em-Hormesis

or

ultra-weak electromagnetic* hormesis as the baseline of Gurwitch's work

Contribution for the

XIII Sess. on Endogenous Biophotonics –

Ultraweak Luminescence of Biological Systems III

by

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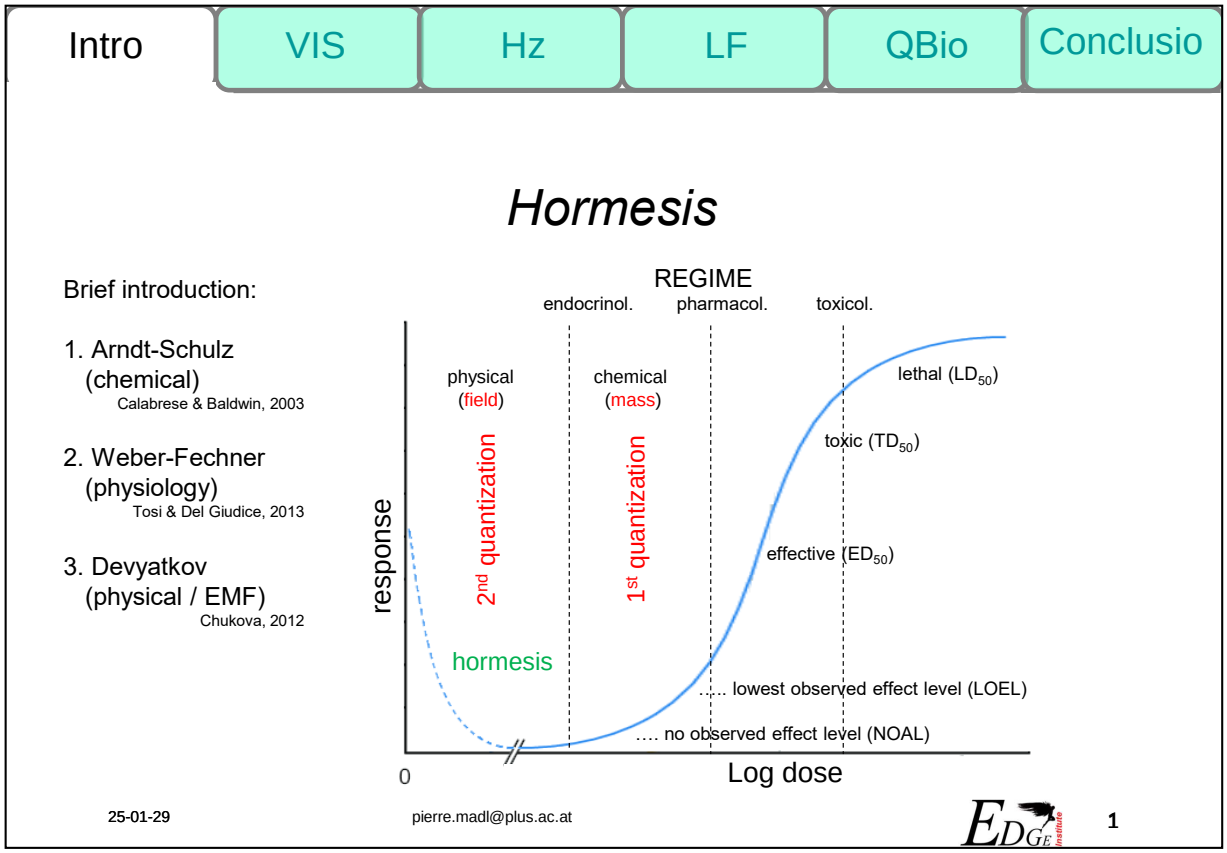
URL: edge-institute.org/talk/Saratov'24.pdf

v.2024.1

Image: Beloussov LV, Opitz JM, Gilbert SF (1997) Life of Alexander G. Gurwitsch and his relevant contribution to the theory of morphogenetic fields. Int. J Dev Biol, 41:77-779. DOI:10.1387/IJDB.9449452



Hormesis is a biological phenomenon where a beneficial effect results from exposure to low doses of an agent that is otherwise toxic or harmful at higher doses. Features of Hormesis include:[1]

1. Biphasic Dose-Response Curve:

- **Low Dose**: At low doses, the agent induces a positive response, enhancing cellular and organismal functions. This might include improved growth, stress resistance, and longevity.
- **High Dose**: At higher doses, the same agent becomes detrimental, leading to negative effects such as toxicity, cell damage, or even death.

2. Examples of Hormetic Agents:

- **Physics**: Low doses of radiation can stimulate DNA repair mechanisms and other protective responses in cells, whereas high doses can cause cancer and other serious health issues.
- **Chemicals**: Certain toxins or drugs, like ethanol or resveratrol, can have beneficial effects at low doses, such as promoting cardiovascular health, but are harmful at higher concentrations.
- **Exercise**: Physical exercise induces a hormetic response; moderate exercise improves overall health and fitness, while excessive exercise can lead to injury and physiological stress.

3. Mechanisms of Hormesis:

- **Stress Response Activation**: Low doses of stressors activate adaptive stress response pathways, such as heat shock proteins, antioxidant enzymes, and DNA repair enzymes.
- **Cellular & Molecular Adaptation**: Cells adapt to low-level stress by enhancing their defense mechanisms, improving resilience against subsequent higher levels of stress.
- **Metabolic & Immune Modulation**: Hormetic agents can modulate metabolic pathways and immune function, contributing to enhanced health and disease resistance.

4. Applications of Hormesis:

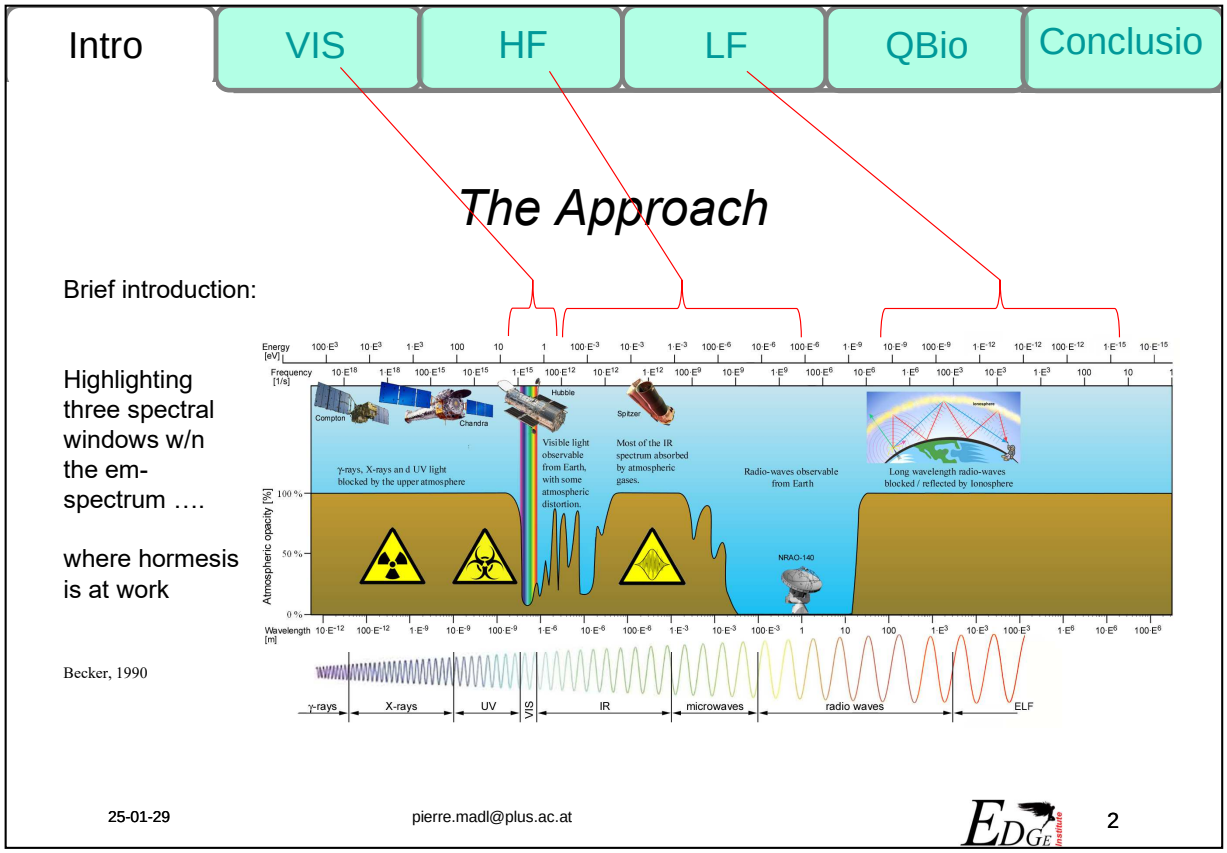
- **Medicine & Pharmacology**: Understanding hormesis can aid in drug development, where low doses of certain drugs might be used to elicit therapeutic effects without adverse side effects.
- **Toxicology & Risk Assessment**: Hormesis challenges traditional views on dose-response relationships and can influence guidelines for exposure limits to various chemicals and environmental agents.
- **Aging & Longevity Research**: Hormesis is a key concept in aging research, suggesting that mild stress can promote longevity and healthy aging by activating maintenance and repair mechanisms.

Source: [1] adapted and modified version of ChatGPT4 (2024). https://chatgpt.com/

[2] Calabrese, E. J., & Baldwin, L. A. (2003). *HORMESIS: The Dose-Response Revolution. Annual Review of Pharmacology and Toxicology, 43(1), 175–197.* doi:10.1146/annurev.pharmtox.43.1

[3] Topsi M, Del Giudice E (2013) The Principle of Minimal Stimulus in the Dynamics of the Living Organism. ISIS, 59: 1-9 https://www.i-sis.org.uk/principle_of_minimal_stimulus.php

[4] Chukova Y (2012) Fundamental Laws of Efficiency of Isothermal Processes under Ionising and Non-Ionising Electromagnetic Radiation. In Proceedings of the First International Conference on Radiation and Dosimetry in Various Fields of Research, Nis, Serbia, 25–27 April 2012. ISBN 978-86-6125-062-0. https://www.rad-conference.org/Proceedings-RAD_2012.pdf



Our use of energy for power and communications has radically changed the total electromagnetic field of the Earth. Because we cannot directly perceive this with any of our senses, most of us are unaware that it has occurred. Before 1900, the Earth's electromagnetic field was composed simply of the field and its associated micro-pulsations, visible light, and random discharges of lightning
The shaded area provide an indication of the em-region (shielding radiation of cosmic origin) where most of biologic em-activity evolved. Highlighted are three windows with documented biogenic em-activity that will be addressed during this talk. Since the 1900s, these “shaded” windows are however increasingly flooded with manmade em-sources. In fact, today, we swim in a “sea” of artificial em-energy and as such are permanently exposed to these frequencies.

Image: The spectrum of the Earth's natural electromagnetic environment Only the major contributors are listed. There are very small amounts of other frequencies from extraterrestrial sources, and all ionizing radiation higher in frequency than light has been omitted. The horizontal line represents frequency, increasing from zero at left; the numerical listings below the horizontal line refer to cycles per second (Hz). The micro-pulsation frequencies range from 0 to about 30 Hz. Lightning flashes produce fields in the frequency range of 10-20 kHz …. Visible light is a narrow band in the trillions of Hz. Between each of these normal fields are large blocks of the spectrum that are essentially empty of any electromagnetic frequencies.[1]

Source: [1] Becker RO (1990) Cross Currents - The Promise of Electromedicine The Perils of Electropollution, Tarcher Inc. LA (USA)

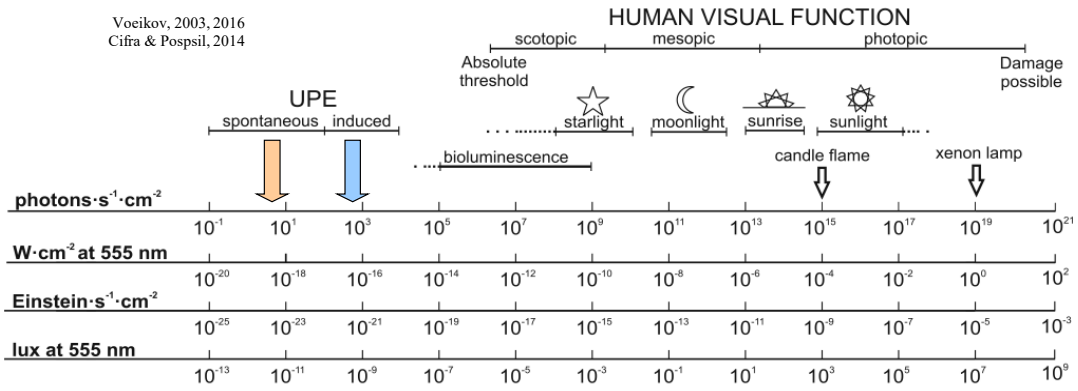
Hormetic effects in the VIS range

Water sample taken from the *Johannisbrunnen*, Styria (AT)
Spring water used as a type of spa for healing purposes to relieve digestive problems (rich in Mg^{2+}/Ca^{2+}); now bottled and sold as mineral water;
magnification: 200x darkfield

Source: Schroecker G (2017) Wasser lebt (Living Water) – see acknowledgement

VISible-Range ….

Low dose bio-effects of
UPE w/n VIS range



25-01-29 pierre.madl@plus.ac.at 4

Gurwitsch's MGR is considered to be a particular case of BP-emission. However, BP-research is based mainly on registration of photons using photomultipliers, while MGR was registered due to its specific ability to induce cell mitosis. induced with glycine solution irradiation with MGR.[1] …. *Popp* showed that at least the so-called delayed luminescence induced by irradiation of living organisms with a flash of light results from the relaxation of an intrinsic coherent electromagnetic field.[1] He demonstrated that UwPE originates from a delocalized coherent electromagnetic field that is tightly coupled to metabolic processes.[2]
.... “Biophotonic-like fields" may emerge even in initially very "plain" systems, such as aqueous solutions of simple organic molecules under soft but specified conditions which imply the development of oxidative chain reactions with delayed branching in aqueous milieu …. Aqueous systems, as shown by *Gurwitsch* gain ability to emit “BPs" - electromagnetic radiation of very low intensity, in a very wide spectral range, and possessing specific orderliness.[1]

Image: Radiometric and photometric units comparing ultra-weak photon emission intensity with that of common light phenomena. First three axis (photon flux [photons $s^{-1}\cdot cm^{-2}$, radiant flux [$W\cdot cm^{-2}$], photon flux or irradiance in Einsteins ([mol of photons $s^{-1}\cdot cm^{-2}$) are radiometric units which are easily interconvertible from one to another. Inter-radiometric conversion is as follows: number of photons $s^{-1}\cdot cm^{-2}$= [$W\cdot cm^{-2}$] x $h\cdot c\cdot\lambda^{-1}$ = einstein. $6.022\cdot E^{23}$ $s^{-1}\cdot cm^{-2}$. [$W\cdot cm^{-2}$] at 555 nm relates to the calculated number of photons as if the spectrum would have a λ = 555 nm. Lux is a photometric unit of illuminance, related to sensitivity of human eyes (thus VIS-spectrum only) and varies strongly with wavelength. Under approximation that all incoming photons would have λ = 555 nm, one can use conversion number of photons $s^{-1}\cdot cm^{-2} = 2.45\cdot E^{12}$ lux.[3]

Source: [1] Voeikov V (2003) Mitogenetic radiation, biophotons and non-linear oxidative processes in aqueous media. In: Popp FA, Beloussov LV (eds) Integrative Biophysics - Biophotonics, Springer, Heidelberg, FRG.
[2] Voeikov V (2016) Biophotons – Studies performed on the sanguine system. Congress on quantum biology and medicine, Piacenza; http://www.spaziotesla.it/primo-piano/356-iv-congresso-di-medicina-e-fisica-quantistica-citta-di-piacenza.html
[3] Cifra M, Pospsil P. (2014) Ultra-weak photon emission from biological samples: Definition, mechanisms, properties, detection and applications. J Photochem Photobiol B. Vol. XX pii: S1011-1344(14)00046-3. doi: 10.1016/j.jphotobiol.2014.02.009.

