

Information, Matter and Energy – a non-linear world-view

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Abstract: As far as we understand life today, it is the most amazing, even the most wonderful appearance on this planet. Only since exploration of space do we become increasingly aware how the entire architecture of the cosmos seems to be synchronized in a way to make life possible in the first place. Embedded in a series of orders the universe - including Earth - is but a ripple in a vast ocean of energy. This highly inorganic realm seems to be in total opposition with the animated world. However, the highly complex physico-chemical interaction of molecules differs only in its phenomenology not in its principles from the non-animated world. Thus the shift from live to non-life must be gradual, a continuum so to speak. As with the cosmic principle, both the animated and inanimated realms are open, dissipative systems that are far from equilibrium. Both rely on injections of energy, or neg-entropy. Based on these dissipative structures these systems undergo changes, which, at a critical point, completely destroy the previous structure only to give rise to new and different dissipative structures. Two basic features characterize such systems: One is the concept of the bifurcation point, the other is the evasion - but not violation - of the 2nd law of thermodynamics. Being supplied with neg-entropy and thus far-from-equilibrium, such systems seems stable at one instant and unstable the next. At the point of bifurcation, predictability seems to collapse, making any determination of the course of these systems impossible. Open systems seem to choose whichever probability it wishes to activate thereby reorganizing themselves. This attribute of self-organizing systems creates order out of chaos. Since this process occurs in both the animated as well as in the in-animated realm, the gap between the inanimate and animate becomes obscured.

Keywords: neg-entropy, bifurcation, animated / non-animated world Self-organizing systems.

1. Introduction

The laws of thermodynamics (LoTD) are idealized concepts that are valid for closed systems. According to the 2nd LoTD, the physical world runs down such that useful energy continually degrades into heat (entropy).¹ This is somehow in stark contrast

to the biological world, which seems capable of doing just the opposite as it increases organization by the flow of information, energy and matter. So where are the boundaries that make these laws applicable to the organic world and what is the secret of life that seems to contradict thermodynamics in the first place?

Thermodynamics operates with a concept known as entropy. In real processes it always increases but never decreases. Hence, with the unidirectional flow of time the change in entropy is always positive, or in the limiting case “0”. Already *Schrödinger* pointed out that living systems are open to the environment. They create a local decrease in entropy at the expense of the surroundings and use it to increase their own organization.² Organization is maintained in some kind of ‘steady state’ by a flow of energy and matter. As soon as that flow is interrupted, decoherence sets in, disorder takes over and eventually leads to large-scale decay.³

Living beings avoid rapid decay into the inert state of ‘equilibrium’ by feeding on negative entropy.⁴ Neg-entropy has not so much to do with free energy, but rather with the way energy is trapped, stored and mobilized. This enables organisms to organize their energies in a coherent fashion and to maintain their long-term survival. In this regard, free energy is just that part of internal energy or enthalpy that can be extracted to do work. The part unavailable for work is entropy.

Entropy can also be explained from an athermal point of view. Therein, the concept of entropy statistically operates in quantum states. That is, each of which can exist in a vast number of different microstates. The greater the number of possible microstates, the greater the entropy, hence ‘randomness’ or disorder. However, in information theory demonstrated that the equivalence of neg-entropy is information.⁵ In this regard, *Schrödinger* seems to unite these various definitions in that he pointed out that messenger molecules are the active agents in living systems. A handful of these molecules bind to specific receptors in the target cell membrane. Their information content is sufficient to initiate a cascade of biochemical reactions that alter the characteristics of the whole cell, the corresponding organ and even the organism in which it is embedded. Pheromonic action among same-species of opposite sex is just one striking example.⁶ In this regard, useful work can be done by direct transfer of stored energy – here bio-molecules. This is in contrast to thermalized energy, which can no longer be converted into stored energy within the same system that ought to be in equilibrium.³

