, hyperadrenergic states leading to increased calcium influx, and vagal stimulation. [84]

They write in this paper:

> *"... it is reasonable to query whether autonomic nervous system changes may contribute to the subclinical atrial disease that ultimately leads to AF..." [ref. 84; p. 300] and emphasize, "the important distinction between changes in autonomic tone that facilitate AF triggers or alter electrophysiological properties to support AF maintenance, and the potential role of chronic alterations in autonomic input to the atria that actually modify the atrial substrate for AF. Both "vagal" and "adrenergic" AF have been described specifically in relation to AF-inducing triggers. Similarly, experimental studies of vagal stimulation, adrenergic stimulation, and combined stimulation showed that these conditions can facilitate AF induction..." and ask, "Does the autonomic milieu a low HRV represents lead to chronic changes in the atrium that help to form the substrate for AF?" [ref. 84; p. 301]*

In their closing statements, they make what we believe is a point that needs to be well-taken in the context of the additional theoretical foundations and hypotheses engendered by RTD and TBD:

> *"Further studies are needed to better understand the effect of chronic changes in autonomic control of the heart, the interaction of these changes with the anatomic substrate underlying AF development, and to what extent autonomic dysfunction directly plays a primary and/or secondary role in AF initiation/ maintenance." [ref. 84; p. 302]*

This paper points to a broad area for investigation in both diagnostics and therapeutics, and particularly from the viewpoint of present-day challenges – and opportunities through biomedical informatics and data sciences – within PHE – population health equity. Weight (both obesity and weight loss practices including radical, acute dieting), exercise, control of sleep patterns (sleep apnea, deficient sleep patterns), stimulant (and depressant) intake and consumption, and all the other stressors that have been mentioned or suggested within this document as well, are impactors of autonomic neural function and balance.

We need more and better autonomic markers that can, as Goldberger and Mitrani suggest, provide a "barometer for the underlying structural, metabolic and inflammatory milieu predisposing to AF." We will simply add: many other forms of cardiac, gastrointestinal, and autonomically controlled subsystem chaos that manifests in pathological, sustained arrhythmia.

{4} Diagnosis and Therapy

Our objectives are not only to produce a more viable theory that answers interesting questions and produces perhaps even more interesting questions. Our objectives in the theoretical space are to build paths and bridges by which we can reach places in that understanding which enable constructing useful and practical applications that serve needs in the medical community. Ultimately this is about enhancing lives. Individuals, families, communities. Better detection, better treatment, and ideally, saving lives and making those lives more relaxed, fulfilling, and with less of the stresses and the schizoid conflicts within their minds and bodies.

We do not yet have concrete new technologies to offer nor to suggest with anything more than hopeful indications that we are on the right track because of what we have been able to glean from other branches of the life sciences. The evidence for being "on the right track" comes from a diversity of sources that include those within cardiology and neurology, and in physics and molecular biology, as presented in previous sections of this document. As for what future technologies will emerge - for identifying predispositions and early developments of disease and for improved and ideally long-term and "more permanently lasting and reliable" curative treatment – that is the rationale for a project that can draw upon the minds and works of many who are working in these complex areas of medical research.

We present a few points of departure for the dialog that can define and initiate such a project and achieve the desired results.

{4.1} Diagnostics

Our goal is to produce a type of weather forecast map. Only this map involves readings and measurements not of temperature, barometric pressure and wind speeds, but autonomic nerve and cardiac muscle activity, taken at selected intervals. We do not yet know, can this be done through one procedure, one visit of a patient to a clinic with the appropriate instruments and skilled technicians, or will it require a series of visits and measurements, perhaps over periods of weeks or months or even years. We do not know if the desired measurements will require a sophisticated set of equipment and personnel, or if it can be done through some set of personalized, wearable, do-it-at-home monitoring.

What we can consider to be certainly plausible and realistic is that there will be measurements that can be used to make reasonably accurate predictions about autonomic nerve health and disorder, including particular organ dysfunctions like cardiac arrhythmias, based upon some combination of direct identification of specific patterns (i.e., something detected in the measurements) and indirect methods including some form of progressed modeling of how patterns in measured behaviors will transform over time into others that are more clearly indicators of both healthy and diseased outcomes. Moreover – and never to be forgotten – this "map" should be one that is useful to any "reader" community; that is, it should serve all population segments, all genetic and social types.

There is a vast amount of work to be done in order to achieve such outcomes. More data, to be sure, is required, and from a wider spectrum of samples – people with a very diverse set of attributes in terms of genetics and especially lifestyles, and within this, more variety in age demographics. We are aiming to create predictive tools that can be used months and years ahead of when serious disorders can arise and be obvious with present-day technologies and medical care practices. We will need to be gathering and assimilating data from people of different ages, diets, fitness, and especially, stressor-input levels. This means cross-cultural, international, and across all types of social-interaction categories.

We may at this point put forth a simplistic model of what we are thinking is possible to do. This is very simplistic but it is a start.

We will focus on cardiac matters, although we continue to emphasize here that many of the principles, from theory to practice, can apply to other autonomic nerve related disorders, whether they are presently classified and named as dysautonomia or not. Let us not forget that, as one clear example, POTS was hardly regarded as a neurophysiological disorder until a few decades ago and rarely received attention and recognition until perhaps a few years ago. There are physicians in the mainstream today who do not regard POTS and somewhat-related MALS as being anything other than "psychological" in nature.

A Set-Theoretic Approach to New Diagnostics

We aim to create a set of templates that we can browse, select a few, and fit them to data that comes in the form of cardiac wave patterns. Let there be a set S_A which contains identifiable wave patterns Θ_A that satisfy the criteria of being signs and indicators of present-tense active arrhythmia. Each element in S_A is derived directly from data collected from an actual physiological measurement. A set of measurements is transformed, electronically, mathematically, into a pattern Θ_i that can be observed. We have such a set today and it is reasonably established. An experienced cardiologist or cardio-technician sees one of these patterns and it stands out as a condition demanding further attention.

Now consider set S_B, containing identifiable wave patterns Θ_B which are considered to be definite indicators of a near-future arrhythmia condition. Each element in S_B is also derived directly from data collected from an actual physiological measurement and similarly transformed into a pattern Θ_i. Some of the elements in S_B exist today, they are identified and described in various literature including many of the studies referenced herein and in expanded bibliographies.

Finally consider set S_C, containing identifiable wave patterns Θ_C which are as yet unknown as to their attributes and even, realistically, regarding their existence. These are wave patterns Θ_C which may derive from measurements taken in similar ways to those Θ_i which make up sets S_A and S_B, but also they may be entirely computed from data collected at different intervals. These patterns Θ_C are the

early-stage precursors we are seeking, but we do not expect that any element Θ_i in S_C will itself, or in combination with only other members of S_C, provide indicators of future cardiac disorders. What matters, in our preliminary thinking here, is whether or not we can identify some Transformation operators T_1 , T_2, … T_n, which can show a transformation from S_C membership into S_B or S_A membership, that is consistent with other elements of the overall biomedical model for how such arrhythmia disorders operate.

There are a few possible paths:

$$f\,(\Theta_C) \rightarrow \Theta_B \qquad g\,(\Theta_B) \rightarrow \Theta_A \qquad h\,(\Theta_C) \rightarrow \Theta_A$$

where *f*, *g*, and *h* denote functions that can transform one wave pattern into another and moreover, we conjecture that there will be some similarities in the operations of these three transformations, or even something like *f* R *g* ==> *h*, or, *h* R *g* ==> *f*. In a way, we aim to build an algebra of sorts that can be used to operate upon the "variables" and "constants" which are the cardiac readings and the known fixed parameters for interpreting them.

What matters is that we can show a relationships between the patterns within the three sets S_C, S_B, and S_A, that demonstrate continuity in the transformation processes without "singularity" events. In topological terms, we want and need to show that patterns, representable perhaps as knots of string-like shapes (mapping to such geometry from the detected electromagnetic signals and their waves), can be transformed into one another and share some common properties. "Untangling without reconnecting", in the lingua franca of knot theory and topological dynamics.

