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THE BIOFIELD: BRIDGE BETWEEN MIND AND BODY

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“Matter of itself has no power to do, to make, or to become. It is in energy that all these potentialities reside, energy invisibly associated with the material system, and in interaction with the energies of the surrounding universe.”—D.W. Thompson [1]

ABSTRACT: Centuries ago, science discarded all notions of a vital force, although it retained concepts of invisible physical forces despite frequent objection by strict empiricists. Yet the concept of a vital force or *élan vital* is central to virtually all indigenous knowledge and perennial wisdom worldwide. It is often regarded as the quintessence of life. In recent decades a concept similar to the “vital force” has emerged at the frontiers of science, known as the “biofield.” The biophysical paradigm embraces a “field” view of life that may be considered complementary to the dominant “particle” view, the biomedical paradigm. While the latter maintains that life is composed of a hierarchy of organized biological substructures down to the level of biomolecules and genes, the biophysical paradigm maintains that the essence of life is like a flame, burning matter into energy, and dancing like a flame—coherent yet somewhat chaotic. The biofield is a field of energy intimately connected with each organism that holds information central to its higher order of being. It has been proposed as having mind-like properties as super-regulator of the biochemistry and physiology of the organism, coordinating all life functions, and key to understanding life’s integral wholeness. Although Western science has essentially neglected the field concept of life in recent decades, today more scientists embrace it for its integrative and explanatory powers.

KEYWORDS: biofield; biologic field; biophysics; energy field; vital force; bioinformation; alternative medicine; complementary medicine; bioelectromagnetics; coherence; mind; consciousness

INTRODUCTION

Biochemistry and molecular biology have dominated biology in recent decades. Their successes have led to the dominant paradigm of molecular reductionism, which reduces the entire organism to genes and other molecular constituents. Although this remains the dominant biomedical paradigm, it is quite limited in scope and explanatory power and does not embrace a holistic view of life. It falls short in explaining many of life's salient features and inextricable wholeness. Medical modalities inexplicable by the dominant paradigm have been excluded from the mainstream, relegated to alternative or complementary medicine, if not entirely dismissed as bogus. Yet many of these alternative and complementary modalities are based on indigenous wisdom and include some of the oldest and foremost therapies still used worldwide. In short, the dominant biomedical paradigm can explain the mechanical features of life, but has been challenged in recent years by discoveries in epigenetics, mind-body science and medicine, energy medicine, and other findings.

We need a new scientific world view that is more encompassing in order to embrace life's full potential and especially the full human potential in health and healing. We need new scientific approaches in basic and clinical research. New unifying concepts that will help us create an appropriate scientific foundation for a more comprehensive medicine are in progress. This paper summarizes the perspective of field concepts in biology and medicine.

There is a scientific view of life based on biophysics. Living systems are regarded as complex, nonlinear, dynamic, self-organizing systems at a global or holistic level. Living systems are constantly exchanging energy-with-information at multiple levels of organization in order to survive and thrive. They also possess emergent properties such as higher order relationships dependent on context and meaning that can have profound effects. This biophysical view is based on an organizing field within and around the organism that carries bioinformation central to regulating life functions. This goes beyond the usual molecular concepts of bioinformation.

So, on the one hand, we have the present dominant paradigm that offers a reductionist, analytical view of life based on molecules and structure-function relationships. On the other hand, the emerging biophysical view is a dynamic one that addresses the whole organism and its environment—its field interactions and integral flows of bioinformation. Metaphorically speaking, the dominant paradigm depicts life as a crystal, and the emerging biophysical view depicts it as a flame. While each view has its limitations, together they are complementary, similar to particle-wave duality, the principle of complementarity in quantum physics. Together they offer a more comprehensive view of the living state. Life is simply richer and more complex than it is possible to express in a single model or metaphor.

HISTORY OF EARLY BIOLOGIC FIELD CONCEPTS

Since antiquity, there have been two opposing views of the nature of life. Democritus, who coined the word “atom”, maintained that everything, including organisms, is reducible to its constituents. By contrast, Aristotle held that life processes were autonomous and organisms were integral wholes. These two viewpoints remain today with molecular reductionism and a holistic view that embraces a field concept of life.

