

The Well-Tempered Biological Physics

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I

On the Cause of Molecular Function

Theory of channel-like "blinking" at single molecules.

Single molecules are proven to be the material cause but not the efficient cause of biological functions. The "causa efficiens" is proven to be the law of entropy in Einstein's superior formulation. Exactly following the physical origin of Brownian motion and diffusion, and of the fluorescent emission of photons after Einstein's entropy-based quantum theory, the channel-like "blinking" of the quantum yield results from the same causa efficiens as does the channel-like "electrical noise" of membranes. Hamiltonian fluctuations result for the same reason, explaining the spectral jumps observed at single molecules. These phenomena are inexplicable by the hitherto Copenhagen interpretation of quantum theory. Experimentally, single enzyme induced channel-like fluctuations in lipid bilayers and in single hydrolytic reactions are predicted in detail. Acetylcholinesterase and the cholinergic excitation of nerve by catalysis of acetylcholine are established: Visualisation by single molecule study in optical patch clamp is now predicted.

The key idea is to assure the impossibility of the violation of the second law of thermodynamics from the start. Probability is a physical reality then prior to any view-point of the observer. It is even prior to representation in time and space. Any observable n_i is merely an argument of that probability $W(n_i)$. It is impossible to realise any machine that, without manipulation, reproducibly alters this probability. Probability is not plausible, in contrast to view-points i , so observers have constructed such machines based on other principles than probability $W(n_i) = \exp S(n_i)$. Entropy S is scaled on the proper Boltzmann constant. To assure this principle in statistical physics, it is not sufficient to supplement a Boltzmann factor $\exp(-\text{energy}/kT)$ because probability law is not assured from the start. The consequence then is that the universal validity of this law of probability is no more seen, the view-point of the observer dominates the theory although no fundamental law of nature does depend on the view-point of the observers, the meaning of temperature T is reduced to a mean, and, basically, the key second law is lost by thinking in terms of energy or matter or the historically first law of thermodynamics. Planck never was tired to stress this point, although judging such error impossible to abandon. Einstein has based all of his statistical theories on this inversion, placing entropy first as an analytical potential $S(n_i)$, and never choosing the view-point of the observer as a foundation of physics but only to check the validity of the theory.

The proper entropy $S(n_i)$ now unifies the "living" as it did the "non-living". Hydrated single molecules do possess proper entropy that may be imagined as interfacial. The consequences of the second law of thermodynamic do therefore unify the observed n_i with the result that the thermodynamic forces and the well-observed thermodynamic fluctuations of single molecules unify or embrace so different view-points n_i from nanotechniques and spectroscopy that this evident consequence of the most fundamental law in physics appears paradox to any other theory starting in contrast from the observed view-point n_i . This is the reason why single molecules exhibit fluctuating Hamiltonians in contrast to quantum mechanics, and "channel-like" quantum yield, since aqueous interfaces of membranes exhibit proper entropy $S(n_i)$, too, even though there electrodes will see them first in history.

References: Boltzmann Einstein Bohr Schrödinger Wigner Eyring Eigen Orrit Rigler Xie

II

On the Excitation of Surfaces

Proper interfacial entropy does explain "living" excitations.

Proper entropy is introduced as foundation of surface science in biology. This is made possible following Einstein's method. Excitable "2D worlds" indistinguishable from "living" excitations are proven to be the result, in chemistry and in physiology. The theory is applicable to reversible biological and artificial interfaces. The theory generalises to biological interfaces Einstein's statistical theories of molecular motion, of quanta, and of critical phenomena. The "living" can thus be explained on the basis of physics alone, given proper entropy is the first principle of the theory. The failure to explain the "living" instead by Boltzmann factors and energy landscapes is thus attributed to the too narrow interpretation of the second law of thermodynamics.

