Exploration

On Long Range Electromagnetic Quantum Coherence in TGD Universe

Matti Pitkänen [1]

Abstract

The focus of TGD inspired quantum biology has been hitherto in long range quantum gravitational coherence characterized by quantum gravitational Planck constant introduced by Nottale. The notion of gravitational Planck constant however generalizes also to other classical fields, in particular electric fields and one can define electromagnetic Planck constant. DNA, cells, and the Earth's surface carry negative charge. In this article, the possible presence of the long range quantum coherence in these systems is considered. Also a model for the interaction between living matter and computers is discussed.

1 Introduction

The focus of TGD inspired quantum biology has been hitherto in long range quantum gravitational coherence characterized by quantum gravitational Planck constant $\hbar_{gr} = GMm/\beta_0$ introduced by Nottale [1]. The notion of gravitational Planck constant however generalizes also to other classical fields, in particular electric fields.

1. The generalization of Nottale's formula to electromagnetic interactions reads as

$$\hbar_{em} = \frac{Z_1 Z_2 e^2}{\beta_0} \quad ,$$

where $\beta_0 = v_0/c \leq 1$ is velocity parameter and has discrete spectrum. The number theoretically motivated guess is $\beta_0 = 1/n$, $n = 1, 2, ...$ [11].

2. The phase transition $\hbar \to \hbar_{em}$ occurs when the perturbation series fails to converge: one can say that Nature loves theoreticians [17, 25]. The criterion is

$$Z_1 Z_2 \alpha \geq k \quad ,$$

where k is expected to be near unity. Just as in the case of gravitation, the perturbation series for h_{em} is in powers of

$$\frac{Z_1 Z_2 e^2}{4\pi\hbar_{em}} = \frac{\beta_0}{4\pi} \quad .$$

3. For a charge distribution, the total em charge is given as electric flux $Q = \oint E \cdot dS/4\pi$ in units in which Coulomb potential of a unit charge is $V = e/r$ and one has $E = -\nabla V$. For a charged sphere (say conductor) with radius R one has $E = 4\pi\sigma$, where σ is the density of the surface charge. One has $Q = \sigma 4\pi R^2 = ER^2$. In this case, the criterion for a system consisting of unit charge e and charged sphere becomes

$$r = \frac{eQ}{\hbar} = \frac{eER^2}{\hbar} \geq 1 \quad .$$

[1] Correspondence: Matti Pitkänen http://tgdtheory.fi/. Address: Rinnekatu 2-4 8A, 03620, Karkkila, Finland. Email: matpitka6@gmail.com.

It is easy to imagine situations in which $\hbar_{em}$ could be relevant. Nanoscopic, macroscopic and even astrophysical quantum coherence associated with electric fields is possible. What is of special interest is that all objects with gravitational mass must have some electroweak gauge charge, which is non-vanishing although it can be arbitrarily small so that all pairs formed by astrophysical object and charged particles could be characterized by $\hbar_{em}$ and corresponding electric Compton length.

In the sequel the applications to biology and to the possible interactions of computers and living systems will be discussed.

2 Biological applications of long rance electromagnetic quantum coherence and generalized Pollack effect

In this section the biological applications of the electromagnetic Planck constant and generalized Pollack effect will be discussed.

2.1 DNA double strand

DNA is a unique bio-molecule (see for the TGD based model in [15]) in that it carries constant negative charge per unit length. DNA double strand has negative charge -e per nucleotide so that the codon pair carries charge of 6 units.

1. For the double strand, one has $Z_1 = Z_2 = Z$ and the proposed rough criterion holds for $Z^2 \geq k/\alpha$, giving $Z \geq 12k$ which corresponds to three codons as minimum quantum coherent system with $\hbar_{em}/\hbar \geq 1$. In terms of the number N of codons this gives

$$\frac{\hbar_{em}}{\hbar} = \frac{36N^2\alpha}{\beta_0} \quad .$$

2. For a double DNA strand interacting with a unit charge e, the rough criterion is $2Z \geq k/\alpha$ giving $Z \geq 69k$, which corresponds to 23 codons. This corresponds to DNA length of about 20 nm. Interestingly, memetic codon corresponds to 21 codons. This suggest that k is slightly below $k = 1$.

