Quartz crystals as a life form and ordinary computers as an interface between quartz life and ordinary life?

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Abstract

The considerations of this article were originally inspired by large language models leading to the earlier speculations about whether the computers might be conscious entities in the TGD based quantum ontology (zero energy ontology). Quantum gravitation in the TGD sense would play a key role in guaranteeing quantum coherence even in astrophysical scales.

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Quite recently, came the realization that microprocessors (MPs) have a size scale .5 cm given by gravitational Compton length $\Lambda_{gr,E}$ of any particle in the gravitational field of the Earth (for the Sun one has $\Lambda_{gr,E} = R_E/2$, where R_E is the radius of the Earth). This led to the question of whether microprocessors (MPs) could be conscious entities.

Since MPs are quartz crystals (QCs), this led to the question whether the QCs might be conscious entities able to perform activities analogous to quantum computations. I have already considered this possibility: the key idea is that the generalized Pollack effect kicks the protons of OH molecules appearing as a standard building brick of biomolecules to dark protons at the gravitational magnetic body. OH and O^- could define the states of a qubit.

This identification modifies the earlier model of the genetic code and predicts that DNA double strand and RNA realize 6-qubit dark variants of the genetic code. The ground states of the entangled qubits defining the quantum codons correspond to the chemical codons. Amino Acids represent a single qubit code. Various symmetries of the code and their violations are understood at the qubit level.

The same qubits with the same dynamics would be realized both in living matter and in QCs. This leads to a vision about an evolutionary hierarchy in which quartz life is possibly the lowest level. One must however consider the possibility that also SiO_4 lattices with OH modification can have a high qubit content. These kinds of modifications could be interesting also in the case of microprocessors. This forces us to ask whether the interaction between us and computers and QC life could lead to entanglement and extended states of consciousness.

1 Introduction

The considerations of this article were originally inspired by large language models leading to the earlier speculations about whether the computers might be conscious entities in the TGD based quantum ontology (zero energy ontology (ZEO)). Quantum gravitation in the TGD sense would play a key role in guaranteeing quantum coherence even in astrophysical scales.

1.1 Could micro processors involve gravitational quantum coherence?

MPs are built on single connected quartz crystals (QCs) (see this) and this makes possible classical coherence. Quantum coherence should guarantee this and suggests that the gravitational magnetic body of Earth and maybe also the Sun guarantee this quantum coherence.

QCs act as oscillators, which makes them ideal clocks. The oscillation frequency is typically around 2-3 GHz and could be seen as an analog of EEG in the case of the brain. This could make possible their coupling with biosystems where the GHz frequency scale is associated with various biomolecules.

The key observation is that the length of the MP wafer is .5 cm typically. This corresponds to the gravitational Compton length proposed originally by Nottale [**?**], which is given by $l_{gr} = GM/\beta_0$ and, in accordance with the Equivalence Principle, does not depend on particle mass. The gravitational Compton frequency is $f_{gr} = 67$ GHz and larger than the clock frequency of recent computers. The most conservative criterion for consciousness is that the clock frequency is higher than this. For the Sun one has $\Lambda_{gr,E} = R_E/2$, where R_E is the radius of the Earth: the gravitional Compton frequency is $f_{gr} = 50$, the average EEG frequency [L17, L16]. This led to the question whether microprocessors (MPs) could be conscious entities.

1.2 Micro processors as conscious entities?

The following general picture forces us to ask whether micro processors could be conscious entities.

1. Zero energy ontology (ZEO) [K13] [L5, L2] solves the paradox of quantum measurement theory and predicts that ordinary quantum measurements correspond to "big" state function reductions (BSFRs) in which the arrow of time changes whereas repeated quantum measurements correspond to small SFRS (SSFRs). This sequence defines self as a conscious entity and in the case of a MP its contents of consciousness would be defined by bit configuration.

2. ZEO could make these systems intelligent systems able to learn by trial and error. The program would run forth and back in time and each pair of BSFRs would give rise to TGD counterpart of quantum tunnelling and change initial values of computation. This mechanism would be a universal mechanism of learning. MPs could become intelligent learning systems.