The point is here that, as in single molecule studies, proper entropy $S(n_i)$ of the interfaces assures the validity of the second law and the impossibility of any perpetuum mobile. There are no particular mechanisms for particular observables n_i , such as Newtonian for mechanical or Bohrian for optical. Matter or energy or Hamiltonians are variables n_i even if conserved in an ensemble. This foundation of surface science is unifying biology by the presence of aqueous interfaces. Alike in all liquid-crystals, entropy $S(n_i)$ and consequent forces $dS(n_i)$ and also fluctuations related to d^2S/dn_i^2 are therefore ubiquitously observed. Entropy, forces, fluctuations have in "3D" been fully explored already. They unify all observables, there by the analytical potential $S(n_i)$. This foundation explains by entropy, forces, and fluctuations the excitation, propagation, and noise of signals. No paradox remains, although for example molecular Brownian motion from time-space view points gives no clue, except $S(n_i)$, to the ordered propagation of sound and its excitation by a musical instrument. In "3D" observers have rather accustomed to this thermodynamic foundation than to find it more plausible than, say, the view-point of mechanics. This subjective limitation is even more obvious in biology of "2D" aqueous interfaces, because there, Einstein's "entropy first" foundation of statistical physics on proper entropy $S(n_i)$ had not yet been introduced.

The consequences in the living and the non-living are the same. $S(n_i)$ did unify in Einstein's theories Brownian motion, quantum statistics, matter-wave nature of light, critical fluctuations, spectroscopic absorption and emission, or condensation of ideal gases, apart from the crucial lesson from the independence of fundamental laws on the view-point n_i of the observer, for relativity and the most plausible but paradox nature of time and space. The same theory now of proper entropy $S(n_i)$ does unify the biological physics of single molecules, aqueous surfaces, biosensors, charge transfer, catalysis, DNA, membranes and synapses, robust cells, and even of the human brain. This seems revolutionary. But, as in detail presented in the corresponding symposia, it is the same unification that Einstein already achieved in the non-living, based on the lesson from the impossibility to violate the second law of thermodynamics expressed as entropy $S(n_i)$. Surface science does observe thus the foundation of the living on entropy, forces, and fluctuations, and the phenomena of excitation, propagation, and noise in all its observables.

References: Laplace Gibbs Einstein Langmuir Landau Pauling Hodgkin Watson Helfrich

III

On the Sensation of Tone

Biosensors in hearing with application to music.

Physiological receptors and artificial biosensors are predicted from the proper entropy of interfaces. Their Darwinian optimum is exactly predicted and compared with the observed physiological receptors for the peripheral and synaptic stimuli. The laws of sensory receptors at phospholipid bilayer membranes are deduced from the Boltzmann principle following Einstein's procedure. Optimisation of mechano-sensation after the thermodynamic theory correctly predicts the structure of the hair cell. Optimisation of aqueous chemo-sensation after the same theory predicts the established mechanism at the cholinergic synapse: acetylcholinesterase and the proton-induced excitation of the lipid bilayer. The theory of hearing is discussed. Helmholtz' physiological theory of music is confirmed and founded on conservation of proper excitation entropy in the inner ear, in the eighth nerve, and also in the auditory cortex. Musical consciousness for time and rhythms as well as for tone and harmonics is deduced. The same conservation law is known in "3D" for sound in air, continued now in "2D" for proper entropy. This reversible theory of biosensors in hearing confirms the theories of Helmholtz and of Descartes and does answer crucial Aristotelian questions on the theory of music.

The key to these results are Einstein's statistical theories. Following the procedure introduced for single molecule studies and surface science, proper entropy $S(n_i)$ predicts sensors for any "2D" observable i to be optimal if proper excitation $d n_i$ of the interface is optimised. Biosensors in the peripheral sensory organs therefore prevent access of other variables j except i , otherwise sensory illusions are the consequence. Acoustics in 3D then excites 2D optimally if the interface is displaced point-like. The hair cell in the inner ear is the Darwinian optimum. Mechanoelectrical coupling is evident, and in phase as observed. In other words: sound is thermodynamic, and optimally thus sensed by the membrane interface. Vision is on the other hand optimised by optical modes in the interface. This prediction explains free energy storage in photosynthesis and is compatible with dark currents in the photoreceptor. Excitation by aqueous chemistry proves optimal by catalytic protons. This is realised at the electric organ and in reconstituted cholinergic synapses. Taste is sensible to acid, too, and olfaction therefore distinguishes HOH from HSH, inexplicable by other theories. But the brain is crucial in sensation, of course.

Hearing proceeds by the law of proper entropy. Coupled in the inner ear, propagated by the forces $dS/d n_i$ that explain nervous conduction, hearing and the theory of music do follow from an exact argument made from entropy conservation in the brain. This argument is presented in detail below. Briefly, only three principles restore conservation in the brain: $\leftarrow \leftarrow$; $O \leftarrow$; $O O$. These originate axons; synapses; images. And; Or; Not. Evidence; doubt; ignorance. Applying to the aspects such as impulses of sensation, these three principles explain in detail the nature of perception and of composition of music. From pitch recognition $\leftarrow \leftarrow$ and required variation $O \leftarrow$ the theory proceeds till the analysis of the compositions of Bach or Jobim. In conclusion: the physical principle of biosensation in hearing exactly predicts three principles of brain function evident in music.