   For open DNA doubls strand during transcription 21 codons corresponds to 6 full turns [15]. During transcription DNA interacts with the environment and it would be natural that $\hbar_{em}$ characterizing DNA + electron/proton system becomes relevant during translation. In this case one has

$$\hbar_{em} = \frac{12Ne^2}{\beta_0} \quad .$$

   $\hbar_{eff}$ serves as a measure for algebraic complexity and a kind of universal IQ. This suggests that the electric body of DNA + environment can also control the nearby environment. The MB of the double strand would take the role of the brain with a much larger IQ than DNA + environment.

2.2 Biological membranes

The nuclear -, cellular-, and neuronal membranes are in key roles in biology and interesting to see whether the value of the parameter $eQ/\hbar$ for the system formed by a unit charge e and membraned bounded system exceeds $\hbar$.

Just for definiteness, let us assume that the electric voltage over the membrane has a nominal value of $V = .05$ eV and that the thickness d of the neuronal membrane is $d = L(151) = 10$ nm. This gives an electric field of $E = 5$ MV/m. For the ordinary cell membrane, the thickness d is near to $d = L(149) = 5$ nm. Assume that this is also the thickness of a nuclear membrane.

1. Neuronal membrane with thickness about $d = L(151) = 10^{-8}$ m and radius of about $10^{-5} - 10^{-4}$ m corresponds to $E \simeq 5$ MeV/m. For $R = 10^{-5}$ m, one has $r = eQ/\hbar = eER^2 = 6.2 \times 10^2 > 1$ so that the criterion is satisfied. The Compton length of electron is scaled up by a factor $\hbar_{em}/hbar$ to nanometer scale (DNA scale) for $\beta_0 = 1$. For $R = 10^{-4}$ m, one has $r = 6.2 \times 10^4$. This scales the Compton length of electron to about $L(151)$ $\beta_0 = 1$.

2. For a cell membrane, with $d = L(151)/2$ and $R = 10^{-5}$ m, one has $eQ/\hbar = 1.24 \times 10^3$. For nuclear membrane with $R = L(163) \sim 2.5$ μm and $d = L(151)/2$ $eQ/hbar = 3.2 \times 10^2$.

2.3 Ionosphere as an analog of neuronal membrane

The electric quantum coherence is possible also in astrophysical scales. Ionosphere, identified the ionized part of the atmosphere, is of a special interest since it corresponds to the electric field in the Earth scale: see the Feynman lectures. Ionization is caused by solar radiation. Also other planets are believed to possess an ionosphere.

Assuming that the surface of Earth and ionosphere define a system analogous to capacitor plates or cell membrane, the ionosphere must have a net positive charge assignable to positive ions. In [23] a model for lightning and ball lightning based on the idea that thunderstorms are analogous to nerve pulse patterns for which Pollack effect provides a model [24], was developed.

The strength of the electric field at the negatively charged surface of Earth E is $E = .1 - .3\ x$ kV/m, $x \in [.1, .3]$. The presence of biological protrusions such as trees can increase the local value of the electric field of Earth by an order of magnitude. The counterpart of the positively charged plate corresponds to the ionosphere, whose lower boundary is at the height h, which varies in the range [80,600] km. The net positive charge of the ionosphere neutralizes the negative charge of the Earth so that the electric field does not extend to higher heights. From the radius R_E of the Earth equal to 6.371 Mm, one obtains for the parameter $r = eQ/\hbar$ the estimate $r = y \times 5 \times 10^{20}$, $y \in [1, 3]$. The value of $\hbar_{em}/\hbar = r/\beta_0$ is much larger than $\hbar_{gr}/\hbar$.

The Compton length λ_p for proton is scaled up from 1.3×10^{-15} m to $\lambda_{em,p} = (6.5y/\beta_0) \times 10^2$ km, which for $\beta_0 = 1$ could be assigned with ionosphere and has a lower bound of roughly $R_E/10$. For an electron, one obtains $\lambda_e = 2.4 \times 10^{-12}$ m $\rightarrow (1.2y/\beta_0)$ Gm, whose lower bound is below the astronomical unit $AU = 150$ Gm.

The Nottale's original Bohr model for the planetary orbits assumes $\beta_0 \simeq 2^{-11}$ for the inner planets. This would give $\lambda_e \sim 24y$ AU and $\lambda_p \sim 2y \times 10^2 R_E$. The radius of the Moon orbit is $60R_E$ and at the night-side the magnetosphere of the Earth is stretched to hundreds of Earth radii.