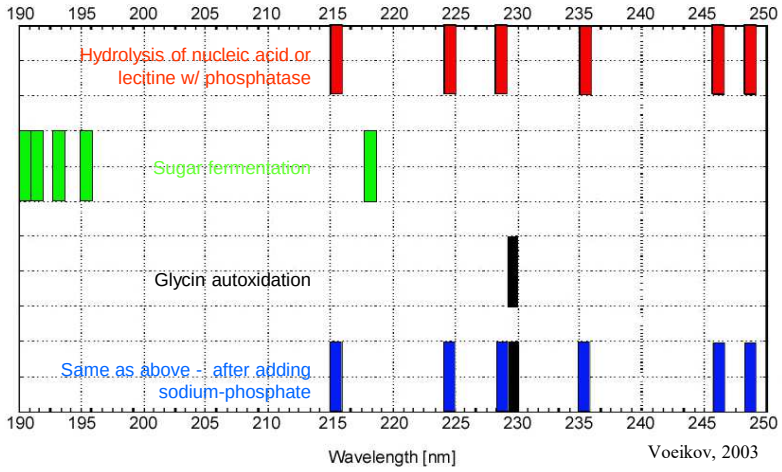
…. & UV-Range ….

Contrasting the dominant view - MGR is ….

- traceable w/n UV_c (!)*
  - UV_A 380–315 nm
  - UV_B 315–280 nm
  - UV_C 280–100 nm
- hormetic evidence

Voeikov, 1999, 2003, 2016
Voeikov & Beloussov, 2007

(*) exposure to solar radiation in that range is considered harmful



Spontaneous MGR accompanied not only by some biochemical reactions (in biota) but also physical processes going on in aqueous systems (abiotic). These can by hydrolysis, glycolysis, sol-gel transitions in aqueous solutions and RedOx-reactions in aqueous systems. Stimulated MGR (Dlelayed luminescence) is used to "charge" a biological specimen, thereby identifying the decay peculiar properties. Necessary conditions for MGR to emerge: essential ingredients: water, oxygen (is a crucial precondition) & embedded EMR (UV-VIS-IR). [1]

Image: MGR spectra represented sets of spectral bands; some of them were as narrow as 1 nm wide. Sets of bands from different emitters differ very much in the number of lines, their width and position (Image).[2] Cell divisions could be induced by any photons in the region between 190 and 280 nm in the darkness and up to 326 nm if the detector cell population was illuminated by even a dim visible light. MGR spectra from various sources looked as sets of distinct bands. The latter varied in width from 25 to 0.5 nm. Each individual source of MGR produced a spectrum with the unique set of bands.[3] In the course of embryonic development, the intensity of spontaneous radiation decreases, while that of mitogenetic-laser significantly increases. That means, first, that during the development of the interconnectedness of the newly emerging parts of the system, its overall coherency increases, so that its energy losses as a result of radiation emission decrease. Second, the developmental process includes saturation of the system with the most "expensive" energy – the energy of electron excited states.[4]

[1] Voeikov V (2016) Biophotons – Studies performed on the sanguine system. Congress on quantum biology and medicine, Piacenza; http://www.spaziotesla.it/primo-piano/356-iv-congresso-di-medicina-e-fisica-quantistica-citta-di-piacenza.html
[2] Voeikov V (2003) Mitogenetic radiation, biophotons and non-linear oxidative processes in aqueous media. In: Popp FA, Beloussov LV (eds) Integrative Biophysics - Biophotonics, Springer, Heidelberg, FRG.
[3] Voeikov VL Beloussov LV (2007) From Mitogenetic Rays to Biophotons. In: Beloussov L., Voeikov V, Martiniuk V. (eds), Biophotonics and Coherent Systems in Biology. Springer, Heidelberg, FRG.
[4] Voeikov VL (1999) The Scientific Basis Of the New Biological Paradigm", 21st Century Sci & Tech. Vol.12(2): 18-33.

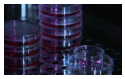
…. & UV-VIS-Range ….

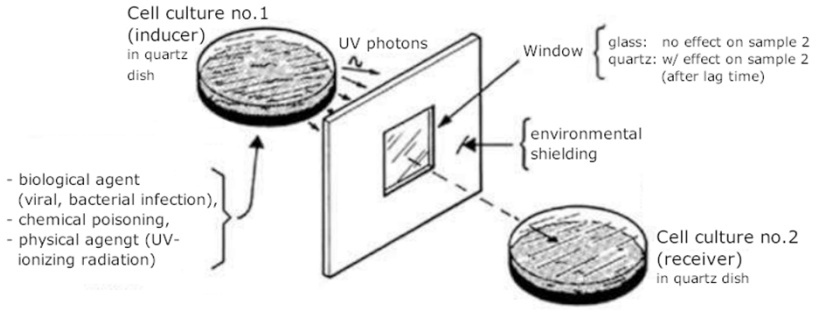
UV-test set

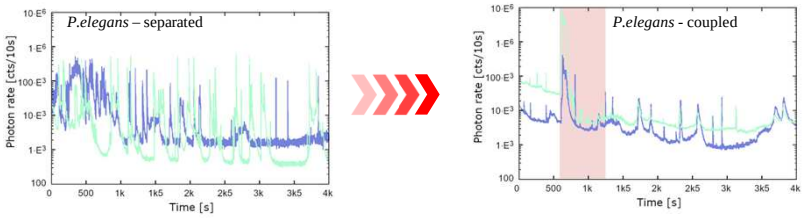
Cell-cell communication

Kaznacheyev et al , 1976;
VanWijk et al., 1999
Zhang et al., 1995

Relevant in: polycarbonate dish cultures (incubation) / blood bank / parabiosis
→ challenge for cell culture studies !







25-01-29

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6

Any perturbation induced at the genomic level (by biological, chemical, or physical agents) will direct the stress-induced biophotons via the cytoskeleton to the membrane, where they can pass through the extracellular matrix and, if the stimulus is strong enough, inform neighbouring cells of the adverse impact. Since the dipolar properties of the membrane are affected by UwPE, membrane potential is likewise altered, which can be easily monitored using the DL approach (DL, induced photo-stimulation at selected wavelengths with subsequent measurement of the delayed luminescence). In the same way, it is possible to determine the dynamics of the cytoskeletal in autotrophic algae.[2]

Image-Top: Two groups of cells from the same batch were separated by a physical barrier (either glass or quartz). Upon exposure of sample-1 to a toxic agent, the intercellular cascade of ROS production generates UwPE spikes. If the window is made of quartz, the flush of UwPEs is perceived by the untreated sample-2, which, after a certain time lag, showed signs of stress and started to induce apoptosis. If the window however is just standard glass (opaque to UV), sample-2 remains unaffected. [1]

Image-Bottom: Photon emission from two *P. elegans* populations. The abscissa displays the running time, the ordinate shows the photon intensity (cps). Note the uncorrelated photon emission from samples (a) and (b) in the left column (shutter closed). While there is an almost perfect synchronization of the flashes from (c) and (d) occurs when the shutter is opened. In that case, only Sample (c) is exposed to electrical filed stimulation of 500 V/m during the time slot shaded in red.[3]

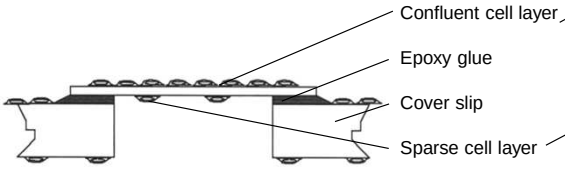
Source: [1] Kaznacheyev et al (1976) Distant intercellular interactions in a system of two tissue cultures. Psychoenerg Syst. 1(3): 141-142
[2] Van Wijk R, Scordino A, Triglia A, Musumeci F (1999) Simultaneous measurements of Delayed luminescence and chloroplast organization in Acetabularia acetabulum. J Photochem.Photobiol B Biol 49:142–149. doi: 10. 1016/S1011-1344(99)00048-2
[3] Zhang JZ, Popp FA, Yu WD (1995) Research on cell communication of P. elegans by means of photon emission. Chinese Science Bulletin, 40(1): 76-79. doi: 10.1360/sb1995-40-1-76

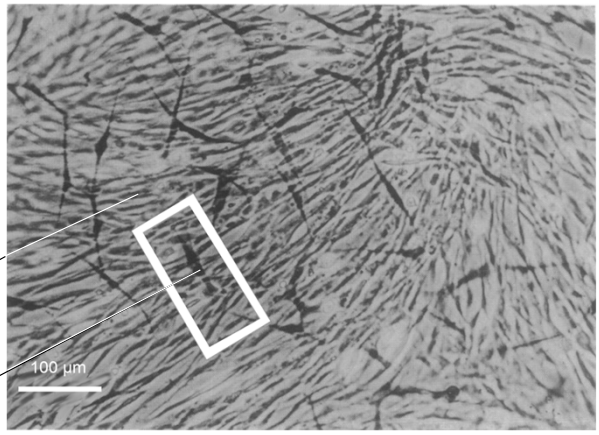
…. & NIR-Range

NIR sensitivity of cells grown in darkness

Rudimentary form of cellular vision – demonstrated with BHK cells on either side;
→ Confluent layer (gray) affects growth of BHK cells
→ predominate orientation of sparse cells is orthogonal to confluent cell layer

Albrecht-Buehler, 1982;





Cells seem to approach distant infrared light sources (because they mistook them for other cells). To test this possibility, BHK cells were plated on opposite faces of thin glass films. Cells were plated densely (confluent layer) on one face ("c-face") of the glass film and were allowed to form their typical patterns of whorls. Two days later cells were plated sparsely on the opposite face ("s-face") and were kept in total darkness in a culture incubator for 7hr while they attached and spread. The cells of the second inoculum did not spread randomly but predominantly oriented themselves orthogonally with respect to the cells directly opposed on the other face of the glass film …. Since the effect was not influenced by a thin coat of silicone on the glass, suggesting that the wavelength of this radiation is likely to be in the red to infrared range (800-900nm). The ability of cells to detect the direction of others by electromagnetic signals points to a rudimentary form of cellular "vision."

Image: Regular test substrate (sketch) used in this study revealed that after 7hr incubation of sparsely plated BHK cells on the lower side made evident that the orientation of the cells on the lower face (fat cells) and the direction of the cells on the confluent upper face are orthogonally placed (thin cells). The predominant orientation of BHK cells on the lower face (sparse, darkly stained cells) traverses the local direction of whorls of BHK cells on the confluent face (unstained, dense layer of cells) seen in phase-contrast. One of the examples of a cell traversing the local direction of the cells on the other face of the glass film is surrounded by a white frame.

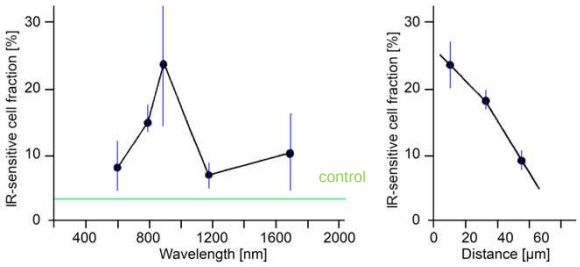
Source: [1] Albrecht-Buehler G (1992) Rudimentary form of cellular "vision". PNAS, 89(17):8288-92. doi: 10.1073/pnas.89.17.8288

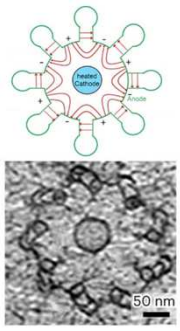
…. & NIR-Range cont'd

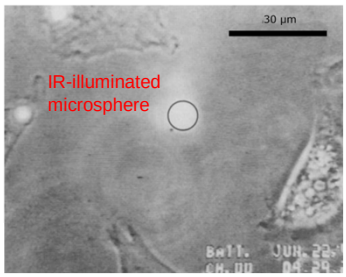
NIR sensitivity of cells grown in darkness

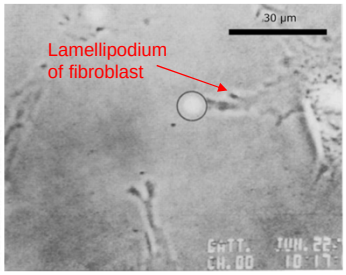
Rudimentary form of cellular vision (using 3T3 mouse fibroblasts);
→ most responsive to 800-900 nm
→ sensitivity: 2k5 photons/s @ 900 nm (induced)
→ IR-sensitive entity: centriole (≈ magnetron) !

Albrecht-Buehler, 1991, 1985
Li et al., 2023









25-01-29 pierre.madl@plus.ac.at 8

The use of a IR-spot illuminator integrated within a phase–contrast microscope revealed that 25 % of 3T3 fibroblast cells extended pseudopodia towards the microscopic IR-light sources nearby. Offering a pair of such a light source increased the fraction of positive cell responses to 47 %. The strongest responses were observed at in an 800-900 nm window with an illumination frequency of 30-60 pulses per min.
At an average distance of 35 µm from a particle that scatters infrared light of 900 nm wavelength with an intensity I. = 0.5 µW/cm^2 the centriole would receive the infrared energy of E = 5 x 10^{-16}, which corresponds to ~2,500 photons/s for that wavelength. Considering that retinal cells have been shown to detect single photons of visible light, it appears that our speculation about the role of centrioles in the localization of infrared light sources is at least compatible with the results reported here.

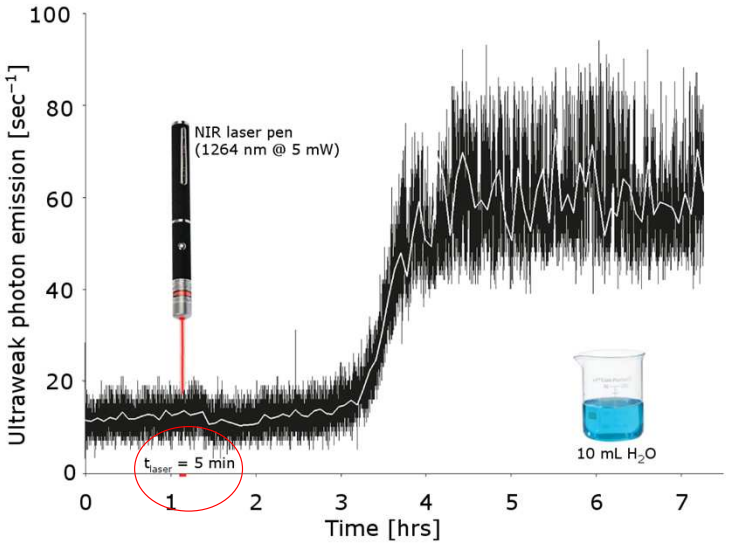
Image: Percentages of cells extending lamellipodia along their tail in response to infrared irradiation of the base of the tail as a function of wavelengths (left); Distance-response curve for cells extending towards infrared light-scattering particles at wave- lengths between 800 and 900 nm regardless of pulse frequency and shape (right).
Phase contrast images: Extension of a separate lamellipodium (arrow) towards a latex particle that scattered IR light of 800 nm wavelength for 50 min. The irradiated particle is marked with a circle. The glare in the left hand panel is the result of automatic video gain control during the "on» phase of the spot irradiator.
As postulated by Albrecht-Buehler, the centriole acts as an NIR-transducer, possessing all the necessary features to act as a waveguide in order to coordinate em-properties within the cytosole.[2] Cross-sectional view of human centriole.[3] It very much resembles a technical analogon called magnetron (a microwave generating device).[4]

Source: [1] Albrecht-Buehler G (1991) Surface extensions of 3T3 cells towards distant infrared light sources. J Cell Biol. 114(3): 493-502. doi: 10.1083/jcb.114.3.493
[2] Albrecht-Buehler G (1985) Is Cytoplasm Intelligent Too? In: Shay JW (ed) Cell and Muscle Motility. Springer, Boston (MA). doi: 10.1007/978-1-4757-4723-2_1
[3] Li S, Wang Z, Jia X, Niu T, Zhang J, Yin G, Zhang X, Zhu Y, Ji G, Sun F (2023) ELI trifocal microscope: a precise system to prepare target cryo-lamellae for in situ cryo-ET study. Nat Methods 20(2):276-283. doi: 10.1038/s41592-022-01748-0
[4] Magnetron - how does it work: https://youtu.be/bUsS5KUMLvw