Thus, we are seeking to find transformation operators that can convert one type of wave pattern (and not necessarily isolated to one region of the heart, for instance, but perhaps a more global-topology pattern, such as the spiral ("rotor") waves described earlier and illustrated in Figure 29 above) into another. We must operate with the physics of wave dynamics and with the biology of cardiac tissue.

We hypothesize that S_C is not an empty set!

Perhaps some of the answer can come from further examination of work such as by Parlitz, Luther, et al, [80 – 83] with echo state networks and convolutional autoencoders, or other forms of neural network [pattern-learning algorithms. The challenge here is in identifying the training set of patterns to be used at the outset of the learning process.

There may also be value from somewhat conventional tools, well-proven in a variety of signal processing applications, such as wavelet analysis. Wavelets have been employed for transient signal analysis. Performing local time-scale decompositions of the signal may become significant, or it can be useful to focus upon the low frequency part of a signal and discard the high frequency part, in order to obtain a smoother representation of the original signal, leaving the low frequency components intact for later tasks such as pattern comparison with other signal fragments.

There are also intriguing possibilities to explore with the knot-theoretic work from Sutcliffe, Maucher and colleagues. [85] [86] [87]

> *"Spiral waves in excitable media occur in a range of biological and chemical settings, including the Belousov-Zhabotinsky (BZ) reaction [3], ventricular fibrillation [4], and chemotaxis in Dictyostelium [5, 6]. In a three-dimensional medium, spiral waves become extended scroll waves with a line-like filament core." [ref. 87, p. 1]*

And further, in the same paper, they write:

> *"...an important mechanism that drives filament dynamics is the location of wavefront collision interfaces, but these evolve in a subtle manner due to small differences in the frequencies of wave emissions from differing parts of a filament..." [ref. 87, p. 1]*
> and
> *"The interaction of thrings represents an elegant and simplified platform for understanding the interactions between waves and filaments in excitable media more generally. It represents a quasi-two-dimensional arena in which to study filament motion induced by wave slapping due to differences in wave frequencies." [ref. 87, p. 4]*

Precisely what we have occurring in the heart, including under normal "healthy" operations, is "Figure wave slapping due to differences in wave frequencies". Now, imagine what this wave slapping activity becomes in an environment of massive collisions and interference as in a full-blown AFIB condition.

Figure 34 below illustrates the evolution of a "colony" of (only) 36 thread rings ("thrings"). Consider what it might be if the methods developed for such topological entities were applied to a collection of wave patterns detected in real-time from a beating heart. Figure 35 gives an impression (taken from an image of the surface of a body of water into which acoustic vibrations have been introduced) of what things turn into under the circumstances of arrhythmia.

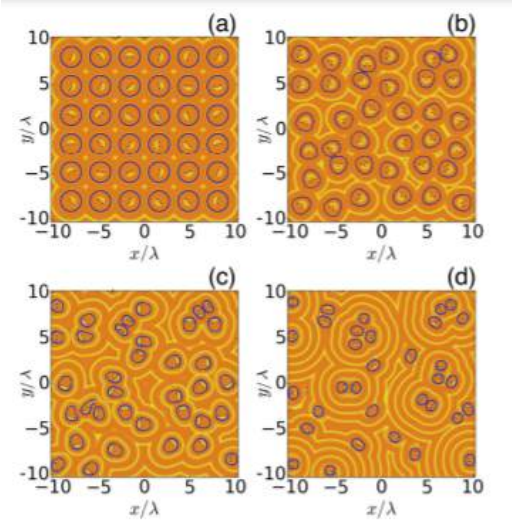


Figure 34 – Evolution of a colony of threaded rings [cc]

Figure 35 – Water Surface with interference patterns [dd]

{4.2} Therapeutics

Realistically, it is very early to make suggestions on the types of therapeutics that can emerge from the investigations that are themselves suggested on the basis of theory and "guided, guarded speculative hypothesis". We have goals, certainly, to produce tools for cardiologists and general practitioners alike, and for the individual patients who ultimately will make the difference in their health outcomes based upon protocols and again, emphatically, lifestyle habits and changes, not all of which come easy for anyone. We have goals to produce therapeutics that will be more lasting and permanent than many results from ablation and cardioversion procedures. We aim to find ways to do more-with-less and earlier than in emergency or near-emergency hospitalization settings. We aim to find techniques that can be non-invasive procedures, going beyond even the promising work in optogenetics.

What will be possible from the approach being defined for "Neuroplex-C" is all going to depend upon the progress in the theory, in the models, in the applications, and first before therapeutic measures, the diagnostics that will give more accurate pictures (literally) of what is going on in these neuro-muscular disorders.

Certainly, advances in how signal data can be interpreted, transformed, and viewed, can be an early-stage and virtually certain benefit to cardiologists faced with choices regarding ablation, cardioversion and other invasive and "force majeure" treatments, and as well for emerging new procedures such as through optogenetics.

We hope that there can be new techniques that prevent, curtail and/or reverse many conditions such as arrhythmias which will be simpler, easier, and non-invasive. How much can be "reversed" when there have been neural and muscular changes in an organ such as the heart, or in non-cardio neural ganglia, is still a very open question. However, there may be promising methods that draw upon both modern new technologies as well as very traditional and even "ancient" methods of restoring health to over-stressed bodies- and the minds that go with(in) those bodies!

There is evidence that acoustic including ultrasonic acoustics may be beneficial. There is research in

several branches of medicine including psychology, including non-invasive vagal nerve stimulation for treatment of disorders such as sleep apnea. [88] [89] [90] [91]

There is evidence that electromagnetic stimulation – and in particular the role of the magnetic fields therein - may have positive value. Some of the most promising results have been in a wide range of medicine and psychology: wound healing and reduction of infection, skin melanoma, enhancement of certain immunizations, and particularly in treatments for depression, anxiety, and PTSD. [92] [93] [94] [95] [96]

There is evidence of the positive therapeutic value that may be gained through a variety of lifestyle activities including personal and family proactive measures in nutrition, weight control, substance intakes including caffeine, alcohol, tobacco and a variety of drugs both prescriptive and non-prescriptive (particularly opiate painkillers which are linked with post-operative ileus, for instance, and clearly disruptive of similar autonomic control processes albeit in a different organ and modality).

There is particularly very promising evidence of the value in different forms of physical fitness and mindfulness disciplines. Especially noteworthy are several forms of meditation (Zen (Sŏn), yoga) and martial arts practices (t'ai chi ch'üan, kung fu (kungpu), taekwondo). The practices of both performing and listening to music, particularly classical forms both Western and Eastern, are also noted for psychophysical healing value. [97] [98] [99] [100]

All of these measures need to be considered as part of a holistic, whole-person mode of treatment for disorders that clearly affect the most central and “whole-reaching” and “whole-serving” networks of the human organism – heart, lungs, digestion.

However, in all of these possibilities, we do not yet claim to know how such techniques would be successful or not in affecting neuromuscular dynamics that have already begun and proceeded to the stage of where there are arrhythmias and other dysfunctional conditions so advanced that they are being detected through present-day general medical practices using present-day technologies.

We consider as one distinct possibility that a combination of methods, including some suggested above, particularly the use of ultrasonics and electromagnetics (either/or) in combination with lifestyle and behavioral actions that are focused upon exercise and fitness, may offer therapeutic value that can reverse certain dysautonomia and specifically certain cardiac nerve and muscle pathologies, even where there have been visceral changes in tissue growth, size, density. This is not unfounded within medicine. We see remarkable regenerative and restorative (“resetting”) processes in response to injury and stress within all tissue types. We see restorative processes in response to ischemic stroke both transient and severe, in the capacity of the brain to engage in some adaptive “rewiring” of functions. We see restoration function without abnormalities in non-insignificant number of cases involving myocarditis from infectious diseases, and in restoration of ejection fraction within individuals who have suffered from AFIB and related trauma.

It is not inconceivable that there can be slow and gradual restoration of a heart that has been subject

to the early stages of spiral wave dynamics, without the need to resort to surgical or other "acute" procedures. But we will not know the answers, or even the realistic probabilities of positive answers to these questions, unless we first tackle the challenges of analysis and diagnosis, with a major emphasis upon the wave analytics that will give us the right information and in the right formats for understanding the wave dynamics.