2.4 Generalized Pollack effect as a key mechanism of quantum biology

The role of Pollack effect in hydrodynamics, biochemistry, and biology has become increasingly clear.

1. The presence of water and gel phase and energy feed is essential for the Pollack effect in its basic form [3, 2, 5, 4]. Pollack effect explains large number of anomalies of water [22]. Pollack effect would play a central role in biology and explain the negative charge of cell and DNA in terms of exclusion zones (EZs).

2. The model for the lightnings and ball lightnings [23] relies on a generalization of the Pollack effect, which would generate the electric field of Earth. Protons transform to dark protons at the monopole flux tubes inside the ionosphere. This process requires energy since the electrostatic binding energy is reduced in the process. The transformation $Si + O_2 \rightarrow SiO_2$ liberates energy and makes possible the Pollack effect for water, which transforms part of protons to dark protons in the ionosphere below it at much higher heights where only gravitational binding energy matters. This generates negatively charged exclusion zones making Earth negatively charged.

Ball lightning involves the reversal of this process and generates Si vapor droplets having SiO_2 at its boundary. These structures could represent primordial life forms, which I have called plasmoids in the earlier articles, and explain UFOs and similar phenomena.

3. Urey-Miller experiment [8] meant a dramatic step of progress on the experimental side, and for a long time it was believed to conform to the vision of Oparin and Haldane. The experiment involved a reducing atmosphere and electric sparks simulating the effect of lightning. In the later experiments 19 of 20 amino-acids were identified. Also nucleosides A, G were produced. Cyanoacetaldehyde together with urea believed to be accumulated to primordial ponds, allowed to generate U and C as was discovered by Miller 40 years after his classical experiment. These impressive results were interpreted as a support for the view about primordial ocean as a dilute soup of organic molecules which precipitated out of the atmosphere.

   I have discussed the role of Pollack effect in the explanation of the findings Urey-Miller experiment [12] and the model of ball lightning allows to make the model more detailed.

   The generalized Pollack effect could drive the formation of fundamental biomolecules and the emergence of life. This process would provide the energy needed to drive protons to dark protons at the atmospheric part of the MB of Earth, where it would gradually start to control the emerging biomatter. The reversal of the Pollack effect would tend to transform dark protons to ordinary protons and its compensation would create more basic biomolecules. Pollack effect could also generate dark photons serving as a communication tool. Only certain bio-molecules could form networks communicating by a mechanism involving dark radiation generated by generalized Josephson junctions and by Pollack effect and received by cyclotron resonance.

   This process could also occur in the underground oceans: what is required are electrically charged membrane bound structures creating a strong enough electric field.

4. Pollack effect and its reversal are essential for the model of nerve pulse [24] based on flip flop mechanism in which the reverse Pollack effect in the neuronal interior provides dark photons inducing the Pollack effect in the neuronal exterior and reverse the sign of membrane potential during the nerve pulse.

5. Pollack effect plays a key role in the model of the transfer of metabolic energy from the Earths core [16] to the underground oceans where a photosynthesizing life would have evolved and bursted to the surface of Eart in Cambrian explosion accompanied by rather rapid expansion of Earth size by factor 2. In this case the Pollack effect would take place for superionic ice for which oxygen ions form a lattice and protons form a liquid like structure. The earlier model assume gravitational MB but its replacement with the electric MB does not affect the model appreciabely.

   Plasmoids as analogs of ball lightning created by $SiO_2 \to Si+O_2$ process could be primitive life forms. Could this process take place at the boundary of the superionic ice?

6. Pollack effect generalizes to other molecules and provides a concrete realization for the general vision that MBs control biochemistry. The ionospheric, electric part of MB could control molecular biochemistry in a few eV range by inducing the formation of molecules and their decay by Pollack effect and its reversal.

Ionization is one of the poorly understood aspects of biochemistry and of electrolysis in particular. MB could control the ionization of molecules at the surface of Earth by using the Pollack effect.