References: Aristoteles Descartes Helmholtz Ramon y Cajal Tasaki Rigveda Bach Jobim

IV

On the Control by Protons

Proton fluctuations and charge transfer in protein-lipid membranes.

The Darwinian optimum of charge transfer in aqueous interfaces is proven from first principles of thermodynamics to be protonic control. Proper entropy, reversible forces, and the thermodynamic fluctuations are calculated given proper interfacial diagrams of state. For example, the squid giant axon impulse carries up to 10^{11} protons of 10 to the power minus 13 kcal free energy vice proper entropy. The protonic control of synaptic transmission of nervous impulses at synapses is proven theoretically and experimentally. Proper entropy of the interfaces is therefore the key in charge transfer, while free energy landscapes for ion transport are subject to "earth-quake" fluctuations due to the probability foundation of entropy. This is the origin of the impossibility to observe in reality the results of Newtonian simulation programs in molecular dynamic simulations. The observations on water channels and potassium channels are explained in the light of these results. The theory predicts observable and far-reaching conclusions for active and passive charge transfer across membranes, at DNA, proteins, for the rôle of catalysis, and of protonic control of phospholipid bilayer membrane functions. It is discussed what rôle is played by the optical modes and by the photo-electric couplings in proton-controlled aqueous interfaces, in comparison to photo-reaction centers and sensory photoreceptors. The physical origin of synaptic transmission by acetylcholine is in detail presented again. Observations with Hanke and Silman are reminded. The cholinergic transmission and postsynaptic excitation is caused by the specific protonic control of the phospholipid membrane fluctuations. The Darwinian optimum of this physical foundation of synaptic transmission is realised in the electric organ of the electric eel from Amazon. It is the richest source of the fastest protonic control system ubiquitous in the nervous systems of the animal kingdom, and the optimal protein is that with the most specific activity called acetylcholinesterase.

The key to charge transfer in membranes and at biomolecules is the proper entropy of the aqueous interface, $S(n_i)$. The meaning of entropy has been formulated by Einstein and is superior to any other models supplemented by Boltzmann factors. This is so because all observables n_i do fluctuate according to d^2S/dn_i^2 , and all participate in signal propagation due to the forces dS/dn_i , so each observable i can excite, by dn_i , to various degrees the biological interface. This is observable since recently only. The physical reality of charge transfer is thus paradox against models based on observables, supplementing probability law later, and thus absent entropy $S(n_i)$ except for global average observation. Protons are optimal. They cannot be buffered from the aqueous volume. nH^+ is an interface variable, excitation dS essentially protonic. This is directly observed when pH dependence is made observable. Charge transfer of protons and alkali ions in catalytic and non-catalytic transport physically observed directly, does confirm the theory of proper entropy.

References: Einstein Hodgkin Onsager Eigen Träuble Luzzati Mitchell Skou Silman Hille Nagle Agre MacKinnon

Theory of Catalysis

On the physical origin of catalysis.

The theory of catalysis deduced is the consequence of the second law of thermodynamics in Einstein's formulation. The origin of catalysis is nothing but the systematic consequence of Einstein's statistical theories for the proper entropy of interfaces, once reactive adsorbents come into the "entropy game". The most famous paradoxes of catalysis are solved, and the question is answered: How does catalysis come about? Exact predictions for optimal catalysis are confirmed by properties of carbonic anhydrase. Horseradish peroxidase, acetylcholinesterase, alcohol dehydrogenases support the theory. The key-lock paradoxon, the proton-tunnelling paradoxon, isotope and solvent effects confirm the new theory of catalysis. The failure of the theory of quantum transition states in explaining the cause of catalysis is attributed to the Copenhagen interpretation. It is proven that the interpretation of quantisation of energy $h\nu$ in terms of averaged kT is too narrow-minded, that is, it is in terms of energy instead of action vice entropy. The cause of catalysis is identified only now, despite of the correct focus on heat and thermodynamics in history. The cause was missed by First-Law-like formulations of the *causa efficiens*: the Second Law of Thermodynamics in Einstein's superior formulation. The rôle of proper entropy as *causa efficiens* of catalysis is identical to the rôle of bulk entropy as *causa efficiens* of diffusion. In both cases, molecules, macromolecules, solvents in Newtonian or quantum mechanical description do not provide the *causa efficiens*, but the inert, passive *causa materialis* only. This material cause, although unable to explain catalysis, is however the origin of considerable evolution in the living, caused by catalysis, and the thus evolved complexity of catalysis caused as consequence of the simple law of proper entropy.