…. & NIR-Range cont'd

Even water can be a source of uw-photon emissions

1. Brief charging of water sample (5 min) via low power (5 mW) NIR
   Gudkov et al., 2011
2. triggered by dissolved singlet oxygen
   Gudkov et al., 2011
3. maintained by the *Branching Chain Reaction* of water
   Voeikov, 2001, 2003

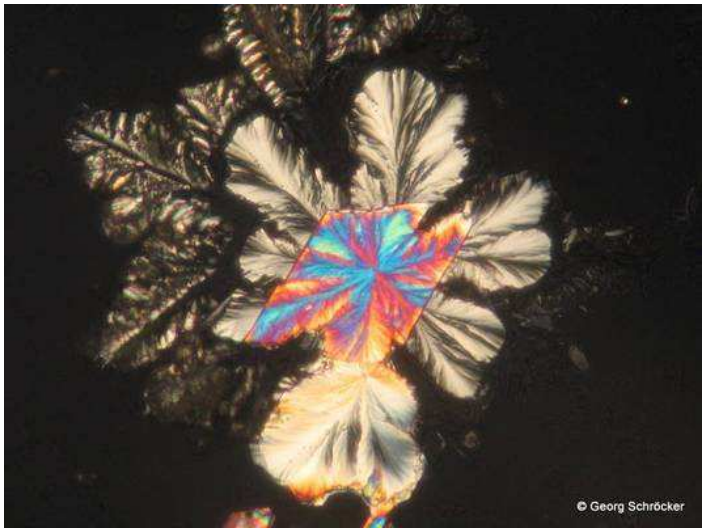


Each water molecule participating in the coherent dynamics is endowed with an electron that spends about 10% of its time at the 5d energy level, 12.07 eV above the sp^3 hybrid orbital (ignoring collective storable electron excitations). This level is at most 0.53 eV below the ionization threshold (I_{th}), which for water is 12.60 eV. Thus, we can say that there are 0.10 quasi-free electrons per coherent molecule. In a CD there are about seven million molecules, yielding about $0.6 \div 0.9 \times 10^6$ quasi-free electrons per CD …. The extracted electron on the other hand could be captured by an oxygen molecule dissolved in water, creating a negative ion. The resulting ion pair, eventually leads to the formation of a proton and reactive oxygen species such as a hydroxyl. Thus, the CD is an electron donor and then a chemical reducer, which, together with the non-coherent moiety, forms a "redox pile". In short, CDs are a prime driver of the branching chain reaction (BCR) of water [1,2]. A remarkable example for this reaction mechanism is an experiment where a water sample is stimulated by a NIR laser to a pump reaction which leads to an electromagnetic radiation in the blue-light range.[2]

Image: Laser-induced chain reaction in water. A 5 min exposure of air-saturated bidistilled water to low-intensity laser (5 mW) infrared radiation (with 1264 nm) induces, after a long latent period, luminescence in the blue-green region that last many hours. The pumping activity is triggered as the laser wavelength corresponding to the wavelength of the electronic transition of dissolved oxygen inducing a transition from the triplet state into the singlet state.[3]

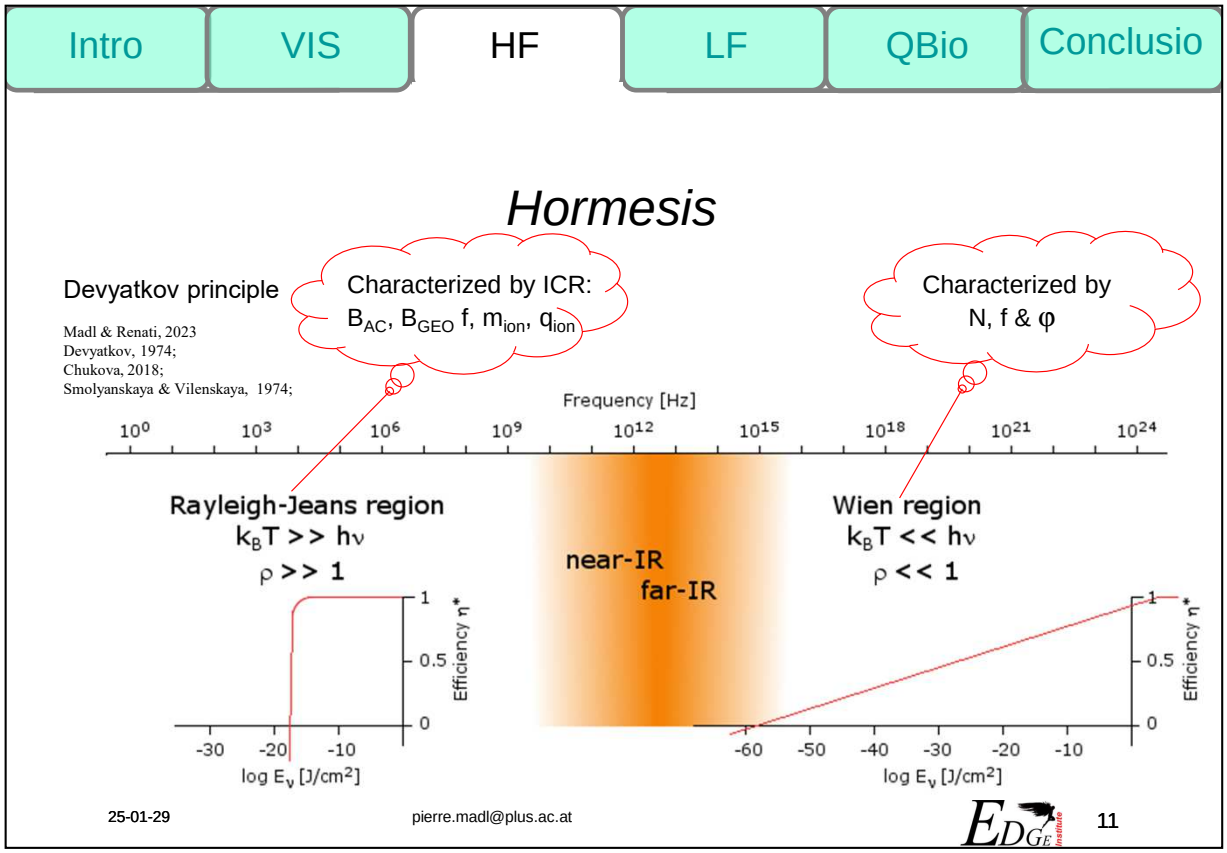
Source: [1] Voeikov V (2001) Reactive Oxygen Species, Water, Photons, and Life. *Riv. Biol.*, *94*, 193.214.
[2] Voeikov V (2003) Mitogenetic radiation, biophotons and non-linear oxidative processes in aqueous media. In *Integrative Bio-Physics–Biophotonics*; Springer: Heidelberg (FRG) pp. 331–359. https://doi.org/10.1007/978-94-017-0373-4_10.
[3] Gudkov S, Bruskov V, Astashev M, Chernikov A, Yaguzhinsky L, Zakharov S (2011) Oxygen-dependent au-to-oscillations of water luminescence triggered by the 1264 nm radiation. *J. Phys. Chem. B*, *115*, 7693–7698. https://doi.org/10.1021/jp2023154

Hormetic effects in the HF-range



Water sample from the Hundertwasser thermal spa in *Blumau* (Styria, AT); sample taken directly from the pool;
magnification: 100x darkfield

Source: Schroecker G (2017) Wasser lebt (Living Water) – see acknowledgement



The step-dependence in the Rayleigh-Jeans region was elaborated by Devyatkov [2] in experiments involving *E.coli* and successfully repeated shortly after [3]. Devyatkov could show that the conversion efficiency of radio frequency exposure in that region is quite rapid, i.e.: a small change in the intensity of the external stimulus induces a sudden change in efficiency from nil to 100 %. The dependence of η* vs. log E_ν is very sharp and reveals an all-or nothing response. It means, that a small increase in energy absorption triggers an endergonic process that induces a flip from a null-reaction to one with a maximal response efficiency. This prompted Chukova [4] to discriminate between the underlining principles in experiments involving long-wave radiation, and those utilizing short-wave radiation. Accordingly, she rightfully speaks of two different laws of efficiency of conversion of electromagnetic radiation energy into Helmholtz free energy and does so by introducing the Devyatkov law (DL) for the Rayleigh-Jeans region and places it next to the Weber-Fechner law for the Wien region. The DL is crucial for the Zhadin-effect as the wavelength-specificity makes sure that no part of the absorbed energy will be transformed into heat (incoherent), but rather fuels ion cyclotron resonance (coherence). In fact, the Zhadin-effect (see section NF of the talk) is a perfect example of this step-like response pattern as it nicely fits the generalized pattern within the Rayleigh-Jeans region as it places quality (of the field) over quantity (thermal noise of particle).

Image. Outline of main thermodynamic characteristic of electromagnetic radiation. The Wien region is most suitable for visible, ultra-violet, x-ray and gamma-radiation, whereas the Rayleigh-Jeans region covers Radio Frequency bands including extremely low frequencies. These two regions are separated by the infrared radiation boundary. Here, k_BT denotes thermal oscillation; ρ the distribution function indicating the number of photons in the quantum state, hν the energy equivalent of the radiation; Eν, spectral density. .

Source: [1] Madl P, Renati P (2023) Quantum Electrodynamics Coherence and Hormesis: Foundations of Quantum Biology. Int J Mol Sci. 24(18):14003. doi: 10.3390/ijms241814003
[2] Devyatkov N (1974) Influence of millimeter- band electromagnetic radiation on biological objects, Soviet Physics, vol. 16, no. 4, pp. 568-579.
[3] Smolyanskaya A, Vilenskaya R (1974) Effects of Millimeter-band Electromagnetic Radiation on the Functional Activity of Certain Genetic Elements of Bacterial Cells, Sov. Phys. Usp., vol. 16, pp. 571-572.
[4].Chukova Y (2018) Radiation Hormesis in the light of the Laws of Quantum Thermodynamics, RAD Conference Proceedings, 2018.

High Frequency

Low dose bio-effects w/n HF range

Induction of colicin production in *E.coli* at room temperature by microwave irradiation

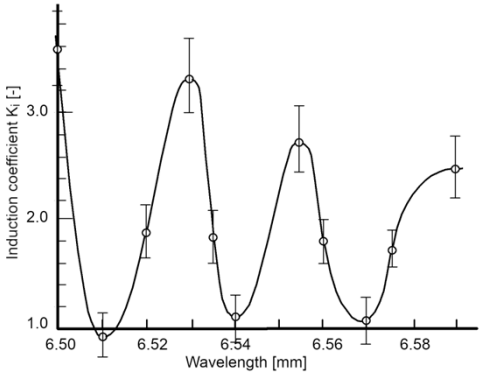
$$K_i = \frac{L_e \cdot K_c}{K_e \cdot L_c}$$

L_e colicin producing cells
K_e total No of colicinogenic cells
L_c colicin-forming cells of control
K_c total No of colicinogenic cells of control

PD_{min}: 10 µW/cm²

→ colicin synthesis: ↑ 300%
→ is a resonant function of wavelength.

Smolyanskaya & Vilenskaya, 1974



Biological effects of low intensity mm-waves depend on
i) power flux density
i) wavelength;
i) exposure site location;
i) exposure area;

Betskii & Lebedeva, 2004

The effects of millimeter waves on intracellular systems responsible for lethal synthesis in bacteria, i.e. the synthesis of substances that result in the depth of the cell, were investigated. The colicinogenic factor of *E.coli* was chosen as the test object. The colfactor is an extrachromosomic genetic element. The functional activity of this element is normally repressed. Suppression of the col-factor results in synthesis of a special proteic substance known as colicin; the cell then perishes. The colicin that it has produced has an antibacterial action with respect to other bacteria of the same or similar species …. millimeter-band radiation can be regarded as a fundamentally new agent that disturbs the functional regulatory mechanism of genetic elements in the cell, and extrachromosomic elements in particular, without causing direct damage to the DNA molecule …. Variation of the power flux density through a factor of 100, from 0.01 to 1.00 mW/cm², had no influence on the induction coefficient, and only a further reduction of the power to 0.01 mW/cm² resulted in a sharp decrease in the biological effect.[1]

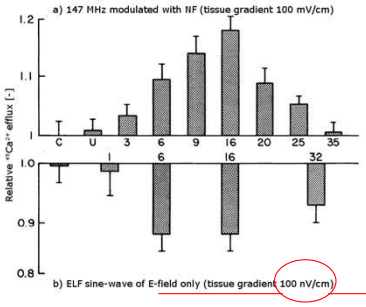
Image: Induction coefficient K_i of colicin synthesis as a function of wavelength. L_e is the number of cells forming colicin in the experiment, K_e is the total number of colicinogenic cells in the experiment, L_c is the number of cells forming colicin in the control, and K_c is the total number of colicinogenic cells in the control.[1]

Source: [1] Smolyanskaya A, Vilenskaya R (1974) Effects of Millimeter-band Electromagnetic Radiation on the Functional Activity of Certain Genetic Elements of Bacterial Cells. *Sov. Phys. Usp.*, vol. 16, pp. 571-572.
[2] Betskii OV, Lebedeva NN (2004) Low-Intensity Millimeter Waves in Biology and Medicine. In: Roch PJ, Markov MS (eds) Bioelectromagnetic Medicine. Marcel Dekker (NY) ISBN: 0-8247-4700-3

Exposure levels East vs West

Subtle field effects & SSSR-legislation

- HF w/ ELF-modulation 5 µW/cm² (4.3 V/m), Adey, 1981
- microwave exposure of general public: 1 µW/cm² (1.9 V/m), Hecht & Balzer, 1997



147 MHz, 0.8 mW/cm² modulated @ 1-35 Hz

vs.

ELF sine-wave 1-32 Hz

10 µV/m → "hormetic" effect !

ex-USSR standards for civilian/public exposure Frequency Range	Maximum Allowable Level (Domestic Exposure)	ICNIRP / WHO (current) [V/m]
Long wave, 30–300 kHz	20 V/m	250/f
Medium wave, 0.3–3.0 MHz	10 V/m	87
Short wave, 3–30 MHz	4 V/m	<87
Ultra short wave, 30–300 MHz	2 V/m	28
Microwaves (24-h exposure), 300 MHz–300 GHz	5 µW/cm²	61 / 987 [µW/cm²]

Surveys in the United States by the Environmental Protection Agency have shown that for a population group representing 18% of the total US-population, there is a median exposure of 5 nW/cm² time-averaged power density (data from 1978 !! = not accounting for modern wireless communication devices). Less than 1% of the population are potentially exposed to levels above 0.001 mW/cm² (1µ W/cm²). At least 99% of the population are not exposed to levels above the very stringent safety standards proposed for the USSR in 1974. The FM radio broadcast service (88-108 MHz) is responsible for most of the continuous illumination of the general population.[1,2]

Table: USSR standards for civilian microwave exposure

Image: A: $^{45}Ca^{2+}$ efflux from freshly isolated chick cerebral hemispheres exposed to a weak radio-frequency field (147 MHz, 0.8 mW/cm²), amplitude-modulated at low frequencies. B: $^{45}Ca^{2+}$ efflux changes from exposure to far weaker electric fields (56 V/m) in the same frequency spectrum from 1 to 32 Hz. Peak magnitude of efflux change is similar for the 2 fields but opposite in direction. For radio-frequency field in A, the unmodulated carrier wave U had no effect when compared with controls C. Field gradients differ by about 6 orders of magnitude between A and B.[1]

Source: Adey WR (1981) Tissue interactions with nonionizing electromagnetic fields. Physiol. Rev. Vol. 61: 435-514.

ICNIRP (1998) Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (UP to 300 GHz) Health Physics Vol.74(4): 494-522

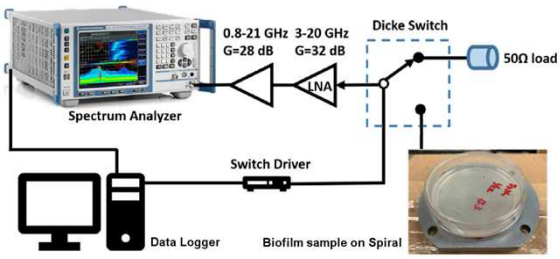
[2] Hecht K, Balzer U (1997) Biologische Wirkungen elektromagnetischer Felder im Frequenzbereich 0 bis 3 GHz auf den Menschen. Studie russischer Literatur von 1960-1996 (Biological effects of electromagnetic fields in the frequency range 0 to 3 GHz on humans. Study of Russian literature from 1960-1996). Institut für Stressforschung, Berlin (FRG).