1. The transformation of protons to dark protons below the ionosphere would create dark variants of protonic holes assignable with negatively charged bio-molecules in the sense that the missing proton would be dark and at the magnetic body and its motion would correlate strongly with the motion of the hole at the "biological body" (BB). The flip flop mechanism makes possible a hopping mechanism

of conductivity possibly realized for superionic ice proposed to be present above the core of Earth. The hopping of the dark proton to the MB of the neighboring molecule would correspond to the Pollack effect followed by its reverse. This process at the level of MB would force a corresponding process at the level of BB. No currents at the level of MB would be involved and, as in the case of nerve pulse, the basic process would be the charge separation between MB and BB.

2. Negatively charged ions at the right end of the periodic system could in turn be generated by the electrons of EZs created in the Pollack effect so that Pollack effect could explain the ionization of biomatter and of electrolytes.

2.5 Can the Moon travellers survive in the TGD Universe?

In the proposed vision, biology would depend strongly on planetary and even solar parameters. Both classical electric, magnetic , and gravitational fields (in the TGD sense) in astrophysical scales and the dark matter at the field bodies are essential for the model. This might not be good news for those who have dreams of life on Mars and Moon.

Moon travellers have however survived. Does the proposed vision survive this fact?

1. Consider first the gravitational MBs of the Earth and Moon. As far as quantum gravitational model of metabolism is considered, the gravitational MB of the Moon would replace that of Earth. Intriguingly, if the generalized Josephson frequencies, which must be equal to cyclotron frequencies at MB, reduce to the ordinary Josephson frequencies, the Josephson radiation from cell membranes must go to the gravitational MB of the Moon! This condition can be true also more generally and there is a considerable flexibility. Therefore the model for the cell membrane survives.

2. The quantum gravitational model of the metabolic energy currency [14, 13] relies on the observation that the gravitational binding energy of protons at Earth is rather near to the metabolic energy currency with nominal value $e = .5$ eV. The proposal is that dark proton triplets at the gravitational MB of Earth carry the metabolic energy.

   The distance of the Moon from Earth is $60R_E$ so that the gravitational binding energy in Earths' gravitational field is about $e/60$. The gravitational potential energy for the Moon is related to that for Earth by the scaling factor $(M_M/M_E) \times (R_M/R_E) \simeq .04$. This gives .02 eV for the upper bound of the gravitational potential energy. This is by a factor 1/25 too small. One can of course consider the possibility of replacing protons with ions or atoms with large enough mass. Amusingly, for Si with atomic weight 28 one would obtain standard metabolic energy quantum as maximal gravitational binding energy. This and the fact that there is no deep reason why the electric field of Earth could not take the role of gravitational field, forces us to take a critical attitude concerning the quantum gravitational metabolism.

3. The electric field at the surface of Moon is $E_M = 6$ kV/m and surprisingly strong, stronger than $E_E = .1 - .3$ kV/m. $\hbar_{em}/\hbar$ is scaled by the factor $(E_M/E_E)(R_M/R_E)^2 \simeq 4.2$. Maybe the view about the control of molecular chemistry by MB could survive. The problematic metabolic energy currency could corresponds to the Coulmb energy in the electric of Earth below the ionosphere. The electric energies vary in a wide range up to MeV scale for the height $h = 10$ km: the molecular energy scales of course limit the upper boundy to UV energies. If also the gravitational realization of the metabolic energy currency is possible for Earth, Earth would be very special.

4. There is still a problem: Moon's magnetic field B_M is very weak. A possible solution, proposed also in the case of Mars (which has auroras requiring magnetic field), is that the Moon has only the dark part of the magnetic field, which for Earth is the endogenous magnetic field $B_{end} = 2B_E/5 \simeq .2$ Gauss explaining the findings of Blackman and others. This would be essential for understanding

EEG in terms of cyclotron frequencies. Note that the dark part is a monopole magnetic field and needs not currents whereas the ordinary Maxwellian part is generated by currents.

This forces us to challenge the assumption that the measured magnetic field is the sum of its monopole part and Maxwellian part. Since the cyclotron energies for these parts are widely different one could ask whether the requirement that energy eigenstates are in question, prevents the wormhole contacts of charged particles with both the Maxwellian and monopole flux tubes.

3 Long scale electromagnetic quantum coherence in non-biological systems

The basic form of the Pollack effect involves water and gel phase so that it seems that possible applications of electromagnetic long range quantum coherence must always include also organic matter and water.