2. Energy

In the classical sense, energy is the potential for causing change. In living organisms, energy-yielding reactions are always coupled to energy-requiring reactions. Being

noiseless, fluctuationless and highly specific, the coupling can be so perfect that the efficiency of energy transfer is close to 100%. It is only determined by the frequency of the vibration itself ($E_{QM} = h \cdot \nu_0$), in that resonating molecules attract one another. Energy is trapped directly at the electronic level and is stored as vibrational and electronic bond energies, in gradients, fields and cyclic flow patterns, compartments, organelles, cells, tissues, organs, organisms and entire populations.³ The ‘downhill flowing stream’ of electrons for example is tapped and used to make ATP, which in turn converts back to ADP in the biosynthesis of all biomolecules, to grow and develop, to sense, to feel, to move, to think, to love - in short to live.⁴

Since electronic transitions and emission of electromagnetic radiation (EMR) in biological tissues are tightly coupled, it is not surprising that both are subject to reciprocal interaction. It is the stage where coherence comes into effect. Coherence is the property of waves to superimpose to each other. This can either be constructive or destructive. Such interference yields a state of higher order that in turn generates an inter-connected communicative field. The hyperbolic decay pattern in biophotonics is clear evidence of the synchronized emission pattern and distinguishes itself from chaotic emission pattern in random events that lack coherence and become manifest as exponential decay patterns. The basis for all those criteria is in the physics of quantum coherence.³ It results in biophotonic emission that completely decays only after minutes or even hours – just like a laser that coherently feeds back part of its emission to the source.⁶ As living beings are in an excited state, the active biological matrix somehow acts like a resonator cavity for the trapped energy. However, the high information density within the DNA leads to a phenomenon known in physics as *Bose-Einstein-Condensate* (BEC - see also contribution Yip/Madl – Biophotons). Thus, the crucial difference between living and non-living systems lies in how energies are stored, channeled and directed in a coherent way. Life depends on “catching an excited electron” – by means of specific light absorbing pigments – and then tapping off its energy as it falls back towards the ground state. Life uses the highest grade of energy, the quantum that is sufficient to cause specific motion of electrons in the outer orbitals of molecules.³

3. Matter

Since the development of quantum mechanics, we should consider matter as a frozen standing wave patterns of the collapsed wave function.⁶ This seems to be in opposition with *Einstein's* famous energy-matter equation ($E_{RT} = m_0 \cdot c^2$). However, there is a continuum between energetic and materialistic domains, where “free” energy represents one aspect while the “fixed” energy the atomistic-molecular aspect.

According to quantum theory, the electronic, vibrational and rotational energies of a molecule exist at discrete levels. Yet the spacing among the upper vibrational energy levels is so small that the levels practically merge into a continuum. In the language of quantum theory, the living system has achieved a ‘population inversion’ deviating from the equilibrium prediction of *Boltzmann’s* law. That is, life as we know it typically operates around 300K, whereas this law would assign its equivalent only at around 3000K. Hence, living organisms do not act as thermodynamic engines.³ Even earth’s ecosystem is one big energy store, which is maintained far away from thermodynamic equilibrium.⁷ It generates a hierarchy of space-time structures, which in turn organizes the flow of energy. The same space-time catenation of processes can be found in all organisms, ecosystems, societies and even on the planetary scale - here it involves just larger dimensions and longer durations. Cascades of cycles span the entire gamut of space-time from slow to fast, from local to global, that altogether, make up the life cycle. This inspired *J.Lovelock* to compare our planet with a super-organism, commonly referred to as GAIA. Since the origin of life and biological evolution are strictly tied with the evolution of our solar system we should no longer consider life on our planet as a series of lucky ‘frozen accidents’.^{3, 5, 6}

Coupled cycles and energy-matter interactions are the ultimate wisdom of nature and occur at all levels, from the molecular to the ecological through a wide range of characteristic time scales, from split seconds to millennia. The residence time of energy within the biosphere is directly related to the stored energy, and hence, to species diversity or the size of the trophic web. Yet, the key is neither energy flow nor energy dissipation, but energy storage under energy flow. This assigns biodiversity a much more important role for the homeostasis of our planet than is generally recognized.³ In this regard, it seems obvious that self-organization is a logical step in the meaningful management of resources and maintaining viability among all biota.⁸ Non-linearity can simply be understood through the interplay of positive and negative feedback-cycles that fuel natural selection. This leads to wider ecological processes, which are also continuous and subject to cybernetic principles of regulation. While positive feedback increases the number of configurations, negative feedback controls and stabilizes them. The interaction between them creates intricate and chaotic patterns, which can develop very quickly until they reach a stable configuration, an attractor so to speak.³