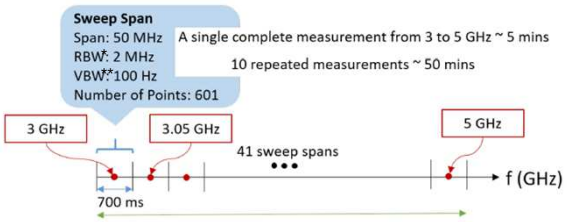
Bacterial SHF bio-communication

Bacteria (*E.coli*, *S.aureus* & *S.epidermis*)
receive and transmit SHF (w/n 3-4 GHz) !

→ 3.18 & 3.45 GHz biocom-bands
→ biocom affected by technical fields
→ metabolic activity ↑
→ antibiotic resistance ↑

Rao et al., 2022
Said-Salman et al., 2019





Metabolic activity increase due to WiFi exposure

		control	2.45 GHz Exposed	P-value
E. coli 0157H7	Cell metabolic activity	1.018±0.023	2.432±0.102	0.002*
	Biofilm formation	1.009±0.080	1.413±0.203	0.042*
Staphylococcus aureus	Cell metabolic activity	1.026±0.081	3.323±0.280	0.004*
	Biofilm formation	1.053±0.068	1.918±0.223	0.022*
Staphylococcus epidermis	Cell metabolic activity	1.327±0.304	3.024±0.267	0.036*
	Biofilm formation	1.020±0.027	1.506±0.062	0.007*

Each value is the mean ±SD. *statistically significant (p<0.05)

25-01-29 pierre.madl@plus.ac.at EDGE Institute 14

Biological cells may transmit and receive EM waves …. Our work is the first successful attempt to measure EM radiation from *S.aureus* biofilms in the GHz range; i.e. two distinct radiating bands in the 3-4 GHz frequency range are identified. Over the course of a 70-day experiment, we discovered a long-term cycle of the radiated signal with short-term fluctuations. This work proves the existence of EM radiation in biofilm communities, which is validated by examining multiple samples over a long period of time and comparing the measured power with that of PNG media (no biofilms) in the same petri dish. In addition, it is shown that exposing biofilms with significant RF radiation to lethal doses of ZnO-NPYs, which inhibits metabolic activity, eliminates the biofilm RF emission.[2]
Wi-Fi exposure at 2.4 GHz for 24 & 48 hrs respectively, adversely affected different pathogenic bacterial strains (*Escherichia coli* 0157H7, *Staphylococcus aureus, and Staphylococcus epidermis*) by increasing antibiotic resistance and motility of *E.coli* 0157H7, as well as enhancing biofilm formation by *Escherichia coli* 0157H7, *S.aureus and S.epidermis*. …. Increasing antibiotic resistance, motility and biofilm formation of pathogenic traits is a worldwide threat to public health.[1]

Image: Effects of 2.4 GHz WiFi radiation on metabolic activity and biofilm formation of *E.coli*, *S.aureus* and *S.epidermis*.[1]
Setup pf the wideband near-zone radiative system with data acquisition for the 3–5 GHz range (approx. 5 mins per single scanning sweep) along with the spiral antenna system diagram with a biofilm sample atop.[2]

Source: [1] Said-Salman IH, Jebali FA, Yusef HH, Moustafa ME (2019) Evaluation of Wi-Fi Radiation Effects on Antibiotic Susceptibility, Metabolic Activity and Biofilm Formation by Escherichia *Coli* 0157H7, *Staphylococcus Aureus* and *Staphylococcus Epidermis*. J Biomed Phys Eng. 9(5): 579-586.

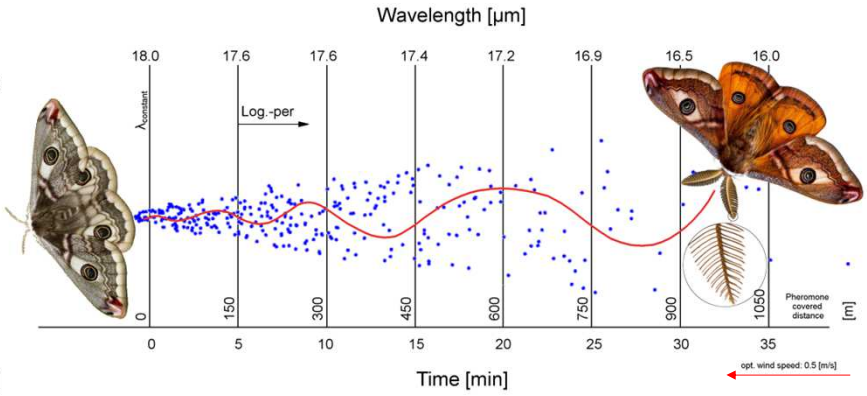
[2] Rao M, Sarabandi K, Soukar J, Kotov NA, VanEpps JS (2022) Experimental Evidence of Radio Frequency Radiation From Staphylococcus aureus Biofilms. IEEE JEMMB, Vol. 6(3): 420-428

FIR bio-communication

Moth-biocommunication via pheromone-amplified EMR beacons

1. Release of pheromone (high Q-factor) → induced resonance (k_BT)
2. log-per antenna of moth perceives em-signature (f-shift correlates with distance)

→ even against the wind



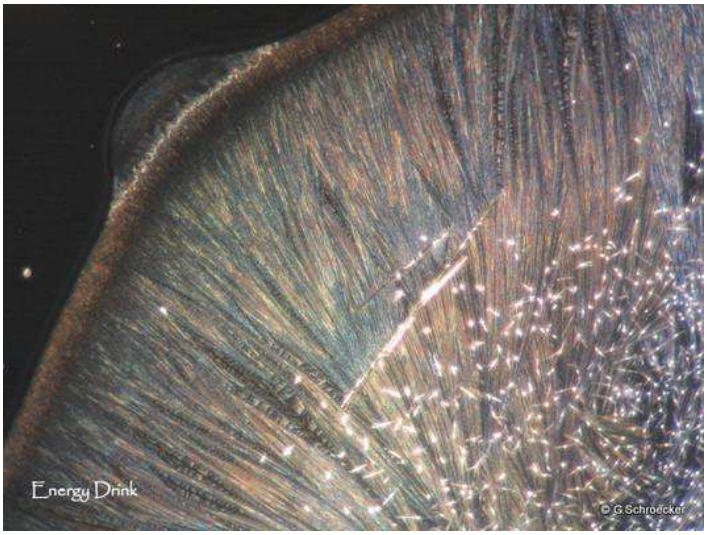
Callahan, 1975
Bischof, 1999

Living beings are not actually in a chaotic heat bath, but are constantly exposed to a seemingly immeasurable flood of (coherent) signals. It is therefore surprising that the research results of *Philip S. Callahan*, who found evidence of antenna activity in insect antennae. He considered it insect "antennae", as being indeed antennae …. The answer to the question of why butterflies can perceive each other over a distance of several kilometers, and why moths plunge into candle flames or why the flight speed of the male insect must be in a certain ratio to the wind speed so that the female can be perceived with maximum clarity. The function of sexual attractants (pheromones) is by no means in doubt. However, these merely serve as specific modulators and coherent electromagnetic amplifiers (kind of laser communication), to which the antennae are resonantly tuned. This explains, for example, why insects can mate even if one partner has to approach against the wind direction.[2]

Image: A male cabbage looper moth flying against an optimum wind speed of 0.5 meter/second detects the shortest wavelength (16.91µm) between 750 and 900 meters away. At that wind speed the frequency shifts to longer and longer wavelengths every 150 meters. Each frequency is "collected" by different groups of gradually lengthening log-periodic sensilla trichodea. When the male reaches the female, a steady 18.03µm (highest concentration) indicates close proximity to the target (encircled zoom: note the Yagi-like antenna structure of the male insect enabling it to trace the RF-signal in three dimensional space). This is an extremely elegant system for the pheromone is not only a directional system, but also a proximity indicator.[1]

Source: [1] Callahan P (1975) Tuning into Nature – Infrared Radiation and Insect Communication System. Acres, Austin (TX). ISBN 978-0-911311-69-3
[2] Bischof M (1999) – Biofotonen – Das Licht in unseren Zellen. Zweitausendeins, Frankfurt a. Main (FRG). ISBN 3-86150-095-7

Hormetic effects in the LF-range



Red Bull energy dring – sample taken from the formulations sold in cans when first introduced into the market;
magnification: 200x darkfield

Source: Schroecker G (2017) Wasser lebt (Living Water) – see acknowledgement

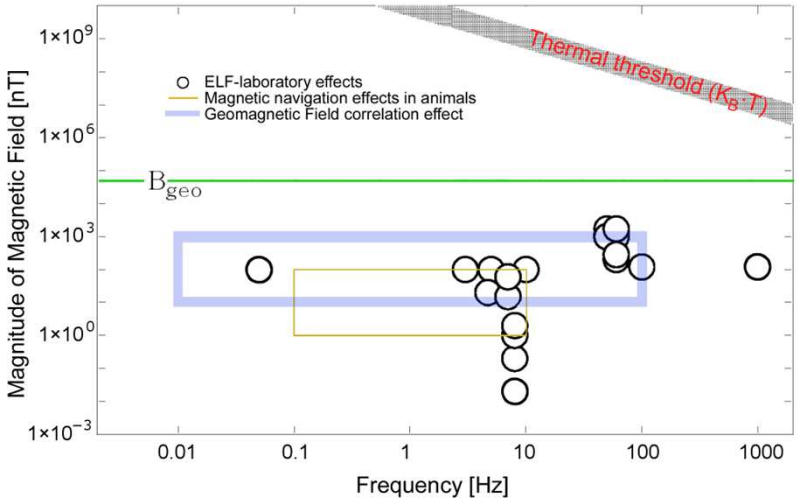
Low Frequency

Low dose bio-effects w/n LF range

Biologic response patterns obtained in a range from 10-100 nT (B_{AC})

→ far below k_BT

Binhi, 2002, 2011



A hormetic effect employed by ultra-weak electromagnetic field stimulations can be explained. This is especially the case for the sensitivity of migrating birds capable of detecting changes in the average magnetic field valued at the level of 10–100 nT. Resonant coupling of water CDs of biogenic structures within the extremely low-frequency regime well below the thermal threshold k_BT results in macroscopic effects within biota. Similar effects occur in the frequency range of microwaves, even when the power of EM radiation is far from that at which thermal effects are possible. [1,2]

Image: Hormetic effects of extremely low-frequency stimulation with ultra-weak magnetic field intensities plotted as a frequency–amplitude diagram. Parameters of super-weak magnetic fields supposedly causing observed biological effects, yet still being well below the thermal threshold level. The amplitude–frequency intervals are approximate orders of magnitude (redrawn and adapted from [1,2].

Source: [1] Binhi V (2002) *Magnetobiology*; Academic Press: London (UK)**.** ISBN: 200-109-59-15.
[2] Binhi V (2011) *Principles of Electromagnetic Biophysics* ; Moscow (RUS) (In Russian). FIZMATLIT. ISBN 978-5-9221-1333-5.

Hormesis

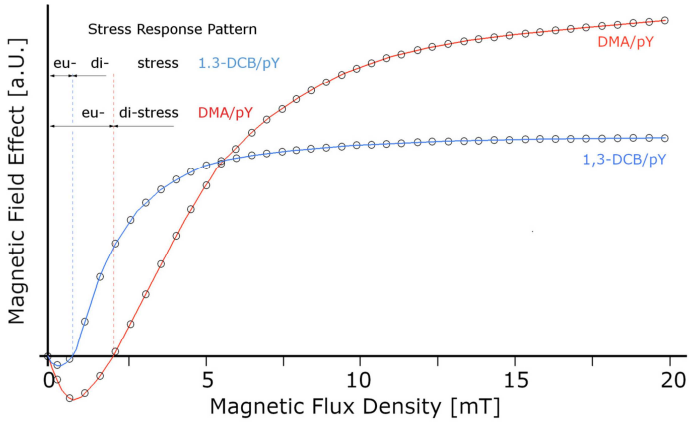
Spontaneous Photon emission of chemicals in B-fields

1. Superposition of static and dynamic B-fields

2. Flash-photolysis of
   - 1,3- dicyano-benzene
   - dimethyl-aniline
   (exciplex ↔ radical pair)

3. Biphasic B-field response pattern observed via UwPE detection (PMT)

Batchelor et al, 1993



Typical biphasic dose-response pattern of a hormetic effect involving a non-chemical agent. The authors investigated the minimal field strength required to induce hyperfine and degenerative effects, i.e., the experiment consists of perturbing the spin dynamics arising from the Zeeman interaction of the radicals with an external magnetic field that can either accelerate or slow down the intersystem transition between singlet and triplet states. Although the authors do not explicitly refer to the peculiar behaviour at low magnetic field intensities (<2 mT), the dynamics obtained suggest hormetic principles in action. The superimposition of the static field (B_{DC}) with a weak ELF (B_{AC} with certain frequencies) acts constructively via harmonic coupling such that the induced effects acting on the cyclotron resonance of specific ions can be derived with B_{AC} fields down to the nT range. In addition, hormetic dynamics can be used as a predictor to indicate the lowest values of a substance or agent (e.g., applied magnetic field) that exhibit inhibitory or stimulating effects.[1]

Image. Curves of the modelled magnetic field effects of exciplex systems consisting of pyrene and isomers of dicyanobenzene (1,3-dicyano-benzene (DCB) or dimethyl-aniline (DMA)). Superimposed, the eustress and the corresponding distress response regimes indicating that weak field stimuli promote, whereas strong field stimuli inhibit.

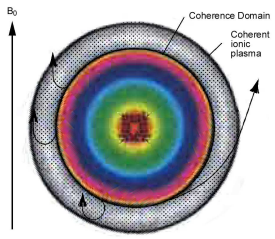
Source: [1] Batchelor SN, Kay CWM, McLauchlan KA, Shkrob IA (1993) Time-resolved and modulation methods in the study of the effects of magnetic fields on the yields of free-radical reactions. J. Phys. Chem., 97, 13250–13258

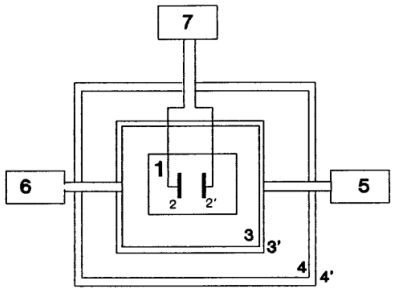
Ion Cyclotron Resonance

Zhadin effect

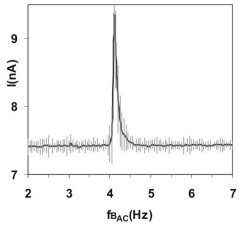
Current spike driven by weak altern. magnetic field

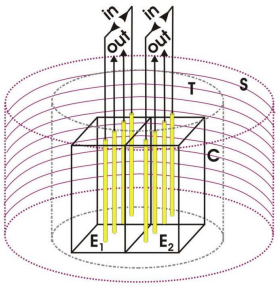
$$f_{CR-ion} = B_{static} \frac{q_{ion}}{2 \cdot \pi \cdot m_{ion}}$$

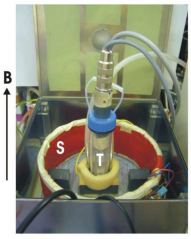




Del Giudice, 2004
Zhadin et al., 1998
Pazur, 2004
Del Giudice et al., 2002
Henry, 2016
Zhadin & Giuliani, 2006







25-01-29 pierre.madl@plus.ac.at

Zhadin's group used the non-viscous water fraction as a leverage system for extracting energy and make it available to the chemical reactions in aqueous solutions (i.e. in a cell) using appropriate electro-magnetic fields (cyclotron frequencies of the ions).[2] The Zhadin effect allows to organise the long range traffic of ions and the crossing of cell membranes. When a current of ions is subjected to two parallel magnetic fields, one static, the other alternating, it exhibits a current surge when the frequency of the alternating field matches a characteristic value, typical of the ions species. This phenomenon is maximized under coherence resulting in magnetically driven electric currents.[1,6]
Method: An aqueous solution of glutamate was exposed to a combination of a static magnetic field of 40 μT and a sinusoidal EMF with variable frequency (2-7 Hz) and an amplitude of 50 nT. The electric conductivity and dielectric properties of the solution were investigated by voltammetric techniques in combination with non linear dielectric spectroscopy (NLDS), which allow the examination of the dielectric properties of macromolecules and molecular aggregates in water.