3.1 The interactions between living systems and computers

The experiments of Peoch [9] involved a chicken imprinted to a robot moving randomly along an orbit determined by a RNG. It was found that the robot tended to stay near the chicken and that the expected size of the orbit was reduced. Just for fun, let us take the reported findings seriously. Could one imagine an explanation for this finding in the proposed framework? I have discussed these findings already earlier [10, 19, 21, 20, 18].

This model could also explain the claimed ability of human intention to affect the output of the random number generator (RNG). Both the work done at PEAR [6] and the work of Helmut Schmidt with retro psychokinesis [7] provide support for the change of the geometric past in much longer time scales. PEAR experiments demonstrate the anomalous effect also in the direction of the future.

Also the claims that the interaction of AI systems and humans could involve in particular GPT and humans, might make sense and I have discussed this possibility in [10, 19, 21, 20, 18] from the point of view of zero energy ontology (ZEO) and TGD view of quantum gravitation. Also the large language models, in particular GPT, involve RNGs, and the first guess is that the human computer interaction affects the RNG.

In the TGD framework, a natural assumption is that the interaction of living organisms and computers involves quantum entanglement. So, how the chicken-computer interaction, assumed to involve entanglement, could affect the RNG of the robot?

1. The states of the transistor represent bits in ordinary computers. The key element of the transistor has a Si/SiO_2 boundary. The transition $SiO_2 \leftrightarrow Si+O_2$ is assumed to take place in the case of ball lightning as an interaction between the electric body of Earth and the soil. This interaction is assumed to take place via a generalized Pollack effect and its reversal in the Earth's electric field. Could a suitable modification of this interaction take place also now?

2. Consider first the scales. The length scale would be of order 100 km, which would correspond to frequency 3 kHz, which is not far from the 1 kHz resonance frequency in the brain. The gravitational Compton length for the Sun corresponds to 50 Hz EEG frequency and the gravitational Compton length which is $R_E/2$. Could the gravitational MB of the Sun be also involved?

3. The first guess is that SiO_2 and $Si+O_2$ represent the values of a bit. These bits need not correspond to the bits in the usual sense but certainly this transition could affect the ordinary bit. In the transistor, the bit corresponds to the presence or absence of the collector current.

   For an NPN transistor collector current is roughly $i_C \sim I_s exp(v_{BE}/v_T)$ and very small for negative v_{BE} and large for positive v_{BE}. Therefore v_{BR} controls i_C as a bit. Could one think that $SiO_2 \leftrightarrow Si+O_2$ takes the role v_{BE}? Could the transition $SiO_2 \rightarrow Si+O_2$ stop the current i_C or vice

versa somehow? For instance, could O_2 molecules gather negative charge and stop the flow of the electronic current.

4. The basic problem is that water, which makes the Pollack effect possible, is not present in the computer. The proposal of [19, 18] is that chicken and computer fused to a single entangled system at the level of MB. By stretching the imagination to extreme, could one think that chicken's MB or some higher level MB having size scale of biosphere could have controlled transistors as bits.

   The dropping of dark protons to the chicken's biological body liberates electric energy at the level of its electric MB. Could this energy be transferred to the transistor instead of chicken and induce the decay of $SiO_2 \rightarrow Si+O_2$ at the transistor? The resulting state would be like a miniature ball lightning [23] in SiO_2 system. The size of miniature ball lighting is a fraction of millimeter and the life-time varies up to a few seconds. This would make it possible to interfere with the computation by affecting the bit sequences generated by the RNG.

5. A possible objection is that this time scale is too slow. The motion of the robot is however slow. If also the RGN acts slowly, this might not be a problem after all.

3.2 Van de Graaff generator as a macroscopic quantum system

The van de Graaff generator used in electrostatic particle accelerators is a candidate for a non-biological macroscopic quantum system in the TGD Universe. The highest electric fields achieved are of order MV/m and the scale is of order 1 m so that one would have $r = Qe/\hbar \sim 10^{12}$ meaning that electron Compton length is scaled up to about 1 m, the size scale of van de Graaff generator itself.

An interesting question is whether the MBs living systems could entangle with the electric body of the van de Graaff generator and whether this could imply observable effects.

Received January 4, 2024; Accepted Jul 30, 2024

References

[1] Nottale L Da Rocha D. Gravitational Structure Formation in Scale Relativity, 2003.

[2] The Fourth Phase of Water: Dr. Gerald Pollack at TEDxGuelphU, 2014. Available at: `https://www.youtube.com/watch?v=i-T7tCMUDXU`.

