The Quantum Coherent Organism & EMF Sensitivity

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Abstract
The organism consists of a liquid crystalline continuum of giant molecular dipoles optimised for coherent energy storage and rapid and efficient energy transfer, approaching quantum coherence in the ideal.

All parts of the organism can intercommunicate instantaneously for perfect coordination.

Within the cell, giant molecular dipoles undergo phase transitions with changes in polarisation that affect cell states and biological function.

A major intercommunication channel is via 'jump conduction' of protons through the polarised multilayers of water associated with the liquid crystalline matrix.

Coherent electrodynamical activities on every scale make the organism extremely sensitive to electromagnetic fields.

The coherent liquid crystalline organism
This is what the organism is like if you know how to see it properly. No, you are not under the influence of LSD or anything like that. This is my favourite portrait of the Rainbow Worm, a little fruit fly larva just emerged from the egg, looking psychedelic as it goes exploring. This was captured from a live video recording done with a ccd colour camera attached to a polarising light microscope that earth scientists use to look at rock crystals and liquid crystals, which is what gives the brilliant interference colours. It depends on a high degree of order in the atoms and molecules in the crystals. In the case of liquid crystals, it depends on dipolar molecules having a coherent alignment

But this worm is alive and moving, and all its molecules are furiously turning, transforming energy, so how can it appear like a liquid crystal display?

Light vibrates at 10^{14} cycles per second, perhaps at least ten thousand times faster than molecules can move in concert, so the light passing the worm through 'sees' static order at every instant, as long as the motions of its molecules are sufficiently coherent. It is like taking a still image of a fast moving athlete in the Olympics with an even faster film.

Not only are all the molecules moving together, but they are aligned in the entire organism from head to tail, and furthermore, the liquid crystalline organism is 70% water; this water is largely associated with the proteins and other macromolecular dipoles inside the cells and in the extracellular matrix. These water molecules are an intrinsic part of the liquid crystalline matrix, and they too, must be moving coherently along with the proteins.

This image is telling us that the organism is coherent to a high degree, perhaps quantum coherent; and it owes its coherence to the liquid crystalline continuum that connects up the entire organism, throughout the extracellular matrix and into the interior of every single cell. It is that which enables every part of the organism, down to single molecular machines, to intercommunicate rapidly and efficiently, enabling it to act as a perfectly coordinated whole. That's how come the four-minute mile and other heroic feats of athletics are possible.

All organisms are like that, the brine shrimp and daphnia that you feed to your goldfish and you too, if put under a powerful enough microscope.

This is one of the most striking evidence for the coherence of organisms. A lot of what I have no time to talk about is in this book [1], *The Rainbow and the Worm, the Physics of Organisms*, and also in successive issues of this must-read magazine, *Science in Society*.

I shall sketch the argument as to why I think the organism is quantum coherent, so all parts of it can intercommunicate instantaneously for perfect coordination. Molecular dipoles naturally communicate through changes in polarisation, and that's what the body uses. A major intercommunication channel is via 'jump conduction' of protons, positive electricity, through the polarised multi-layers of water associated with the liquid crystalline matrix. Organisms are exquisite flexible electronic creatures, with coherent electrodynamical activities on all scales, which is ultimately why they are extremely sensitive to electromagnetic fields.

There's a lot of talk on making molecular machines in nanotechnology. As it happens, the organism is jam-packed with living molecular machines embedded in the liquid crystalline matrix [2]. They run in almost perfect cycles, drawing on *coherent* energy extracted and stored from metabolism. Living molecular machines essentially borrow coherent energy and return it only slightly degraded to the matrix. Their efficiency is such that very little waste heat is generated, which is why they can be packed so densely and work ceaselessly without burning out.

It is immediately obvious that there is something special about the mobilisation and transformation of living energy that cannot be understood in terms of conventional thermodynamics. I am going to sketch out a different kind of thermodynamics, not from first principles as in my book, but with a simpler heuristic argument [3].

Space-time structure of living processes

It is usually said that the organism is an open system whose organization is maintained in some kind of 'steady state' by a flow of energy and chemicals. When that flow is interrupted, disintegration usually sets in and death begins. That steady state, however, is not a static bulk phase in a rigid container, far from it.

Within the organism, one finds *organized heterogeneities* or dynamic structures on all scales. This is the most beautiful electron micrograph of a cell that I have ever seen, a rat liver cell magnified 82 000 times by Dr. Ludwig Edelmann of Saarland University, Homburg, Germany, using excruciatingly slow freeze-sublimation without harsh solvent treatment, in order to capture and preserve the cell in its most life-like state [4, 5].

