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Biosystems Liquid Crystals

and potential effects of Natural & artificial ElectroMagnetic Fields (EMFs)

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Abstract

It is proposed that the **origins of terrestrial biological life** may have required (1) the presence of EMF flux of different waveforms and intensities, and (2) the prevalence and interaction within the Living cell of a variety of biological liquid crystal (LC) forms which provide fundamental support and/or detection mechanisms to explain quantum-level sensitivity.

The lipid molecules of biological membranes exist in an LC state and provide a matrix for membrane proteins to perform their function. Not only lipids, but also other major classes of compounds (proteins, carbohydrates and nucleic acids) exist in LC phases under well-defined conditions. Therefore, it is very important to know the properties of LC materials in order to better understand biological processes.

How did liquid crystals and the EMF relationship originate? The planetary resonator hypothesis and wave interaction as a key determinant of biological structure (EMF flux as an information field) are 2 hypotheses proposing the evolution of an ultra-sensitive protein (LC) transceiver biocommunications mechanism for ELF (Extremely Low Frequency) EMFs. Precambrian Earth may have supplied the intense fields as environmental factors and catalytic energy sources for the beginning and evolution of Living systems.

Biosystem effects from received EMFs (natural and artificial) will be briefly discussed -- e.g., survival information from geomagnetic cues (location/migration, seasonal variations, hurricanes, tornadoes, earthquakes); detection of food, enemies, and mates; electrosensitive humans; immune system enhancement or suppression, visual and hearing inputs, anesthesia, and healing. Natural EMFs associated with and transitted from biosystems also provide survival factors in defense, attracting food and mates, and establishing territory. Intriguing and controversial anomalous human electrical and electronic equipment interactions reported in recent years will be briefly discussed and data presented about how reacting allergy patients, persons in intense emotional states, and those experiencing sudden personal stress level shifts sometimes affect computers, photoelectric devices, and other sensitive electronic threshold devices!

"Don't bite my finger. Look where I'm pointing."

-- neurophysiologist Warren McCulloch

1. Introduction

The goal of this exploratory paper is to serve as a source of potentially useful information for additional understanding of the extraordinary sensitivity (almost single quantum level) of biosystems to natural and artificial **electromagnetic fields** (EMFs). It is proposed in this paper that Life could not have evolved without the prevalence and interaction of a variety of **biological liquid crystal forms** which provide a fundamental mechanism to explain this quantum level sensitivity for survival in an ever-changing hostile environment.

This is a composite of information from my background of aerospace engineering in nondestructive testing and a 45-year perspective of Living and associating with unusual and creative people, unexplained phenomena associated with Living systems, and unconventional ideas. Some of the bridging information from my experience and observations herein is conjectural and skirting the "creative edge" with limited supporting information. This can't be helped since some areas have not been adequately explored yet! However, for those who wish to challenge the conclusions herein and who have the nerve and imagination to explore further, the references cited provide considerable additional information.

Because some of today's superstitions will become tomorrow's science, we need to have an overview of what's happening. Scenarios to present alternatives and prevent future shock. This is a synthesis of data which seem important about what's going on in the areas closest to practical application in matters of Life processes and human health (mental and physical).

So "caveat emptor - let the buyer beware": there are no guarantees that the explanations for or the reality of the phenomena presented here will be verifiable or what you wanted them to be. But that's the way it's always been with exploratory knowledge.

Life processes are of an extremely complex nature. They are dynamic processes involving systems and subsystems, forever changing through a constant holding pattern right on down to the atomic level and beyond (fields within fields!). We understand little about the single cell and its functions. What happens when you put billions of cells together to form brain and body and then expose to another dynamic variable - the environment? Several orders of magnitude of complexity exist to challenge our technical capabilities. Thus, it is not surprising that occasionally hierarchical [higher-order] phenomena may occur in healing (and other areas) which cannot be explained by conventional means [see [2.7](#)].

The process of quantum-level sensing by biosystems of portions of the electromagnetic spectrum, and reactions to those inputs, needs more objective study. And parallel studies are needed relating to transmissions from biosystems of various electric and magnetic field phenomena. This will lead to improved medical diagnostic devices; therapies for specific whole body applications; and monitoring of healing processes as influenced by mind and medicine. A good start has recently been made in 2-dimensional brain electrical activity mapping of **electroencephalographic** signals and the more complex 3-dimensional brain magnetic activity mapping of **magnetoencephalographic** signals.

A phenomenon may have been judged truly impossible 10 years ago. Advances in seemingly unrelated fields now have caused the constraints to disappear. However, the specialists are unlikely to realize that unless they are confronted with a re-examination of the problem. The re-examination is often due to some sort of "forcing function" (e.g., an unusual situation, causing a global, national, or local threat to humans collectively or to one's personal survival or well-being). Immediate attention ('constraint removal analysis') is required. Acceptance of the risks is then seriously considered for the first time.

2. Body

2.1: Liquid Crystals in Biology

From the beginning, liquid crystal (LC) research has been a fantastic adventure for scientists and not without reason. F. Reinitzer described in 1888 his new compounds when observed under a microscope as "Living materials". And there are indeed many important biological systems based on liquid crystalline order.

There are thousands of types of molecules which show an intermediate phase before they crystallize on cooling. The molecules in the phases behave like liquids and flow, but also exhibit the properties of crystals. The organic molecules -- about 25 Angstroms in length -- are typically rod-shaped. Their ordering is a function of temperature.

Water plays a fundamental role in cell membrane structure in that it drives the formation of the LC lipid bilayer [1]. With some of the orderliness of crystalline solids and some of the freedom enjoyed by molecules in a liquid, LCs are important for biology but are better known as the basis for the multi-billion-dollar flat-panel-display industry (LCDs) which depends on a phenomenon in which the rod-like molecules composing the layers of LCs -- when activated by a low voltage source -- can rotate the polarization of light to create an on-or-off shutter-like effect. Liquid crystals are also important for the study of pattern formation in non equilibrium systems [2] (systems to which energy is being added as in Living systems). A brief summation of some of the important research about the connection between biological systems and the spatial and temporal order of LC patterns will be presented herein.