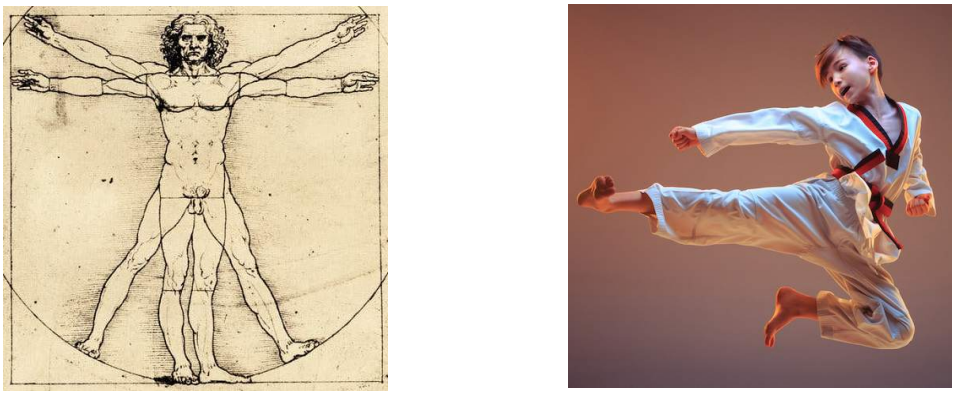


Figure 36 – Two views of wholeness and balance in mind-body [ee]

{4.3} Looking at the horizon and going forward

This document began as a brief synopsis to a plan that was sketchy and full of many gaps, with a map that was rough and vague, and a lot more questions than answers regarding what would be the right path to even begin on a "hike through the mountains at night and in the fog".

What was originally intended to be a few pages in summary fashion turned into what this is now. Still very rough, a lot of loose ends, gaps, omissions, and rough spots. More questions than answers. But at least there has been an attempt to link some very abstract theoretical foundations – and notions – and speculations – with the real biology and some very real pathologies that occur in that biological framework. Everything thus far, here, is still just a beginning, an outline, a map that probably (assuredly) has many wrongly and poorly described features and descriptions.

However, in the face of ample self-criticism and in expectation of ample criticism from readers of these pages, there is optimism of being on generally the correct path for traversing these mountains and reaching some good place on the other side. Fertile oasis, lush verdant valley, relaxing beach, all nice images to relax the mind. All part of a collective optimism in which, hopefully, all of us can share.

Where to go next and what to begin next? This is where everything transforms into the space of dialog, with argument, dissent, agreement, questions upon questions, consensus, and synthesis. Or to put it simply into Hegel's classic paradigm – thesis, antithesis, synthesis.

This can lead into good science, good medicine, healthier and happier lives, and even good commercial outcomes. It need not and should not remain as only "interesting theory". A creative and open-minded team can accomplish a lot with what has been introduced here.

I will close with one word from the language with which all in the field of medicine have some familiarity, due to historical reasons – Latin. This one word is

coadunatio

It derives from, and means, a "gathering together of sheaves from the field for the harvest". Sheaves of wheat, barley or oats, for instance. Gathering nutrition and energy within those fruits of labor and Nature's blessing, and putting them to proper good use for society. It is also the gathering-together of the people who work the fields, who toil over the harvest, and who reap the beneficial results.

In our times, in the complexity and multidisciplinary expertise requirements of contemporary science and particularly in medicine, we need good teams. We need collaboration. We need "thinking outside the box" and also thinking and working "inside the box".

We need the spirit of *coadunatio*.

Let's think carefully and prudently and see what we can do Together.

Figure 36 – "Harvest in Provence" (Vincent van Gogh, June 1888)

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[m] 20a - Knots in chemical forms – source will be provided

[n] 20b DNA and knots – source will be provided

[o] 20c Proteins and knots – source will be provided

[p] 20d Functional chem and knots – source will be provided

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{6} Appendix

{6.1} Entropy and Negentropy Reflexively Implicitly Bound

EPR = GR = QR
Martin Dudziak (and others, tbd)
The TETRAD Institutes (and others, tbd)

Abstract
Susskind and Maldacena introduced the notion that the Einstein-Rosen-Podolsky conundrum may not be far afield from general relativity but coming from a perspective of holographic projection from 2D to 3D spacetime. Finkelstein laid foundations earlier for a process-based algebraic integration of quantum mechanics and relativity, drawing upon perennially orbiting notions of a spacetime code that makes information the underlying fundament of any observable physical universe. Modern theoretical physics is increasingly painting pictures of a no-thing-ness space that exhibits continuity emerging from an infinitesimal network of discrete primordial elements. The thesis is developed here that there is an integration path which is consistent with the Standard Model entirely as observed in experiments, with certain questions raised regarding whether portions thereof can be taken as reflecting the natural course of cosmic evolution. A random dark-energy sea dominated by entropy is presented as a necessary foundation for the emergence of any order and structure and that such order or negentropy is a necessary consequence of such a sea being non-finitely-bound, in much the same manner as one can approach continuum and cardinality within number sets. The course of emergent order that follows in Nature is one that serves to minimize the cost of energy in maintaining the freedoms of entropic action in the underlying scales of observation. In other words, an origin of spacetime in discrete quanta simplexes demands the appearance of finitized quanta of bosons and fermions through a natural curvature of the manifolds created by those simplexes assembling and disassembling. Gravity is entanglement is unity.

[potential section headings]
Introduction

Foundations of Entropy, Information and a Topological Approach to what these are

A New Way of Thinking about Heat Flow and Geometry Flow
CS and CDT demand bendi ng and curving in order to preserve entropy
Curvature demands finitized concentration of CDT and string-nets
Gas to liquid to condensation = matter (of the light type)
Curved spacetime generates mass
Entanglement is unity and at the root of gravity which is not a force after all

{6.2} Tensegritons

A general model is presented for the emergence and stability of structures arising from the interactions within a network of multiple dynamic components that can be represented as wave-like processes that possess solitonic properties such that factors influencing the nonlinear and dissipative terms of these processes, referred herein as "tensegritons," are modulated by the interactions with neighboring processes.

The model is motivated and suggested as being of value in addressing fundamental questions in particle physics and also for diverse other mathematical and physical applications including the representation of certain cognitive and cybernetic processes.

We begin by considering an n-dimensional space in which there exists a network of multiple processes, tensegritons, that behave as waves moving within specific constrained regions of the n-space that function as channels or chreodes. The chreodes define pathways by which signals propagate. These tensegritons are assumed to possess wave-like and in particular solitonic properties but we reserve at this point the assertion that these processes are describable by classical soliton equations because their own shape and form is influenced by the interactions with their neighbors. In this sense the model has some similarities with cellular automata systems but the analogy should not be over-extended. [12]

Let us have a starting point for understanding how a network of tensegritons behaves by considering wave q_i that are based upon the simple KdV soliton as defined by the general form $u_t + 6uu_x + u_{xxx} = 0$, of which the more typical expression often given is

$$Sech\left[\frac{\sqrt{b_1}\left(x - 2tb_1\right)}{\sqrt{2}}\right]b_1 = 0 \qquad \boxed{1\ 0}$$

Of course this 1-dimensional form is the simplest and will not suffice for long but perhaps it will work for clarity in understanding the basic model.

We begin with the definition of the tensegriton as a modification of the general wave q. It is a string-like process occupying a general region (and staying within this region) in the n-space through which such a wave moves. The region through which a tensegriton q_i moves can be likened to a channel or chreode. Its properties however are not external to the wave that propagates in this general vicinity but rather are defined by the probability density over time that this continuous wave is propagating within the bounded range of such a chreode. This range can be likened to a radius extending perpendicular from any point along the path of the chreode.

Define the chreode as α_i. Let it be assigned arbitrary beginning and end points which are defined by coordinates within the n-space. For initial purposes of argument we take the n-space to be D=3.

12 The model is based upon the concept of delimitable regions that are describable in terms of a network of interacting and interdependent processes. These processes are most closely described as solitons, but these are understood to be not pure or simple soliton waves. Rather these processes are named "tensegritons" because their nonlinear and dissipative terms are influenced by the presence of interacting neighbor tensegritons.

(x0, y0, z0) is the beginning point and (x1, y1, z1) the ending point for a given chreode α_i.