4. Information

With regard to single molecules involving quantum molecular processes, stored energy has meaning as much as it has with regard to the whole organism. Energy

storage in the molecular range occurs within a spatial extent of nano-meters and a characteristic timescale of nano-seconds. On a macroscopic scale, such as an entire organism, the overall energy stored domain is in meters and decades respectively. Hence, nature can no longer be interpreted by means of matter and energy alone - a third component is required: information.

The underlying principles can be found in the morphogenetic field (MGF),^{8,9} This chemo-mechanical electric field acts in the nano-meter-range where it utilizes the multitude of resonance modes available in the macromolecules. It induces a holistic action on structures like our DNA (see contribution Yip/Madl – Biophotons). Coherent action of the MGF acts on gene-expression. In a healthy organism, the expressed gene feeds back onto the field in a positive manner, thereby sustaining the integrity of the entire organism. Growth, differentiation and coordination are controlled by the MGF. Tightly connected to the MGF is the quantum potential. It is a multi-dimensional information potential and affects the particle according to its shape rather than its magnitude.¹⁰ The effect is the same regardless of the strength of the wave. The wave may have larger effects even at long distances, for the wave does not carry energy; it is an information wave. The quantum potential suggests that what we see as separate parts of reality are only aspects of a totally interconnected underlying quantum world.

5. Information-Energy-Matter Triad (IEM)

Now it is possible to interpret nature as a continuous “matter-energy-information” give and take relationship. Energy, used as a concept to understand dynamics of most physical processes, is the potential for causing change, while matter on the other hand is the substance of which physical objects are composed. It constitutes the observable universe. According to the theories of relativity and quantum mechanics there is essentially no distinction between matter, frequency and energy. Thus, information as the third element in this relationship obviously determines shape and ‘gestalt’,¹¹ (see contribution Manzelli - What Means Life). Mediated with the necessary energy, materialized information is matter. The IEM-triad, so to speak bridges soma and significance in that the wave function (field) as the mental (or significance) aspect of the electron. Here, the field and particle are never separate and are actually aspects of the same reality.¹⁰ The field acts on the particle, not by intensity, but by its information content (form). It gives rise to an activity that is identified with meaning (proto-intelligence) that guides the electron. However, this is not a one-way flow, both information and materialized entities feed back to each other via energetic means, with the interface between spirit and matter being

information.⁸ Unfortunately, a current scientific understanding emphasizes physical aspects, as it is not yet able to understand and interpret the associated meaning.

6. Properties of life

Based on *Bohm's* conception of order, we find that primacy is given to the undivided whole.¹² The apparent duality - such as particles and quantum states should be considered as artifacts. Here, the implicate order encompasses all things, structures, abstractions and processes. Nothing is *entirely* separate or autonomous. Life is a continuous flowing process of enfoldment and unfoldment involving relatively autonomous entities, which are part of the continuum between the implicate and explicate orders. Hence, organisms are much more than the sum of their parts.

The hierarchic structure of life covers the entire spectrum of viroids to single-celled prokaryotes all the way to multicellular eukaryotes.¹³ With all organisms being part of the continuous dynamic equilibrium of the environment they are embedded in, anabolic (building up) and catabolic (degrading) processes form a continuum between the extremes of the abiotic and biotic matter. The underlying order is maintained as homeostasis (a constant inner balance despite environmental fluctuations). Life must not be understood in *Darwinistic* terms but rather in quantum leaps; i.e. symbiotic associations that bring about new forms of life.⁸