Specific types of LCs -- nematic, cholesteric, and recently a smectic variety - chiral (relates to layer twist) -- have become everyday items because of their advantages in LCD flat-plate displays (nematic), detection of thermal and EMF anomalies (cholesteric), optical switches (nematic), high-density data storage devices (chiral), and other applications. The study of LCs is gaining an ever-increasing role in condensed matter physics and Macro-molecular science as well as in commercial applications.

Because LCs form the membrane around cells, they seem to play an important part in systemic effects (**healing** or **harming**) by sensing and responding to very minute changes in temperature, amounts of chemicals, and EMF potentials and changes. In addition, it seems that they may also selectively store energy information patterns received from physical and emotional events (traumas and transformations). LCs in their variety of forms appear to provide quantum energy interface detecting mechanisms which are behind both discrete biological sensing systems for light, sound, taste, smell, pressure, temperature, and whole-body sensing for automatic (subliminal) maintenance of body health and survival in an ever-changing environment.

LC properties in Living systems may provide the basic support for several of the background mechanisms proposed to explain the biosystem effects of natural and artificial EMFs. In this case, the LCs in their various biosystem forms may react to amplify unusual internal or external energy inputs, transmitting their sensing reactions to stimulate other systems (e.g., immune system response, melatonin production, various symptoms, etc.).

Biogenic magnetite [3, 4, 5] is found primarily in the brain and highly enervated ethmoid sinus area in humans. It is also found in specific brain areas of insects, fish, birds, and mammals, and more concentrated in the brains of migratory creatures which must get their cues from geomagnetic variations and patterns. This biomagnetite is most likely concentrated in a differentiated cell type (a magnetocyte) which might contain thousands of magnetosomes (individual crystals of single-domain molecular size).

In the almost quantum-energy detection level of biological sensors to EMFs, the LCs in these areas may play an important part in detecting and amplifying the effects of EMFs on the magnetosomes -- perhaps providing fixed storage of environmental geo-electromagnetic patterns for migration/navigation purposes.

Dr. Kirschvink states [6]:

"The discovery of biogenic magnetite (Fe_3O_4) in a variety of human tissues suggests that it may be responsible for some of the reported effects of weak ELF magnetic fields. A previous analysis suggests that individual crystals of magnetite of single domain size could contribute enough mechanical energy to activate trans-membrane ion channels. Detailed analysis of the magnetic property data from human tissues (normal and pathological) indicate the presence of substantial magnetic intergrain interaction effects. This implies that biological averaging of ELF EMF effects at the cell membrane is a possibility."

Since this is an exploratory session we might consider the latest development in LC technology: high density optical storage [7], perhaps using a chiral [twisted] smectic ferroelectric LC. Attempts to use LCs as optical data storage media have met with limited success because of the complexity of writing and rewriting schemes. The new technique involves the use of polarized light to induce molecular alignment with high spatial resolution. Varying the polarization direction varies the LC chiral twist angle. The light (energy) transmittance of each region varies with the twist angle, thus much information can be stored in each molecular layer. Data storage densities of approximately 3 Gbit in 2 (3 billion bits per square inch!) are possible with current systems. Much higher density storage systems are expected in the near future. Is this the first step in the understanding of how the brains and bodies of biosystems store and genetically transmit survival and response information to environmental stimuli (which eventually evolves into instinct and/or memory)?

Until the 1950s, most biologists regarded a 'cell' as a minute bag of fluid that was relatively simple in structure. But under the electron scanning microscope, cells were seen to be exceedingly complex. What earlier seemed to be a simple cell membrane was likely to be folded and convoluted -- precisely the right kind of structure to serve as a semiconductor. Components of the cell include organic semiconductors such as liquid crystals -- a material that is hypersensitive to temperature changes, magnetic and electric fields, stress, ionizing radiation, and trace chemical variations. To complicate matters even more, many cells have a double outer membrane. Electrically, such a membrane functions as a capacitor with the characteristics of a leaky dielectric [8]. It should also be noted that at low frequencies, the permeability of the cell membrane to ions is enhanced, thus promoting electrochemical interactions. Is this due to EMF effects on ferroelectric chiral LC? Nerve and muscle actions are also accompanied by electrical activity involving ionic currents.

Viewed as a small but extremely complex electrochemical system, the Living cell is subject to the influence of electromagnetic fields which are linear and nonlinear, static and dynamic, internal and external, natural and artificial. The fields may induce either a single reaction or a combination of reactions and may also act as indicators of other environmental conditions. Small wonder, therefore, that reported EMF effects at the cellular level are diverse and debatable (Figure 1) [9]. The effects depend upon field orientations and frequencies, system LC components and their organization, and other variables [10].

Dr. Phillip Westerman states [\[11\]](#):

"Liquid Crystals are major components of the biological membranes which define the shape of cells and organelles. Biological membranes are thin layers of protein and lipid that permit the compartmentalization of Living matter. Proteins are the functional units of cell membranes and perform biological activities such as the transport of nutrients into cells, the removal of waste materials from cells, and the transmission of signals into cells. It is the lipid molecules of biological membranes that exist in a liquid crystalline state and provide a matrix for membrane proteins to perform their function. The most commonly found state of aggregation for membrane lipids is a bilayer structure in which 2 planar leaflets are interfaced.

"Lipid bilayers are an example of a lyotropic liquid crystal. Liquid crystals are defined as lyotropic if the molecular order in the parent solid state is reduced by a solvent. In biological membranes, water is the solvent which reduces this order. And in most cases, the parent lipid is a compound known as an amphiphile.

"Lipids occurring in biological membranes are usually a complex mixture of closely related compounds in which there is a range of chain lengths for the constituent fatty acids. For instance, the most commonly occurring phospholipid in the human red blood cell membrane is phosphatidylcholine or lecithin. The properties of a bilayer comprised of a mixture of lecithins is quite different from that of a bilayer made from a single lecithin. For example, an aqueous dispersion of a single lecithin species melts at a well-defined temperature at which the hydrocarbon chains change from being rigid and fully stretched out to being flexible.