The notion of a vital force or *élan vitale* goes back to the 1600s. In vitalism living matter was believed to involve a life force, a metaphysical entity intrinsic to life that renders it alive. This force was considered immeasurable and outside the scope of science. Yet discoveries of bioelectricity challenged vitalism. By 1850, experimental electrophysiology had banished vitalism from biological science. [2]

There are various terms used to evoke a vital force or an associated vital energy that originated in antiquity. For example there is *qi* (chi) in Chinese medicine; *ki* in Japanese medicine, *prana* in Ayurveda, and many such terms in other types of indigenous medicine. The notion of a universal life energy is ubiquitous in energy healing delivered by practitioners’ hands. These same practitioners can often sense imbalances in patients’ energy fields. Most traditional healing practices maintain that disease starts with an energetic imbalance such as a blockage or other irregularity in the energy flow through the body. Modern complementary and alternative systems such as chiropractic, homeopathy, and classical osteopathy are also founded on principles of a vital force. Therapeutics in these practices involves restoring the vital force to promote healing.

The concept of field, from physics, refers to a non-material element that interacts with an object within it. Therefore, a field cannot be detected directly but only through its action upon a probe. Contemporary physics holds that there are only four types of force operating throughout nature--gravity, electromagnetism, and the strong and weak nuclear forces, the latter two having a range limited to the atomic nucleus. A particular form of energy (defined in physics as the ability to do work) is associated with each force; for example, electric, magnetic, and electromagnetic energies are associated with the electromagnetic force. Clearly the electromagnetic force is central in biology.

The concept of biologic field first arose in embryology to explain the development of organisms that seemed to follow an underlying informational template. The Russian scientist, Gurwitsch, coined the term, “morphogenetic field” for the highly coherent and dynamic process of the unfolding embryo as well as biological regeneration. Gurwitsch also discovered mitogenetic radiation, ultraviolet light emitted from growing organisms that stimulated similar organisms to grow. From 1900-1950, other prominent developmental biologists including Driesch, Spemann, and Weiss worked from this

same perspective. Some of them maintained a vitalistic perspective. However, there is no reason today to attach vitalism, a philosophy that life is incomprehensible from a scientific perspective, to biological field theory. Weiss, who discovered that the morphogenetic field was unchanged if he removed some embryonic tissue, proposed that the biologic field was a holistic property of the entire organism (Jerman et al., 2009). These early embryologists did not address the nature of the morphogenetic field.

OVERVIEW OF MODERN BIOPHYSICAL FIELD CONCEPTS

As previously mentioned, the electromagnetic field is the most important physical field governing life. Ions, polar molecules, electrons, and moving charges within cells intimately involve electromagnetics. Needless to say, conventional biomedicine recognizes that the electromagnetic force is indeed the main physical force at work in organisms, but its use is typically restricted to explaining extremely short-range interactions such as those between adjacent molecules in biochemistry. Whereas biochemistry is based on individual chemical reactions with discrete transfers of electrons between molecules, biophysics invokes electromagnetic, electric, and magnetic fields to describe an all-encompassing and all-permeating biologic field of the organism proposed to coordinate and regulate life functions. Thus, modern biologic field theories are based on electromagnetics, including quantum electrodynamics.

Nobel laureate Szent-Györgyi introduced the notion of proteins as electronic semiconductors and re-introduced electricity as central to the living state. [3] He proposed that proteins exist in functional units such as charge-transfer complexes, which can absorb light that raises the energy levels of the electrons such that they are delocalized, and their energy moves freely within the complex. The biomolecules *in vivo* were thus considered to be predominantly in an excited state that was coupled to biochemical reactions.

A different approach was taken by Burr and Northrop at Yale University. They measured bio-electric phenomena in organisms in various states of development and health using a voltmeter. They proposed the Electro-Dynamic Theory in which the bodies of organisms, including plants and animals, were mapped for the bio-electric fields. They referred to these fields as “life fields” and believed that electricity molded biological form and controlled development, health, and mood. [4]

In the 1960s, Presman, a Soviet bioelectromagnetics researcher performed groundbreaking work outlining the first holistic electromagnetic field theory of life and its relation to the environment. Electromagnetic fields from the natural environment played a central role in the evolution of life. Organisms behave as exquisitely sensitive antennae for these extremely weak natural electromagnetic fields (exogenous fields

from the environment), such as, for example, the geomagnetic field. These natural fields interconnect life with its environment as well as connect organisms to one another. Moreover, electromagnetic fields produced by the organisms themselves (endogenous or biologic fields) can have long-range effects and play an important role in coordinating physiological functions. [5]