Diffusion is the simplest example. The law of probability is independent of the observer's time and space view-point. It causes fluctuations. Preparing the improbable, the law of entropy causes reversible fluctuations. The observer's view-point imposes means in time and space. This is Einstein's fluctuation-diffusion relation for Brownian motion. Catalysis is another example. The law of probability is now applied to the interface, and the observer's view-point even more remote from the proper entropy $S(n_i)$ except until recent observations. Preparing the improbable, now by adsorption of a reactant to the interface, which in addition changes the state and thus the function $S(n_i)$, consequences arise that are mysterious to the observer in the bulk. Just as "boiling" water better cooks the meat, adsorbent-induced "pK" optimises fluctuation and mean rate of its aqueous reaction. Just as specific critical points diverge fluctuations only there, only specific adsorbents optimise the rate. This example is called "catalysis" by the observer. The theory is confirmed by single molecule experiments and by the solution of the paradoxes of the hitherto transition state theory. A detailed application of this theory is presented to the origin of chirality, the optimisation of complex catalysis by acid sequences, and their optimal folding upon synthesis of proteins and DNA.

References: Berzelius Ostwald Fischer Haldane Polanyi Wigner Eyring Boyer Marcus Zewail Fersht

Why Acid Sequences

Acid sequences, the Darwinian optimisation of the physical origin of complex catalysis.

By exact methods, it is proven that the Darwinian optimum of complex catalysis predicts acid pK linear sequences in complex fluctuating acid interfaces. The evolution of acid sequences crucially confirms the novel theory of catalysis, of proper entropy as its cause, and of its optimum at the specific pK's in aqueous molecular surfaces. Linear "1D" sequences are required to obtain optimally specific complex catalysis of macromolecules. "2D" fluctuating surfaces are not sufficient. This result is exact and therefore strongly suggests to reconsider steric concepts of complex catalysis. Steric concepts furthermore impose Euclidian space, rendering chirality a mystery. Our theory does not impose that limitation. In fact, biaxial interfaces are inevitable in polar solvent. Proper entropy by necessity imposes reversible fluctuations "left" and "right" originating following Einstein's method irreversible mean rates and also chiralities. This effect is already observed in "2D" topologies, e.g during the nervous impulse. It is most famous, since most dramatic in Euclidian space, for "1D". The Watson-Crick Helix reminds the unanswered paradoxon: Why right-handed? Why left-handed? What is the origin of chirality? In this novel theory of catalysis, entropy is "a priori" and space "a posteriori" and the paradoxon disappears. Space itself is catalysed and function can no more be reduced to the representation in Euclidian space. The theory of catalysis caused by proper entropy does generalise Einstein's theories, not only Brownian motion in "3D" and of rates in "time" of diffusion and of catalysis in "2D". Probability, but not space and time, is the nature of the law of catalysis. Optimal "critical" fluctuations explain the specificities and the optimal folding upon fluctuating catalysis. Thus, the most complex specificities are predicted at pK sequences in "1D" requesting care for the meaning of "pK" if measured by titration instead of fluctuation. The theory imposes thermodynamic instead of Newtonian premisses as condition on dynamical models of DNA structure and function. It does use the method of entropy successful for predicting genetic structure since Schrödinger's monography "What is Life?" This novel theory however generalises the static prediction from entropy of "aperiodic crystals" to dynamics and catalysis of considerable complexity. It has to be expected that this new view-point will solve more paradoxes in genetics, as far as caused by the view-point of the observer on replication in "space-time". The simple physical law of proper entropy has allowed already exact conclusions for the optimal biological macromolecules and the functional fluctuations of DNA in complex catalysis.

Einstein's physics when applied to aqueous interfaces does provide the origin of the living. The law is simple and efficient. The matter is increasingly complex to which it applies. And the view-point of the observer is creating paradoxes. Still, as in the non-living, this law is independent from view-points. It does therefore unify the living even where it is most complex: in genes and, as follows, also in brains.