"As a result of this chain melting, the bilayer becomes thinner and more like a liquid. A bilayer consisting of several closely related lecithins has no clearly-defined melting point and exists in a "melted" or fluid-like condition at physiological temperature (37°C). Most biological membranes need to exist in this fluid condition which creates an environment with the liquidity essential for normal membrane protein function. Indeed, it is not sufficient that the bilayer just be liquid-like but that the liquidity (or viscosity) be controlled within very well-defined limits for the organism to live. One of the roles of cholesterol in biological membranes is to help control or regulate the liquidity of lipid bilayers.

"Liquid crystals are not only found in cell membranes but also in extracellular fluids of the body. Bile secreted from the liver consists of a mixture of water, bile salts, lecithin, and cholesterol. These substances can assemble together to form several structures such as spherical vesicles and micelles. If the normal equilibrium that exists in the bile duct between vesicles and micelles is changed, it can lead to the formation of crystals of cholesterol or gallstones which may require surgical removal.

"The digestion of dietary fats (triglycerides) by pancreatic secretions produces fatty acids and monoglycerides in the upper gastrointestinal tract. Mixtures of these compounds in water form liquid crystalline phases. The composition and structure of these phases probably influence the rate of absorption of dietary fats and cholesterol into the blood, and thus may be important in determining blood cholesterol and triglyceride levels.

"Not only lipids but also other major classes of compounds in biological systems (proteins, carbohydrates, and nucleic acids) exist in liquid crystalline phases under well-defined conditions. It is, therefore, apparent that it is very important to know the properties of liquid crystalline materials in order to better understand quite a number of biological processes."

[Authors Note: When the various data sources were brought together and reviewed for this exploratory session paper, relationships emerged which strongly support the following complementary hypothesis. These papers seem to have the most potential for explaining and supporting EMF effects on biosystem liquid crystals, subsequent biosystem processes and reactions, and biosystem effects on other biosystems.]

Indeed, liquid crystals and EMFs appear to be intimately involved in the beginning of Life on Earth!

2.2: The Planetary Resonator Hypothesis -- A Potential Life-Activating Mechanism [\[12\]](#), [\[13\]](#)

Graf and Cole hypothesized that the electromagnetic fields of Precambrian Earth -- and particularly the van Allen belts 2 billion years ago -- provided an active planetary resonator that had a profound influence on the origin of Life from non-living matter. This unrecognized phenomenon may have been both the environmental factor and catalytic energy source in the beginning and subsequent evolution of Living systems. The intense fields and low frequencies of the planetary resonator may have acted as a catalytic function in amino-acid polymerization [liquid crystal forms?] and a directing force in polymer structure and activity [see following report].

The rapid changes in the geomagnetic field caused perturbations in the currents of the van Allen belts and radiation of untold quantities of energy at the characteristic frequencies (0.1 to 100 Hz) of the geomagnetic field, with other frequency components attenuated severely. Thus, a relatively strong 10 Hz feedback component [\[18\]](#) was re-radiated through the ionosphere and into the region of the van Allen belts, becoming superimposed in phase upon the basic geomagnetic field. Such a phenomenon permitted an exponential increase of the 10 Hz component in the equatorial van Allen driving currents. Thus, a gigantic 10 Hz oscillator with a staggering energy capability evolved and field strengths within the resonant cavity were increased to tremendous levels at the characteristic frequency. This was sufficient to break down the primitive reducing gas atmosphere and permit enormous electrical discharge.

The concept of emergence and evolution of prebiotic proteins (in terms of the Extremely Low Frequency (ELF) Planetary Resonator Hypothesis) is developed further [\[13\]](#) to postulate an ultra-sensitive protein transceiver biocommunications mechanism for ELF radiation. This accounts for the apparent sensitivities of biosystems to changes in the ELF region and indicates that technically generated fields in specific environmental regions will have effects on biosystem processes. The protein transceiver system serves simultaneously as a physiologic regulator, an ultrasensitive individuated biocommunications system, and a transduction device for an external timing stimulus.

Cole and Graf summarize some of the properties of the signal that lifeforms emit and/or receive. The signal:

- (1) is common to all and between all lifeforms (i.e.. plant-to-plant, plant-to-animal, even cell-to-cell).
- (2) is transmitted and received with energies available to Life systems, again even with the energy within a single cell.
- (3) is unattenuated by great distances, the atmosphere, oceans, and the usual conducting materials.
- (4) is not present in but may be affected by inanimate objects.
- (5) can contain codified information.

None of the characteristics above are inconsistent with a very efficient and highly evolved ELF transceiver system in biosystems. Such sensitivity in biosystems is evidenced by the energy quanta detection capabilities of the ear, eye, and other sensory systems in animals and humans. In the case of humans, the system is reacting to some sort of stress stimuli as allergic reactions [14, 15, 16, 17] to specific frequencies and waveforms that disrupt normal neural pathways.

As dipoles bearing a net charge, proteins would tend to orient themselves in the external time-changing, 10-Hz resonant EMF [18, 19, 20]. Thus, during millions of years of evolution, changes in protein structure would have had to conform to the dynamics of the 10 Hz external field. Proteins thus evolved would be extremely sensitive to ELF changes in the 10 Hz region in much the same way the eye has evolved to be sensitive to the visible spectrum.

"Subsequent evolution along chemical and genetic lines would enhance the fidelity of transmission and reception, especially between genetically related forms." (See next report)

2.3: Wave Interaction As A Key Determinant Of Biological Structure: Electromagnetic Flux As An Information Field

A more complete original mechanism is detailed in this second paper [21] which presents evidence that biological forms follow the energy patterns laid down by the environment and re-radiate coherent waveforms derived from the environment. This unusual report proposes that the flux of different waveforms in the environment provides an interference pattern which forms an organizing grid or energy structure for the construction of biological form. This is somewhat analogous to magnetic particles attracted into a 3-dimensional pattern around a strong magnetic field. Only in this case, the organic molecules would be polarized and react in a similar way to dielectric forces.

Hagan and Reid state:

"Just as the material units of existence, atoms and basic particles can be viewed as waves or particles depending on the observational frame chosen by the physicist, so also can biochemical Macromolecules -- the units of biological existence -- be viewed as waves or particles by the biologist. It is proposed that the flux of different waveforms which floods biological systems provides an interference pattern, whose energetic distribution forms a scaffold for the construction of biological forms. In this way, the biological whole becomes the Fourier transform of the parts and histological pattern becomes the

determinant of Macroscopic form. Evidence is offered suggesting that biological forms follow the energy patterns laid down by the environment.