A model related to Szent-Györgyi's approach that involves an extended excited state inside the organism is the concept of the bioplasma, developed independently by Sedlak [6] and Inyushin. [7] First of all, a plasma is a unique phase of matter—a collection of ions produced by heating ordinary matter (solid, liquid, or gas) or subjecting it to a strong electromagnetic field. It is the most common phase of matter in the universe and comprises the stars and galaxies. Plasmas are exquisitely sensitive to exogenous fields and can spontaneously self-organize into complex dynamic forms. The bioplasma is one in which the biomolecules *in vivo* are predominantly in a stable, collective, excited state. It is a cold plasma (not glowing) that forms an energetic and informational network throughout the organism involving a colloid of semi-conducting proteins as the main constituent in a redox (oxidation-reduction) chemical oscillator displaying complex dynamics. This is analogous to a low-power laser that uses chemical, electrical or magnetic energy to pump it into an excited metastable state. Coupling between the biochemical reactions of the living state takes place electromagnetically, with a wave-like internal coordination surrounded by an electromagnetic wave externally emitted. Biological effects of exogenous electromagnetic fields are ascribed to collective resonance properties of the whole bioplasma and not just to any of its parts. [8] [9]

Based on a quantum physics approach along with nonequilibrium thermodynamics (the energetic properties of open systems exchanging energy and/or matter with the environment), Fröhlich proposed a biophysical theory of the living state based on coherent oscillations. [10] [11] Coherence is a physical state where all components oscillate collectively in phase and create long-range dynamic order. For example, the laser is a device with coherent dynamics that emits coherent light. Electrically polar structures of biomolecules that contain electric charges can generate electromagnetic fields when they vibrate, thereby producing an endogenous electromagnetic field of the organism with coherent modes. In relation to this, the majority of proteins are electrically polar structures typically immersed in water, a highly polar liquid. When metabolic energy exceeds a critical level, these polar structures engage in a steady state of nonlinear vibration, and energy is stored in a highly ordered manner, as a coherent excitation. This order expresses itself as a long-range phase correlation, where the behavior of the particles in the living state is

communal and inseparable. By this approach, the order in biological systems is not just spatial, but dynamic, and can include long-range coherence within the entire organism. By analogy, a stage full of ballerinas performing pirouettes repeatedly such that they always face the audience simultaneously, is an example of dynamic coherence. Fröhlich's approach predicts certain resonant frequencies of the biological field in the microwave region of the electromagnetic spectrum between 100 – 1000 GHz. [12]

Fröhlich's model inspired others who further developed the concept of an endogenous coherent electromagnetic field. Pokorny invoked a particular structure, the cytoskeleton that involves microtubules, tree-like structures throughout the cytoplasm. These are electrically polar structures that can be excited and are expected to generate an endogenous coherent electric field that could have a dominant effect directing the transport of molecules and electrons throughout the cell. [13] [14] Connective tissue with an extracellular matrix composed of collagen that interconnects cells throughout the body is another prospect. [15]

Another approach stemming from Fröhlich's basic model comes from quantum electrodynamics (QED) of condensed matter, which involves hypothetical nanostructures in liquid water called coherent domains. Since the human body and many other organisms are comprised of 70% water or greater, this approach is biologically relevant. E. Del Giudice and G. Preparata theorized that a certain fraction of liquid water contains coherent domains of ~100 nanometers in diameter, consisting of water molecules that are resonating with fields in the environment. [16] Water molecules within these domains vibrate in unison, because they are in a state of coherent excitation in which photons are trapped in resonant states. These coherent domains of structured water provide dynamic order over distance, as, for example, within cells, tissues, and the whole organism, and can also act as "antennae" for exogenous fields. In doing so, water coherent domains can easily be excited and capture surrounding electromagnetic fields to produce additional coherent excitations at those frequencies. The QED theory of water with its intrinsic, vibratory, coherent domains that are exquisitely sensitive to exogenous fields may underlie the dynamic organization of life itself. [17] Due to this dynamic substructure that is in constant interaction with the environment, water can register extremely subtle information about its environment through rapid changes in its internal processes. This model has also been invoked to explain the "memory" of water, the ability of water to store and convey specific information relevant to health, as, for example, in homeopathic remedies, hypothesized to exist through electromagnetic signals stored in water's coherent domains.