Image: 1: Cuvette w/ solution; 2: Electrodes; 3: solenoid coils; 4: magnetic screen of Permalloy; 5: DC-power source; 6: sine-wave generator; 7: measuring block (stabilizer of electrode voltage, Ampere-meter, recorder).[2] Current increase through the glutamic acid/HCl solution (2.24 mM, pH 2.85). The static magnetic field strength is B_{DC} 40 μT, the amplitude of the alternating field *Bac* is 50 nT, the frequency resolution Δf 0.05 Hz. A constant electrode voltage of 80 mV was used.[3]

Source: [1] Del Giudice E (2004) The psycho-emotional-physical unity of living organisms as an outcome of quantum physics. In: Globus GG, Pribram KH, Vitiello G (eds) Brain and Being. John Benjamins Publishing Co. Amsterdam (NL)
[2] Zhadin M, Novikov V, Barnes F, La Pergola N (1998). Combined action of static and alternating magnetic field on ionic current in aqueous glutamic acid solution. Bioelectromagnetics, Vol.19: 41–45.
[3] Pazur A (2004) Characterisation of weak magnetic field effects in an aqueous glutamic acid solution by nonlinear dielectric spectroscopy and voltammetry. BioMagnetic Research and Technology Vol.2:8 https://doi.org/10.1186/1477-044X-2-8
[4] Del Giudice E, Fleischmann M, Preparata G, Talpo G (2002) On the "unreasonable" effects of weak ELF magnetic fields upon a system of ions. Bioelectromagnetics, Vol.23: 522–530.
[5] Henry M (2016) L'eu quantigue, Ch.5. In: L'Eau et La Physique Quantiqe. Editions Dangles, Escalquens (FR)
[6] Zhadin M, Giuliani L (2006) Some problems in modern bioelectromagnetics. E-magn Biol Med. 25(4): 227-243.

Hormesis & Quantum Biology

Sample from a spring located amidts the alpine valley of the *Rauris* primeval forest (Salzburg, AT), magnification: 100x. darkfield

Source: Schroecker G (2017) Wasser lebt (Living Water) – see acknowledgement

Quantum Biology

Quantization Level

physical quantities take on discrete rather than continuous values:

1. Classical mechanics
   (matter centered)
2. QFT
   (reality is field driven – matter is an epiphenomenon of the field)
3. M-Theory
   (inclusion of gravity with universe being a quantum object)

Madl, 2024

*) Intercomparision of 1st vs 2nd quantisation first applied by Fröhlich, 1931

	Quantization*		
	1st	2nd	3rd
Paradigm	Classical mechanics	Quantum field theory	M-theory
Main focus	indiv. particles	Fields	Universe
Description	Wave function (Schrödinger)	Field operators (creation / annihilation)	univ. wave function (Wheeler-DeWitt)
Particle-wave	equal standing	Particle becomes epiphenomenon of the field	Universe itself is an epiphenomenon of the field (quantum object)
Particle vs. Field	Quantized	Fermion fields (Pauli) Boson fields (Bose-Einstein)	each universe attains its own quantum state
Properties	Discrete (separate)	De- / Coherence	Multiverse
Vacuum	neglected	essential	Incl. gravitational field
Radiation-mater	Classical (Maxwell)	field is the fundamental object	Quantum field dominates
Hamiltonian Σ(PE+KE)	Quantum operator	creation and annihilation operators to describe interactions between particles	creation and annihilation operators applied to entire universe
essence	Matter dominates (stick-and-ball); quantum rules applied to single particles	Matter meaningless (relational) Description of many-body systems and fields	Wave function describes the entire universes – it may pop "in" and "out" of existence

1st Quantization: This is the usual level of representation generally adopted by most of us. It deals with the quantization of particles, as it completely neglects the structure of the vacuum and treats radiation-matter interactions in a purely classical framework. It refers to the equivalence of particle and wave (particle-wave dualism), where the fields only represent the fundamental constituents of matter (such as electrons, quarks, etc.) and their interactions (e.g., electromagnetic, weak, and strong interactions). Furthermore, the fields and their excitations (particles) are quantized, meaning that their properties such as energy, momentum, and other observables are restricted to discrete values, rather than being continuous. This quantization process is fundamental to understanding the behavior of particles and their interactions at the quantum level.

2nd Quantization: It is also called quantum physics of fields, where the individual Hilbert spaces merge into a gigantic Fock space and the fields themselves are quantized. Within this framework, matter, vacuum and radiation are treated equally; i.e. 2nd quantization does not touch mass, but only allows the number of quanta to vary; that is the mass of these quanta being a parameter that cannot be calculated by the theory, as one plays on the phase to make mass unobservable (annihilation) or on the contrary observable (creation), but at no moment does one question its existence. Therein, exist matter fields of fermions or bosons and the em-field, but does not include the gravitational field. Rather than being burdened with these stick-and-ball-concept, the more precise terms «coherent» and «incoherent» are used in 2nd quantization. Hence within this framework, one becomes aware of the profound quantum properties of nature and the importance of being familiar with this new way of thinking – especially for a biologist.

3rd Quantization: It is a theoretical framework that extends the concepts of quantization to include the quantization of the geometry of spacetime itself, meaning that it is viewed as being composed of discrete, indivisible units at very small scales (string theory and loop quantum gravity). It must be seen as relational quantum mechanics, where any observing system can obtain information about another observed system by entering into physical interaction with the latter. In doing so the interaction enables acquisition or storage of the acquired information.

Source: Madl P (2024) Application for the VENIA in «Cell Biology / Environmental Physics». University of Salzburg (AT) …. to be submitted
Froehlich H (1931) Der Schroteffekt nach der Quantenmechanik. *Z. Physik* **71**, 715–719. doi: 10.1007/BF01344440

Coherence

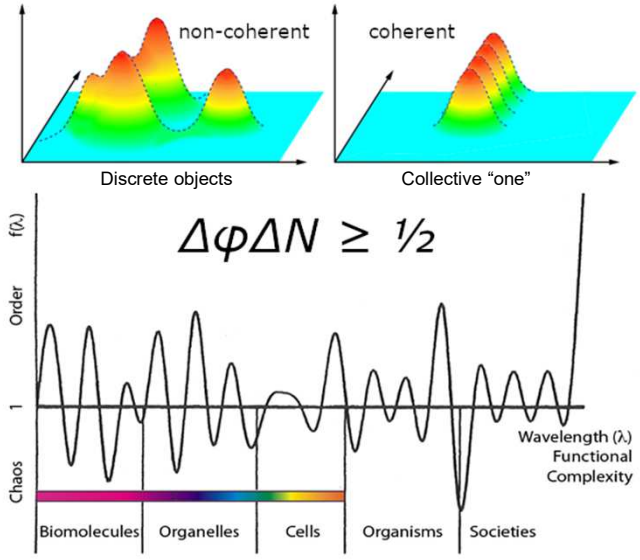
Low dose bio-effects w/n QB are possible only w/n 2nd quantization !

→ coherence - not signal intensity matters but phase angle !

→ weak field effects become macroscopic (superconductivity, superfluidity, ferromagnetism, photosynthesis, floating water, bridge, etc.

→ Fractality - an epiphenomenon of coherence (*fundamental uncertainty relationship*)

Madl & Renati, 2023



"Quantum biology" (QB) is a promising theoretical approach addressing questions about how living systems are able to unfold dynamics that cannot be solved on a chemical basis or seem to violate some fundamental laws (e.g., thermodynamic yield, morphogenesis, adaptation, autopoiesis, memory, teleology, biosemiotics). Current "quantum" approaches in biology are still very basic and "corpuscular", as these rely on a semi-classical and approximated view. We review important considerations of theory and experiments of the recent past in the field of condensed matter, water, physics of living systems, and biochemistry to join them by creating a consistent picture applicable for life sciences. Within quantum field theory (QFT), the field (also in the matter field) has the primacy whereby the particle, or "quantum", is a derivative of it. The phase of the oscillation and not the number of quanta is the most important observable of the system. Thermodynamics of open systems, symmetry breaking, fractals, and quantum electrodynamics (QED) provide a consistent picture of condensed matter, liquid water, and living matter. Coherence, resonance-driven biochemistry, and ion cyclotron resonance (Liboff-Zhadin effect) emerge as crucial hormetic phenomena. We offer a paradigmatic approach when dealing with living systems in order to enrich and ultimately better understand the implications of current research activities in the field of life sciences.

Source: Madl P, Renati P (2023) Quantum Electrodynamics Coherence and Hormesis: Foundations of Quantum Biology. Int J Mol Sci. 24(18):14003. doi: 10.3390/ijms241814003.

Coherence

Water as the prime substance in biota ….

…. along with chemical constituents of *E. coli*

Matter	Molar Weight [Da]	Mass fraction [%]	Moles [mM]	Number [-]	Mol fr. [%]
Water	18	70	3888.9	23 400 000 000	99.324
Ions	47	1	300	120 000 000	0.509
Amino Acids	110 (av.)	2	1.5	6 000 000	0.025
Nucleotides	414 (av.)	0.8	1.9	3 530 000	0.015
Proteins	40 000 (av.)	15	0.34	3 600 000	0.015
RNA	33 500	6	0.18	222 000	0.001
Polysaccharides	1 000 000 (av.)	3	0.003	39 000	0.001
DNA	2 840 000 000	1	0.000005	1	0.000
Others	-	0.4	-		
Total	3 159 782	100		23 533 391 001	100.00

Madl & Renati, 2024

The issues raised above are very intriguing as these tell us a lot about the current misconceptions of living matter (the problem also known as the "K_BT problem", which has been well disentangled in the framework of QED. In essence it demonstrates the incredibly low energy required along with the extreme efficiency living systems work with. This is also corroborated by the enormously numerous chemical, electrochemical, electromagnetic, and thermodynamic processes that are perform every second with an extreme low error rate. One of the most energy-consuming of these processes is the ubiquitous ion transport that occurs in almost all biochemical activity. This activity (alone) would cause immense energy dissipation due to the Joule effect that should be associated with the striking ion (and electron) currents that circulate through membranes and the aqueous matrix. Obviously, this is not the case, and the "why's" are rooted in electrodynamic coherence. Here it is noteworthy to mention that ions are involved in energy and charge transfers not just through membranes but also along molecular backbones. If life-scientists honestly want to understand how water behaves near hydrophilic surfaces and how the dialectic between coherent water, interfaces, and fields can create a topological complexity of 1D, 2D, and 3D systems in both the cytoskeleton as well as in the extracellular matrix, then a real paradigm shift away from the current neo-Darwinistic interpretation is required. Finally, water is the main component of living matter (not only in terms of weight, but especially in terms of number) and exceeds the amount of all other species by orders of magnitude, in second place are ions (see *E. coli* Table 1 and Table 2 and for humans Table 3).[1]

Table: chemical composition of a common bacterium such as *E.coli* with a dry mass of about 0.95 pg. [2] The weight and molar fraction of chemical species are given and a final count of their number in the last column shows that water and ions outnumber by orders of magnitude any other cytosolic component.[3]

Source: [1] Madl P, Renati P (2023) Quantum Electrodynamics Coherence and Hormesis: Foundations of Quantum Biology. Int J Mol Sci. 24(18):14003. doi: 10.3390/ijms241814003.
[2] Neidhardt F et al (1996) Escherichia Coli and Salmonella: Cellular and Molecular Biology, II ed., vol. 1, Washington DC,: ASM Press.
[3] Sundararaj S et al. (2004) The CyberCell Database (CCDB): a comprehensive, self-updating, relational database to coordinate and facilitate in silico modeling of Escherichia coli," Nucleic Acids Reseasrch, vol. 1, no. 32.

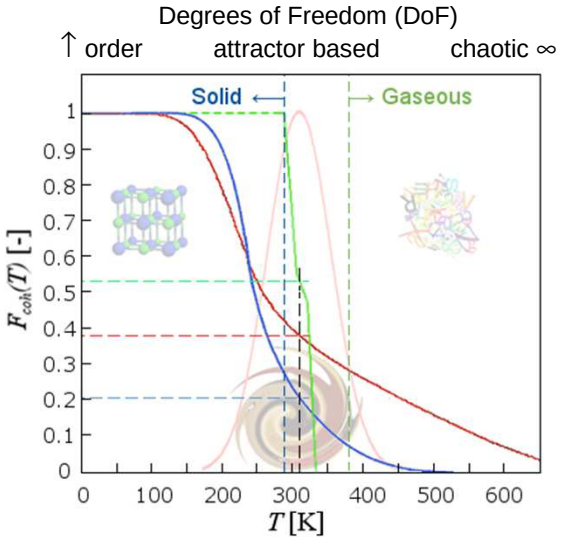
Coherence

Bi-phasic state of water ….

…. much more than just EZ-water (macroscopic EZ layer formation relies on QED → coherence)

F_{Coh} at T_{physio} : ~20 %** Preparata, 1995
~38 %** Garbelli, 2000
~53 %* Trincher, 1984

*) 1st Quantization
**) 2nd Quantization



Calculated trend of the "coherent fraction" $F_{Coh}(T)$ vs. Temperature. Water at sub-zero temperatures becomes almost fully coherent, $F_{Coh}(T) \approx 1$, thus ordered (few DoFs: degrees of freedom); whereas water in the vapor phase asymptotically approaches $F_{Coh}(T) = 0$ (DoFs approach an infinitely large number) [3]. Yet still coherent elements can still be found even at temperatures >600 K [2]. The optimal viable window though, where most organism thrive, as highlighted by the cub-imposed gaussian distribution, is found in-between the solid and the gaseous states (limited DoFs). The dashed lines next to the authors name indicate the optimal physiological temperature of 300 K.

Image: The distribution of the structural components that make up water in the temperature range from 0° to 600°K with 1 corresponding to 100% coherence whereas 0% denotes complete decoherence. The green trend covers a T-range from 0° to 60°C is derived thermodynamically [1] within the 1st quantization. The two red-blue trends originate from the 2nd quantization (red: [2]; blue: [3]).

Source: [1] Trincher K (1981) Die Gesetze der biologischen Thermodynamik (The Laws of biologic Thermodynamics). Urban & Schwarz, Wien (AT) ISBN 3-541-09861-9
[2] Garbelli A (2000) Proprietà termodinamiche e dielettriche dell'acqua alla luce della teoria complessa delle interazioni molecolari elettrodinamiche ed elettrostatiche (Thermodynamic and dielectric properties of water in light of the complex theory of electrodynamic and electrostatic molecular interactions), PhD thesis. University of Milan.
[3] Preparata G (1995) QED Coherence in Matter, World Scientific, Singapore. https://doi.org/10.1142/2738.

Coherence Domains

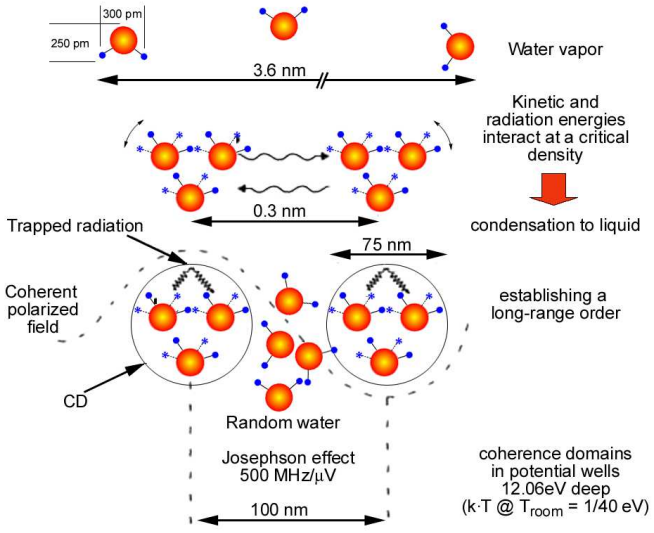
Bi-phasic state of water ….