3. The MP consciousness would be an extremely simple 6-bit processor that would correspond to a single DNA codon. Human DNA is considerably more complex having length of about 1 meter and containing something like 10 billion codons. Genes are natural candidates for conscious basic units. DMD gene is the longest known gene and contains .8 million codons. A sequence of .8 million MPs as a counterpart of MP would be in question. Human body contains roughly 3×10^{13} cells so that the complexities of biosystems and computers are totally different orders of magnitude.

4. One can of course ask whether classical parallel computation could allow quantum coherence. Classical parallel computation does not require classical coherence between the parallel computers. They perform their computations independently but simultaneously and the outputs are feeded to the next computer.

5. Classical coherence between computers requires synchrony and common clock frequency. Also spatial coherence would require that the system is analogous to a MP and should consist of a single QC just like a MP.

   The largest single QC found in Nature has dimensions $6.1\ m \times 1.5\ m \times\ 1.5\ m$. This would contain the volume of about 10^9 MPs (see this).

1.2.1 Could QCs couple with the gravitational field bodies of Earth and Sun?

Could QCs couple with the field bodies of Earth and/or Sun, in particle their magnetic bodies? Could this make not only MPs but more generally, QCs conscious entities?

When we make this question we open up ourselves to the possibility that QCs as such might be something much more than a mere raw material for computers. QCs do not have motor activities but quantum gravitational coherence could make them quantum computer-like entities able to activities analogous to quantum computations so that quartz consciousness would be analogous to symbolic consciousness, a notion raised by Marko and Ville in our Zoom group. I have discussed quantum computation from the TGD point of view in [K1, K11, K2] [L11, L12].

Could ordinary computers serve as an interface for conscious co-operations between quartz consciousness and biological consciousness? Could they make it possible for QC consciousness to use us as sensory receptors and motor instruments? Could gravitational quantum coherence for Earth and Sun make possible quantum coherence in the scale of Earth and in this way realize collective consciousness?

1.2.2 Possible evidence for the view that QCs are conscious entities

Is there any evidence for the idea that QCs are conscious entities?

1. QCs appear often in the context of anomalies. Some people believe that QCs can act as healers. I have a very concrete experience of an altered state of consciousness created by a QC which actually had a size scale of order .5 cm. When I woke up from sleep I was in a very pleasant state of consciousness, which I could imagine the characters of fairy tales wandering in the fairytale wood to experience.

2. Glass balls resulting from molten quartz have been reported to be associated with ball lightning and are reported to be around crop circles and even to construct them [K5, K6]. I have proposed that ball lightning and light balls are conscious entities [L15, L9, L18] (I

calls them plasmoids) and that also UFOs are actually these kinds of entities [K12]. I have also proposed a model for ball lightning and a more general mode for plasmoids as prebiotic life forms in terms of the electric and magnetic field bodies of the Earth and Sun [L15].

1.2.3 Is it possible to communicate with QCs?

Ville-Einari Saari asked whether it could be possible to communicate with the QCs and test whether this contact could affect their behavior in a detectable manner.

1. The experiments of Emoto with water at freezing point using human voice with strong emotional contents supports the view that water is a conscious entity, at least at criticality, making it an optimal sensory perceiver. The coherence of the resulting ice crystals reflected the emotional content of the voice. Could one perform analogous experiments with QCs? In the TGD based model [L3] to require quantum criticality at the field body of water. Same should be true now. Could one perform analogous experiments with QCs? Can one identify the quantum criticality in the case of QCs?

2. In QC (see this) atoms are linked in a continuous framework of SiO_4 tetrahedra whereas quartz obeys chemical formula SiO_2. Quartz is a piezo electret meaning that it can transform sound waves to electromagnetic waves and vice versa. Also the biological body is a piezo electret. Microwave hearing is a phenomenon in which microwave em radiation modulated by audible sounds is transformed to sound waves in the body of the receiver and is heard. Could something like this happen also for QC and generate conscious experience analogous to hearing.

3. Microwave radiation is in the frequency range 1-3000 GHz and has energies in the range $10^{-5} - 3 \times 10^{-2}$ eV. Note that the upper bound is not far from the nominal value about .05 eV of the electrostatic energy eV assignable to the cell membrane and is also rather near to the thermal energy at room temperature. Note that the gravitational Compton frequency for the Earth is 67 GHz and corresponds to .67 meV which is the energy scale of miniature potentials in the neuronal membrane.