These points are defined as the locations where the wave q_i exists.

Let β_i denote the radius of α_i and specifically $\beta_{i(x,y,z)}$ is the radius at or near coordinate (x, y, z).

The general behavior of α_i may be likened to a spline curve but this should be taken only as an analogy. Its shape is determined over some history and influences the behavior of a particular wave q_i – how is something to be explored further, since we need to identify what kind of relationship it makes sense to talk about between the different tensegritons and how the waveguide or chreode geometry can influence these relationships. We hypothesize for for this overall model we cannot predict in advance what will be the waveguide in which a particular wave q_i travels and indeed, based upon the influencing factors upon q_i by its neighbors in the network, the form of α_i can be changed over some arbitrary time interval.

Also note that β_i can vary significantly over the length of α_i and can also change over time, giving the chreode a type of thinning and thickening aspect to its geometry.

Additionally we consider that the behavior of q_i is really describing a probability density and that there is no actual wave following precisely the behavior of q_i. The soliton description is an approximation. We may possibly describe the behavior of q_i for instance more accurately in terms of a strange attractor function and we will give this the identifier γ_i. What is γ_i apart from q_i? The former is defining what could be described as the motion of some particle but the latter is the probability density of this movement and it is what we are really concerned with.

- - - - - - - -

Thus far we have described a hypothetical universe that consists of a space in which there is a pathway through n-space. In this pathway or chreode travels a nonlinear wave that has generally the properties of a soliton wave but which can vary over time. What keeps this wave in its general path? That it is a soliton most of the time. What keeps it this way? We conjecture that it is the energy states of all the other waves in the local system.

For simplicity we will let i=4 so there are a total of four chreodes. We define limits on the interactions between the terms of the individual waves comprising the system, such that exchanges of "energy" can occur only in certain intervals or quanta.

The result is that each wave is modulated by the others.

Next we look for some stable interaction between the four chreodes that is maintained during the course of the life of the system, independent of the actions of any one particular wave or any particular configuration of all four.

Self-organization and emergence of stable virtual structure from the interactions of a set (network) of tensegritons.

X is a measurable object but it does not exist in the classical sense. It is an effect of the interactions among some network made of tensegritons.

Applications of the model

Particle physics and string theory
Strings are the tensegritons, or perhaps the structure X created from interactions of tensegritons in a local network (cLAN) is an example of a string.

Cognitive processing and learning
Relationships create tensegritons and an interaction network among them. The result is something that is new, hypothetical, or inferred, and this X is created out of the interactions of the tensegritons but not attributable to any one, any pair, any subset of the interactions, but only to the whole of the interactions. (Same lat sentence applies to particles)

Notes:
The model is suggested as a basis for a unified model describing particle-like structures including but not limited to fundamental particles of physics and extensible as a possible mathematical description for the behavior of select complex macroscopic systems including certain non-physical informational and computational systems.

Sine Gordon soliton as defined by the general form $u_{tt} - u_{xx} + \sin u = 0$, of which the more typical expression often given is

$$\left[\frac{\partial^2}{\partial t^2}\Phi(x,t)\right] - \left[\frac{\partial^2}{\partial x^2}\Phi(x,t)\right] + \sin(\Phi(x,t)) = 0$$

{6.3} Tensegritons and Topological Solitonic Networks in the Emergence of Particles

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Abstract

Topological solitonic structures, in particular toroidal structures occurring as minimal energy configurations in higher homotopy classes of the Skyrme model and in all homotopy classes of the **n**-field (or Fadeev) model and their gauge generalizations, are examined as underlying general and universifiable models for the emergence of particles including all known types, fermionic and bosonic, within the Standard Model. The derivation of these structures involves a representation of nonlinear field interactions in the formalism of solitonic networks which describe topological changes within a fundamentally particle-free quantum flux ("dark energy matrix"). The stability of nodes defining interactions (collisions) in a simple four-dimensional spacetime within such networks is presented as the dynamic function giving rise to stable and semi-stable formations ("tensegritons") with the properties of particulate matter, both "light" (ordinary) and "dark". The fundamental model is further considered as a potential mechanism for use in the synthesis (engineering) of memory devices that are capable of functioning as qubits within a quantum-entanglement system for computational and informational applications.

{6.4} New Model for Emergence of Order and Structure through Randomness, Chaos and Reflexive Topological Flow Dynamics

EXCERPTS from the Uncompleted Paper – these are only a few notes from the Draft version

Martin Dudziak
The TETRAD Institutes
[new version begun on Sunday, 28.April.2019]

Abstract [to be rewritten]
Random processes are pre-structural, aperiodic, non-algorithmic elementary foundations that lead necessarily into defined chaotic behaviors governed by deterministic functions that are composed of quantum processes. Entanglement originating in the pre-spacetime unity foundational state extends through dimensional-evolved spacetime and the chaotic dynamics (pre-matter), driving the chaos toward stabilizing form and structure and increasing complex order. Ultimately these evolve by mutual relationships and interdependencies into forms and structures that conserve energy and increase complexity. Toroidal dynamics are a driving basic structure for both pre-particle "dark matter" and particle "light matter". Negentropic informatics governs the continual progression of interdependent evolution of increasingly complex structure and order leading to precise allowed geometries and topologies that give rise to atomic, molecular, macromolecular and biological structures. Quantum entanglement is a mechanism of unity and information connectivity which manifests in the measurable relations of gravity. General relativity is consistent with quantum mechanics through the unity/gravity of an increasingly complex universal evolution from randomness to order.

-==========-

A Fundamental Function (AΩ) of Reflexive Topological Dynamics

This is a potentially major reformulation/restatement of everything above and below relating to this paper and RTD theory.

Introduction/Summary

A Fundamental Function that is modified, replicated, with a kind of "complexification-recursion" as scales change (evolve) in Nature. For now, I call this the AΩ (Alpha-Omega) Function. This is the fundamental expression of Reflexive Topological Dynamics (RTD).

This function, which is a composite or hierarchy of functions operating upon itself, provides for the emergence of increasingly complex patterns in a matrix of random flux actions within the topology of a 3-sphere. These actions proceed to constantly push toward formation of singularity events and something like a Ricci Flow process within this AΩ (as generally expressed by

∂ −2 where is the metric, and is the Ricci curvature)

maintains stability and smoothness for local and global geometries, and for the complexities therein.

This process naturally leads to successive increased complexity in different local regions, in order to maintain the higher-scale order, stability, smoothness. (This is something that could become a theorem and even a proof, in a general manner – tbd.) Such increasing complexity is then a measure for the preservation of some deeper, fundamental constancy, uniformity, equilibrium, and it may be related to formal entropy and information models. This increasing complexity, through successive "reflexive-recursive" action of AΩ upon itself, leads to proto-strings, string-nets, proto-particles, particles ("matter") and successively to more complex organizations of matter that also preserve the same

continuity and smoothness overall and within intermediary-scale regions no matter how complex the local geometries become.
This provides insight into why spacetime is curved according to General Relativity and how gravity is fundamental and an origin to all quantum mechanics, and how the behavior of spacetime emerges necessarily from the foundational actions of quantum mechanics. There is also a path here for understanding the topological requirements for the existence of black hole phenomena and an explanation for the energy-geometry flow from a black hole into not simply a singularity but a path of diffusion through "new" (elsewhere, that is) fundamental causal-set dynamics of elementary simplex operations (CSD) (similar to CDT triangulations) and from them, back into the cycle of proto-string-like dynamics (more structured than the basic CSD), then string-nets, then proto-particles (dark matter), then particles (light-matter aka regular matter).
Thus, there is sometime of a unification of theory that works in both directions connection quantum theory and relativity theory. The electro-strong-weak forces, which ought to be understood in a more unified fashion as inter- and intra- particle forces acting within spacetime-stabilized matter (light matter, STD-model matter), can through RTD be shown to emerge necessarily from the fundamental relation (as distinct from "force") of gravity-entanglement-unity.
Further, this same basic AΩ function logically extends to higher-order scales of order, structure and complexity including the origin of atomic, molecular, biomolecular and organic living entities. Complexity in the form of increased order, emerging from a relative "sea" of less ordered spacetime and networks of entities composing that spacetime, at different scales, is the natural and necessary "driving force" for preserving that spacetime from becoming disordered, irregular, and chaotic to the point of topologically ripping and tearing apart, and so the increasing ordered complexity is the dynamic for stabilization and smoothness overall, and preservation of equilibrium, balance, and symmetry.
This therefor provides some path for thinking about connectivity between fundamental physics that is "pre-life" with the emergence, necessarily so, of complexities that lead to self-organization and self-replication, and thus, Life Itself can be understood as a natural evolutional consequence of the Fundamental AΩ Function.