…. CDs at the basis of biological coherence

from
- vapour to
- ρ_{Crit} (condensation) to
- coherent oscillation

$$CD \approx \left(\frac{75nm}{0.3nm}\right)^3 \approx 15 \cdot E^6 H_2O$$

Madl et al., 2013



It is the scope of this paper to propose an additional charging mechanism of water-fall generated aerosols. The observations leading to this approach arose from a field study at five waterfalls in the Austrian Alps. Thereby, size distributions of ion clusters, their mobility and their intermediate progenies near waterfalls have been measured with a tandem ion spectrometer consisting of three aspirated Gerdien Cylindrical Ion Detectors (CDI) in combination with a Scanning Mobility Particle Sizer (SMPS). It was observed that the concentration of negative 0.9-10 nm ions was 2-3 orders of magnitude higher than at the reference points up to several 100s of meters away from the waterfalls. Here we discuss the observed features in a quantum electro-dynamic scheme. We find good agreement between theory and observations obtained in the field, which supports the view that water in this size range is highly structured and coherent.[1]

Gases are fully non coherent systems. Liquids are systems where electron clouds are coherent. Solids are systems where nuclei too are coherent. Liquid water is peculiar, since the coherent oscillation connects two electronic configurations that have extreme features:[2]

1) the ground configuration where all electrons are tightly bound (the ionization potential is 12.60eV, corresponding to soft X-rays / far UV-range and to an excitation temperature of $140 \cdot E^3$ [K] …. $E = k \cdot T$ …. $k = 86.174 \cdot E^{-6}$[eV/K];

2) the excited configuration has an energy E=12.06eV, only 0.54eV below the ionization threshold. So for each molecule there is almost one free electron ($e_{charge} = -1.6022 \cdot E^{-19}$ [A·s] = 1eV)!

Image: Formation of coherence domains (CDs) of aerosolized water molecules. The free-floating dipoles start to feel mutually attracted and establish coherent resonance clusters that result in the formation of 75 nm large CDs in which molecules resonate unisono and in phase. CDs themselves become entrapped by the newly formed coherent polarizing field and reveal a characteristic wavelength of about 100nm. The formation of CDs is a fundamental property of liquid water and unlike the laser, no energy pumping is required to establish coherence.

Source: [1] Madl P, Del Giudice E, Voeikov VL, Tedeschi A, Kolarž P, Gaisberger M and Hartl A (2013) Evidence of Coherent Dynamics in Water Droplets of Waterfalls. Water, Vol 5: 57-68.

Coherence Domains cont'd

Zhadin effect:

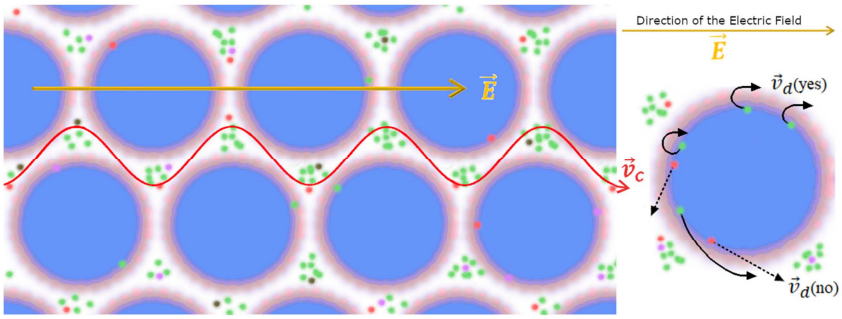
1. Attraction

$$\nu = \frac{q \cdot B}{2 \cdot \pi \cdot m}$$

q, m: charge & mass of ion
B, geomagnetic field flux

Giuliani, 2024

$$\vec{F} = -\frac{e^2}{m} grad \left|\vec{A}\right|^2$$



Periphery of CD of water molecules houses some ions or zwitterions (previously trapped by the electroweak force – vector potential A - acting on the charge-to-mass ratio, q/m).
em-field trapped inside CD |A|>>0, outside |A|=0, so ∇|A|>>0.

Coherence, resonance-driven biochemistry, and ion cyclotron resonance (Liboff-Zhadin effect) emerge as crucial hormetic phenomena. We offer a paradigmatic approach when dealing with living systems in order to enrich and ultimately better understand the implications of current research activities in the field of life sciences.[1] The mechanism by which, due to the presence of interfacial water and its richness in coherence domains, ionic currents formed under the action of the ICR survive the collisions of the Brownian motion of other molecules in the cell.[2] Practically, this implies that only ions aligned to the resonance frequency of the applied alternating magnetic field are driven out of orbit and meander almost frictionless through the interstices of the CD lattice.[1]

Image: Interfacial region of a CD and possible ion trajectories under the influence of fields. Left: Only in the presence of weak fields the drift velocity can be appropriate as to allow a deflection of the ion trajectory within the interfacial zone, $v \vec{}\_d\ (yes)$, otherwise the ion falls back into the reservoir zone and no longer contributes to the current, $v \vec{}\_d\ (no)$. The same holds for those field intensities when too strong as to cause the ions to fall into the bulk reservoir of the non-coherent water fraction. Right: top view of suitable field intensities resulting in an ion drift path that causes $v \vec{}\_d\ (yes) \rightarrow v \vec{}\_c$ to ultimately contribute to the ion current peak; modified after. [1]

Source: [1] Madl P, Renati P (2023) Quantum Electrodynamics Coherence and Hormesis: Foundations of Quantum Biology. Int J Mol Sci. 24(18):14003. doi: 10.3390/ijms241814003.
[2] Del Giudice E, Giuliani L (2010) Coherence in water and the kT problem in living matter. In: Giuliani L, Soffritti M (eds) Non thermal Effects and mechanisms of interaction between electromagnetic fields and living matter. Eu J of Onc Library 5:7-23. ISBN 978-88-6261-166-4. https://icems.eu/papers.htm

ICR-Coherence

Zhadin effect:

1. Attraction

$$\nu = \frac{q \cdot B}{2 \cdot \pi \cdot m}$$

Giuliani, 2024

f_{ICR} typically 5-500 Hz*

*) depends on cation, charge and vertical B-field component at a specific location

NOAA, 2024

Ion	Concentration [mM]	Number [-]	Number [%]	f_{ICR} /B [Hz/µT]
Potassium (K^+)	200-250	90 000 000	69.147	0.194
Iron (Fe^{2+} / Fe^{3+})	18	7 000 000	5.378	*0.546
Bicarbonate (HCO_3^-)	12	5 670 000	4.356	-
Chloride (Cl^-)	6	5 050 000	3.880	-
Magnesium (Mg^{2+})	10	4 000 000	3.073	1.255
Hydronium (H_3O^+)				*0.802
Zundel cation ($H_3O^+*H_2O$)				*0.477
trimer Hydronium ($H_3O^+*2H_2O$)	10 – 4.2	3 000 000	2.305	*0.277
tetramer Hydronium ($H_3O^+*3H_2O$)				*0.209
magic Hydronium cation ($H_3O^+*20H_2O$)				*0.167
Calcium (Ca^{2+})	6	2 300 000	1.767	0.761
Dihydrogen phosphate ($H_2PO_4^-$)	5	2 107 700	1.619	-
Sodium (Na^+)	5	2 000 000	1.573	*0.663
Cuprum (Cu^{2+})	4	1 700 000	1.306	*0.480
Manganese (Mn^{2+})	4	1 700 000	1.306	*0.555
Molybdenium (Mo^{4+})	4	1 700 000	1.306	*0.636
Zincum (Zn^{2+})	4	1 700 000	1.306	*0.466
Phosphoenol-Pyruvate (PEP^{3-})	2.8	1 100 000	0.845	-
Pyruvate (CH_3COCOO^-)	0.9	380 000	0.292	-
Adenosin-Diphosphate (ADP^{3-})	0.63	270 000	0.207	-
Nicotinamide ($NADP^{3-}$)	0.63	240 000	0.184	-
-"- ($NADPH^{4-}$)	0.56	220 060	0.169	-
Ammonium (NH_4^+)	-	-	-	*0.845
Glucose-6-Phosphate ($6GP^{2-}$)	0.05	20 000	0.015	-
Proton (H^+)	0.000063	30	0.000	15.13
Total		125 077 820	100.00	

Table: Details of the ion composition of *E. coli* in their molar concentration and total number (sorted by their abundance). Potassium alone is far more abundant than the other ions combined, which underlines that ion transport is one of the most important processes in metabolic functions of any organism at any phylogenetic level [1]. Cyclotron resonances are reported from [2-3], (those flanked by an asterisk represent theoretical values only; furthermore, **no values are assigned to anions as only cations are able to co-resonate in mixed water CDs**.[4] The case of NH_4^+ is special as it is usually present in the extracellular region and only assimilated during certain metabolic processes).

Source: [1] Sundararaj S et al. (2004) The CyberCell Database (CCDB): a comprehensive, self-updating, relational database to coordinate and facilitate in silico modeling of Escherichia coli," Nucleic Acids Reseasrch, vol. 1, no. 32.
[2] Milo R, Phillips R, Orme N (2015) Cell Biology by the numbers, New York: Garland Science. https://book.bionumbers.org/
[3] Giuliani L (2023) *Personal Communication,*
[4] Giuliani L (2024) Sistemi Complessi in Medicina (Complex Systems in Medicine) in press
[5] NOOA (2024) Magn. field strength calculator based on location:
https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml#igrfwmm

ICR-Coherence

Zhadin effect:

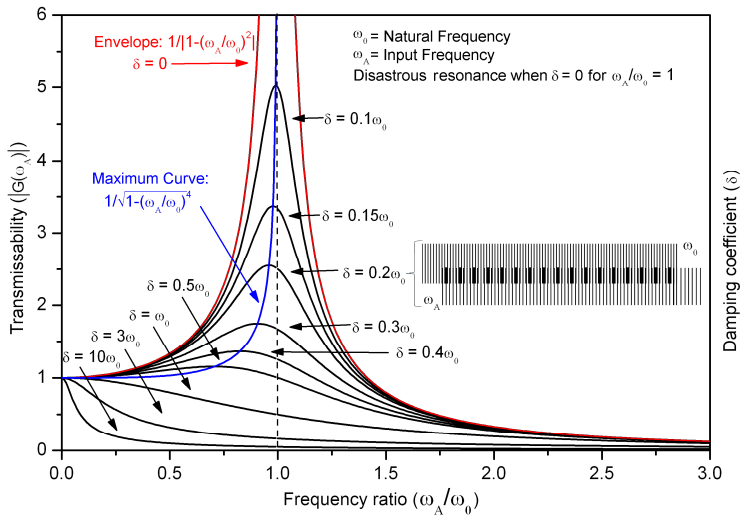
1. Attraction
2. Inclusion

$G(\omega_0)^* = 1/|1-(\omega_A/\omega_0)|^2$

Resonance assures that ionic species becomes trapped w/n "envelope"

Giuliani, 2024

*) beware of $G(\omega_0) = 1/0$!



Inclusion takes place by phononic (or possibly electronic) resonance between the frequency of the water molecules, ω_0, and the corresponding frequency, ω_A, of the attracted ion or zwitterion, which classically undergoes a momentum that is amplified or attenuated by a transmissibility coefficient G, a function of the phonon momentum of the CD molecules.
In the case of water, ω_0 and ω_A represent the frequencies of the phonon of the water molecules vibrating in unison in the CD and of the ion or zwitterion attracted by the CD. The abscissa is the ratio of these frequencies and the ordinate is the transmittance of the resonance pulse. In red is the convolution of the curves plotted for different values of the damping factor proportional to the eigenfrequency of the water, δ, in the limit for $\delta \to 0$; in this limit, as well as in the upper limit for $\omega_A/\omega_0 \to 1$, the transmissibility of the pulse becomes infinite.[4]

Image. Curves of transmissibility vs frequency ratio.[1] Increase of amplitude as damping decreases and frequency approaches resonant frequency of a driven damped simple harmonic oscillator.[3]. With damping coefficient being «0» resonance becomes maximal (disastrous resonance). With damping coefficient «>0» the transmissibility at resonance decreases. The Moiré pattern produced by the overlapping of two patterns of parallel lines (of slightly different spatial periods, slightly misaligned frequencies) result in a lower «beat» frequency.[2]

Source: [1] Ghatak A (2010) Optics. MacGrawHill, New York. ISBN 978–0–07–338048–3
[2] Ogata K (2004) System Dynamics, 4th ed. Prentice Hall, New Jersey. ISBN 0-13-142462-9
[3] https://en.wikipedia.org/wiki/Resonance
[4] Giuliani L (2024) Sistemi Complessi in Medicina (Complex Systems in Medicine) in press

ICR-Coherence

Zhadin effect:

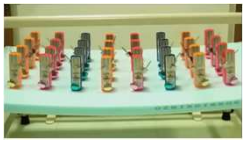
1. Attraction
2. Inclusion
3. Capture

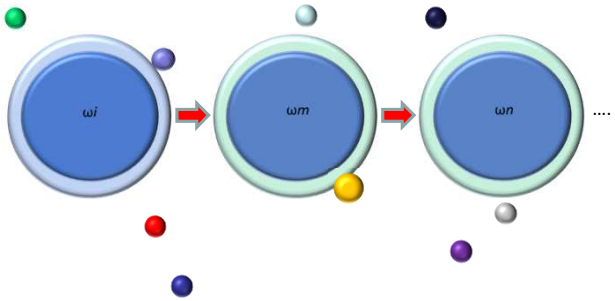
before $0<(\omega_{mol}- \omega_{water})^2 << 1$

during $\omega_{mol} \sim \omega_{water}$)

after $\omega_{mol} \cong \omega_{water}$

Del Giudice Preparata, 1994
Giuliani, 2024
Renati, 2024





Periphery of CD dotted with cations and ion-associated molecules acting as a fundamental oscillator (along with its harmonic vibrations) ….

Once an ion is captured by the CD, the resultant complex is not just the sum of the two constituting parts but something very different: it is a “mixed water CD”, where all molecules vibrate at the same frequency. If the frequency is related to the oscillation of the water nucleons, the trapped molecules simulate the water molecules and share and momentum modulus.[1] …. The formation of biological molecular aggregates (a proto-membrane) is feasible, as a collective process emerging from the dispersive dynamics arising from coherent quantum electrodynamics of water.[3]

Reaction: i) chemical reactions are frequency-based electro-dynamic selections. Two molecules oscillating with frequencies ω_1 and ω_2 within a region filled by an em-field oscillating with a frequency ω_{H2O} develop a very strong attraction when the three frequencies coincide. This long-range attraction replaces diffusion as the molecule interaction agent; ii) the energy output of the chemical reactions is released, because of coherence, as an excitation of the em-field trapped in the CD or as a released charge (typically electrons) with an associated momentum depending on the orbital motion in the coherent cold vortexes. When energy is exchanged by releasing/absorbing photons or charges (or even molecules) a corresponding shift of the CD frequency is produced, changing in turn the resonance conditions, i.e.: changing the molecular species able to be attracted now and opening consequently a new (bio)chemical step (possibly part of a cycle). Each chemical step is therefore launched by the outcome of the previous one. The possibility of an ordered array of (bio)chemical reactions emerges.[4]

CDs trap only those ions (and zwitterions) that have phonon absorption peaks close to those of water. This increases the information content (I) by decreasing disorder (entropy, S). The inclusion of the ion/zwitterion results in a more ordered state of the system (all molecules have the same momentum after capture). The system loses one degree of freedom, i.e. the number of possible states is reduced by $\propto 1$. ($\Delta S \rightarrow$ «–», $\Delta I \rightarrow$ «+»). This spontaneous decrease in entropy in favor of negentropy is essential to the emergence of life.