"It is proposed that the ability of biopolymers to re-radiate coherent waveforms derived from the environment has given evolved systems the autonomy which has allowed a free and prolific evolution. This coherent illumination can be analyzed by Fourier methods and this shows that the results are peculiarly appropriate for biological systems. The Gaussian waveform is all-important and may explain the influence of homogeneous and heterogeneous DNA in cell surface kinetics, hybridization, and carcinogenesis."

They propose that the cell coat consists of a complex array of networks which develops switching points similar to those in the circuits of a silicon chip and functions in a similar way by turning on-or-off various metabolic processes within the cell in consonance with environmental change [\[22, 23\]](#).

The building blocks of biological systems, nucleic acids, carbohydrates, proteins, fats, etc. are theorized to be insufficient to produce definitive forms. The flux of electromagnetic and mechanical waveforms (which flood biological systems during their formation and function) must play some part in their actual structuring by supplying an invisible energy framework or scaffold. It is believed that when biological systems are formed, there is created a relationship between the microscopic structure of the organ or organism and its definitive Macroscopic form. This can be expressed in a novel mathematical concept that the Macroscopic whole form is the inverse Fourier transform of the microscopic parts.

There is much evidence that biological forms follow the energy patterns laid down by the waveforms of the environment. Electromagnetic vibration can rearrange molecules and Macromolecules into patterned forms (sound, radio frequencies, microwave, heat, light, etc.). Lissajou or Chladni figures produced in liquids and solids appear as structural biological patterns in simple organisms (diatoms, for example).

If we accept that local EMF patterns are important control factors in growth processes, then long-range patterns of the same type would also influence these processes. Patterns are found in many of the research papers herein showing **geophysical, Lunar, and Solar influences on Living systems** [\[12-14, 21, 22, 24-40\]](#).

In the field of pre-biosis, to determine the origins of primitive biochemical and metabolic systems, a source of radiation is required to create complex molecules. The supply of energy in the form of multiple, interfering wave patterns causes the molecular structuring and supports the framework of the specific molecular shape. A biopolymer may be regarded as being a physical, structural memory of some previous environmental configuration -- a memory of a previous wave state of the environment [this may assist in explaining the imprinting of migratory patterns in insects, fish, and birds, and the memory storage capabilities of the smectic/chiral form of LCs --jb]. If this particular wave state has had a part in the original structuring of the biopolymer, then when it re-radiates energy, it will simulate the wave pattern of the environment. This supports Kaznacheyev's hypotheses of electromagnetic bioinformation transfer between identical cell cultures [\[41\]](#).

The nerve impulse is considered a wave of membrane depolarization accompanied by ion passage through the membrane. It is postulated that this wave and ion flow are only symptoms of a rapid conformational change in surface polymers in order to align the polymers and provide a path for electron (or perhaps photon) flow, which would become the impulse. This offers a potential explanation of **acupuncture** meridian electrical flow phenomenon as reported by Becker [\[42, 43\]](#) and Motoyama [\[44\]](#).

Fourier (or optical) transformations may be of great biological significance -- microscopic patterns determining Macroscopic patterns and vice versa. As an embryo develops, the gross form of an organ may be produced by Fourier transformation of a molecular arrangement, which pre-exists in the egg or develops from previous patterns. The developing organ would be the Fourier transform of the molecular pattern. The energy fields which could provide the structural imaging are available as electron flows which are especially strong during rapid cell division as reported by Smith [15], Rivera and Pohl [20], and many others.

In [45], Rauscher and Van Bise outline a detailed Fourier analysis informational model of biological tissue signaling.

Marx states [46]:

A "lthough a great deal is now known about antibody synthesis and assembly, the final stage of antibody action remains shrouded in mystery. The question of exactly what an antibody 'sees' when it recognizes its antigen has not been fully answered. Without the answer a complete understanding of how the immune system distinguishes between foreign and indigenous molecules is not possible."

A possible description of the final stage of antibody action is provided by Hagan and Reid [21]:

"The transform of a positive is identical to that of its negative.' This is a statement of Babinet's theorem -- well-established and proven in the theory and practice of optics. Thus the transform of a white cross on a black background is identical to that of a black cross on a white background. And the diffraction pattern of a particular 3-dimensional shape -- using its contour edge as the object -- will be identical with that of the contour edge of a shape with which it is congruent.

"The intimate molecular shapes of enzyme and substrat, of mating strands of DNA and of antigen and antibody molecules will exhibit this congruency. Since the transform of an antigen contour becomes identical with that of its antibody in this way, a pair of harmonic oscillators will be produced. These will be forced together - even from large distances -- by the same miniature 'gravity-like' forces described by London and van der Waals to explain molecular 'attraction'. Oscillations of the antigen-antibody complex -- once formed -- may then cause such a harmonic disturbance on the surface of the cell as to cause its disruption, a phenomenon well known to immunologists as 'immune lysis'."

Bilateral or radial symmetry is a characteristic of biosystems which may result because the diffraction pattern of an object results from the interference of waves from every part of the object. Thus, linear objects tend to produce transforms with bilateral symmetry; other shapes produce radial symmetry.

It is interesting to note that the cell surface steroids and sugars (which exert a strong influence on cell function) are optically active and can function as spatial filters, optical rotators, or diffraction gratings to achieve a modifying influence on tissue during its formation in morphogenesis. Thus, tissue formed on a diffraction pattern (an energy pattern or scaffold) can itself become a modifying influence for subsequent tissue growth.

It would seem, therefore, that biological organisms -- from a prebiotic congruency with environmental waveforms at a primeval level [12, 13] to the sophisticated cycling of human integration with Solar and Lunar periodicity at an evolved level -- have been so harmoniously integrated with and

dependent upon environmental flux that it seems to have almost disappeared (in much the same way as a man may not notice the well fitting clothes he is wearing or the essential activities of his internal organs (or like water to a fish!)). The "Ghost In The Machine" which Koestler has drawn to our attention might well be an optical transform.