AΩ Function begins with

Alpha A(x) where x is a space curled up into a point but divisible into infinite parts…
This is underlying, "before" everything. Random foam, zero-point expanding. There is no spacetime. It can be called "no-thing", or "pure dark energy, vacuum flux"
It is underlying but not as if it exists for some "eternity" – there is no time, as no space, to speak of.
There is no Ricci Flow process here because there are no surfaces or volumes to speak of. Everything is just the "primal flux" or foam.
But Alpha produces Beta. This is inevitable, and the challenge is to show how Alpha leads into Beta and why everything does not simply stay in pure Alpha. Some actions must have a tendency to predominate. Here it may be appropriate to bring in the topics of transcendental numbers like pi, e, and also the sequence of prime numbers. Random, but not "pure random", but dictated by precise mathematical rules. Something about irrational numbers and specifically transcendentals does seem to be important for Alpha being transformable as a function into Beta.
Alpha governs pre-CSD actions. This is not something leading to anything structured, not even like CDT, nor strange attractors, nor chaotic models. It is random in a pure sense, and the most complex

things may be some appearances that seem non-random, an occasional line or triangle.
Alpha produces Beta.

Beta B(A(x))
This function acts upon Alpha.
Proto-ordering, triangulating dynamics, connected as causal sets, or more properly, CSD, and these are all actions of multiple types of simplexes. Dimension in space and time emerges, because things are happening as elementary simplex operations. This is where the randomness, the foam, is producing brief elementary patterns but they dissipate quickly. Proto-strings. Chreode-like activity of proto-string formation. The proto-strings are like chunks that appear and dissipate.
There is an underlying process that is entropic, but this is also what is and will create order, because the entropy drives all the elements to move, to act, to change, and the way that this is optimized, maximized, is for things to move in some directions, some patterns, with total freedom that is only constrained by nearest-neighbor and by causal time-direction.
Here is where there comes into the picture Ricci Flow, not as an ordinary heat flow, but more to do with the whole geometry ("Geometric heat flow"), Everything is happening smoothly, continuously, but through micro-Planck-scale discrete chunks, the triangles and tetrahedral being the action-components.
Quoting from [JM-1] --- "This geometric invariant will usually be some form of curvature or other, and thus the flow will tend to let curvature in the space flow around and become more evenly distributed. These flows are thus very useful, since if they can be shown to have solutions for all times, then they will tend towards a space which is evenly curved everywhere…"
But there are not yet well-defined structures. This is a "gaseous-like" state (gas-like, but without particles making up the "gas"), and what makes up the space are an infinity of geometrical primitives that operate according to the constraints of what is here called a "Ricci Flow-like" process, so that things stay relatively smooth locally.
Beta produces Gamma. Some activities lead to more defined shapes, namely, string-like.

Gamma Γ(B(A(x)))
This function acts upon Beta.
This leads into what may be termed a "string-net liquid". This is "Liquid—1". Similar, I believe, to how Wen, Levin and others later with Wen have developed that proto-physics. There are semi-stable and stable string-like entities that form, join, interact, and all are as part of, not independent, but integrally part of a global, universal network structure.
There are no strings apart from being elements, threads, within the net ("blanket"). Strings exist as parts of the net. The whole influences the parts.
The Ricci Flow model applies, now to the network and its local topologies and, scaling up, to how any local topologies connect. Seamless. No breaks, no singularities. But as there will be more complicated arrangements of strings interacting within the Net, that is where, in the next Function level of organization, there will appear things that are "like" singularities! This is how finite objects, starting with proto-particles ("dark matter") and then particles ("light-matter") evolve!
This is a "liquid-like" state (liquid-like but without particles…), and what makes it up are the string-nets. There is an inevitability that some of the local regions within the string-net are going to knot up, get more tangled, and here is where there are the beginnings of the unity-gravity-entanglement dynamic – things are not so disconnected, they come from the same source, they remain fundamentally unified micro-regions of spacetime action, and thus there will be a tendency to act in similar or complementary

ways – and this leads toward the string-net activity getting more structured, more regular, in the next phase (function).
The increased structure and regular-order that is emerging is linked to the topological operations of making the overall local, intermediary, global regions not break apart into singularities and undergo "automatic Ricci Surgery" operations which will not necessary bring things "back together".
Gamma produces Delta.

Delta **Δ(Γ(B(A(x))))**
This function acts upon Gamma.
Eddies and vortices. Liquid-2 state. Dark-matter proto-particles, that are composed from string-net local actions that have become more twisted, more convoluted, more inter-related locally than with the rest of the net. And yet, they are all connected, always, within the global net. It's just that some local behaviors are now doing things a bit differently, and so there is the growing tendency toward distinct behaviors that will result in more distinctions.
There are not yet particles as such, but definite patterns, semi-stable, and these could be called proto-torii – they "almost" take shape. Much as in the river, there are certain stable wave-crest patterns (corresponding to light-matter particles) but all around and underneath are unstable, constantly changing, "almost" formed patterns.
The Ricci Flow is now about the smoothness and stability and unbreakability of the energy flow which constitutes the whole which is constituted by a "sea" of the flux-foam transitioning into proto-strings and in some regions string-nets, and all the regions with more distinct geometries forming, almost forming into distinct and identifiable, longer-lived entities. The Ricci Flow aspects here pertain to continuity and smoothness at all levels.
In this phase, it is almost like the 3-sphere is "bubbling up" and not entirely dissimilar, phenomenologically, to how water is when it is approaching the boiling point. There is turbulence, there are breaking of bonds – in this case, between water molecules – but with respect to this "Delta function space-energy-time" it is not from some increased heat but increased geometrical chaos and turbulence, and the way to stabilize this, is first through the concentration of CSD actions into proto-particles that are still only turbulence, not taking stable shape-structures, and then through the next phase, Epsilon, where the "release" of energies, in order to preserve the flow-geometry of the whole, to avoid an "infinite sea of micro-singularities", is to proceed to doing a kind of spacetime "Ricci Surgery" that keeps all the "bubbles" within the whole and maintains the optimal geometry of the whole, but with all these concentrated point-like elements that have a lot of energy and a lot of CSD action within.
Delta produces Epsilon.

Epsilon **E(Δ(Γ(B(A(x)))))**
This function acts upon Delta. This is the Condensation phase. From among the proto-particles, some actions become such – as a result of how the whole "sea" is acting, not just at isolate points – that there is a condensation into torus-like processes that have a variety of stability in the spacetime. This is the Standard Model family of particles – all bosons and fermions. Their energies, their dynamics, their properties, are determined by both local dynamics in the emergence from proto-particles that somehow transition to having continuity in the flow of energy as dynamic triangulation flows, as strings from the net, into torus-like geometries, which also have rotation that gives rise to spherical properties that are observable, but the fundamental process is an in-flow and out-flow of energy as strings, as constant

geometrical dynamics of the same fundamental micro-Planck-scale triangles and tetrahedral, and these are sustained not only because of their local/internal geometries, almost like spinning tops or the "inverse" of balls spinning around a vortex channel, but because of the whole spacetime around each particle – the whole "river" or "sea" provides something that may be termed a Geometrical Pressure which helps to "keep each particle tightly bound together upon itself".

This Geometrical Pressure somehow figures into the Ricci Flow process in this Epsilon Function. What is being maintained, smoothed, evened-out, across all spacetime is the curvature of spacetime, but now there are many distinct almost-singularity points, namely, the particles of light-matter (regular "matter"). So in these regions, there are distinctive curvatures in spacetime and a natural tendency – in order to preserve the smoothness and uniformity overall, for the curvatures associated with matter and associated with mass, and thus the connection grows with general relativity.