This can be compared with a holographic image, which is an interference pattern produced by two intersecting, coherent beams of light. The entire body is regarded to exist in a quantum holographic form, which can be reconstructed from a small part, albeit with loss of detail – skills that can be witnessed in the regenerative properties of the Salamander.⁹ The holographic analogy is reflected in all cell as each one contains the entire genome regardless of tissue specialization. It is even assumed that all organisms, including humans act as holographic bio-computers. A common hypothesis claims that information in the brain is not stored in localized areas of the brain but rather smeared like a hologram over the entire brain and stretches out over the entire body.³ Thereby, information is retrieved via a built-in *Fourier*-transformation and converted to distinct action potentials. The holographic properties of the entire organism, provides all parts of the body to with information regarding its overall status. The coherently radiating MGF within each cell that drives cellular metabolism is thought to be the result of this bodily memory function.⁶ The nerves are the trigger, while the body is the coordinator. Coupled with the holographic structure, it results in a biophotonic field that affects life as a whole. By using a broad spectral range along with polarization (mediated via bodily tissues), the organism is capable to transmit signals from one part of the system to

the other almost instantly. This instantaneous coordination of various nonlocal body functions is thereby mediated, not by the nervous system, but by the body consciousness. Organisms are quantum superpositions of coherent activities that are actively maintained. This has profound implications on the nature of knowledge and knowledge acquisition, as well as issues of determinism and freewill.³

Much of personal memory may be stored in an ambient collective quantum holographic memory field delocalised from the individual organism. This is fully consistent with the foundations of quantum theory that all nature is interconnected, and that separateness or discreteness of things in the common, sensible world is illusory.³ The material structures involved in such a process act like antennae that pick-up information and re-emit them into the delocalised quantum field. In order to do so, evolution helped by coming up with perfectly matching molecular geometry of biomolecules thereby enabling the development of such highly synchronized biophotonic field resonators.⁶

7. Organisms as Non-Linear Systems

Quantum coherent states maximize both global cohesion and local freedom. Within the coherence volumes and coherence times of energy storage, there is no space-like, nor time-like separation, and that is why organic space-time can be non-local.³ However, since the system is constantly interacting with its environment, there is a tendency to decohere the system. Thus, the fully coherent state is an idealization that can only be approximated but never reached, just as is the case with an attractor. Rhythms with constant amplitudes are not perfectly periodic. Such deterministic chaos is especially evident in the so-called healthy stage. It reflects the constant intercommunication between different biological rhythms that must take place in a healthy organism.³ Chaotic behavior in non-linear systems, as in living beings, is a dynamic attribute. Chaos may look pretty random nonetheless it is deterministic. The trajectory of a chaotic system is sensitively dependent on the initial condition. That is, at the right time and the right place, an unobservably small cause can produce large effects. In other words, regularly occurring points of instability represent symmetry breakages or bifurcation points, with both paths stabilizing themselves again in temporary robust states. Thus, chaotic systems reveal a fractal nature. Both fractals as well as bifurcation patterns are found to be universal.¹⁴

Whenever brief disturbances tip a system, homeostasis is sooner or later restored. However, if the disturbance is significantly long or intense, a series of irreversible events shift the system to a new 'steady state'³ Chronic disturbances

favor development or differentiation of “new” response mechanisms. Evidence of such response behavior can be found in the *Aristotelian* concept of epigenesis.^{8,9}

According to its dissipative nature, the organism is able to flip-flop from one state to the other (from a healthy to a sick state).⁶ Whenever the oscillatory pattern reverses direction it passes through a point that is most sensitive to external disturbances – the Point of Inflection (PoI). Here, changes to the oscillating system can be effortlessly made at the PoI, whereas changes during the full swing are almost impossible to induce.¹¹ Hence, various attractors constitute various regulatory patterns of a healthy or a diseased state in a human. This obvious chaotic motion is a driving force in the self-organizing phenomena and is subject to external triggers.^{8,14}

Accordingly, disease should be considered as a decoupling process - healthy cells resonate unisono, i.e. they are coupled systems of specific tissues, organs and include even the entire organism. A sick organism is in disharmony, is out of tune and is no longer capable to “learn”, to adapt to new situations. Disease on a physical level is tightly connected to coherence in mind. Even an improper thinking pattern, or self-acquired persistent mental reflexes may trigger situations of tension or conflict.¹² In case of prolonged activation, this may lead to chronic distress, and if no bio-energetic regulation takes place, psychological and or physical disturbances may result; i.e. sleeping disorders, stomach cramps. In turn that may pave the way for pre-cancerogenic stages.⁴ Such stages can be considered as decoherent states, which in the end are induced by cultural, political, religious, or social disturbances.