Biologists have already begun to produce optical transforms of cells, which indicate that a normal cell is completely different from a cancer cell. This is consistent with the concepts expressed in this report that the cancer cell has more -- and not less -- organization (contrary to the popular view) than the normal cell, because it has a biopolymer content which is homogeneous and more crystalline. More research on this approach would seem to offer rapid diagnostic possibilities.

Frohlich [47] proposes that coherent vibrational sources exist in energized biopolymers [and this implies diffraction patterns...and liquid crystal information storage capabilities --jb]. Some in the brain may have become specialized to form and process images and store information similar to the hologram [7]. Energy interference patterns -- similar to **holography** -- have been hypothesized by Karl Pribram and others to explain certain processes of memory storage in the brain [48].

As indicated in this report [21], a diffraction pattern may act as a structure and achieve 3-dimensional form when molecules align and group themselves upon it. This relates very well to the general "information field" theories now being utilized to explain biosystem processes and the area of imprinting by the energy of the pattern; waveforms imprinting their targets. This may explain embryology enigmas (such as the cascade-like process of sequential stages producing increasing complexity) if each tissue imprints its surroundings with its transform. The "organizer substance" of embryology may be described as the result of the optical transformation of a moving mass of cells by a coherent flux producing an energy scaffold. This would be helpful in understanding the early stages of blastulae and gastrulae where the genetic process plays little part.

In the external mucoid coat of the cell, the whole nucleotide chain and associated network may constitute a series of resonators tuned to various frequencies in the environment. It is in an appropriate position as an intermediate transducing layer to sense environmental changes and transmit them to the cell beneath [17].

It is claimed that the more heterogeneous (dissimilar) the waveforms generated by the cell membrane, the more stable the internal lattice networks and the metabolic cycles and structures. Any circumstance which reduces the heterogeneity (i.e., increases homogeneity or uniformity of the cell surface layer will affect the metabolic processes within). A good example of this is the effect of **inbreeding** in biological systems, which reduces the number of ancestors and tends to homogenize the biopolymer constitution.

Species may operate in a defined and narrow bandwidth. The mixing of 2 genomes -- with small difference in their repetitive sequences during fertilization -- produces a zygote whose polymers would show 2 closely resonant vibrational grids. Embryogenesis proceeding on these grids may then exhibit features of increased size and vigor characteristic of hybridization in animal and plant breeding. The pairing of musical frequency beats is an analogy. If the notes are identical or widely separated there are no beats of interference. If the notes differ only slightly in frequency, beats of high amplitude appear. With a wider gap in frequency, the number of beats increases and the amplitude is smaller. It is proposed that hybrid vigor is represented by the increased amplitude of close frequencies. And the absence of resonance represents inbreeding which produces a frequency separation too wide or too identical.

2.4: An Integrated Mechanism

Dr. Persinger states [49]:

"If ELF electric and magnetic fields were involved with the formation of lifeforms [see 4, 5], then these fields should still influence those diffuse but essential processes that were available to lifeforms at that time. Reflexively catalytic reaction series (reflexive cycles), an emergence condition for origin of Life would be specifically affected because of their time variation.

""One of the most common properties of biological systems is the ability to maintain ion-molecular concentration disparities through the use of membrane selective permeability. Such selectivity is in large part governed by a precariously balanced structure of lipoproteins that has been called the 'liquid crystal condition'. There is strong evidence that lipids and lipoproteins are involved with other basic Life processes relevant to ELF field interactions. Rhythmicities in heart cells are intrinsically related to lipid levels. Lipid solvents -- which change membrane selectivities to the ionic milieu -- are important anesthetics [is this what is affected by the electroanesthetic process [50]?] and toxicants. The reported intense attraction of peripheral nerves to magnetic fields also seems dependent upon lipid structure."

Certainly this model could explain many ELF field research results. Weak EMFs that produced localized changes in charge density could alter the conditions required for liquid crystal conditions and consequently produce small changes within the viable limits of the system. Changes in phospholipid membrane properties or variations of specific cations (e.g., Na^+ , K^+ , Ca^{++}) known to be controlled by membrane properties have been frequently reported in ELF research.

One group of candidates is the Macromolecules involved with the connective tissue and ground substance of Living organisms [the fascia --jb]. Connective tissues include the tendons, cartilage, and -- most important -- the intercellular matrix around the cell or ground substance. Ground substance contains large proportions of proteins with covalently-bound carbohydrates that give it a gel-like character. Such support tissue would be phylogenetically quite old and a coincident condition for Life formation [tie-ins with the electrophysiology and the analog control mechanisms of **acupuncture** here [51, 52 -- jb]. The connective tissue have invaluable structural and functional roles and are involved with homeostasis.

2.5: Nonlinear Mechanisms

Dr. Byrd states [53]:

"Recent observations [54, 17] point to the conclusion that investigation of nonlinear molecular information transfer processes will provide a fundamental quantum mechanical model of the Life processes. As a consequence, medical and physical science should achieve new levels of control over tissue growth and regeneration, the development of malignancy, antibodies, and perhaps almost all basic chemical processes. Because of the universal nature of the fundamental mechanisms, an immediate consequence will be a substantially extended understanding of brain information transaction, storage, and retrieval."

Recent work indicates that low-intensity, nonlinear, ELF and low intensity ELF pulse-modulated fields influence various physiological and behavioral processes in cells, tissue, animals, and humans [55]. Major shifts in calcium efflux occur with fields that produce very small gradients in the extracellular space (interstitial fluids) surrounding cell membranes. The extracellular fields are about 10^{-7} V/cm, far below transmembrane gradients of 10^{-3} V/cm associated with a typical synaptic depolarization. This implies that cells can act as sensitive detectors of ELF signals. This apparent capability has led to specific alteration of cell function including hormone and insulin decrease, accelerated wound healing and bone growth, interference with nerve conduction, entrainment of cell transcription processes, and alteration of brain chemistry.

The effects range from alteration of the firing rates of neurons in the brain, Calcium-ion binding disruption on cell surfaces in the brain, to response time ...[and] respiration rate changes and even putting an animal to sleep ...[and] spectral components in the kHz range appear to cause effects selectively in bone tissue.

Behavioral modification in animals [also see 49] as the result of weak (as low as 10 microwatts per square centimeter) microwaves include induction of grooming responses, altered heart and respiration rates, epileptiform seizures, and various others. The lower the power, the more immediate the effect, provided an effect was present [see 55]. Also noted is an adaptivity to the signals. The greatest response occurs on first exposure; repeated exposures yield a decreasing effect.