A geometric energy flow, analogous to heat flow, and mathematically some type of Ricci Flow, is working to maintain a type of equilibrium, a smoothness, without "big breaks or rips or tears" in the whole of space(energy)-time, and as the Condensation process of Epsilon function develops, making "almost singularity points" which are light-matter particles, these are stabilized and do not become individual singularities, and overall, there is a bending of the space that accommodates the density of these particles, in such a manner that they have a tendency to draw together, in very simple ways as forming atoms and then molecules, and further, to draw together in also simple ways but now as atoms (and particles) to form larger and more concentrated local geometrical bumps and nodules, all of which is serving to keep the whole spaceenergy-time maintaining its smoothness and not having big rips and tears where the concentrated energy in the form of dense concentrated knots and vortices and tori of string-nets are located.

Zeta and Beyond **Z(), H(Z), Θ(H)**

Evolution further proceeds in two types and ways – one type of scale is that of 3-sphere size and this pertains to everything beyond atoms. This encompasses scale increase of different types, including the evolution into galaxies and a condensation process within them of forming stars and then, by the usual classical physics, planets and other entities, but also other scale increases into molecules and beyond. Call this the Zeta Function, operating upon Epsilon.

The other type of natural and necessary evolution is in an internal complexity growth, and this is what progresses through the levels of atoms, then simple molecules, then highly-organized chain molecules, leading to proteins, nucleic acids, and then their combination in a complexity that is a big leap in ways but still adhering to the same basic principles of maintaining order and preventing total-breakdown singularity-mayhem disorder, through the emergence of self-replication and self-modification, and this is called Life.

Call this the Eta Function, operating upon Epsilon, and Zeta as well. There are different ways that size and number grows in complexity, and whereas Zeta is mainly about size and mass accumulation, and dominated by gravity and less so by EM+S+W forces, Eta is more about a more internally, inwardly focused growth of complexity, involving the relationships between elementary components, as atoms, as molecules, and as combinations of molecules including in the situation called Life.

Then within living systems, this is where the Theta Function begins to operate, still doing the same "basic" activity as found in Beta, Gamma, all the way through. Maintaining simplicity, equilibrium and continuity through growth in increasingly organized complexity.

Theta functionality gives rise to higher levels of internal control and self-organization. This is through the evolution of neural functions and ultimately a central nervous system (CNS) and then a CNS with a

brain, and then a brain that can generate patterns of activity that are truly reflexive upon itself, in the process of performing all its control functions. And all of these are operating through the topology of a biological system that is operating according to fundamental Ricci Flow type principles of maintaining unity. smoothness, equilibrium, shortest-path optimal travel of energy as signals between points, etc. Everything in the psychological framework of sensations, memories, cognitions, motor responses is also constructed and proceeding in ways that can be understood as topological constructs, intersections, bendings, foldings, and other dynamics.

More on all of this, because all of Life also is encompassed by the Fundamental AΩ Function.

Notes to the Notes:

[JM-1] Informal blogsite: https://www.quora.com/What-is-an-intuitive-explanation-of-Ricci-flows

[JM-2] Also this point: "This means that he [Perelman] would allow the Ricci flow to flow for a time, until it looks like a singularity is about to form. Then, the manifold may be cut, and reglued in a way that avoids the singularity. The Ricci flow may then be turned back on. Eventually, by keeping track of the surgeries that were performed and the end result, the original manifold may be reconstructed and understood."

{6.5} Reflexive Dynamics and the foundations of a cybernetic interpretation for quantum and relativistic phenomena based upon stochastic perturbation, approximation and random fitting

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and
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This is an exploratory work, based upon the hypothesis of an underlying process dynamic governing quantum events that may be described in physical and informational terms but which is essentially non-algorithmic (in the classic Penrose sense) and non-computable in the Church-Turing model. Randomized and stochastic perturbation models have originated and developed principally in the domain of control theory and formal cybernetics, with applications to extremely complex state-spaces and highly non-linear dynamics within the same. The question of how a spacetime geometry may evolve from "pre-dimensional" action-relations is considered in the light of such models, with a view toward a horizon that suggests something comparable to cellular automata behavior, in a Planck-scale-limited, probability-density controlled "action-space." Such relational processes give rise to emergent and increasingly stable structures that are consistent with observation and representation as four-dimensional space. Time serves as a different measure, mathematically consistent with time in general relativity but ontologically different, providing a correlation of 3D spatial constructs (observables) transiting in a fourth dimension. Analogies may be found with the motion of image frames within a video stream or to holographic image constructions. This investigation further suggests that increasing complexity of structure, including emergent behavior of mass and particle-concentration (as a topological condensation process), is a necessary consequence of a universal "principle of least action" ("stationary action") governing all energetic relations. Expansion of scale implies increasing expansion of interactions and the principles cogently stated by Fermat, Maupertuis and Euler are satisfied through complexity of structure.

Certain issues that have been dilemmas within quantum mechanics and relativity theory are addressed with the suggestion, not dissimilar from Susskind's "EPR = GR" papers, that superposition and entanglement, at the scale of photons or in more complex structures including molecules, derives from a pre-spacetime unity that is logically and physically prior to an observable spacetime. Within the observable realm of finitized, 3D objects measured as separable in location, the phenomenon of gravity is an expression of that underlying unity and should be regarded as a relationship entirely different from a force between separable objects.

{6.6} Reflexive Topological Dynamics and the Basis of Topological Limits and Bounds of Structural Deformation and Morphological Change

Martin Dudziak, Ottorino Ori

Comments in advance:

[1] This probably should be two or even more papers. But perhaps it starts out as one, and then there will be splits into different specific areas. The aim here is to have one or at most two papers that provide a suitable foundation for going further into at least two areas where theory can be applied to well-defined need-areas in industries that are stable and capable of supporting further research. We want to show as theoretical results some X which will clearly bring benefits to some Y that people and the society need and where those needs and benefits are understood by enough people.

[2] I see two such application areas – medicine (specifically virology, VESID), and ge9ological exploration and discovery (specifically, mining for metals). These may seem very far apart, and in some ways, this is true, but when it comes to topological stressors, strains, and efficiencies of transformation operations, this is where there is more unity.

[3] To move VESID forward, we absolutely need some other persons who have more direct and experimental activity, right now, active in some lab, with the protein and lipid structures of the SARS-CoV-2 virus. And, of course we need Funding, for both actual and immediate use (us, including me, unsalaried at present!), and also for that all-important thing called “Image” - the “PR” value of being seen as “having-lots-of-support-and-money-already”, which is necessary these days in order to gain acceptability and attentiveness from others...

[4] But there are other application areas for which I believe we are closer to being able to show some results which are also practical in the sense of engineering. For now, I call this

> TGMFD – Topological geomorphic flow dynamics – new technology for improving the processes of exploration, detection, analysis, and the identification of optimal deposits of different minerals, especially valuable metals.

Next, some generalized claims, and then some ideas about the structure of an initial paper along these lines.

Claims:

[1] Given a complete and closed topological surface (2D? 3D? - which may represent symbolically,

informationally, a non-physical set of data that has been mapped to such a topology), there is a mapping that can represent the whole as a unique unitary entity. This mapping (M), perhaps represented as a formal set of numbers (not as just one number), sufficiently represents the Whole and not just any one segment of the manifolds that make up the whole topological structure. This M controls (limits, constrains) the variations by which any given subset of that surface – any delimitable (bounded, finite) portion – can be modified, deformed, changed in its shape.

The shape of the Whole controls what can be done (changed) to any portion (part). The information in M, about the Whole, governs any changes within the parts (down to some limit point in scale, something to be determined and defined).

We can term this as the principle of wholism – the whole controls the parts and how they can change and still be a contiguous part of that same whole, and without destroying that categorizable, definable "essential characteristic" of the Whole. (Something here reminds me of eigenvalues, eigenvectors...)

The next claim is very pertinent to problems like VESID and can potentially explain why certain objects, such as viruses, have the shapes that they do. But this second claim, I will also suggest, is important in geology and the dynamics – the flows and possible changes in shape - of geological regions such as in crust and upper mantle, etc.