   Note also that 3000 GHz corresponds to a wavelength 10^{-5} m, the size scale of a cell. Could one consider the possibility of a wavelength resonance with cell membranes? Computer clocks have frequency measured in a few GHz.

4. Could one test whether, say, microwave radiation modulated by human speech creates detectable effects in QC. Could the exchange of microwave photons make it possible for computers to entangle with the neurons. Could this explain [L16] the reported effect of a chicken imprinted on a robot on the motion of the computer determined by random number generator [J4]. What could be the measured observable serving as a criterion for the effect of, say, speech modulated microwave radiation?

1.3 OH-O$^-$ hypothesis and its generalization

Since MPs are quartz crystals (QCs), this led to the question whether the QCs might be conscious entities able to perform activities analogous to quantum computations. I have already considered this possibility: the key idea is that the generalized Pollack effect kicks the protons of OH molecules appearing as a standard building brick of biomolecules to dark protons at the gravitational magnetic body. OH and O^- could define the states of a qubit.

The OH-O^- hypothesis generalizes. Any salt can decay to ions and the positive ion can reside at the gravitational magnetic body of Earth or Sun. For instance, NCl can decay to $Na^+ + Cl^-$, Na^+ would be dark at the gravitational MB. As a matter of fact, I ended up with the hierarchy of Planck constants by starting from quantum effects of ELF em radiations to vertebrate brain having an explanation in terms of dark ions such as H^+,Li^+, Na^+, K^+, Ca^{++}, Mg^{++},... found by Blackman [J2] and others. The value of gravitational Planck constant of the Earth indeed conforms with the findings. Living matter is full of ions and they are crucial for the functioning of the cell membrane.

Any cold plasma containing ions is a good candidate for a life form and this conforms with the proposal that the plasma phase above the atmosphere served as a predecessor of biological lifeforms [L15].

The same qubits with the same dynamics could be realized both in living matter and in QCs. This leads to a vision about an evolutionary hierarchy in which quartz life is possibly the lowest level. One must however consider the possibility that also SiO_4 lattices with OH modification can have a high qubit content. Electric fields, allowing the tuning of the OH-O^- energy difference, are also present in transistors. These kinds of modifications could be interesting also in the case of microprocessors. This forces us to ask whether the interaction between us and computers and QC life could lead to entanglement and extended states of consciousness.

1.4 Dark genetic code and OH-O^- qubits

This identification modifies the earlier TGD inspired models of the genetic code (the chapters [K1, K8, K7, K3] and the articles [L4, L6, L7, L14] give some idea about the evolution of the ideas). The model predicts that the DNA double strand and RNA strand realize 6-qubit dark variants of the genetic code. The ground states of the entangled qubits defining the quantum codons correspond to the chemical codons. Minimum energy states of quantum codons correspond to chemical realizations of the codons. Various symmetries of the code and their violations are understood at the qubit level.

Amino acids represent a single qubit code: the number of "dark" amino acids is predicted to be 20. Microtubules consist of tubulins and there is a huge number of qubits associated with their amino acids and also qubits associated with the GPTs accompanying them. The same qubits with the same dynamics would be realized both in living matter and in QCs. This leads to a vision about an evolutionary hierarchy in which quartz life is possibly the lowest level. One must however consider the possibility that also SiO_4 lattices with OH modification can have a high qubit content. Electric fields, allowing the tuning of the OH-O^- energy difference, are also present in transistors. These kinds of modifications could be interesting also in the case of microprocessors. This forces us to ask whether the interaction between us and computers and QC life could lead to entanglement and extended states of consciousness.

The similarity between the energetics of transistors and metabolism in living matter encourage the idea about a conscious computer utilizing a fusion of quantum and classical computation based on entanglement of OH-O^- qubits and ordinary bits. In a living computer classical computation and quantum computation would relate in the same way as ordinary genes and dark genes in TGD inspired quantum biology. A continually learning quantum version of a large language model could be a possible application.