Biophotonic investigations of healthy and diseased stages have shown that there is a significant difference. A harmonious state results in a coherent field and reveals itself as a Poissonian distribution, while EMR of a decoherent field is always stochastic. Photon counts of normal liver cells for example, have a relatively stable or even falling level of photon counts at increasing cell density, while cancer cells of the same cell type show an increasing photon count at higher cell densities.⁶ Populations of cancer cells have lost the harmony otherwise so typical for healthy tissues. Hence, a malignant tissue is the result of an erratic reconstititional attempt, which results from the loss of negative feedback cycles between chaos and order of the entire organism.⁹ Therefore, cutting out the tumor is not equivalent with healing (see contribution Payrhuber/Madl/Frass – Information alters Matter). The hyperbolic biophoton-decay function can be taken as a measure of incoherence, as it is directly correlated with the inability of the system to re-absorb emitted energy coherently. These results are consistent with the suggestion that tumor cells have a diminishing capacity for intercommunication. As there is no such thing as a bad cell¹⁵ - virus, bacteria, plant, animal, individual, group of people, etc. - it becomes obvious that only the interaction with its surroundings determines the response of an

embedded entity. Here the disease itself becomes a messenger, the vehicle that tries to communicate to the outer world / brain.¹⁰ Projected into a social analogy, it would be as wrong as to say that someone is anti-social. It does not solely depend on the person, but rather on the interaction with the person's environment.³ Thus cancer must be considered as disturbed coherence of biophotonic communication.

8. Conclusion

Extending our perspective by the dimensions of the IEM-concept, implies a complete paradigm shift in our current scientific understanding. This has been already asserted by most indigenous traditions as they neither regard living processes in terms of a physico-chemical processes nor as a fight in the Darwinian and Neo-Darwinian sense against external enemies. They consider live as a game, a challenge and an adventure.⁸ Rather than protection and mistrust, mere curiosity and trust are at the forefront. Be it indigenous or quantum-mechanical terminology, one can characterize life by four complementary realities, which are: (1) everything is spatially and temporally limited, (2) everything is connected to everything else, (3) everything is a symbol that represents something else, (4) everything is one and part of an undividable whole.¹⁴ In accordance with *Heisenberg's* uncertainty principle, it is impossible to gain absolute knowledge by applying common scientific understanding, as reality cannot be described by gazing deeper and deeper into matter. With science, we can only gain approximate knowledge.¹⁶ Hence, it is time to ask serious questions regarding the ultimate goal of various scientific disciplines:^{4, 11, 14} Can physics uncover the real aspects of matter by diving ever deeper into the subatomic world? By keeping analyzing and dissecting organisms, elaborating complex webs of interaction and models, does biology really comprehend the essence of life? Is our medicine really uncovering the origins of disease or still trapped to deal with symptoms? Can psychology help us to understand the concept of the soul? Does sociology really get involved in the universal connectivity among social beings? Is our economy truthfully used to promote sustainable development?

Confronted with these questions, the new-paradigm thinking in science should shift its focus toward the relationship between the parts and the whole. The properties of the parts can only be fully understood through the dynamics of the whole. Ultimately, parts are just the nodes of the more important inter-nodal structure of this web. Rather than stressing the forces and mechanisms through which processes interact, science should investigate the manifestation of the underlying principles. Here, we should be prepared to shift from objective science to epistemic science, in that knowledge can never be obtained by detached, objective observation, just as the

riddle of the inseparability of ‘the observer and the observed’ in quantum physics – although they still can be distinguished. Increasing accuracy, precision, and thus knowledge can only result in asymptotical convergence to the absolute knowledge that eventually we will never reach. Rather than the quest for the ultimate truth, approximate descriptions must again be at the forefront. As all natural phenomena are ultimately interconnected, science can never provide any complete and definitive understanding.¹⁶ Human survival in the face of the technological holocaust will be possible only if we shift from an attitude of domination and control of nature / humans, to one of cooperation and non-violence. Today both science and technology are predominantly still used for purposes that are dangerous, harmful, and anti-ecological.¹⁷

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