[2] A given structure, which may be composed of many elements, can be represented as a continuous, closed topological entity. From the parts, as long as they are connected, we can say that one can move (e.g., a pointer, like a pencil) from one segment to another to another and eventually connect all segments. We can then make transformations of shape for the given structure and these changes will, we can assert, be reflected in some dynamic changes within some, if not all, of the component parts. For example, consider a simple ball, a virus, an organ system in the body, or something much larger, such as a large 3D segment of the Earth's crust or mantle. Such a volumetric object must follow certain rules by which it can transform its shape, and making changes in one part will make changes in 1 or more other parts, just like pushing down on a soft ball will make deformations in other regions. These rules are governed by the physics and chemistry of the materials that compose the object (volume, region). If the object has a complex multi-part geometry, then the changes will be reflec5ted in a variety of ways, but we can assert that there will be some changes affecting everything, somehow.

There are regions, and especially at borders and joins between polyhedral (polytopic) and polygonal segments, where there is some measure of efficiency in terms of the level of energy needed to change one structure into another, to make a break or preserve a join. We can measure some type of stress or strain that exists where one segment of the object joins another, and these regions, whether they are treated as lines or areas or volumes, will all express some change, some dynamics, when the object-as-a-whole is being manipulated, or when one region of the object is directly affected (i.e., there will be consequences for the other regions). Indeed, many parts (segments, regions) may appear to be unaffected, to have “zero” (join-stress, etc.), but actually, the claim is made here, even

those regions in a “real world” object (using a virus and a geological flow formation as two examples) which seem to have “zero” change, really do have something changing, and it may be not evident unless specific measurements (molecular or larger scales) are made.

{6.7} CQER and Bioelectromagnetic Methods in Medicine

Martin Dudziak (and others, tbd)
The TETRAD Institutes (and others, tbd)

Abstract

Experiments and clinical practice employing electromagnetic stimulation has demonstrated positive response in a wide variety of medical instances and with a diversity of technologies and ranges of EM frequencies. The range of observed effective action includes wound healing, immunization response to vaccines, reduction of skin melanoma, and positive response to forms of depression and dementia. Underlying mechanisms remain unclear and speculative in spite of progressive empirical results. We introduce a model involving quantum physical coherence based upon entanglement relations at macroscopic scales involving directly large composites of cells and topologically distinct regions of organ tissues. In this model, living tissues can attain and sustain a type of intercellular communication based upon resonance and coherence involving molecular configurations and biosolitonic transfer of energy and thus information. We examine the process known as Posner molecules and environment-assisted quantum transport (ENAQT) in the context of biomagnetics employed within neuromedicine. Our goal is to define how further research at both the molecular scale and that of macroscopic system experiments through clinical trials can refine such a model, which we term coherent quantum entanglement resonance (CQER), in a manner that leads to more effective use of bioelectromagnetic therapies.

[potential section headings]
Theoretical Foundations

Early Experimental Evidence

Biomagnetics in Neuroscience

Neurorestorative (Neuroregenerative) Processes

Directions for Exploration and Investigation

Notes and Fragments from earlier beginnings

? Quantum entanglement and coherence between non-locally connected regions of neural activity in the brain

Quantum entanglement as a process for triggering associations between discontinuous biological neural networks in the brain – region a becomes quasi-entangled, and then there is somewhere a region b, which is activated because there is a connection between a and b.

? Epigenetic actions for gene activation to produce exosomes in response to events such as neurodegenerative (esp. trauma) in a given region.

? Turbulence as a model of diffusion of cognitive associations in the brain
How do we move from one thought to another and another?

NOTES (started 1.May.2019)

Goal is to show how there can be something comparable to QE (quantum entanglement) and CQER in the brain between different regions that are related by similar functions or one part being available for "reprogramming" and application to new functions as a result of trauma or overload or increased demand elsewhere.
So this is not only happening in pathological cases but in normal brains – intellectual, artistic, athletic activities, for instance, put on increased demands.

[Listen to the Sound Recording I made @ 5pm today, 1.May]
There is a common ground of "primal functions" that operates at the level of neurobiology and including everything in cognitive behavior, with what is operating at simpler levels of biology, in chemistry, in atomic/nuclear physics, in particle physics. Causal sets and nets, Ricci flows, string-nets, proto-particle vortices, particles, all the way up.
There is also relevance to some of the material in the (as yet) unfinished paper,
Topological Representation of System State Spaces and
Geometric Mapping and Computation with Topological Information Resonance
(As a Fundamental Process in Nature)

Picture two regions of the brain that have functional association (example: word/concept formation and speech). Call these R1 and R2.
Both, in general/normal operations, have state-spaces that may be understood to be their network topologies, taken as surfaces, the surface points being composed of the neurons that are firing at or near some specific intervals of times.
So, one can think of mappings of both R1 and R2, consisting of constantly changing surfaces that are made of the network nodes of neural firings. For the moment, let's not think about how the firings in one surface lead to those in another – that will be the basic chemistry of neurons and their axon traffic and dendritic connections. For now we only care about the aggregate behaviors in each region R(n) and the fact that each timeslice interval gives us a surface that is continuous and within the given R(n) volume.
But these surfaces have characteristics that are measurable and translatable into "what they are doing" and "how they are doing it" and these can "inform" that they are normal/abnormal, functioning well or functioning poorly.

This information here is not about what word/concept or what speech element is being formed, but just how the regions are working with relation to each other.
Is the general coherence between them existing or disrupted?
The claim here is that R1 can somehow be informed, in a manner that is like basic resonance/dissonance in anything – e.g., optical, audio – that there is a good fit or a bad fit between the two regions.
If R1 "senses" that R2 is not performing its functions, relative to R1, then this can trigger a response within R1, which may be manifest in biochemical changes – triggering of genetic activation to produce new proteins which then lead to production of exosomes, for instance, which are then rel4eased by cells in or connected with R1, and then those exosome-agents go do their role elsewhere, which may be in R2, and which may involve activation of different sets of neurons to replace the functions of the disabled R2, in order to bring the R2 or its substitute-R2 region into "sufficient and proper tuning" to then resume the work that R2 is supposed to do.

[A]

[1]

[mini-preamble, prior to talking about neuro- and ultimately clinical, medical aspects]

[1.1] Usually, in history, something gets discovered that seems at first to be purely mathematical, abstract, theoretical, and then after some decades or usually centuries, people discover that it is valuable, even important and essential, for some things that are very "applied", practical, and generally also of socio- and economic value.

What I am about to outline here, and which is something "converging" for a long, long time in my work/mind, is that sometimes things can work in the other direction, from the "applied, tangible, in-view, in-hand" down to the "theoretical, invisible" - or from working from both directions in some kind of hopeful harmonious and integrated manner.

[1.2] Consider a universe that grows in complexity and order, "deliberately" (inevitably, from very fundamental functions ("laws", "principles", "rules"). At any given "scale" one can find randomness that is seemingly self-emerging, dictated, into increasing order and structure. In this there are certain common behaviors, dynamics, which can be found to be underlying, and in a manner such that each higher scale or complexity is another form of that which is the lower-scale foundation.

Abstract example:
Lines are made of points, triangles made of lines, all other planar and spatial entities made of triangles (all this very "liberally" taken)

Still abstract but not quite so:
There are state-spaces of wave-particle behavior that are very strongly immune to dissipation

(by our timescales) - protons, electrons, to a lesser extent other particles of "light-matter" (the usual "matter" - so-called "dark matter" being energy with a different behavior)
-and-
There are the wave-particle phenomena we know as "solitons" - they will dissipate, eventually, but depending upon the medium (light, phonons, ATP-ADP exchanges in protein chains, water, etc.) it will vary. These are more complex than in "lower" scales, but also more delicate in a way, subject to more disturbances (i.e., easier in general to disrupt an atom or a molecule than to break apart most "elementary" particles)
-and-
Up the scale we go to comparable "soliton-like" behaviors that are not in simple wave forms of one type of matter or another, but in highly complex systems of composite, aggregate entities - cells, complete organisms, and looking inward, brains/CNS and their activities.