References: Schrödinger Pauling Watson Crick Monod Eigen Luisi Ventor Fersht

VII

Theory of Nerve and Synapse

The physical origin of the nervous impulse.

The reality of the nervous impulse cannot be related to the theories of channels anymore since the discovery of the historical limitations of electrical observations as opposed to the physical reality of the nervous impulse. The ubiquitous observations of the inseparable electrical, non-electrical, and in fact thermodynamic properties of the nervous impulse, do impose the following physical origin. Proper entropy determines the excitation, the reversible Einstein forces in the layers correctly predict the propagation and the nature of the impulse. The associated thermodynamic fluctuations do explain the channel-like fluctuations, related to the forces that explain the nerve action potential thermodynamically via the entropy derivatives, just as in the Brownian motion during the propagation of musical sound by the forces. The pioneering observations of Tasaki and Hodgkin are explained. The paradoxes of hitherto theory are solved. Still, the mathematical form of the Hodgkin-Huxley model is reobtained, once taking the view-point of electrodes on the law of proper entropy. The history since Galvani is in every detail presented. It identifies what prevented to see the physical origin of nerve conduction before. The impulse is the "first sound" of the nerve membrane, however, dielectric and nonlinear, but truly thermodynamic as is the reality of any other sound. It is the polar aqueous interface that rendered the nervous impulse visible by electrodes first, while the physical reality had to await early and present nanotechniques to be considered. Meanwhile, the terminology taught many generations has rendered the physical reality of the nervous impulse "unspeakable". The novel theory of proper entropy of the causal interface immediately predicts the nature of the sensory receptors, too. It unifies conduction with the synaptic transmission of interfacial signals across gap junctions and chemical synapses wherever that may occur in the living cell.

This theory concludes two centuries of search for the physical foundation of nerve excitation. Reading history backward in time, the origin of the paradoxes is identified in the view-point of the observer limited to the method of the time. Reading forward, Galvani's discovery of former *causa materialis*, "*electricitta animale*", and Volta's toward the "*causa efficiens*", contact or interfacial potentials, characterised the present situation already. Now, "channels" are material causes while "proper entropy" is the efficient cause. When Helmholtz discovered the velocity of propagation, he was close to the answer. He excluded three causes: infinite, light, and velocity of sound. Right on the latter, as now established in detail, he had no access to the interface entropy. Bernstein correctly concluded reversible chains, and Einstein reversible forces, but not specific channels, to cause electrical potentials at interfaces. Hodgkin correctly warned of ohmic channels in view of Hill's thermodynamic contradiction, and Tasaki established the physical reality of the nervous impulse to be as now proper entropy requests. As to be expected for any change of paradigm after generations, human plausibility has become fixed by language. This is the superior difficulty in admitting the physical reality of the nervous impulse and its physical foundation.

References: Volta Helmholtz Bernstein Langmuir Hill Hodgkin Katz Tasaki Helfrich Träuble Silman Neher

VIII

On the Entropy of the Cell

Robustness of the living cell by the second law of thermodynamics.

The second law of thermodynamics is applied to restrict the theories of complex networks of interfaces in the living cell. The view-point of the observer on aspects of nature is only second in priority, or a posteriori, after the first, a priori principle of proper entropy. Therefore, aspect view-points have both clarified and obscured insight into the physical laws in the history of Science, and did create paradoxes when adopting this view-point erroneously as theoretical foundation. In history, laws without paradoxes turned out to be independent from the view-point of the observer. The second law of thermodynamics is such a law, and the only one strictly applicable to aqueous systems. In Einstein's superior formulation, its validity has never been seriously challenged even in the living. This law imposes an analytical entropy potential as limitation on the validity of any model of the observed aspects. This limitation is predicted to be the physical cause of robustness of the living cell. Experiments are proposed on cross-correlations. The inseparability of mechanical, electrical, spectroscopic, and catalytic cooperativity in the living cell is a crucially testable prediction of the theory. Another prediction is the appearance and the correlated nature of cellular oscillations. Finally, fluctuations have to appear, based on that proper entropy potential, in each of the observable aspects. The rôle of time is reconsidered. Temporal cross-correlations identify normal coordinates only, while reversible Maxwell relations identify true thermodynamic cross-correlations. The mathematical logic and the robustness of aspect dynamics is assured by the method deduced from Ginzburg-Landau generalised potentials after Graham. The starting point is the potential, not the phenomenological differential equations. Still, such equations can be logically deduced from the analytical nature of the entropy potential. Graham's and Haken's application to the non-living and the living is with this Boltzmann-Einstein meaning used, teaching how to deduce conventional but robust differential equations from generalised proper entropy potentials.