Further development of the QED model of water in relation to the living state

stems from the fact that most of the biowater (water comprising living organisms) is either intracellular or interstitial water and is in extremely close proximity to charged membrane interfaces, so-called confined interfacial water, the water confined to nanospaces. Such water exhibits unusual physical properties that are quite different from bulk water. Interfacial water is energized by the membrane electrical potential as well as acted upon by ambient fields, including exogenous fields such as ambient light. Del Giudice and colleagues predict higher concentrations of coherent domains in confined interfacial water. [18] Furthermore, charged aqueous colloids, which are considered *in vitro* models of cytoplasm, at the interface of charged membranes and in the presence of ambient light, self-organize into remarkably complex structures ranging up to several millimeters. [19] That is, self-organization into coherent structures is observed at the mesoscopic level in certain colloids under nonequilibrium conditions, producing dynamic life-like behavior under the influence of externally applied electromagnetic fields. Additionally, others have proposed that the flow of protons along confined interfacial water, for example, in the extracellular matrix comprised of collagen fibers, may exhibit coherence and be the basis of bioenergetic regulation. [20] Confined water was found to have proton conduction rates many orders of magnitude higher than bulk water, among other unexpected physical properties. Thus, the mesoscopic level of the living state is characterized by emergent collective properties that are governed by electromagnetic fields.

Another modern approach that originated with Gurwitsch's discovery of mitogenetic radiation entails studies on the emission of visible and ultraviolet light from organisms. Due to internal electronic excitations that are considered as a coupling of Fröhlich coherent modes, living organisms emit ultraweak photon emission in the visible region, 400-700 nm, called biophotons. These can be measured using sensitive detectors, photomultiplier tubes that count single photons. Although the scientific mainstream typically associates this ultraweak photon emission with bioluminescence from reactive oxygen species, i.e., as a waste product of metabolism, a growing number of researchers maintain that at least some of this light emission is coherent, contains bio-information, and is indicative of dynamic coherence within organisms, which is inferred from statistical properties of the light emitted. [21] Although the intensity of biophotons is extremely low, of the level of 10–200 photons/s•cm² of tissue, the information carried by this light, called electromagnetic bioinformation, can be significant for organisms. [22] For example, biophotons been shown to be involved in intracellular communication as well as in communication between organisms. [23] Furthermore, biophoton emission has been measured from humans. [24] There is preliminary evidence that biophoton emission measured from energy healers and their

patients before, during, and after energy medicine sessions changes over time and may be implicated in energy healing. [25]

Other researchers have proposed various concepts of a biologic field. [26] Tiller proposed the existence of a new force with a subtle energy unique to life, one that could be addressed by science. [27] Zhang called the biologic field the “electromagnetic body” and considered it to be a complex, ultraweak field of chaotic standing waves, a dissipative structure maintained through ongoing consumption of energy. Zhang’s biologic field is composed of electromagnetic fields that form the energetic anatomic structures including the chakras (energy centers of the body along the midline) and acupuncture meridians. [28] [29] Jerman proposed that the endogenous coherent electromagnetic field of organisms is the central entity of life rather than DNA. [30] Savva considered the biologic field to go beyond electromagnetism and to carry the information of intention and the psychic realm. [31] [32]

The term “biofield” was conceived in 1992 by an *ad hoc* committee of complementary and alternative practitioners and researchers convened by the new Office of Alternative Medicine at the US National Institutes of Health. It was recognized that many of the manual medicine modalities including chiropractic, classical osteopathy, and massage, as well as the energetic therapies such as Reiki, Therapeutic Touch, and external *qi* therapy, were all founded on the concept of a vital force, and each had its own terminology to describe it from a particular cultural context. The committee sought a universal term that would describe a central organizing biologic field grounded in science that would bring unity to this area. “Biofield” was coined for this purpose and defined as “a massless field (not necessarily electromagnetic) that surrounds and permeates living bodies and affects the body.” [33]

This author has proposed the biofield as nature’s original “wireless” communication system, in which the field is complex and dynamic, like a moving hologram, conveying information throughout the organism and the central regulator of homeodynamics, the steady state behavior that changes as the organism integrates new information. [34] [35] [36] The biofield may be involved in biological development and regeneration, by virtue of its high bandwidth, extensiveness throughout the organism, and rapid communication capabilities. [37]

Measuring energy emitted from the human body is insufficient to establish whether it is relevant to the biologic field. However, studying the human energy emissions associated with the various energy healing modalities such as Reiki, Johrei, external *qi* therapy, and determining whether these emissions affect other organisms beneficially, would provide evidence of energy-with-information and therapeutic efficacy. [38]