[1.3] Claim: By examining certain highly complex, large-scale systems - specifically the CNS and specifically certain sensory-motor-cognitive functions in the most accessible and mutually-communicable complex brain, that of humans, we can accomplish two things somewhat simultaneously:
(a) Achieve a better model for how both "normal" and "abnormal" functions operate, with value for what may be the hardest and most pressing areas today for clinical medicine, and
(b) Achieve better ways to "redirect" the model "downwards" to shed light on how these "primal" functions operate at other scales of biology, chemistry and physics.

[2]
[now, just a few words here about certain neuro- and ultimately clinical, medical aspects]

[2.1] Something known in topology as the "Ricci flow" is a more general way of thinking about "heat flow" in some object, some volume/space. At the level of brains, this may be applicable to measuring and modeling what could loosely be called volumes and even better as surfaces, constantly changing, in a given region R(n) of the brain.

At any given time t there is a surface (but it may be highly twisted and folded, etc.) in any region R(n) which "is" the neural activity - the whole set of axon-synapse transmissions - and this set, representable and physically distinct as a surface of dynamic actions, is the way that the rest of the brain "works with" that region R(n). Do details matter? Sure, in various ways, but not probably to the extent that many neuroscientists have pursued things heretofore. It's more about the surfaces as wholes. The surface - its topology - has a specific order and a lot of characteristics that set it apart from any other variant it can have, and also, importantly, between different "general states" (which may correspond to what we on the outside looking in may call (logical, clear, confused, decided, undecided, disordered, dysfunctional...)

Ricci flow and other techniques could help to map and characterize these qualitative as well as quantitative differences in the surface dynamics. [more about this later]

[2.2] Let's say that R1 and R2 are two such regions (e.g., R1 may be linked with word and concept formation, and R2 with speech and getting that word "out" in verbal communication). Let's say further that R1 and R2 are in some sort of well-defined relationship, such as: word-concept work gets done in R1 and is "set" and then propagates to R2 for generating speech

In this relationship, I argue, there is some built-in and repeatedly-being-measured resonance between R1 and R2, something that is simple in the sense that it operates more as a field, automatically in the course of R1 and R2 being in their natural operating states - and there is NO special "third-party" communication channel, protocol, chemistry, that is separate from the basic field/surface states.

In this relationship, somehow, R1 can "measure" the field-surface state of R2, and howsoever this process works, it will generate changes in R1 that correspond to certain (abrupt, severe, drastic) changes in R2.

Let's simply call one of those results in R1 to be an indicator that R2 is **not** operating within "general tolerance limits". It is not so different, after all, from the unconscious feeling of not being able to reach some object with one's arm because it is just too far (muscle strain and all that), and the conscious thought, "I can't reach that, it is just too far or high".

But it is a lot simpler and definitely unconscious - at least initially, in the logic-space of this discourse.

[2.3] Then here comes another "leap" - but mind you, I will argue that the "elementary functions" involved are mappable, mathematically, across all levels of scale in Nature, so this is not any more "magical" than things going on at subatomic and atomic and molecular scales.

In this "leap" we have R1 reacting, acknowledging, that a significant operational change has occurred with R2. R1 does not "know" whether the person (in this case) got wacked hard on the head, had a stroke, or incurred radical inflammation or a lesion from whatever lesion-producing agent. Only that, simply and crudely put, "R2 is SNAFU".

Now these changes within R1 as a result of this "IN-FORM-ATION" may result in a response such as the production and release of exosomes which may then play a role in both natural (no external medicine) or enhanced (drugs, stem cell therapy, bikoelectromagnetics, VR and physical therapy, etc.) methods by which R2 can, in essence, "rewire" itself or else have its functions taken over by another region (call it R(x)(2)) which is a "spare" or "spare-enabled" region of the brain capable of taking over R2 functionality.

[3] Well, I am getting more sure about the maths and the toplogy-biology stuff here, and the commonality with underlying physics.

[3.1] Claim: All this does have practical value and it will not take a huge budget of time or money, and it can show results rapidly, even if not "Nobel Prize" sort of stuff (which btw can be for guys like you and your colleagues who are more "recognized" and "established" in those academic systems; I just want to make it all happen, finally!)

[3.2] There are more medical implications beyond the above, and specifically in the broad area of oncology. It may shed light on why apoptosis-regulation in different cellular regions and topologies (again the geometry!) fail, and how to fix them in different and more comprehensive ways. It may also shed light on the regulation process for stem cell differentiation and also return to stem cell status, and how that can be better understand and even controlled.

[3.3] I am convinced that “God” (many other names and concepts here!) started out with basically one simple "equation" but choosing to do so in a manner that it constantly acted upon itself making things more complex, more structured, more beautiful, and ultimately conscious of Itself. [obviously, not something that can be mentioned in any formal publications these days!)))]

~ ~

[B]

A few outliers here - just the brief sentences/phrases, which can be discussed later including at the meeting:

Although the following may seem to be unrelated to the above items (as well as being more downright "clinical" - they are connected! (in my mind at least) ---

[1] Specific ideas on use of "geometric" (shapes, tilings, lots of aspects) techniques for exercises and therapies, for a variety of neuropathologies including MS and different dementia and stroke. These can be done (made into) the form of games.

[2] More about games, for patients, and less about "VR" (virtual reality) and more about fun things that encourage memory, associations, new learnings. Some of these can also be associated with "motivators" for people (i.e., it's not just yet-another-task given by my doc or therapist, but, hey, I can win points and even prizes and money - I know that some companies would sponsor such things. It's not so much "E-Sports" as perhaps better called, "M-Sports" ("M" for Mind) and it is NOT like all those other products that companies have been making and pushing for some years now.

[3] The importance of people with different neuro- dysfunctions, especially those who may be homebound, elderly, forcibly "retired" etc., to have activities and networks that have some meaningful pull or draw to them, as persons, to get engaged, to do something, to be involved.

Not the usual "social network" stuff. It could and even should be entertaining, fun, but the main point is that people will be able to feel, genuinely, "I have to get up, get moving about, and check in and do something here with this activity, because something - or some others - are in some way depending upon my activity, moves, answers, responses, etc."

[4] The above 3 points are not just for generally older adults with clearly physiological dysfunctions or diseases. I think it can open some things with children on the autism-spectrum, too.

{6.8} Topological Solitonic Networks, Conservation of Curvature and Virtual Qubits

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Abstract

Topological solitonic structures giving rise to stable and semi-stable toroidal structures occuring as minimal energy configurations, are examined as elements within a (3+1) spacetime where summations of curvature and rates of curvature variation spanning a closed system constitute a "conservation of curvature" Ȼ. The underlying theoretical framework derives from investigations into the emergence of particles including all known types, fermionic and bosonic, within the Standard Model and the derivation of these structures involves a representation of nonlinear field interactions in the formalism of solitonic networks which describe topological changes within a fundamentally particle-free spacetime matrix. The stability of nodes defining interactions (collisions) in a simple four-dimensional spacetime within such networks is presented as the dynamic function giving rise to stable and semi-stable formations ("tensegritons", τ) with the properties of particulate matter in the physical universe and the utility for construction of synthetic "virtual" particles within a computational environment. In such an environment, transitions in energy states among such tensegriton nodes τ will be propagated to other nodes in the closed system (e.g., "qubit array") in a manner that preserves the topological Ȼ including through the introduction of system noise within such a computational array, thereby addressing certain critical concerns in the design and operation of quantum-entanglement based trans-Turing computing machines.

{6.9} A new approach to Ricci Flow in developing a topological ordering that implies internal teleology governing emergence of order and structure in complex systems including biological organisms

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[new version begun 03.May.2019]

Abstract
Is the Ricci Flow much more than a very interesting mathematical tour de force which is vitally important within general relativity as well as formal topology? The examination of more general interpretations of entropy and complexity within systems leads to a concept of geometric information flow that optimizes in order to maintain consistency of both the entropic and negentropic processes. A system may exhibit increased turbulence and chaos as a necessary component of increasing organization that locally preserves information and increases order that enables successive stages of such behavior. Such a system can be shown to lead to an increase of topological information that is preserved over the course of many turbulent phases including catastrophic disorder phases. This behavior can be seen as a different type of Ricci Flow that is useful in examining the complexity-phase transition mechanisms that lead to self-replication within molecular structures and consequently in multi-molecular structures given the attribute of “life, itself”.