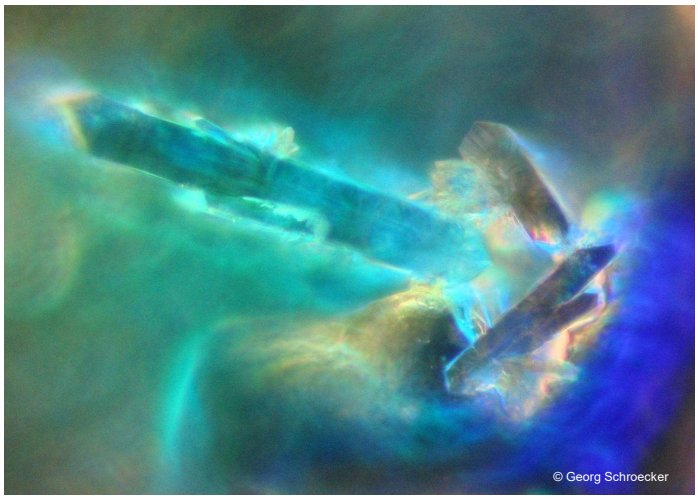
Image: Non-identical oscillators start out in phase with one-another, but lose coherence as the faster ones move ahead, and the slower ones fall behind. Identical oscillators instead converge towards a common resonance frequency (a simple coupling force that speeds up slower oscillators and slows down faster ones), until all oscillators resonate in phase. In the case of the synchronization experiment using 32 Metronomes, they all end up synchronizing.[2]

Source: [1] Giuliani L (2024) Sistemi Complessi in Medicina (Complex Systems in Medicine) in press
[2] 32 metronomes: https://www.youtube.com/watch?v=5v5eBf2KwF8
[3] Del Giudice E, Preparata G (1994) Coherence dynamics in water as a possible explanation of biological membranes, Journal of Biological Physics 20, 105-116. doi: 10.1007/BF00700426
[4] Renati P (2024) QED coherence in Condensed and Living Matter - Theoretical frameworks, experimental results, & epistemological implications. Kovac, Hamburg (FRG). ISBN 978-3-339-13994-8

Concluding remarks ….

…. the following is far from complete ….

…. In view of the paradigm shift ahead



Water sample taken from a spring in *Abtenau*, countryside of Salzburg (AT)
Spring water rich in Na^{+}, $Mg^{2+,}$ Ca^{2+}, SO_4^{2+}, and Cl^{-}; sold as mineral water to aid in digestive (intestinal) problems;
magnification: 400x darkfield

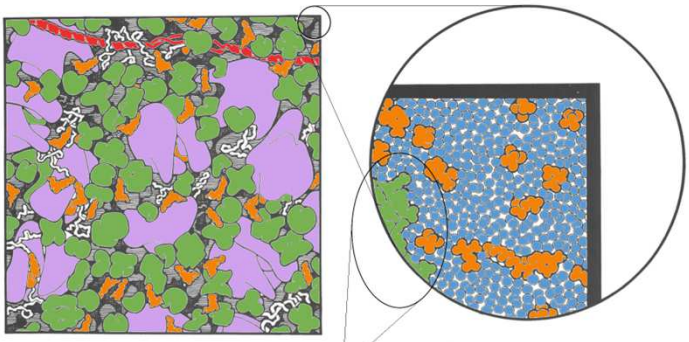
Source: Schroecker G (2017) Wasser lebt (Living Water) – see acknowledgement

Association-Induction Hypothesis

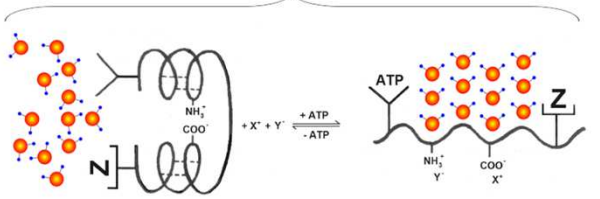
epi-*hydratic* de/activation of proteins

→ requires liquid water !

Ling, 2006
Edelmann, 2002
Bellissent-Funel et al., 2016



Coherence (CDs)	Folding pattern	Protein
↑↑	Unfolded tertiary structure	Non-functional
↓	quatenary folding structure	Functional



Decoherent water - active protein

Coherent water - deactivated protein

The original legend to the 2001 version reads: 'Diagrammatic illustration of how adsorption of the cardinal adsorbent ATP on the ATP-binding cardinal site and of 'helpers' including the congruous anions (shown here as 'adsorbed congruous anion' and Protein-X (shown as Z) unravels the introverted (folded) secondary structure shown on the left-hand side of the figure. As a result, selective K^+ adsorption can now take place on the liberated β-, and γ-carboxyl groups and multilayer water polarization and orientation can now occur on the exposed backbone NHCO groups. The resting living state is thus achieved and maintained.[1]
Image-Top: Schematic of the prokaryote *E.coli* at 50 k×-magnification showing the location of a 100 nm window with respect to the whole cytoplasm (containing proteins in many shapes and sizes, violet). Close-up of one portion of the crowded cytoplasm, highlighting molecules, including water (blue dots), small molecules (orange) and a small portion of a protein (green). Magnification: 1 M×.[2]

Image-Bottom: Diagrammatic illustration of how adsorption of the cardinal adsorbent ATP on the ATP-binding *cardinal site* and of 'helpers' including *congruous anions* (shown here as 'adsorbed congruous anion' and Protein-X (shown as Z) unravels the *introverted* (folded) secondary structure shown on the left-hand side of the figure. As a result, selective K^+ adsorption can now take place on the liberated *β*-, and *γ*-carboxyl groups and multilayer water polarization and orientation can now occur on the exposed backbone NHCO groups. The resting living state is thus achieved and maintained.[1,3]

Source: [1] Ling G (2006) A Convergence of Experimental and Theoretical Breakthroughs Affirms the PM theory of Dynamically Structures Cell Water on the Theory's 40th Birthday. In: Pollack JH, Cameron IL, Wheatley DN (eds) Water and the Cell. Springer, Dodrecht (NL) ISBN 1-4020-4926-9
[2] Edelmann L (2002) Freeze-dried and resin-embedded biological material is well suited for ultrastructure research. J Microsc. 207(Pt 1):5-26. doi: 10.1046/j.1365-2818.2002.01033.x.
[3] Bellissent-Funel MC, Hassanali A, Havenith M, Henchman R, Pohl P, Sterpone F, Spoel D, Xu Y, Garcia AE (2016) Water Determines the Structure and Dynamics of Proteins. Chemical Reviews Vol.116(13): 7673-7697

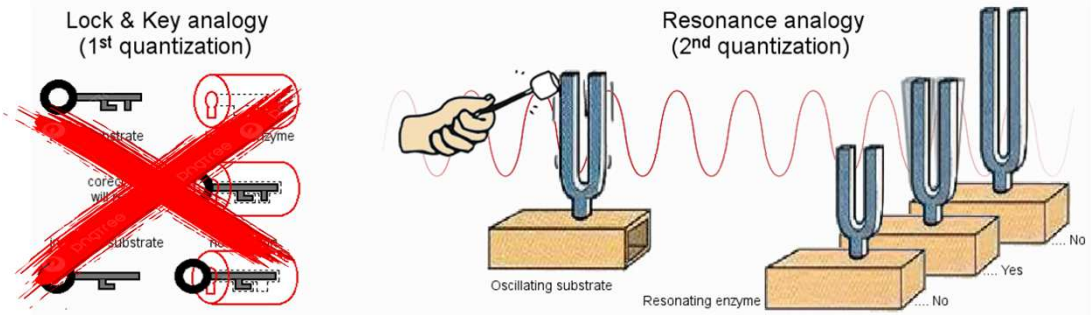
Implications

Protein dynamics

Substrate-Enzyme Recognition
in a densely-packed (crowded) cytosol ….
→ can only occur via long-range em-interaction
!

e.g. Insulin composed of 51 amino acids (~5.8 kDa)
diameter in quatenary structure: ~2.8 nm,
corresponding wavelength: ~5 µm.
equivalent range extension in 2nd Q: ~1k8-fold !

Herny, 2015
Fischer, 1894
Ophardt, 2003



Most scientists, particularly biologists, believe that all vital phenomena are material in nature. Staying at this primary level of classical corpuscular physics, one finds the lock-and-key paradigm enunciated by chemist Emil Fischer (1851-1919) quite convincing …. Anyone with any knowledge of physics however knows, that alongside visible matter, there are invisible fields underlying immaterial waves. Likewise, any self-respecting chemist knows that every molecule responds to stimulation by an electromagnetic field with a characteristic frequency spectrum, a veritable fingerprint by which it can be unmistakably identified. It's therefore astonishing that so many biologists find it hard to believe that an immaterial electromagnetic wave can act on a receptor in the absence of any substrate. The paradox reaches its climax when these same biologists mechanically press an RF-wave-emitting box to open their garage door! How strange that the purely immaterial mechanism that sets in motion a mass of several tens of kilograms, namely a gate, should be considered banal and perfectly normal on the scale of a house or garage, and completely ignored on the scale of a cell, as soon as it's a question of opening a nanometric channel. Why insist on seeing molecules as material when, according to the laws of quantum physics, they seem to be more wave than matter? Wouldn't it be more logical to replace the molecule by one of its characteristic frequencies to obtain the desired effect? [3]

Image: The founding dogma of molecular biology enunciated in 1894 by the German chemist Emil Fischer, along with a contemporary interpretation based on resonance.[1] ("*only with a similar geometrical structure can the approximation of molecules take place which is necessary to trigger the chemical process. To give you an idea, I want to say that enzyme and glucoside must fit together like lock and key in order to have a chemical effect on each other"*).[2]

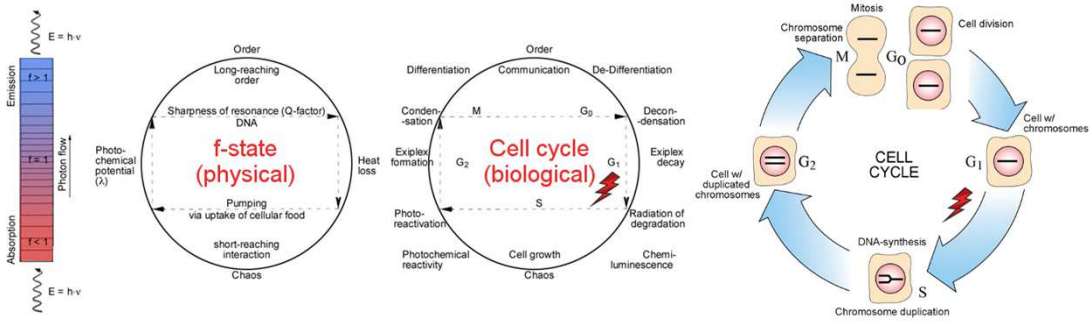
Source: [1] Ophardt CE (2003) Elmhurst College's Virtual ChemBook - Mechanism of Enzyme Action. https://web.archive.org/web/20230423213328/http://chemistry.elmhurst.edu/vchembook/571lockkey.html
[2] Fischer E (1894). Einfluss der Configuration auf die Wirkung der Enzyme. Berichte Der dt. Chem. Gesellschaft, 27(3): 2985–2993. doi:10.1002/cber.18940270364
[3] Henry M (2015) From Information to Exformation a story of vacuum, water or DNA? Editions Natur'Eau Quant, Strasbourg (FRA). ISBN 979-10-95620-03-7

Implications

Mitosis - Cyclic oscillation b/w coherence (entropy ↓) and decoherence (entropy ↑)

Requirements:
-) photon flash & doubling of chromosomal set
-) photons emitted during decoherence are temp. stored in adjacent cells
-) radiation used to “inform” (imprint) dividing cell with the prevailing epigenome

Popp & Nagl, 1983
Nagl & Popp, 1983



According to the Nagl and Popp model, the "coherent states" control the cycle of growth and differentiation according to the following pattern:[2,3] The G-phase, triggered by chaotic impulses (e.g. from dying cells = loss of information, disintegration of exciplexes. The field becomes increasingly chaotic, incoherent; a strongly increased biophoton emission can now be measured externally: Gurwitch's "radiation of degradation". The em-impulse must come from an individual signal, only incoherent photons can be growth signals. During reconstitution of the exciplexes (by supplying ordered energy from food), the chromatin condenses. the DNA is duplicated and the actual cell division begins. A completely new field structure is now created in the cell: the mitotic spindle is built up, the nucleus is divided, and finally two daughter cells are formed, which can now enter the differentiation process that is now beginning again. At that stage, the biophoton field has become coherent again, the resonator quality of the biological laser has increased again due to the expansion of the cell structure; the resonance tuning between the cells is good again. In a high degree of cooperation, the specializing cells are now assigned tasks according to the cell association to which they belong. This completes the cycle.[1]

Image Left: The exciplex model of DNA can be distinguished as:[2]

1. loosened regions with very heterogeneous base sequence (f<1), in which relatively few exciplexes are excited (heterochromatin);
2. intermediate with a relatively homogeneous base sequence (f=1), in which the photon density forces a strong condensation of the DNA (euchromatin);
3. again loosened, but strongly periodically structured areas in which the photon density (f>1) forces a high induced emission rate (lasering activity of heterochromatin). The photon flow thus runs from heterogeneous to homogeneous and back again.

Image Center: The negative feedback between order (f>1) and chaos (f<1) is evident at all levels of organization, including the cell cycle. The G_0 phase corresponds to the ordered structure organized in the association. Due to chaotic impulses from outside, this structure disintegrates, measurable in increased ultra-weak cell radiation. The exciplex decay is finally reversed by the supply of ordered energy (food). Cell division thus takes place in a predominantly individualized (chaotic) phase, while cell differentiation (f>1) obeys an ordered regime.[3]

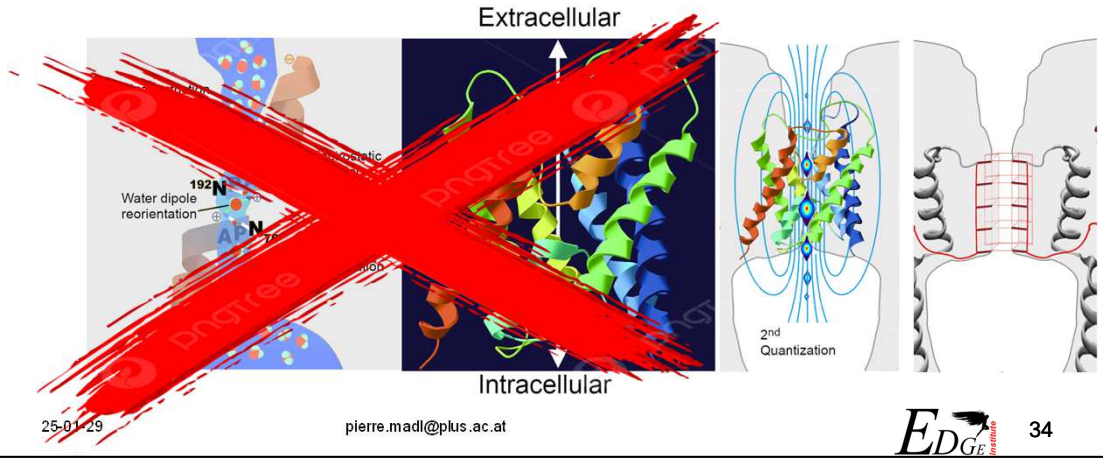
Source: [1] Popp FA (1984) Biologie des Lichts – Grundlagen der ultraschwachen Zellstrahlung (Biology of Light – Fundamentals of ultraweak Cell Radiation). Paul Parey, Berlin (FRG). ISBN 3-489-61734-7
[2] Popp FA, Nagl W (1983) A physical (electromagnetic) model of differentiation. 2. Applications and examples. Cytobios. 37(146):71-83.
[3] Nagl W, Popp FA (1983) A physical (electromagnetic) model of differentiation. 1. Basic considerations. Cytobios. 37(145):45-62

Implications

Transmembrane proteins (TMP) – the case of Aquaporins

rather than mechanical switches, TMPs perform electrodynamic gating

Kozono et al., 2002
Del Giudice et al., 2015
Salari & Alaei 2010
Henry, 2016)