Studies finding beneficial effects of energy healing on *in vitro* cellular systems have established that these therapies involve energy beneficial to organisms beyond mere placebo effects. [39] These studies, along with others documenting physiological effects, as well as clinical trials on animals and humans, taken together, provide evidence for the functionality of the biologic field and its importance in medicine. [40]

THE ROLE OF CONSCIOUSNESS

Over 400 years ago, science expelled consciousness from its quest, deeming it outside of the material realm and in the realm of religion. However, this split between mind and matter is distinctly a Western dilemma. The East maintained an integrated biophilosophy of mind inseparable from body. In Oriental medicine there is an ancient principle—that where the mind goes, *qi* flows, and the blood follows *qi*. So, at least in the East, the mind is the overarching commander of the vital force, which moves the energy, and then the flesh follows suit.

It is notable that in recent years science has begun to explore consciousness. Research on the mind-body interrelationship with practical applications in mind-body medicine is underway. There are laboratory experiments on distant mental interactions with living systems that demonstrate measureable changes. In addition, physicists are deliberating over the role of the observer in quantum mechanics and the interrelationship of consciousness and the physical world.

There are various ways to relate the biofield to consciousness, as follows. For one, the biofield as the endogenous biophysical field of the body may be envisioned as a “bridge” or “mediator” between mind and body, similar to the role of *qi* in the principle of Oriental medicine. Consciousness—through conscious intent, will, visualization, affirmation, prayer, etc. may, in fact, govern the biofield because it denotes a higher level of being. According to living systems theory, new properties appear at higher levels of organization, irreducible to lower levels, and may, in fact, override lower-level regulation by “top-down” causation. So, changes in the biofield may be the first in the sequence of responses to thought and intention, followed by subsequent shifts in the physiology and biochemistry. By such means the biofield and the flows of energy-with-information associated with it may play a role in the *modus operandi* of mind-body therapies.

An extended concept of information is needed in biology. In conventional biology, it is well known that molecules such as DNA and hormones convey information. Biofield science offers the new concept of electromagnetic bioinformation, in that energy fields, however weak, carry information that affect life functions. Moreover, energy medicine interventions—including healer interventions, homeopathic remedies,

and bioelectromagnetic therapies, act informationally and utilize energetic stimuli that are extremely weak, on the order of intensity as the biofield itself, rather like small “nudges” working in harmony with the organism’s system dynamics, to produce rapid, integral beneficial effects. In addition, we must consider that there are informational flows among and between all the levels of organization in living systems with their innumerable connections from the viewpoint of living systems. One may extend the concept of information beyond that conveyed by matter and energy to the realm of consciousness itself. Thus, conscious intention, will, and thought may provide active information that may be causal, too, affecting health and healing. [41]

Another possibility, which is not exclusive, is that there may be other fields presently unknown to science that are subtle, which may, in fact, comprise consciousness or act as an agent of consciousness. The biofield may consist both of veritable electromagnetic fields as well as other, putative subtle energies, beyond known energies. In relation to this, consider the fact that contemporary electromagnetic theory was truncated from Maxwell’s original formulation, when his 20 original equations with 20 unknowns were reduced to only four equations by Heaviside to simplify the theory into a form usable by electrical engineers. [42] In light of these fundamental modifications in Heaviside’s reformulation, it stands to reason that the original Maxwellian theory of electromagnetics may encompass more complexity that has been overlooked—including the possibility of a subtle energy field involved in the biofield. Distant healing and other phenomena involving conscious intent may involve such a putative energy, a postulated subtle energy or energies, [43] [44] one that serves to explain a class of phenomena beyond the four fundamental forces, and which does not dissipate over distance by the inverse square law. Finally another distinct possibility is that distant healing may not involve any energy transfer whatsoever if the healer and patient are connected via quantum nonlocality.

At a higher level of organization, the therapeutic partnership in medicine and other relationships may involve interacting biofields. For example, the biofield of a sick patient may entrain to the biofield of the healthier practitioner. For social interactions that involve yet higher levels of organization, we might expect new emerging interpersonal and group biofields. Thus, it is possible that no single concept of the biofield will encompass all the ramifications of organizing fields in living systems.