You can see numerous compartments, membrane stacks and organelles, each with its own 'steady states' of processes that can respond directly to 'external' stimuli and relay signals to other compartments. In the nested structure of the organism, the environment of a small compartment is enclosed within a larger one, which is in turn enclosed by yet a more inclusive domain, and so on. And within the smallest compartment, 'microdomains' with no obvious boundaries can be separately energized to give local circuits; and complexes of two or more molecules can function as 'molecular machines' that can cycle autonomously without immediate reference to its surroundings. The organised heterogeneity is crucial to why organisms are so good at storing and mobilising coherent energy.

Thermodynamics of organised complexity

The key to understanding the thermodynamics of organisms is not energy flow or energy dissipation, but energy storage under energy flow [6].

Energy flow is of no consequence unless the energy is trapped within the system where it circulates, to do work *and to build up structures for storing the energy* before it is dissipated

An organism arises when the loop of circulating energy closes on itself to give a regenerating, reproducing life-cycle. Within the life-cycle, energy is mobilized, remaining largely stored, or *coherent*, as it is mobilized. The energy goes into complex cascades of coupled cyclic processes within the system before it dissipates to the outside. These cascades of cycles span the entire gamut of space-times from slow to fast, from local to global, that all together make up the life-cycle.

Think of the cycles as eddies forming in a pool off the main river stream. The more eddies there are, the more energy is stored, and the longer it takes for the energy to dissipate. The average residence time of energy is correlated with the organised complexity of the system, and is therefore a measure of it.

Coupled processes are familiar in biochemistry. Practically all thermodynamically uphill reactions - those requiring energy - are coupled to the thermodynamically downhill ones - those yielding energy. The ATP/ADP couple, ubiquitous to the living system, effectively turns all biosynthetic and other energy requiring uphill reactions downhill.

Another prominent way in which cycles appear in the living system is in the familiar spectrum of biological rhythms, with periods ranging from microseconds for work cycles of molecular machines to circadian and circa annual cycles of whole organisms and populations of organisms.

These cycles interlock to give the organism a complex, multidimensional, entangled space-time very far removed from the simple, linear Newtonian space and time of mechanical physics. Each cycle, when enlarged, will have a structure similar to the whole. This self-similar fraction structure is characteristic of living processes.

There are some suggestive observations that *all* biological rhythms may indeed be entangled or coupled and correlated. Geneticists have discovered that mutations in at least two genes of the fruitfly, *period* and *timeless*, which speed up, slow down or abolish circadian rhythm, also cause corresponding changes in the millisecond wing beat cycle of the male fly's love song. This correlation spans seven orders of magnitude of characteristic time scales, reflecting the full extent of coupled energy storage and mobilisation in the living system.

Energy storage and mobilisation is symmetrical

Because all the modes of activity are coupled together, energy input into any mode can be readily shared, or delocalised over all modes; and conversely, energy from all modes can become concentrated into any mode. Another way to express the same thing is that energy from any point can spread throughout the system, and can also become concentrated to any point from all over the system. Energy transfer is reciprocal and reversible.

As a result, the living system tends towards a dynamic balance as a whole. The simple equation $\Sigma \Delta S = 0$ inside the life cycle represents the overall internal balance and compensation of entropy so that the system's organisation is maintained, while the necessary dissipation and entropy are exported to the outside, as represented by $\Sigma \Delta S > 0$.

That's the abstract ideal. In practice, dissipation within the system goes to a minimum, not quite zero. The system does grow old, and eventually dies, but only slowly.

Thermodynamically speaking, *the living system consists of all cyclic processes with net entropy equal to zero coupled to dissipative processes the entropy of which is exported to the outside.*

Some consequences of the thermodynamic model of the organism

a. There is always energy available

The dynamic, energetic closure of the living system gives rise to a number of important consequences. First and foremost, it frees the organism from the immediate constraints of energy conservation – the first law – as well as the second law of thermodynamics. That is also the basis of the autonomy of organisms.

On account of the coherent energy stored, organisms are never simply at the mercy of their environments. Thanks to that, we don't have to eat constantly, leaving plenty of time for other useful, pleasurable activities, like conferences?

b. Intercommunication, not control

Because coherent energy is stored locally at every point, the organism is exquisitely sensitive to specific weak signals.