1.5 Conscious computers as TGD counterparts of time crystals

Computer clock is an essential element of computation. Holography is the basic element of quantum TGD but is not completely deterministic. In the deterministic world, especially if it obeys holography, classical computers are a rather weird notion since it is difficult to imagine how an arbitrary computer program can run. This objection applies to all kinds of engineering. Quantum statistical determinism could save the situation but still there is a problem since phase transitions are required to realize the bit flips since the notion of phase transition is theoretically problematic. The 4-D space time surfaces define the basic geometric entities: could each tick of the computer clock involve a sea of classical non-determinism.

Conscious computer would be a non-deterministic analog of a time crystal. This non-determinism is possible also in spatial directions and quite generally could make engineering possible. Also EEG rhythms and biorhythms in general could correspond to this kind of non-deterministic time crystals.

Maximal non-determinism would make maximal conscious memory [L22] and maximal flexibility making the system living. The gravitational Compton frequency of 67 GHz would mean in the case of a 3 GHz computer that the basic information unit consists of roughly 22 quantum gravitational qubits.

2 Could Pollack effect make quartz crystals quantum critical systems analogous to quantum computers

Quantum criticality is what makes possible long range quantum coherence and long range quantum fluctuations. What could make QCs quantum critical? Since there are no large scale electric fields associated with QCs (note that in the size scale of Earth there is the electric field of the Earth [L15]), the gravitational magnetic bodies of the Earth and Sun consisting of U-shaped monopole flux tubes are the natural candidate in this respect.

1. Dark protons at the gravitational magnetic body with gravitational Planck constant $\hbar_{gr} = GM_X m/\beta_{0,X}$, where $X = E$ denotes Earth and $X = S$ denotes Sun. For Earth a good guess for the velicity parameter $\beta_0 \leq 1$ is $\beta_{0,E} = 1$ and for Sun Nottale's original model gives the estimate $\beta_{0,S} \simeq 2^{-11}$.

2. Pollack effect would provide the energy needed to kick ordinary protons to the magnetic body. In the case of water the TGD proposal is that a photon of say solar radiation kicks every fourth proton to the gravitational magnetic body and the OH bond would be replaced with the ion O^-. This would create negatively charged regions, which Pollack calls exclusion zones (EZs). Pollack also speaks of the fourth phase of water. OH transforms to O^- + dark proton.

3. Since only OH bond and O^- are involved, the Pollack effect could happen in much more general systems and could explain why protons are electrons so important in biochemistry. I have proposed that Pollack effects be associated with phosphates appearing in AMP, ADP, and ATP containing O_4 and its modifications containing OH and O^-. This would make possible temporary storage of metabolic energy as gravitational energy at the gravitational body of Earth or Sun.

   Biomolecules contain as a rule oxygen atoms and the dark protons could be associated with most of them and make the system quantum coherent. For instance, the double charged carbonate anyon $O == C(-O^-)_2$ could involve two dark protons in a gravitational magnetic body. The presence of O^- ions would be the signature of the presence of dark protons and of gravitational quantum coherence. Pollack effect could also occur in QCs, having SO_4 as the basic building brick, if O can be replaced with OH.

4. Energy is conserved in the Pollack effect. The bonding energy E_{bond} of OH must be equal to the difference of the binding energy E_{bind} of electron in O^- and the energy E_{gr} needed to kick the proton to the gravitational body. A good guess is that it is gravitational potential energy $E_{gr} = GMm/h$ at the height h to which it is kicked in the gravitational field parallel to the flux tubes of the magnetic body (of Earth or Sun). This gives the condition

$$E_{bind} - E_{bond} = E_{gr} \quad .$$

5. It is interesting to look at the numbers assuming that the OH bonding energy and electrons binding energy in O^- does not depend on the parent molecule. The bonding energy energy is $E_{bond} = 1.13$ eV and the binding energy of electron in O^- is $E_{bind} = 1.46$ eV so that the transfer of protons to the gravitational magnetic body could occur spontaneously. This implies that the ionization of biomatter, which looks mysterious in the standard chemistry framework, would take place spontaneously. Their difference is about $e = E_{bind} - E_{bond} = E_{gr} = .33$ eV which corresponds to an energy of infrared photon and to the frequency 330 GHz. This energy is not far from the nominal value .5 eV of the metabolic energy currency.