The physical origin of cooperative cell function proposed is encouraged by the unification of the foundation of catalysis and membrane excitation. It has proven to exactly originate first principles observed in the brain. In essence, in the living cell, the picture is this: interfaces obey proper entropy $S(n_i)$. Signal propagating forces dS/dn_i for i being observable as reaction coordinate or as electrical signal, cooperativity is assured by reversible conservation of excitation entropy. Irreversibility is imposed by the observer's means, while the living cell operates with optimal efficiency. Optimal complex catalysis is proven to require acid sequences, vice proteins and DNA, while simple catalysis enlarges amphiphilic surfaces. Entropy, forces, and fluctuations provide cooperativity, signalling, and stability vice replication of empty cells or vesicles already. The theory asks for critical experiments that could determine the limits of its validity.

Reference: D'ArcyThompson Watson Landau Graham Haken Textbooks The Logic of Life

IX

Theory of the Brain's Principles

Proof of three first principles of brain function.

The discovery of a fundamental physical symmetry has made this theory possible: the symmetry of the laws of the nervous impulse against reversal of the time axis. A conservation law of nerve excitation is the consequence, broken and restored in arbitrary neural systems. This conservation law, if assumed the unifying physical cause of brain function, does cause exactly, by symmetry argument, three and only three principles of the functions of the brain. These three principles do have the semantic meaning of "And, Or, Not" but not the formal logic meaning. Only all three together do explain the observed principles of the nervous system: Axons, synapses, images, realising respective excitatory, inhibitory, and projective couplings. The various aspects of the objects of thought and perception do then associate, discriminate, ignore, respectively. In this way, they order the manifold excitations of the human nervous system, and do apply to order the various aspects of the objects of perception and memory, and the various observable excitations in the brain. The fundamental symmetry generalised from the nervous impulse can be directly observed in the dramatic phenomenon of spreading depression. The contradictions of these three resulting principles turn out revolutionary for brain theory: they explain the origin of creativity. They are predicted to be observable in any object of thought. Though deduced exactly from the physical and observed symmetry of the conservation of proper entropy in excitation, these principles are proven to be creative. They turn out to have the property of First Principles in the origin of Philosophy, Art, and Science. Causing ever new variations and paradoxes, once by ignorance and cortical blindness, once by attention and contradiction into ever new distinctions, once by association and identification, these three principles can be falsified but appear to be observed in any memory task and always do correspond to the meaning of Not, Or, And, respectively. These principles turn out "a priori" in the meaning of Kant's Critiques. No Hebb synapse is required. Pavlov's discriminative conditioning is explained by two, but exactly three different principles are predicted to apply to any human memory task. Quantitative consideration leads to the conclusion: We learn to ignore most, to draw attention first, and to associate last. Proven by the fundamental method of physical symmetry breaking and restoration, the result is no less than first philosophy. Applications focus on the origin of logic, and on the origin of Gödel's paradoxon, the origin of mathematics most generally. Computational methods are compared. The physical understanding of the phenomenology of the mind includes the origin of wit, missing in hitherto philosophy, the origin of illusion, of colour perception, the origin of geometry and number, and the physiological origin of time and music.

In brief: three principles restore the conservation of proper entropy in the brain - named And; Or; Not, creating logic and Gödel's paradox, creative by mutual contradiction, predicted to be seen as aspects of any human thought, deduced exactly from proper entropy conservation and observed in the brain. Aristotle, Descartes, or Einstein represent crucial experiments.

References: Descartes Helmholtz Ramon y Cajal Sherrington Eccles Popper Marr Hopfield Lauterbur Leao Creutzfeldt Singer Koch Florey

On the Evolution of “2D” Worlds

Can the origin of the "living" be explained by physics alone?