We have demonstrated that **mast cells** (occurring in large numbers in the brain) can be degranulated in rats, causing stores of histamine, heparin, and other substances to be dumped into the brain. [Accomplished with a system supplied in 1983 by Van Bise with Dr. Rauscher providing the theoretical model -- jlb]

It has been repeatedly demonstrated that cells can sense the EMF environment and respond to three orders of magnitude lower than self-generated fields. The dielectric behavior [19-21] of biological systems in conjunction with nonlinear excitation can give rise to solitary, nondispersive waves known as 'solitons' [53, 45]. More than 90% of Living matter consists of polar molecules of proteins, nucleic acids, lipids, carbohydrates, and water. Depending on certain microscopic properties, the supply of energy may either make a system hot or result in the creation of a new type of order.

2.6: Combined Self-Organized Macroscopic & Microscopic Mechanisms [56]

A model developed by Dr Walleczek and his associates presents a unique combination of mechanisms to deal with both the energetic and the informational aspects occurring during biological EMF coupling. Their simulation results demonstrated EMF response patterns showing dependences on:

- (1) the field frequency in a nonlinear, resonance-like fashion ("frequency windows");
- (2) the field amplitude in a nonlinear, resonance-like fashion ("amplitude windows");
- (3) the combination of appropriate static (DC) and time-varying (AC) fields;
- (4) the internal biodynamical state of the field-exposed system;
- (5) the system's capacity for high-gain amplifications of initially small microphysical field effects;
- (6) the system's capacity to stabilize and maintain field effects in the presence of relatively large incoherent (noise) perturbations.

The model predicted that amplitude and frequency-dependent resonances and the other complex dynamical behaviors may result from primary field interactions in combination with self-organized biochemical states.

It was suggested that neither thermodynamic/energetic concepts nor bioinformational concepts alone would lead to realistic models of EMF biological interactions -- only approaches that were capable of integrating energetic and informational mechanisms.

2.7. Electromagnetic Field Effects

2.7.1: Unique Natural and Artificial EMF Effects Transmitted To Biosystems.

The information transmitted to biosystems (microorganisms to elephants) from the natural Earth (geomagnetic) environment also seems to play a survival role in navigation, migration, biological rhythms, and anticipation/detection of weather and earth changes both subtle and catastrophic (e.g., seasonal variations, weather fronts, hurricane/tornado proximity, and earthquakes [58, 59]). How much of this information do we humans use or react to unconsciously in our daily Life? And how much is latent talent which can be trained? Consider the human sensitivities of the Australian aborigines and martial arts masters. As understanding increases about our long-term health dependence on natural and artificial EMF factors, our environmental awareness will be increased.

There appear to be trends in insect, fish, bird, primate, and human research over the years which indicate that continual **long-term EMF exposure** of individually-specific pulse rates, intensities, and waveforms, may produce behavioral, physiological, and psychological reactions in the Living systems exposed [14, 57-68].

Human hypersensitivity to electric and magnetic fields is of particular interest and concern [10, 14-17, 24, 40, 65, 66, 68-75]. Persons already hyperallergenic to many chemicals claim that EMF sources from nearby powerlines, home appliances, transformers, and switches are one more irritating factor to avoid.

The most common symptoms are skin problems and various kinds of nervous problems. Skin problems have symptoms such as irregular reddening, pinkness or redness, rashes, blushing, prickly sensations, aches, tightness, itching and sensitivity to light. Nervous symptoms include dizziness, prickly sensations, fatigue, weakness, headaches, breathing problems, perspiration, depression, heart palpitations, difficulties in concentration, and forgetfulness. Most of those who are hypersensitive experience the problems in connection with work at display terminals. But other sources can also be named: fluorescent lights or electrical wiring and machinery. Many sensitive people develop extremely serious problems and have to take extended sick leaves. In Sweden, about 120 cases of occupational illness due to display terminal work are reported annually. 30-to-40 of these cases concern hypersensitivity to electrical fields [75].

These trends have caused popular concern, controversy, confusion, and much initial condemnation without investigation. However, the public concern about environmental pollution has stimulated government, industry, and legal actions to investigate the biological effects of power frequency electric and magnetic fields.

Research programs are finally beginning to investigate these anomalous raw signals (transient spikes & surges). We are becoming more aware in recent months of the sensitivity of various lifeforms to EMF via their sensory system reactions [76], immune system effects [62-64], allergy reactions [65, 14], etc. Nighttime EMF effects have been discovered which reduce brain pineal melatonin hormone production, which in turn affects immune system efficiency (especially in older people) [62, 63].

Recent research indicates that continual long-term exposure to EMF of particular pulse rates, intensities, and waveforms [65, 14, 77] can result in allergic reactions. Environmentally-ill (EI) persons

with compromised immune systems -- already hyperallergic to many chemicals -- often find that EMF transients are one more irritating factor to avoid.

Dr. Cyril Smith states [78]:

"Biological systems have sensors which are almost single quantum sensitive. To amplify a signal from such a sensor to the level at which it can trigger a nerve impulse requires a gain of the order of 10^9 or 10^{10} . The characteristics of such high gain amplifiers depend only upon the feedback arrangements. If the feedback path goes open-circuit for any reason, then the smallest signal above threshold will saturate the output, or produce a 'panic reaction' which is exactly what seems to be happening to multiply-allergy patients."

Not only may an allergen provoke a skin or a respiratory reaction, but for example it may also instead provoke muscle rigidity or conversely loss of muscle tone. Even cardiac abnormalities have been provoked.

The same general pattern of symptoms is likely to be provoked in a given patient whether the trigger is a chemical or biological allergen or an electric or magnetic field, which makes it possible that it is a feedback control system which is malfunctioning. Reactions in multiple-allergy patients have been provided by chemical, biological, or electrical stimuli at frequencies from milli-Hertz to Gigahertz and neutralized by any of these stimuli. The effect of increasing frequency seems to be equivalent to increasing dilution.