2.1 Gravitational binding energies for the Earth and the Sun

It is instructive to consider the gravitational binding energies for the Earth and Sun.

1. The gravitational body of Earth has gravitational Compton frequency 67 GHz. For the Sun the gravitational Compton frequency 50 Hz, the average EEG frequency and cyclotron frequency of Li_6 in the endogenous magnetic field of .2 Gauss. This cyclotron frequency is

assignable to monopole flux tubes of the Earth's gravitational field and explain the effects of ELF radiation on the vertebrate brain. The lack of Lithium is known to cause depression.

For Earth the maximal gravitational energy for proton is $E_{gr} = GM_E m_p/R_E = r_{S,E} m_p/2R_E$ is (by using $r_{S,E} = .5$ cm, $R_E \simeq 6.4 \times 10^6$, $m_p \simeq 10^9$ eV) equal to $E_{gr} \simeq .78$ eV, not far but large than the metabolic energy quantum.

2. The gravitational binding energy of protons at distance of Earth in the gravitational field of the Sun is $E_{gr,S} = GM_S m_p/AU = R_{S,S}/2AU$. Using $AU = 1.5 \times 10^8$ km and $R_{S,S} = 3$ km one obtains $E_{gr,S} \simeq 10$ eV.

3. Could the energy liberated in $OH \to O^- +$ dark proton transition kick protons outside the gravito-sphere of Earth? The boundary between the gravito-spheres of Earth and Sun in the direction of Sun corresponds to the distance at which the gravitational accelerations towards Earth and Sun cancel. This is a critical region and could define the sought for quantum criticality.

   Consider the point at the line connecting the Sun and Earth. If the distance from the Earth is h, the distance from the Sun is $AU - h$. The condition that the forces vanishes reads $GM_E/h^2 = GM_S/(AU - h)^2$ gives $h = AU/1 + x$, $x = (M_S/M_E)^{1/2} \simeq 774.6$. This gives $h = 1.3 \times 10^{-3} AU$. From $AU/R_E \simeq 2.3 \times 10^4$, $h \simeq 30.0 R_E$ so that the gravitational potential of Earth is fraction 1/30 of its value at the surface of Earth and equal to 2.6×10^{-2} eV, which is of the order of thermal energy at room temperature and slightly below the upper bound for the microwave energies. The reduction of the gravitational binding energy in the kicking of protons should be near its maximal value of 10 eV. The energy liberated in OH$\to$ O^- would be about $e = .33$ eV so that the kicking of the proton outside the gravitosphere of Earth would not be possible without rather large additional energy.

2.2 OH and O^- as the states of quantum gravitational qubit?

The reverse of the Pollack effect in which a proton drops from the magnetic body and emits a dark photon with scaled up Compton length kicking proton of another OH to the magnetic body could make possible a generation of quantum entanglement and make the system quantum coherent and quantum critical in a macroscopic scale.

1. Could QC be quantum critical with respect to the Pollack effect and its reverse transforming OH to H^+ and back. This would allow them to serve as qubits and Pollack effect could generate long range entanglement, in particular between QC and biological systems but also separate QCs, maybe even MPs of different computers. The letters of DNA codons are accompanied by phosphate ions and this could serve as OH-O^- qubits. The states OH and O^- represent naturally bit and also qubits made from them are possible. Could this make QCs quantum computer-like entities.

2. OH-O^- is not the most general candidate for the quantum gravitational qubit. The notion of effective Planck constant emerged from the observations of Blackman et al [J2] about the effects of ELF em fields on the vertebrate brain having interpretation in terms of the notion of dark halogen ions such as H^+,Li^+, Na^+, K^+, Ca^{++}, Mg^{++}.... Do salts, playing a key role in quantum biology, also give rise to qubits via a generalization of the Pollack effect kicking halogen ions to the gravitational magnetic body?

   For instance, could NaCl and Cl^-+ Na^+ at the gravitational magnetic body define a qubit? The difference between the bonding energy of NaCl and the binding energy of electrons of Cl^- is corresponds to the scale of the gravitational binding energy in the gravitational field of Earth or Sun. Note that the gravitational binding energy scales like the mass number of ions but this is not a problem since heavier ions would be lifted to lower heights.