CONCLUSIONS

The concept of the biofield emerged from a vitalist perspective but is now firmly grounded in science. It provides the rudiments of a scientific foundation for a holistic view of life and a *modus operandi* for integrative medicine. The variety of energy healing

practices that have been widely practiced since antiquity, now called biofield therapies, may involve biocommunication and energy transfer via the biofield. Additionally, the biofield may serve as a bridge between mind and body and underlie the *modus operandi* of mind-body interactions.

Although “Occam’s razor” has ruled science with its emphasis on simplicity and reductionism, life is inherently complex, and science should be mature enough to embrace its complexity. From a systems view, we expect new biological principles at higher levels of organization. The biofield is one such concept. Moreover, now that epigenetics has modified genetic reductionism, such that “top-down” regulation is meeting “bottom-up” approaches, the biofield, with its exquisite sensitivity to environmental factors, may also prove to be an important mediator in epigenetics. This could pave the way toward a truly novel biological paradigm that unifies the “particle” and the “field” views of life.

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REFERENCES

- [1] Thompson, D’Arcy W. *On Growth and Form*. Cambridge: Cambridge University Press (1917): 160.
- [2] Bishof, Marco. “Vitalistic and mechanistic concepts in the history of bioelectromagnetics” In: Belousov, L.V. and Popp, F.A. (eds). *Biophotonics—Non-equilibrium and Coherent Systems in Biophysics, Biology, and Biotechnology*.

- Proceedings of the International Alexander Gurwitch Conference, Sept 28-Oct 2, 1994. Moscow: Bioinform Services 1995: 3-14.
- [3] Szent-Györgyi, Albert. Towards a new biochemistry. *Science* 93 (1941): 609.
- [4] Burr, H.S., Northrup, F.S.C. The electro-dynamic theory of life. *Quarterly Review of Biology* 10 (1935): 322-333.
- [5] Pressman, A.S. *Electromagnetic Fields and Life*. New York: Plenum Press, 1970.
- [6] Sedlak, W. A model of a system radiating the biological field and electrostasis (In Polish). *Kósmos A2* (1967): 154-159.
- [7] Inyushin, V.M. Bioplasma: the fifth state of matter? In: White, J, Krippner, S. (eds) *Future Science*. Garden City, NY: Doubleday (1977): 115-120.
- [8] Zon, J.R. Physical plasma in biological solids: a possible mechanism for resonant interactions between low intensity microwaves and biological systems. *Physiological Chemistry and Physics* 11 (1979): 501-506.
- [9] Wnuk, M.J. and Bernard, C.D. The electromagnetic nature of life: the contribution of W. Sedlak to the understanding of the essence of life. *Frontier Perspectives* 10.1 (2001): 32-35.
- [10] Fröhlich, Herbert. Long-range coherence and energy storage in biological systems. *International Journal of Quantum Chemistry* 2 (1968): 641-649.
- [11] Fröhlich, Herbert. The extraordinary dielectric properties of biological materials and the action of enzymes. *Proceedings of the US National Academy of Sciences* 72 (1975): 4211-4215.
- [12] Fröhlich, H., Kremer, F. (eds.) *Coherent Excitations in Biological Systems*. New York: Springer, 1983.
- [13] Pokorný, J., Jelinek, F., Trkal, V., Lamprecht, I., Holzel, R. Vibrations in microtubules. *Journal of Biological Physics* 23 (1997): 171-179
- [14] Pokorný, J. Conditions for coherent vibrations in cytoskeleton. *Bioenergetics*. 48.2 (1999): 267-271.
- [15] Oschman, J.L. *Energy Medicine*. New York: Churchill Livingstone, 2000.
- [16] Del Giudice E., Preparata, G. A new QED picture of water: understanding a few fascinating phenomena. In: Sassoroli, E., Srivastava, Y., Swain, J., Widom, A. (eds.) *Macroscopic Quantum Coherence*. Hackensack, NY: World Scientific Publishing Co, 1998.
- [17] Del Giudice, E., Elia V., Tedeschi, A. Role of water in the living organisms. *Neural Network World* 19.4 (2009): 355-360.
- [18] Del Giudice, E., Spinetti, P.R., Tedeschi, A. Water dynamics at the root of metamorphosis in living organisms. *Water* 2 (2010): 566-586.
- [19] Jabs, H.S. and Rubik, B. Self-organization at aqueous colloid-membrane