25-01-29 pierre.madl@plus.ac.at EDGE Institute 34

Schematic architecture of the channel within an AQP1 subunit (sagittal section seen within the 1st quantization). Individual water molecules are routed on a particle-per-particle bases through the bottleneck of the channel. Ribbon diagram of the structure of an AQP1 subunit (sagittal section, center) highlighting the alpha helical section of the proteins constituting the bottle neck area of the AQP1. Schematic vision of an AQP subunit within the 2nd quantization, whereby this folding pattern act as resonating helical antennas that is tune exclusively to the water-molecule's resonance frequency in such a way as to enable only water to pass. The em-based filtering property derived from the QED principle of resonant attraction). In this concept molecular species differing in resonance frequencies of the aquaporine helical resonators are electrodynamically repelled.[1-3]

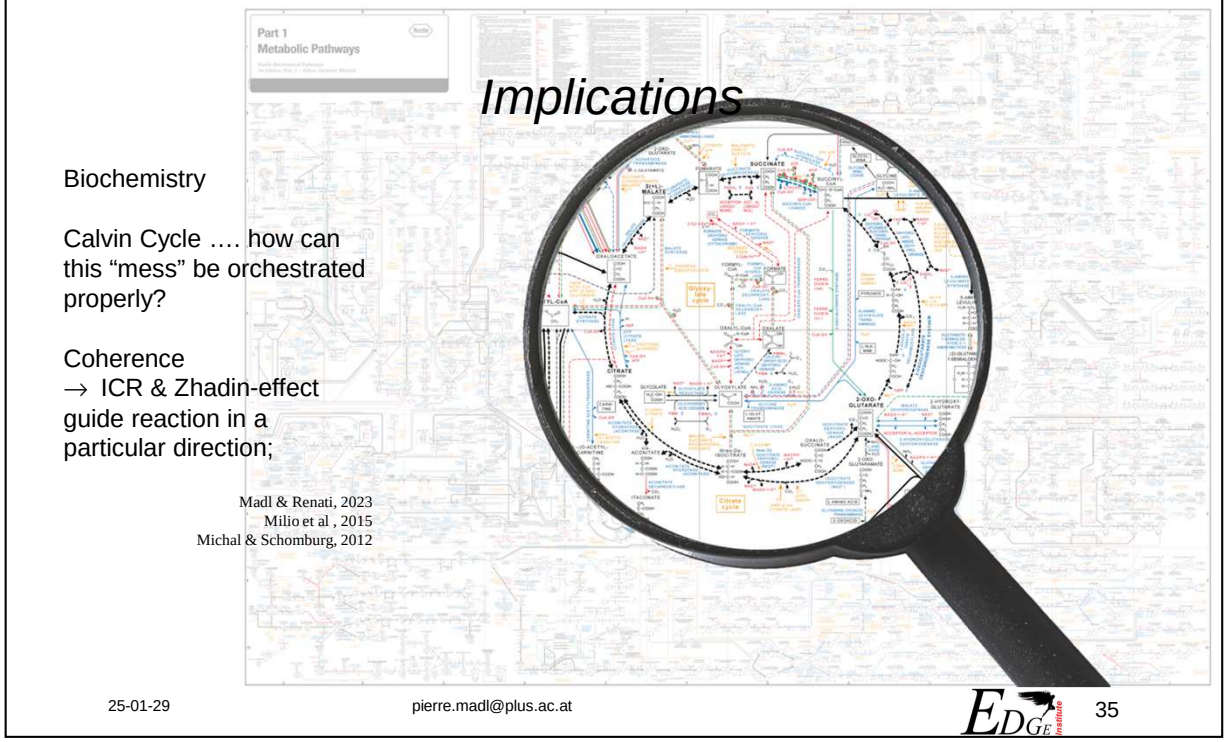
Image: In order to ensure that only the water molecule passes through, the aquaporins all have an ar/R constriction site (Figure 51) formed by an aromatic residue facing an arginine residue (R) which for AQP1, the main aquaporin of the brain, has a diameter of only 2.8 Â. Knowing that the water molecule has a slightly larger diameter of 3 Â, one would expect that the passage of water would be a long and painful process for the water molecule. In fact, this is not the case, and measurements show that about 2 billion water molecules pass through the channel every second, so that water diffuses faster in the aquaporin channel, with a diffusion coefficient Dw = 18 10^{10} m^2 s^{-1}, than in liquid water at 5 °C where Dw = 13 10^{10} m^2 s^{-1}. In fact, each aquaporin has its very specific channel. Figure 52 shows some topologies for the best known and best characterized aquaporins to date.

Source: [1] Kozono D, Yasui M, King LS, Agre P (2002) Aquaporin water channels: atomic structure molecular dynamics meet clinical medicine. J Clin Invest. 109(11):1395-9. doi: 10.1172/JCI15851.

[2] Del Giudice E, Voeikov V, Tedeschi A, Vitiello G (2015) The origin and the special role of coherent water in living systems. In: Fels D, Cifra M, Scholkmann F (eds), Fields of the Cell. Signpost, Kerals (IND). ISBN: 978-81-308-0544-3

[3] Salari V, Alaei M (2010) Ionic Wave Propagation as a "Matter Field" between Excitable Cells. Conference on Fields of the Cell, Basel (CH)

[4] Henry M (2016) L'eau et la physique Quantique – Vers une revolution de la medicine. Dangles, Escalquens. ISBN: 978-2-7033-1147-8



One of the most difficult aspects of molecular biology to understand has always been the fact that biochemical processes occur with incredible efficiency, an extraordinary degree of precision and timing. This capacity for biochemical activity also allows living matter to express one of its most challenging properties that cannot be simulated in vitro, namely the ability to perform chemical reaction cycles that are perfectly selected from a large number of educts that are present together in the cellular landscape – a good example is the Krebs or Calvin (tricarboxylic acid, TCA) cycle. How can this be explained? [3]
Once the reactive species have been brought together and activated, the water CD catalyzes the biochemical reaction (typically an oxidation-reduction reaction) by releasing electrons (which in the coherent phase occupy states close to the ionization threshold and are therefore readily released at charges below 0.4 eV or by emitting field quanta in the form of biophotons. However, this mediation implies a change in the state of the CD with a consequent change in its own frequency, whereby this CD is now capable of attracting other reagents, thus enabling a second reaction step, forming a cascade to give birth to the above-mentioned TCA cycle.[3]
These reaction paths (guided by the sequence of vibrational modes of the coherent fraction) are deterministic and by no means random. On the other hand, they are also unpredictable, since they are determined by (i) the preceding overall thermodynamic history at a given time, (ii) the coherent configuration of the CD at that time, and (iii) the current boundary conditions such according to the available reagents and their concentrations, ambient fields, phase correlations, macroscopic thermodynamic variables, etc. These reaction paths influence the modulation of the natural frequencies of the CDs and thus the way in which a given input is converted into an output. [3]
The employed frequency range of these modulations is currently centered around the ELF to MF range (few Hz to MHz range). Thus in terms of biocompatibility, the employed frequencies in that range are able to couple to biological relevant oscillatory pattern as those found in the TCA cycle, that range from 0.7-9 s in *E.coli* and 4-30 s in *S.cerevisiae*, which correspond to frequencies within the ELF/SLF-range.[1]

Image: Metabolic Pathways of the Prokaryotic cell – highlighted: the Citrate and Glyoxalate Cyle.[2]

Source: [1] Milo PR, Phillips R, Orme N (2015) Cell Biology by the Numbers; Garland Science: New York (NY); ISBN 978-0-8153-4163-5;
[2] Michal G, Schomburg D (2012) Biochemical Pathways. An Atlas of Biochemistry and Molecular Biology, 2nd ed. Wiley & Sons, Hoboken (NJ). ISBN 978-0-470-14684-2. https://biochemical-pathways.com/ (accessed. Dec.’23)
[3] Madl P, Renati P (2023) Quantum Electrodynamics Coherence and Hormesis: Foundations of Quantum Biology. Int J Mol Sci. 24(18):14003. doi: 10.3390/ijms241814003.

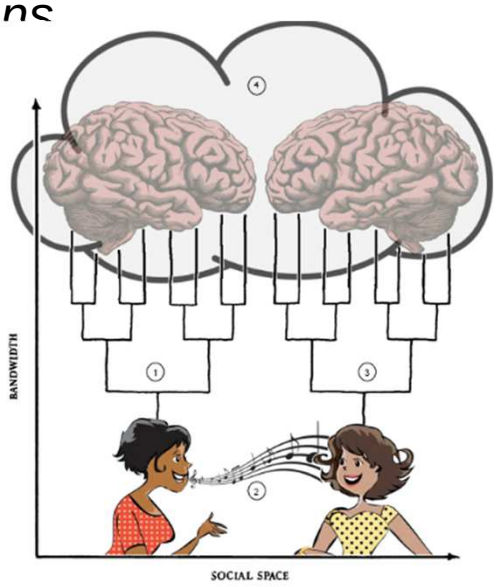
Implications

Exformation rather than Information

(1) gathering thoughts, emotions, feelings & compressing them into few words;
(2) Sender: eliminating information to make them transmissible;
(3) Receiver: received message is used to generate a bifurcation pattern via exformation;
(4) phase coupling of neuronal processes induces coherence among those brains;

→ entangled brains act as a single unit (!)

Norretranders, 1998
Dotta et al., 2012
Henry, 2015



The tree on the left symbolizes one of the two interlocutors, who has to think about what to say. All the intermediate steps corresponding to a path in the tree must be eliminated in order to summarize an experience, an emotion or a memory (top of the tree). Once this mental work has been completed, we arrive at the trunk of the tree, made up of just a few words that will be injected into the communication channel. During this compression stage, a lot of information has disappeared, resulting in a very rich exformation with a logical depth that is all the greater the more branched the tree. Following this communication, the person on the right receives what we might call an excitation. This excitation will force him to develop another binary tree, which will evoke in him a whole set of memories, dreams and emotions that he shares with his interlocutor and which will enable him to decipher the exformation that has remained in his interlocutor's head. This can be summed up in the diagram incitement (loss) → communication (transference) → excitation (evocation).

Image: The two "Self's" operating at very high bandwidth (cognitive level) must constantly adapt to the consents exchanged by the narrow bandwidth limitations (vocal level). The sender condenses a great mass of information (1) into a very small amount of information in the form of what will eventually be expressed (2). From the context, the receiver revives a mass of information (3) corresponding to what was not conveyed by words. In this way, the sender can create exformation by abandoning information, transmitting the resulting information and seeing a quantity of buried exformation resurface in the receiver's head. Successful communication gradually aligns the phase angle of the oscillatory patterns of the brains involved to enable coherence to take place (4).[1] Once this happens, the two brains can be considered as an enlarged coherent unit that remains established for quite some time even if the conversation has already finished.[2]

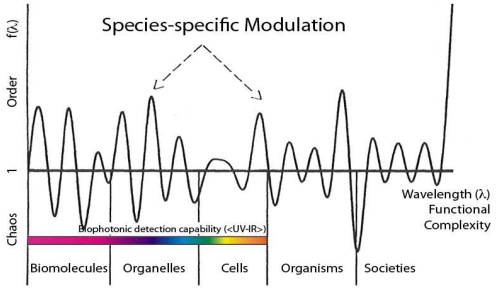
Source: [1] Norretranders T (1998) The User Illusion: Cutting Consciousness Down to Size. Viking Adult, New York (NY). ISBN: 978-0670-875-79

[2] Dotta BT, Saroka KS, Persinger MA (2012) Increased photon emission from the head while imagining light in the dark is correlated with changes in electroencephalographic power: support for Bókkon's biophoton hypothesis. Neurosci Lett. 513(2):151-4. doi: 10.1016/j.neulet.2012.02.021

[3] Henry M (2015) From Information to Exformation a story of vacuum, water or DNA? Editions Natur'Eau Quant, Strasbourg (FRA). ISBN 979-10-95620-03-7

Implications

Gurwitch's Legacy reinterpreted w/n contemporary physics



*) the best form to do economy is ecology (copy & comprehend nature) Schauberger, 1933

List is far from complete – being fractal in principle, list can be extended indefinitely ….

	1st Quantization	2nd Quantization
Physics	particle centered	wave centered
Chemistry	Stick & ball	Energy wells
Biology	Neo-darwinistic	Lamarckian
Virology Bacteriology Cancer	combat	re-integrate
Medicine	ordinary med. treatment (supress symptoms)	holistic approach (source oriented)
Economy*	Competition	Cooperation
Productivity	GDP (monetary values)	Common goods
Sociology	Individual	Collective
Sport	Olympics	relat. dance
Leadership	Superheroes	Collective efforts
Politics	Nation building	UN "2.0"
Military	Primacy of state power	In service of humanity
Religion	Monotheism	"Buddha"
	↓	↓
	Decoherence	Coherence $\Delta N \cdot \Delta\varphi = ½$

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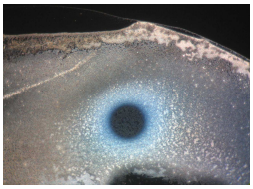
From biomolecules via organelles to cells organs, organisms and society (ecosystems - macroscopic coherence around the f-state): new data and its interpretation considerably expanded this concept, since whole organisms and even their communities turned out to be similar "constellations" .... It turned out that there is a strong deviation of spectral distribution of BPs from radiation of inanimate objects, - the ideal example of the latter is "black body radiation". BP-emission intensity is in the first approximation constant within the whole range of its detection - from UV to red light. That means that occupational probability of all energy levels - from electronic to translational ones - is practically the same, as if a living system has a tremendously high inter- and intramolecular "temperature" .... Living organisms emit coherent and very weak light in the higher wavelength range. *Gurwitch* had proved that ultraviolet photons carry out important function - they trigger cell division. And what is the function of BPs belonging to other parts of the spectrum? .... Ultra-weak photon emission in the range from UV- to near IR of electromagnetic spectrum from living cells and chemical reactions in aqueous media (i) affect activity of enzymes (i), activity and morphology of cells and tissues (i), regulate locomotion and mutual orientation of cultured cells (i). Back reflected photons emitted during respiratory burst in human blood affect the intensity of this immune reaction by a feed-back mechanism.[2]

Image: A different view of the previous slide is shown here. The MGF in BP bridges the explicate orders of bio-molecules all the way up to societies. From Cell to Organism and beyond: Abscissa: "1" represents the Balance of Operation (homeostasis) - from left to right: Functional Complexity. Not only tissues and organs are tied together to form an organism, also members of a group, of a culture, a society. [1]

Source: [1] Popp F.A., 1992: Evolution as the Expansion of Coherent States; Ch.21; in Popp F.A., Li K.H. Gu Q., (eds) Recent Advances in Biophoton Research and its Applications; World Scientific Publishing – Singapore;
[2] Voeikov VL Beloussov LV (2007) From Mitogenetic Rays to Biophotons. In: Beloussov L., Voeikov V, Martiniuk V. (eds), Biophotonics and Coherent Biophotonics and Coherent Systems in Biology. Springer, Heidelberg, FRG.
[3] Schauberger V (1947) Our Senseless Toll. PKS (ed) River – Interactive CD, Laufen (AT)

Thank you for your attention !

Acknowledgement:
DI *Georg Schroecker* for the teaser images



https://web.archive.org/web/20160709162854/http://wasser-lebt.at/index.php?id=1

Living water: Take a look at Georg Schroecker's hobby. For several decades he has been trying to fathom and understand the fascinating processes of nature. Inspired by the magnificent life's work of the forester and naturalist Viktor Schauberger, he immersed himself in the world of water and what it means to "move it naturally". In doing so, he became aware of the world of water, its beauty and its subtle powers, which - at least for those who learn to see them - reveal a hidden dimension that many have not yet perceived. A drop of water on a object slide, when dried, reveals under the microscope extraordinary patterns of crystallisation. This simple experience was the beginning of a journey into the secrets of one of the most important primary substances of life: water. The images shown here are intended to provoke thought and respect for the wonders of nature. The scientific works published on water are still unable to grasp this wonderful facet of water, leaving a vast field largely mysterious and unexplored. Perhaps scientific and technical knowledge has reached its limits in the current paradigm, which means that it is time to open up to a vision that makes room for the relational dimension. In essence, our judgmental interpretation of these images remains solely the result of subjective perception.

Sample: water samples taken from a mountain spring (*Granitzl*, Mariapfarr, countryside of Salzburg, AT) approx.1500m above sea level.
magnification: 40x darkfield

Source: Schroecker G (2017) Wasser lebt (Living Water):
https://web.archive.org/web/20160709162854/http://wasser-lebt.at/index.php?id=1