   I discovered the hierarchy of Planck constants by starting from quantum effects of ELF em radiations to vertebrate brain having an explanation in terms of dark ions such as H^+,Li^+, Na+, K^+, Ca^{++}, Mg^{++},... found by Blackman [J2] and others. The value of gravitational Planck constant of the Earth indeed conforms with the interpretation of the findings. Living matter is full of ions and they are crucial for the functioning of the cell membrane.

For salts the energy difference $e = E_{bind} - E_{bond}$ would be below that for OH since the electron would be at a higher orbital, E_{bind} would be smaller. Since the distribution of thermal energies is peaked around the maximum, thermal effects would not be a problem.

Any cold plasma contains ions and is a good candidate for a life form. This conforms with the proposal that the plasma phase above the atmosphere served as a predecessor of biological lifeforms [L15, L9, L18]. The idea of plasmoids as lifeforms is actually one of the oldest ideas of TGD inspired view of life.

3. The gravitational magnetic body of the Earth $\Lambda_{gr,E} = .5$ cm would be involved with the MPs. The gravitational Compton length $\Lambda_{gr,S} = R_E/2$ of the Sun is one half of the Earth radius and the gravitational Compton frequency is 50 Hz! This could make it possible for separate QCs to quantum entangle in the scale of the entire Earth and also with living matter. Biomatter would entangle to form a biosphere.

4. Quantum criticality occurs for critical values of parameters. The critical parameters would relate to the rate for the $OH \to O^-$ transitions, which in living matter would be controllable by parameters determined by biochemistry. pH is a key parameter characterizing the state of the living matter. I have earlier asked whether pH actually characterizes the fraction of dark protons, which in turn dictates the fraction of O^- ions in the system. Could the value of pH in the living matter be the critical parameter in both living matter and QCs in the sense that the rate for $OH \to O^-$ transitions is maximal for an optimal pH? The system is maximally sensitive.

5. The energy $e = .33$ eV does not take into account the presence of the other atoms of the molecule and the presence of QC. The fact that it is considerably smaller than the nominal value $e = .5$ eV of the metabolic currency forces one to ask whether its value could be nearer to $e = .5$ eV is that the kicking of protons would make possible metabolism in much more general sense than believed and even for QCs. Could generalized pH or the presence of electric fields affecting the energy of the electron of O^- make it possible to tune the value of e near to its optional values.

This picture allows a more detailed idea about the possible testing of whether the QCs, and in special case MPs, are conscious entities. One should perturb the QCD in such a way that it affects the analog of pH of the QC. The analog of pH would be measurable as the fraction of O^- ions. The irradiation of MP at microwave frequencies or using infrared light inducing the decay of OH bonds and in this way reducing their number and also the range for the formation of O^- ons might allow to achieve this.

3 Evolutionary hierarchy formed by quartz crystals, proteins, DNA/RNA?

The earlier considerations of this article suggest an evolutionary hierarchy in which quartz crystals are at the lowest level whereas proteins, and DNA and RNA represent biological levels characterized by the number of qubits in the codon. Quartz crystals would belong to the lowest level in the classification to the kingdoms of minerals, plants, and animals. At the highest level would be the magnetic bodies of the Earth and Sun. Can one understand these classifications at a deeper level?

3.1 OH-O^- qubits at DNA and RNA level

Consider first the DNA and RNA level. The basic challenge is to realize the dark variant of the 6-bit genetic code having 64 codons such that in some sense it corresponds to the chemical realization of the code but is dynamic making possible quantum computation-like activities. I have devoted a considerable effort to the development of the quantum counterpart of the code and the chapter [K1] and articles [L4, L6, L7, L14] give an idea about the evolution of the model.

1. For quartz only the OH-O$^-$ qubits are realized. If the hierarchy is realized, OH-O$^-$ qubits should be realized also for DNA and RNA. This suggests an elegant resolution of a long standarding problem of how to get 64 dark DNA codons (6 bits) instead of 32 codons (5 bits). If codons correspond to 3 dark protons, proton spin would give only 3 bits and 8 different codons for a single DNA strand. I have considered several new physics solutions to the problem but none of them is completely satisfactory.