No part of the system has to be pushed or pulled into action, or be subjected to mechanistic regulation and control. Instead, coordinated action of all the parts depends on rapid *intercommunication* throughout the system. The organism is an excitable matrix filled with molecular machines, organised in cells and tissues, that are poised to respond specifically and disproportionately to weak signals, because large amounts of coherent energy are available everywhere to amplify the weak signals into macroscopic actions.

c. The organism has a full range of coherence times and coherence volumes

I have stressed that stored energy is coherent energy. As energy is stored over all space-times, the organism possesses a full range of coherence times and coherence volumes. In the ideal, it may be regarded as a special quantum coherent state with many, many modes of activity. We shall explore that possibility next.

The 'thermodynamics of organised complexity' I have just described is applicable to organisms as well as sustainable ecological and economic systems, as argued in more detail elsewhere [7].

Coherent excitations

Living organisms are packed densely with dielectric or dipolar molecules, and are rather like (semi) solid-state systems in which electric and viscoelastic forces constantly interact. Under those conditions, metabolic pumping may result in a build-up to collective modes of vibration, like laser action. That's essentially what solid-state physicist Herbert Fröhlich had proposed since the 1960s [8, 9].

Fröhlich thought that thermal energies arising from metabolism could be retained in the system by the excitation of giant dipolar molecules such as proteins, nucleic acids and cellular membranes that typically have an enormous electric field of 10^7 V/m across them. The excited molecules and structures vibrate at various characteristic frequencies depending on the interaction between displacement of electric charges and mechanical deformation of the molecular chains. This eventually builds up into collective modes of both electromechanical oscillations (phonons or sound waves) and electromagnetic radiations (photons) that extend over macroscopic distances within the organism and perhaps also outside the organism.

Electromagnetic radiation from coherent lattice vibrations in a solid-state semi-conductor has been experimentally demonstrated. The radiative mode arises because oscillating charges always emit electromagnetic waves. Fröhlich refers to all these collective modes of vibrations as 'coherent excitations'.

There are three kinds of coherent excitations. The first is a stable or metastable, highly polarized state where the separation between positive and negative charges is

maximum. This results from 'mode-softening' of interacting frequencies towards a collective frequency of zero.

The second is limit-cycle oscillation, a limit-cycle being a cycle with a stable orbit that neither becomes smaller nor bigger.

The third mode arises when the energy supply exceeds a certain threshold, and oscillations of much higher frequencies occur in many modes. Each collective 'mode' can be a band of frequencies, with varying spatial extents, as consistent with the space-time structure of the living system. Nevertheless, the frequencies are coupled together through a 'heat bath', so that random energy fed into any specific frequency can be communicated to other frequencies. One must remember that the 'heat bath' is no ordinary heat bath but a highly efficient medium for energy conservation and mobilization on account of its liquid crystalline structure.

Although Fröhlich based his theory on the solid-state and not the liquid crystalline state, I believe his general argument will apply even better in the liquid crystalline state. In liquid crystalline mesophases, all the dipoles and dielectrics will be aligned, so charge displacements can potentially grow macroscopically, by inter-molecular interactions both directly, and through resonance. At the same time, the 'plasticising' effects of biological water on proteins and other macromolecules will also amplify viscoelastic deformations. Macroscopically coherent oscillations, giant excitons and solitons may propagate throughout the liquid crystalline matrix.

Theoretical physicist Duffield, a student of Fröhlich, has proved that under the most general conditions of energy pumping, the Fröhlich state of coherent excitations is 'globally, asymptotically stable' [10]. That means the system will tend to evolve towards that state, and more over, stay in that state and return to it on being perturbed.

Thus, the living system has all the thermodynamic and other physical characteristics for the highest degree of coherence to arise, perhaps quantum coherence.

Could organisms be quantum coherent?

Let me summarise the arguments for answering in the affirmative so far.

First, coherence is directly observed in the living organism using an imaging technique based on detecting molecular order. Second, molecular machines are *quantum* machines, and quantum coherence is necessarily involved in their coordination. Third, the rapidity of long-range coordination in the living system is such as to rule out classical coherence due to classical phase transitions to coherent dynamic order. Fourth, thermodynamically, the living system is optimised for coherent energy storage over all space-times. Fifth, the nature of living matter – its dielectric properties and liquid crystallinity - predisposes the living system to coherent excitations as proposed by Fröhlich. Finally, theoretical considerations suggest that the coherent Fröhlich state is globally and asymptotically stable.