The question on the origin of the living has been raised since Aristoteles. Erwin Schrödinger systematically introduced statistical physics as answer in his monography "What is Life?" predicting the basic structure of genetic matter. Manfred Eigen introduced the kinetic hypercycle for the evolution of macromolecules in the origin of life, and emphasised the crucial but missing physical understanding of catalysis. Vitaly Ginzburg raised this question recently as the final of the questions to be answered by the physicist. The following answer to the question is proposed based on the law of proper entropy of interfaces, i.e., from the physical origin of catalysis thus deduced. Before the origin of phenomena called "living" by the observer today, prebiotic matter was as present matter still is driven by the law of proper entropy, starting from amphiphilic layers. Einstein's method is used to draw consequences. No specificity can be achieved at this stage, as demonstrated in an entropy game presented. Layer area increases, however. Evolution sets on as follows. Physical size limitation by thermodynamic fluctuations determines primitive replication of early empty cells. Molecular autocatalysis is not required. Photons additionally but poorly couple proper entropy into the interfaces by their optical modes. Free energy storage, hitherto mysterious, is predicted by optical modes in aqueous interfaces. This membrane storage is predicted to be seen even today by optical patch clamp. Optimal catalysis is proven theoretically to use proton fluctuations at such interfaces. The prebiotic optimum is proven to be layers of acid interfaces. Today, they appear as phospholipid bilayers. Closed bilayers, too, are still seen today as empty vesicle-cells and invite for primitive replication. Their proper entropy, consequent signalling by reversible forces, and fluctuations and stability, do explain the resulting cellular dimensions. Empty cell replication by thermodynamic fluctuations does select now crucially the evolution of intracellular catalysis. Darwinian catalysts must be capable then of complex but nevertheless specific participation in such no-more-empty-cell cycles. The Darwinian optimum is exactly proven from the theory of catalysis: it is acid sequences. In a nutshell: the physical origin of the "living" proceeds from 3D to acid 2D layers and 1D sequences of acids. Today, the result is seen as amino and nucleic acid catalysts. Together with the physics of non-specific replication of the cell, these acid sequences do establish Eigen's selective hypercyclic coupling of fluctuating cellular interfaces. Such evolution is predictable on the basis of the law of proper entropy alone. This theory generalises Schrödinger's prediction of the structure of the genetic matter to the physical cause of the dynamics, still using the same foundation: the Boltzmann principle. The theory of proper entropy does unify naturally the physical origin of the function of membranes and catalysis in evolution and today. It is the consequence of the superior meaning of the second law of thermodynamics established by Einstein. This result does answer the question raised by Ginzburg. If the predictions of the theory hold true, even Aristoteles' writings on the "self", in Greek "auto" characterising the living, can be based on physics alone from this origin of life.

References: Aristoteles Lamarck Darwin D'ArcyThompson Einstein Schrödinger Watson Crick Eigen Orgel Luisi Kiedrowski

On Complexity in Observation

We are the problem! Complexity caused by the observer.

Complexity has since the times of the *Vis Vitae* accompanied biology in the pursuit for physics. In certain instances, complexity disappeared. Examples in biology are Volta's introduction of "contact" surface instead of Galvani's "electricitta animale", Helmholtz' "Sensation of tone" and "Physiological optics" replacing by physics previous ideas, or the crucial example of Nernst's still one-dimensional electrochemical potential orthogonal to the membrane, and Einstein's superior "conservative forces in layers" replacing e.g. selective channels by interfacial thermodynamics. The anthropology of human theorising is now traced backward in time. The origin of complexity is identified. Complexity is caused by the observer. This was evident in physics, chemistry, and physiology, since the finally discovered law was simple. This simple law however was still complex when interpreted from the earlier view-point. The origins of complexity and its disappearance are found to be the following. New methods cannot solve complexity. Critical observations by new methods, however, did rule out the cause of complexity. New methods did remove complexity only if the former view-point was allowed to be falsified. Crucial is "plausibility" judgment by one brain principle only, previous conditioning "And", requiring ignorance of any attention to the paradoxes of complexity. The life-time of complex theories has been in the order of a generation, once the observed paradoxes were considered. Here, the brain principles compete, that of ignorance, "Not", and that of attention and curiosity, "Or". Again, after brain theory, we learn mostly ignorance, else first to draw attention, and to identify or associate last, e.g. with a new law. Complex theories did survive for unlimited time, if consensus was more important than the paradoxes, ignoring thus the key to simplicity. The rôle of semantics is proven crucial for survival times of complex view-points. Semantic fixation of complex view-points rendered the physical reality "unspeakable" long after the discovery of the true law. "Imagination is more important than knowledge", a famous citation, is interpreted in anthropological terms after Malinowsky's "Magic and Science". Present complexity theories for the "living" are discussed. Finally, the secret of Einstein's success is identified in removing complexity.