Homeopathic remedies include potentized tinctures which have been exposed to electric or magnetic fields, X-rays, or ultraviolet radiation. Exposing a sealed tube of water in a cell excited by an oscillator at the patient's neutralizing frequency gave a preparation which was as effective at neutralizing the allergic reaction as having the oscillator turned on in the patient's room. This water seems to retain its effectiveness for about 1-2 months. It can be diluted as if it was a chemical allergen and shows the same periodic provocation-neutralization effects.

Some patients are sufficiently sensitive to react to a tube of allergen which is held some distance from their skin. This action-at-a-distance effect permits screening experiments with metal meshes. A metal mesh passes all wavelengths shorter than twice the mesh size. The effect of an allergen was completely screened by solid Aluminum, whereas a 1-cm aperture metal mesh had negligible screening effect. A millimeter aperture mesh had an intermediate effect. This implies that there was an electromagnetic interaction between the patient and the allergen in the millimeter wavelength region, which corresponds to frequencies above 100 GHz (10^{11} Hz). This part of the electromagnetic spectrum has also been implicated in biological effects by Professor H. Frohlich from consideration of theoretical physics [79]. He expects the fundamental oscillation in cell membranes to occur at frequencies of the order of 100 GHz (10^{11} Hz) and has considered the general implications of coherent oscillations in biological systems (Figure 2) [77].

Since clinical effects are obtained with allergens diluted far beyond Avogadro's Number, and since it seems that allergic reactions at least in the most sensitive patients can be triggered by an electrical resonance, it must somehow be possible to set up a resonant structure in pure water -- resonant at any predetermined frequency.

If some form of bonding in water is capable of "remembering" frequency, it must be compatible with ice structure because not only are the tubes of allergen unaffected by storage in the deep-freeze, they can also provoke allergic reactions while still frozen.

From the electrical point of view, the 5 water molecule helix shown in Figure 3(a) would be a good model to start with. It resembles an electrical delay cable [Figure 3(b)] which can be used to construct an electrical resonator in a manner analogous to the acoustic resonance of the string used in a musical instrument. Taking and structuring the whole of just 1 ml of water as a single such helix could provide a delay of about a minute. That is, it would make a resonator for about 1/100 Hz. To set up this sort of structure in water would need an alternating magnetic field to induce current flow paths through the evanescent hydrogen bonding structure that makes up liquid water and sufficient energy so that the internal field pattern resulting is stable against thermal diffusion.

Similar water structures might originate from the molecular fields of chemical allergens, remembering that it is the duality between electromagnetic fields and chemical structure which makes spectroscopic analysis possible.

There are many **beneficial** -- as well as potentially hazardous -- biological interactions with the artificial EMF and natural (geomagnetic) environments in which we live and work. It has long been established (30+ years) that electromagnetic therapies of controlled specific pulse-type (sharp rise time or square-wave) waveforms and various frequencies can produce visual [80] and hearing [81] effects (without lights or speakers); induce sleep and anesthesia; suppress pain; ease depression; improve tissue and bone growth healing [66]; and successfully treat addictions to hard drugs, alcohol, and tobacco [82, 83]. The applications mentioned above are considered the body-penetrating effects of the magnetic field pulsing components and have been primarily conducted in other countries. **Electromagnetic therapies appear to be rapidly emerging as the medicine of the future.**

In this country, the electric field is not considered a health factor because it does not penetrate the body. However, note that the whole-body acupuncture system found in all living things is associated with healing. It is more primitive than the nerve system [66] and has discrete electrical components that change slowly with time. It appears to be affected by mind, body, and environmental changes and thus may respond to electric field changes (natural and artificial). Perhaps the acupuncture total body surface system acts as a sort of "transceiver" -- transmitting and receiving subliminal information on many different levels about EMF variations (external and internal) which may then (through LC detection/amplification) stimulate (or indicate) body, mind, and healing reactions.

2.7.2: Unique Natural EMF Effects Transmitted From Biosystems.

It is well known that the electric and magnetic field information transmitted from the life processes of biosystems plays a survival role in defense against enemies, establishment of territory, and attracting mates and food [76].

However, as discussed earlier, human beings are exceedingly complex biosystems, working with a variety of energy inputs and outputs (mostly on the subconscious level). Our brains may be the most evolved on Earth. But the exploration of **consciousness** -- how our minds affect our bodies, other persons, and the environment -- is just beginning to be explored. It is speculated that relating to the hierarchical nature of the human brain, "more is different". In just the past 30 years, many "impossibilities" have become possible in the area of mind, body, and environmental relationships. A lot of recent anomalous discoveries have come from improved, increased data collection; the sensitivity of monitoring equipment; and the nerve and imagination of often unfunded, dedicated researchers.

How does our technology evolve? Over time, yesterday's *superstition* has become today's science. Thus, change begins in the area of **anomalies** (i.e., exception to the rules, methods, and accepted current notions of scientific orthodoxy). For the anomalist, research conducted by academic, industrial, and governmental institutions is -- though necessary and important -- always secondary to search (the initial

effort which leads to the unearthing of fresh data or the framing of exploratory hypotheses). Such search is generated by skeptical imagination and guided by imaginative skepticism. Because it does not follow the pathways nor respect the boundaries of conventional disciplines, it is of necessity a generalized rather than a specialized enterprise.

This is an exploratory session paper. I've been an anomalist, a generalist, and a networker for over 40 years, exploring the "creative edge" and passing it on. So here are some intriguing and controversial anomalies associated with known (and probably unknown) human energy outputs. Consider the remote human/object interactions of the past and --more recently -- the electrical and electronic equipment interactions reported in the literature [\[15, 77, 84-87\]](#).

This unusual phenomenon includes -- but is not limited to -- reacting allergy patients, persons in intense crisis emotional states, those who experience sudden shifts in personal stress levels, and those with central nervous system disturbances. These persons sometimes transmit electrical signals spontaneously (and perhaps more subtle energies) which affect local computers. (Computer systems seem to be crashing in the presence of people who do not value what they were doing very highly and who are inclined to be anxious about performance [\[84\]](#)). Photoelectric devices or other sensitive electronic threshold devices, electrometer detectors, and other sensors of electric and magnetic fields (and sometimes other objects and persons in the vicinity) may also be affected! Before the advent of very sensitive electronic devices, spontaneous occurrences of this phenomenon were often associated with young persons going through a stressful time of puberty. This was reported as "poltergeist" activity and primarily affected small objects in the vicinity of the young person.