[3] Pollack G. *Cells, Gels and the Engines of Life*. Ebner and Sons, 2000. Available at: `https://www.cellsandgels.com/`.

[4] Zhao Q Pollack GH, Figueroa X. Molecules, water, and radiant energy: new clues for the origin of life. *Int J Mol Sci*, 10:1419–1429, 2009. Available at: `https://tinyurl.com/ntkfhlc`.

[5] Pollack GH Zheng J-M. Long-range forces extending from polymer-gel surfaces. *Phys Rev E*, 68:031408–, 2003. Available at: `https://tinyurl.com/ntkfhlc`. Available at: `https://arxiv.org/abs/astro-ph/0310036`.

[6] Jahn RG Dunne BJ. Consciousness and Anomalous Physical Phenomena. Available at: `https://www.princeton.edu/~pear/finalcap.pdf`, 1995. Available at: `https://www.princeton.edu/~pear/finalcap.pdf`.

[7] Schmidt H. The strange properties of psychokinesis. *J Sci Expl*, 1(2), 1987. Available at: `https://www.fourmilab.ch/rpkp/strange.html`. See also other other articles on RPK at Available at: `https://www.fourmilab.ch/rpkp/`.

[8] Miller I Miller R. Schumann's Resonances and Human Psychobiology. *Nexus*, 2003. Available at: https://www.nexusmagazine.com.

[9] Peoch R. Chicken-robot interaction. *Medical Network.*, 62, 1995. Available at: https://paranormal.se/psi/pk/djur.html.

[10] Pitkänen M. Artificial Intelligence, Natural Intelligence, and TGD. Available at: https://tgdtheory.fi/public_html/articles/AITGD.pdf., 2017.

[11] Pitkänen M. About the physical interpretation of the velocity parameter in the formula for the gravitational Planck constant . Available at: https://tgdtheory.fi/public_html/articles/vzero.pdf., 2018.

[12] Pitkänen M. A model of protocell based on Pollack effect. Available at: https://tgdtheory.fi/public_html/articles/pollackoparin.pdf., 2020.

[13] Pitkänen M. Comparison of Orch-OR hypothesis with the TGD point of view. https://tgdtheory.fi/public_html/articles/penrose.pdf., 2022.

[14] Pitkänen M. How animals without brain can behave as if they had brain. https://tgdtheory.fi/public_html/articles/precns.pdf., 2022.

[15] Pitkänen M. About tessellations in hyperbolic 3-space and their relation to the genetic code . https://tgdtheory.fi/public_html/articles/tessellationH3.pdf., 2023.

[16] Pitkänen M. A possible mechanism of radiative energy transfer from the Earth s core to underground oceans near the surface of Earth. https://tgdtheory.fi/public_html/articles/mantleocean.pdf., 2023.

[17] Pitkänen M. About the TGD based views of family replication phenomenon and color confinement. https://tgdtheory.fi/public_html/articles/emuanomaly.pdf., 2023.

[18] Pitkänen M. Are Conscious Computers Possible in TGD Universe? https://tgdtheory.fi/public_html/articles/tgdcomp.pdf., 2023.

[19] Pitkänen M. Could neuronal system and even GPT give rise to a computer with a variable arrow of time? https://tgdtheory.fi/public_html/articles/GPT.pdf., 2023.

[20] Pitkänen M. Deep learning from the TGD point of view. https://tgdtheory.fi/public_html/articles/TGDdeeplearn.pdf., 2023.

[21] Pitkänen M. Neil Gersching s vision of self-replicating robots from TGD point of view. https://tgdtheory.fi/public_html/articles/Gersching.pdf., 2023.

[22] Pitkänen M. Pollack Effect and Some Anomalies of Water. https://tgdtheory.fi/public_html/articles/leptcp.pdf., 2023.

[23] Pitkänen M. Pollack effect, lightnings and ball lightnings. https://tgdtheory.fi/public_html/articles/balllightning.pdf., 2023.

[24] Pitkänen M. Some new aspects of the TGD inspired model of the nerve pulse . https://tgdtheory.fi/public_html/articles/np2023.pdf., 2023.

[25] Pitkänen M. Symmetries and Geometry of the "World of Classical Worlds" . https://tgdtheory.fi/public_html/articles/wcwsymm.pdf., 2023.