The organism is, in the ideal, a quantum superposition of coherent activities over all space-times, constituting a pure coherent state towards which the system tends to return on being perturbed.

Some consequences of the quantum coherent model of living organisms

a. The coherent sensitive whole

The organism is an exquisitely sensitive coherent whole.

Some years ago, we did an extensive series of experiments exposing fruitfly embryos for 30 minutes to static magnetic fields so weak that the energy is below the 'thermal threshold', and found dramatic transformations of the body pattern of the larva

hatching 24 hours later. The normal consecutive segments became helical. We also have some results suggesting that the quantum mechanical vector potential present in regions with essentially zero magnetic field can nonetheless produce those same changes. These results depend on quantum coherence and cannot be explained classically.

b. Quantum coherence and conscious experience

There has been a great deal written on whether 'consciousness' requires an explanation in terms of quantum theory ever since Roger Penrose suggested that might be the case [11]. One aspect that seems to have been missed is that quantum coherence is a pre-requisite for conscious experience [12].

Schrödinger invited us to think of the "I" that each of us experiences of our own being, the person "who controls the 'motion of the atoms'" in our body [13]. This consciousness is "never experienced in the plural, only in the singular".

c. The "quantum jazz" of life

Perhaps the most paradoxical property of the quantum coherent living system is that both local freedom and global correlation are maximum. This is the consequence of the factorizability of the quantum coherent state – the correlations between the parts are so perfect that they factorise or decomposes neatly into the self-correlations – so the parts behave as though independent of one another. Coherence in the living system does not mean uniformity, quite the opposite: compartments, micro-compartments and micro-domains, right down to molecular machines, all working autonomously, doing different things at different rates, generating flow patterns and cycles of different spatial extensions, yet all coupled together, in step with one another and hence, with the whole organism. I have referred to this hive of coordinated yet autonomous living activities as the "quantum jazz" of life [14]

d. Organic space-time distinct from Newtonian space-time

Organic space-time is big subject to which I have devoted an entire Chapter in *The Rainbow and the Worm*, and elsewhere [15]. Newtonian space and time are linear, infinitely divisible, and independent of real processes. In contrast, organic space-time is non-linear, heterogeneous, multi-dimensional and mutually entangled, being *created* by real processes.

I also considered the possibility that space-time, being tied to organic processes, may have a fractal structure like organic processes.

e. Nonlocality in organic space-time

Coherence is associated with a time and a volume over which phase correlation is maintained. A coherent space-time structure theoretically enables 'instantaneous' correlations over a range of time scales and spatial extents. For, within the coherence time there is no volume separation, just as within the coherence volume there is no time separation. Thus, nonlocal correlations may be a fact of life.

f. Time and entropy

As coherent energy is stored over a range of space-times, the organism can be regarded as a totality of coherent activities in the ideal. Coherent activities generate no space-time or entropy. Thus, one comes to the startling conclusion that space-time may be generated by the incoherence of action. Time and entropy turns out to have the same cause and direction. All the more reason to act coherently that one may fend off entropic decay for another day.

Biological water and liquid crystallinity

I want to go back to the rainbow worm to show how the water associated with its liquid crystalline matrix – 70% by weight and 99% by number of molecules – plays a major role in biocommunication and biological function [16].

We have done the optics and physics for a software package based on the imaging technique for measuring the alignment and birefringence of various liquid crystalline material, such as the skin here, also tendon, cartilage, or *in vitro* self assemblies of collagen fibres. Zhou Yuming, my ex-graduate student has derived equations to show that the brightness of the colours is approximately linearly dependent on the birefringence of the liquid crystalline phase and its degree of coherent alignment [17]. He has used the imaging technique to do experiments, which showed that the water associated with collagen is part and parcel of the intrinsic birefringence, or, as I would say, its liquid crystallinity.

This is in line with many investigations on the hydration of proteins and cell water. For example, in dielectric relaxation measurements, the sample is subjected to alternating electric fields of different frequencies. As the frequency of the applied field increases, the dipole moments of the molecules are unable to orient fast enough to keep up alignment with the applied electric field and the total polarization falls. This fall, with its related reduction of permittivity and energy absorption, is referred to as dielectric relaxation or dispersion. A complex permittivity ε^* describes the dielectric relaxation, the real part of which, ε' represents the permittivity of the medium and the imaginary component ε'' is the loss of the medium [18].