Prize Questions. Physics: What is the Secret of Einstein's Success? Can Quantum Mechanical Description of Reality be Considered Complete? What is the Origin of the Cosmic Background Radiation? Chemistry: Do Molecular Dynamic Simulations Obey the Second Law of Thermodynamics? What is the Origin of Catalysis at Single Fluctuating Enzymes? Can the Living be Explained on the Basis of Physics Alone? Physiology: Can Physics Explain the Reality of Membrane Excitation? Which is the Origin of the Nervous Impulse? The Fluctuating Synapse, what is the Origin of Transmission of the Impulse? Brain: How Precisely do the Neurobiological Processes in the Brain Cause Consciousness? Is there a Revolution of Philosophy toward Brain Theory? Do Unifying Ways of World Making Exist in Science, Arts, and Philosophy? **Answers:** for Physics see Symposium 11, 1, 12; for Chemistry see 4, 5, 10; Physiology 2, 4, 8; for Brain see 9, 3, 10. One proposition can be found at the poster 1. cause of molecular function 2. excitation of surfaces 3. sensation of tone 4. proton control 5. theory of catalysis 6. why acid sequences 7. signal and synapse 8. entropy and cell 9. theory of the brain 10. "2D worlds" 11. on observation 12. Schrödinger's Cat.

Schrödinger's Cat

The solution of the Einstein-Podolski-Rosen paradox by biological physics.

The human notions of time are deduced. The method used is brain theory. It is based on proper entropy conservation and exact symmetry argument. Observations in the cerebral cortex do prove the "a posteriori" nature of physical time. Time "a priori" in the Copenhagen interpretation of quantum mechanics is proven to be the origin of fundamental paradoxes, since it mistakes the brain origin of physics. The Einstein-Podolski-Rosen Paradoxon is proven to disappear. Quantum theory is based on the Boltzmann principle in agreement with brain theory, as in Einstein's formulation. Schrödinger's Cat now turns out to be unambiguously "dead" or "alive", and never in a state of superposition of both. No teleportation does exist in physical reality. Erroneous "a priori" conditioning of in fact "a posteriori" nature of time and space is then considered. An acoustical double-slit experiment is presented. Teleportation is caused here by the free will of the observer even in that classical thermodynamic wave mechanics. Physics without paradox is then predicted. The key is the interpretation of physics in agreement with brain principles: Entropy first, observation second, and no reduction of the thermodynamic law of probability wave functions. The EPR article from 1935 is proven in detail to agree with brain theory. Bohr's reply is proven to invert the order imposed by the principles of the human brain. As intended by Schrödinger 1926, the quantum mechanical wave function corresponds to the principle of entropy vice action. Probability appearing wave-particle to the observer is a physical reality. As any reality, it cannot be "reduced". Uncertainty is the consequence of entropy, proven by Einstein 1909, generalised by de Broglie 1923, and inverted by Heisenberg 1925 to become the alternative first to be used principle in quantum mechanics. The difficulty here is the human brain's conditioning on paradox, inverted but mathematically consistent concepts of space and time. In a nutshell: $A = B$ and $B = A$ are the same concept, but their interpretation is inverted. Entropy is the premis, uncertainty the consequence. The other reading does cause "half-dead" Schrödinger's Cats. Further examples deduce from brain theory geometry, number, and measurement "a posteriori", the origin of chirality, together with the reason of the hitherto impossibility to explain any such origin. As with time, the posterior nature of non-chiral symmetry of space and of no-more-paradox chirality is the result of brain theory based on proper entropy. Chiral specificity in chemical catalysis is for example now explicable and does catalyse spaces very different from Euclides' and Riemann's. The implications for spiral galaxies and cosmology are obvious. There, too, entropy but not space-time is the premis. This is evident today from the perfect Planck spectrum of the cosmic background, or rather "foreground", radiation. It is only from the observer's view-point that stars, or *causa materialis*, became the paradox premis. Big bang and dark matter do not exist without inverted reading of the brain origin of physics. Aristoteles, Descartes, and Einstein did create physics without paradox for the observations of their time. These authors are proven to proceed in agreement with the three and only three first principles of the physical theory of the human brain. Physics without paradox seems in sight again.