- interfaces and an optical method to measure the kinetics of exclusion zone formation. *Entropy* 16 (2014): 5954-5975.
- [20] Ho, Mae-Wan. Illuminating water and life. *Entropy* 16 (2014): 4874-4891.
- [21] Popp, F.A., and Nagl, W. Concerning the question of coherence in biological systems. *Cell Biophysical Journal* 13 (1988): 218-220.
- [22] Popp, F.A., Warnke, U., Konig, H.L., Peschka, W. (eds.) *Electromagnetic Bio-information*. Munich: Urban and Schwarzenberg, 1989.
- [23] Popp, F.A., Belousov, L.V. (eds.) *Integrative Biophysics: Biophotonics*. Dordrecht, Netherlands: Kluwer Academic Publishers, 2003.
- [24] Van Wijk, R., Kobayashi, M., Van Wijk, E. Anatomic characterization of human ultra-weak photon emission with a moveable photomultiplier and CCD imaging. *Journal of Photochemistry and Photobiology B* 83.1 (2006): 69-76.
- [25] Jabs H.S., and Rubik, B. Unpublished data (2012).
- [26] Kefatos, M.C, Chevalier, G., Chopra, D., Hubacher, J., Kak, S., Theise, N.D. Biofield science: current physics perspectives. In Press: *Global Advances in Health and Medicine* (2015).
- [27] Tiller, W. What are subtle energies? *Journal of Scientific Exploration* 7 (1993): 293-304.
- [28] Zhang, C.L. Acupuncture system and electromagnetic standing wave inside body (in Chinese). *Journal of Nature* 17 (1995): 275-281.
- [29] Zhang, C.L. Standing wave, meridians, and collaterals, coherent electromagnetic field and holistic thinking in Chinese Traditional Medicine (in Chinese). *Journal of Yunnan College of Traditional Medicine* 19 (1996): 27-30.
- [30] Jerman, I., Krasovec, R., Leskovar, R.T. Deep significance of the field concept in contemporary biomedical sciences. *Electromagnetic Biology and Medicine* 28 (2009): 61-70.
- [31] Savva, S. A systems approach in biology and biophysics. *Monterey Institute for the Study of Alternative Healing Arts Newsletter* 18-19 (1997): 209.
- [32] Savva, S. Toward a cybernetic model of the organism. *Advances in Mind-Body Medicine* 14 (1998): 292-301.
- [33] Rubik, B., Pavek, R., Greene, E., Laurence, D., Ward, R. Manual healing methods. In: Rubik, B., et al. (11-member editorial review board), *NIH Report: Alternative Medicine: Expanding Medical Horizons*. US Government Printing Office, Washington, DC. 1995: 113-157.
- [34] Rubik, B. Can Western science provide a foundation for acupuncture? *American Association for Medical Acupuncture Review* 5.1 (1993): 15-27.
- [35] Rubik, B. Information, energy, and the unpredictable whole. *Advances: The Journal of Mind-Body Health* 13.2 (1997): 67-70.

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- [36] Rubik, B. The biofield hypothesis: its biophysical basis and role in medicine. *Journal of Alternative and Complementary Medicine* 8.6 (2002): 703-718.
- [37] Rubik, B., Muesham, D., Hammerschlag, R., Jain, S. Biofield science and healing: history, terminology, and concepts. *Global Advances in Health and Medicine* 4(suppl.) (2015) DOI: 10.7453/gahmj.2015.038.suppl. In press.
- [38] Rubik, B. Measurement of the human biofield. In: Freeman, LW (ed.) *Mosby's Complementary and Alternative Medicine: A Research Based Approach*. St. Louis, MO: Mosby (Elsevier, Inc.) 2009: 555-573.
- [39] Rubik, B., Brooks, Audrey, and Schwartz, Gary (2006). *In vitro* effect of Reiki treatment on bacterial cultures: role of experimental context and practitioner wellbeing. *Journal of Alternative and Complementary Medicine* 12.1 (2006): 7-13.
- [40] *Global Advances in Health and Medicine* 4.7 (Entire volume on the biofield) (November, 2015): In press.
- [41] Rubik, B. Energy medicine and the unifying concept of bioinformation. *Alternative Therapies in Health and Medicine* 1.1 (1995): 34-39.
- [42] Heaviside O. *Electromagnetic Theory*. London: The Electrician Printing and Publishing Co., Ltd., 1893.
- [43] Tiller, W. What are subtle energies? *Journal of Scientific Exploration* 7 (1993): 293-304.
- [44] Taylor R. A gentle introduction to quantum biology. *Consciousness and Physical Reality* 1.1 (1998): 64-72.