The frequency-dependent dielectric constant of the combined protein-water system can be written as a sum of four dispersion terms for the protein, bound water, free water and bulk water respectively [19]. The dielectric relaxation time for bulk water is about 8.3ps, for free water, 40ps, and for bound water 10 ns, compared to the typical protein myoglobin, which is 74ns.

There are many other studies using nmr, neutron diffraction and X-ray diffraction on water around proteins and in the cell which broadly support this picture.

Probing biological water of collagen with delayed luminescence

We wanted to see if more information on the populations of biological water could be obtained by measuring delayed luminescence in freshly prepared bovine Achilles tendon, which has a very elaborate fractal structure of microfibrils, subfibrils, fibrils, fibres, and fibre-bundles.

Delayed luminescence (DL) refers to the re-emission of ultraweak intensity light with delay time of milliseconds to minutes from all living organisms and cells on being stimulated with light [20].

Where does DL come from? The closest analogy is in solid-state systems that can be excited by light to decay radiatively back to the ground state over long time scales. The excitation is delocalized over the whole system, and cannot be assigned to specific 'chromophores'. DL from living cells and organisms typically covers a broad spectrum of frequencies, indicating the excitation of a collective of many coupled modes, all of which remarkably, decay hyperbolically back to the 'ground', according to the hyperbolic decay equation [21],

$$I(t) = I_0 / (1 + t/t_0)^m$$

where the parameters I_0 , t_0 and m, are fitted using a non-linear least squares procedure. These parameters are very sensitive to the physiological states of the cell or organism, and have been used successfully to assess food quality, for example. We were quite surprised to

find that these parameters are also sensitive to the degree of hydration of the tendon [22, 23].

A slight transformation of the data to give plots of relative number of excited states *Rn* and relative probability of radiative decay, *Rp*, showed up this multiple phase transition even better. State 1, fully hydrated, has greater than 1.5g/g hydration, is characterized by low *Rn* and *Rp*; state 2, between 1.52g/g to about 0.53g/g is characterized by such low levels of DL that it is not possible to calculate either *Rp* or *Rn* reliably; state 3, between 0.53g/g and 0.26g/g, is characterized by the highest *Rp* level while *Rn* levels remain almost as low as state 1; and finally, state 4, less than 0.26g/g, has a broad range of high *Rn* values as well as a high *Rp*. The transitions between different states are apparently abrupt.

Cell biologists have recently discovered an interesting nonlinear optical phenomenon in collagen fibres, which enables the extracellular matrix and other collagenous material to be imaged without a fluorescent probe under the multiphoton fluorescence microscope [24]. Collagen, on absorbing simultaneously two low energy photons, generates second harmonic, frequency-doubled uv light, which stimulates it to fluoresce. We do not know whether the DL measured in bovine Achilles tendon is related to fluorescence, as we have been using an uv pulse laser (duration ≈ 5ns, λ= 337.1 nm), to stimulate DL.

One mechanism suggested for DL is the formation and subsequent radiative decay of excited Davydov [25] solitons [26], which may be especially applicable to collagen. Optical solitons, induced in collagen, could act as waveguides giving rise to other nonlinear effects such as second harmonic generation. Salguerio *et al* [27] have described a mechanism for generating second harmonic wave in a vortex soliton waveguide.
It is clear that collagen liquid crystal mesophases have very exciting properties that could be responsible for ultrafast intercommunication within the body.

Water of hydration supports jump conduction of protons

There have been many suggestions that interfacial water adsorbed onto the surface of proteins and membranes could support a special kind of jump conduction of protons [28]. Sasaki [29] measured the dielectric dispersion of bovine Achilles tendon at several hydrations levels below 0.3 g water/g protein over the frequency range of 30 Hz to 100kHz. He found both the dielectric constant and conductivity increasing strongly with water content. There was a power-law relationship between conductivity σ and water content ϕ of the form,

$$\sigma(\phi) = X\phi^{Y}$$

where *Y*, the power of ϕ, is between 5.1 and 5.4, independent of the frequency of the electric field, and is thought to be related to the distance between ion-generating sites.

Proton-neural network

I have described some of the findings suggesting that the main function of the liquid crystalline matrix in the body is to facilitate rapid intercommunication that makes organisms so perfectly coordinated, even organisms as large as whales or elephants. A major part of this intercommunication is associated with the biological water, of which proton currents are the best understood, although other nonlinear optical and phonon effects such as solitons may also be important.