There are well-substantiated reports that some people can focus attention (now called "directed intentionality") to bring about more repeatable results in affecting sensitive electronic detectors [\[85\]](#), controlling the movement of large numbers of small objects [\[86\]](#), and emitting large bursts of electrical voltage during healing therapies [\[87\]](#). **[StealthSkater note: this sounds like remote-influencing - a counterpart to remote-viewing (see the [PX#Skeggs](#)" page at => [doc](#) [pdf](#) [URL](#)). Also Dan Sherman reported being trained to manipulate special software on a computer to communicate with ETs (see the "[Sherman](#)" page at => [doc](#) [pdf](#) [URL](#))]**

Dr. Bill Tiller developed a large gap, plasma display type of detector to study the effect of focused human attention on increasing the size of the sub-critical electron micro-avalanche streamers (not a sustained spark) in the voltage regime just below the spark breakdown threshold. It was found that humans can either enhance the micro-avalanche size or not, depending upon their mental focus. This type of detector -- when reproduced by others -- could be used as a feedback device to train abilities to influence the detector and perhaps affect similar sensitive threshold-trigger electronic devices that rely on the same type of activating energy. Standard "Faraday Cage" shielding techniques do not work and no artificial generator of the effect has been found other than a human. Dr. Tiller speculates that a magnetic vector potential wave emission focused by the subject may be the mechanism producing the effect [\[85\]](#). **[StealthSkater note: perhaps a Tesla-type "scalar" wave as theorized by Tom Bearden and others (see the "[Bearden](#)" page at => [doc](#) [pdf](#) [URL](#))]**

Brenda Dunn and Robert Jahn (during the past 17 years of their Engineering Anomalies Program at Princeton) have pioneered many high quality statistical experiments in remote human/machine interactions. These experiments have shown that there was no doubt that an interaction -- though small - - could be repeatedly be brought about by conscious effort between a human subject and an external object or objects [\[86\]](#).

In a Copper Wall Lab at the Menninger Clinic, an anomalous electrostatic phenomenon was noted by Dr. Elmer Green from non-contact therapeutic touch (NCTT) therapists. During NCTT therapy sessions with patients, they produced body-potential surges of negative polarity ranging from 4 volts to 190 volts! There are as yet no known explanations for such a large electrical potential transmitted from human beings. This is 10^3 times larger than skin potential related to emotion, 10^5 larger than EKG voltages, and 10^6 larger than EEG voltages. Since the NCTT therapists had intention and focus in their work, the results suggest a previously unmeasured human potential as well as body potential. The Copper Wall Lab was designed to isolate the subject from ground and isolate (float) the 4 walls which were connected to sensitive electrometer inputs [87].

3. Conclusion

In conclusion, it is hoped that the possibilities and hypotheses discussed in this paper will stimulate further consideration of the part that liquid crystals play in Life processes. Further understanding of the interaction of LCs with natural and artificial EMFs -- and how the near quantum-energy detection capabilities of biosystems originated and operate -- will provide vast medical and psychophysiological benefits..

Monitoring, recording, and controlling (where possible) the potential effects of EMFs and other environmental factors on sensitive biological LC en vivo will provide enhancement of replication efforts in investigations of other human subtle energies, unusual sensitivities, healing, and consciousness.

I've watched bioelectromagnetics emerge over the past 40 years and liquid crystal research over the past 30 years. A ll of the LC and EMF phenomena reported herein were already underway in pilot studies or predicted by 1970.

I've have always felt that understanding "*unexplained phenomena*" awaited the development and application of more sensitive instruments to measure the electric and magnetic fields associated with Living systems. As an aerospace engineer involved in extending the limits of the possible, I've been able to follow the medical and psychological applications of space research spin-off. I've watched the "impossible" and "nonsensical" become useful and applicable though often ignored unless a financial, political, or survival issue provides a forcing function!

So much of what we have learned is inadequate. It is not necessarily wrong. However, it is just a lack of understanding of larger, long-range patterns and the artificial barrier of the "egocentric reality syndrome" (i.e., "If I believe it, it exists. If I do not believe it, it does not exist.").

Based upon the recent worldwide access to virtually unlimited information sources on the Internet, some of the emerging solutions to the challenges facing us biologically, personally, nationally, and globally will upset everything we have learned. But none of what we have observed! It is an exciting era of developing our understanding of the holistic nature of our human body, brain, mind, spirit, and environmental interactions with air, water, light, sound, EMFs, and other more subtle energies yet to be discovered. Now that we have the tools, shall we extend the limits of the possible? [88]

"Biotechnology will provoke the greatest ethical and intellectual debates since the days of Darwin."
.....Megatrends 2000, Naisbitt & Aburdene

Short Bio of Presenter

James B. Beal, B.S. (M.E.) has been collecting and sharing information for over 45 years as a networker and writer on subtle energies, unexplained phenomena, natural and artificial electromagnetic fields and geomagnetic fields and their effects on Living systems.

He worked at the NASA Apollo Space Program Quality Laboratory 10 years in development of nondestructive evaluation (NDE) methods (ultrasonic, eddy current, microwave, tomography, thermographic) where he pioneered thermally-sensitive cholesteric LC applications (1965-1972) for subsurface delamination detection in bonded aerospace structures. At Martin Marietta Manned Space Systems, he continued NDE work for 17 years on the Space Shuttle External Tank Project in New Orleans. During research which led to a patent on electrostatic cooling of the external tank aluminum welds, he developed an unusual allergy from exposure to the strong EMFs present.

He serves on the Advisory Boards of The Monroe Institute, The Institute For The Study of Natural Systems, and The Gladys T. McGarey Medical Foundation and assisted in the formation of The Institute of Noetic Sciences. Various creative-edge topics have been published in 7 book anthologies. Mr. Beal has obtained numerous grants for travel and lectures in the areas of bioelectromagnetic field effects and the future impact of environmental EMF effects ("perils and promises"). Papers have been presented in Canada, England, Netherlands, Switzerland, Israel, Czechoslovakia, Puerto Rico, Mexico, and across America.

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