Welch and Berry [30] suggested that a ‘proton-neural network’ is involved in regulating enzyme reactions within the cell, reactions that are predominantly of a redox nature. Proton currents may well flow throughout the extracellular matrix, and linked into

the interior of every single cell through proton channels. Proton currents could flow from the most local level within the cell to the most global level of the entire organism.

Structural studies carried out on proton pumps such as bacteriorhodopsin and cytochrome oxidase within the past ten years show that they typically form a channel through the cell membrane which is threaded by a chain of hydrogen-bonded water molecules from one side of the membrane to the other. There is now evidence that protons can flow directly along the membrane within the interfacial water layer, from proton pump to ATP synthase, both of which are embedded in the membranes [28].

And the chain of water threading through carbon nanotubes could act as a "proton-wire", with many interesting applications [31].

Collagen in connective tissues has a special role to play in coordinating the activities of each and every cell throughout the body. Giant collagen fibres and especially their associated biological water may be jump-conducting cables linking distant sites with one another.

Ho and Knight [32] proposed that the system of ramifying water channels along aligned collagen fibres might be the basis of the acupuncture meridian system of Traditional Chinese Medicine.

Polarised multilayers of cell water

Finally, I want to draw your attention to Gilbert Ling's work, which dominated the Gordon Research Conference on Interfacial Water and Cell Biology in June this year. He proposed back in 1962 that virtually all of the water in a living cell is bound in polarized layers on an extended protein matrix [33], not unlike the liquid crystalline matrix that I have been talking about here.

Ling's theory went so much against the usual (largely mistaken) understanding of the cell as a membrane-bound bag of predominantly folded-up proteins randomly dissolved in the cell water that it is still not generally accepted today. But recent studies on interfacial water on hydrophilic surfaces have shown that Ling may be largely correct. Here is a diagram of interfacial water layers formed on a carefully prepared hydrophilic surface from a paper in *Science* [34].

These polarized layers of water on the interface are ordered and have very special physicochemical properties, including the ability to exclude large solutes, or solutes with large hydration shells. No one knows how far out from the surface these ordered layers of water go. Some say one layer, others say 5 or 6, and still others say ten or more.

But here are some remarkable findings from the laboratory of muscle biochemist, Gerald Pollack. He and his colleagues [35] show that water forms large exclusion zones next to hydrophilic surfaces. Microspheres 0.5 to 2 microns in diameter are excluded 50 to hundreds of microns away from the hydrophilic surfaces of gels and a muscle fibre. That implies millions of layers of water. If these results are to be taken on board, then certainly, the 5 or 6 layers of water over protein surfaces in the cell must all be special. This is reported in the current issue of *Science in Society* [37].

Another way this interfacial water is special is that it enables proteins to undergo abrupt phase transitions that could potentially explain much, if not all of protein function and even changes in cell states that determine whether it is going to divide or not.

ATP is required for all energy transactions in the cell, but no one understands really how it works, except to invoke conformational changes on binding and unbinding. Ling says it's all got to do with changing the electronic state of the protein matrix. ATP is electron withdrawing, so on binding to some special site on the protein, it induces electrons to be withdrawn, thereby breaking open the hydrogen bonds in the protein backbone that give rise to alpha helices and beta-pleated sheets, so the protein becomes fully extended

and its backbone available for interacting with the polarised multi-layers of water. At the same time, this enables the protein to selectively bind small hydrated ions, such as K^+ over the large Na^+, which explains why the cell excludes Na^+ in the first place. It is the protoplasm of polarised multi-layers of water associated with the protein matrix that accounts for the preference of K over Na inside the cell, and has nothing to do with the cell membrane.

Now, there are also electron-donating ligands that could bind to extended proteins to donate electrons to the proteins, favouring intra-chain H-bonds, and making proteins fold up. These abrupt phase transitions at different levels underlie so-called signal transduction in the cell.

Thus, changes in electronic polarisations in proteins and the associated cell water are what animate the cell.

Conclusion

In conclusion, the organism is a coherent sensitive whole, with correlated electronic and electrodynamic activities over every scale, from the very local action of individual enzyme molecules to the entire organism, all powered by the 70% of biological water associated with the living crystalline matrix.

Now look at what the animated cell is really like. Ludwig Edelmann too, was inspired by Gilbert Ling to seek perfection in life and to show the world what life is really like. And here is my own attempt to show you what life is really like.

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