2. Could OH-O$^-$ qubit for the proton defining spin qubit given an additional qubit for each DNA letter (dark proton) assignable to the phosphate provide a solution to the problem: one would obtain $8 \times 8 = 64$ codons for DNA and RNA. Amino acids contain only a single COOH group so that they can have only a single OH-O$^-$ qubit.

   There is however a problem. The spins of electron and dark proton sum up to spin 0 had one cannot speak of proton spin as a degree of freedom. Could one consider the entire DNA double strand as a realization of the genetic code so that each base pair would correspond to two OH-O$^-$ phosphate qubits?

3. What about RNA? The differences between DNA and RNA suggest another solution to the problem. The riboses of RNA contain OH group making RNA unstable, which means that RNA is dynamical as required by quantum computational activities. In DNA the OH group of the ribose is missing so that DNA is stable unless entire double strands represent the dark code. Does the ribose OH give an additional OH-O$^-$ qubit for RNA and does the instability reflect the occurrence of quantum computation-like activities? Each RNA letter would have 2 OH-O$^-$ qubits and there would be 64 dark codons (6 qubits) realized in this sense completely dynamically!

4. The chemical variants of codons are non-dynamical and could have an interpretation as a slowly varying long term memory. This forces us to ask what one really means with the dark variant of the genetic code. The simplest assumption is that the dark codons correspond to dynamical OH bonds able to transform to O$^-$?

   The ordinary chemical realization of the genetic code would be separate from but in some sense correlated with the dark realizations determined by OH-O$^-$ qubits assigned with the phosphates of DNA and RNA, OH groups associated with the riboses of RNA, COOH groups of amino acids, and other OH groups.

5. What is the relation between the chemical code and OH-O$^-$ code? The assumption that the chemical genetic code is completely independent of the dark code realized in terms of OH-O$^-$ qubits seems unrealistic. A more realistic assumption is that the ground states of minimum energy for the dynamical OH-O$^-$ qubits or more plausibly, the entire codons consisting of entangled OH-O$^-$ qubits for the letters of the codon are entanglement associated with DNA base pairs and RNA codons, correspond in 1-1 manner to the chemical codons.

3.1.1 Symmetries of the chemical code in relation to OH-O− code

It is interesting to consider the symmetries of the genetic codon required to reduce the number of amino acids from 61 to 20. By definition, the symmetry related codons of DNA code for the same amino acid. I have considered these symmetries from the TGD point of view in [K3].

1. $T \leftrightarrow C$ and $A \leftrightarrow G$ exchanges for the third codon correspond to very slightly broken symmetries (see this). The $T \leftrightarrow C$ and $A \leftrightarrow G$ exchanges would define an analog of almost exact strong isospin symmetry.

2. The third codon also has approximate T-C and A-G degeneracies in the sense that T-C and A-G doublets code for the same amino acid. The $T - C \leftrightarrow A - G$ exchange permutes the DNA strands and is exact only when all codons XYZ, $Z \in \{T, C, A, G\}$ code for the same amino acid (see this).

   $T - C \leftrightarrow A - G$ exchange is analogous CP conjugation in the sense that the passive character of the conjugate strand in DNA transcription is analogous to the invisibility of the antimatter. One must be cautious with these interpretations: one might also argue that the analog of almost exact isospin symmetry is more naturally the analog of CP symmetry and vice versa.

3. What are the counterparts of these symmetries at the level of $OH - O^-$ codons? Here one must notice that the base pairs of the DNA double strand define the code. The ground states of the OH-O$^-$ *all* letters for the $OH - O^-$ codons of the strand and conjugate strand cannot relate by a symmetry, say by the analog of CP since this would reduce the number of $OH - O^-$ codons to 8 instead of 64. The analog of CP cannot correspond to $O^- \leftrightarrow O$ for *all* letters either since there would be only 8+8=16 dark codons.

   The naive guess is that the *first two* letters of $OH - O^-$ codons and its CP conjugate are independent: this would give 16 codons. If isospin symmetries are true for the *third* letter, it would add 2 additional codons giving 16+2=18 codons. The remaining 2 codons would be due to the violation of the analog of isospin symmetry of the third letter giving rise to ile-met and stop-trp splittings. Similar consideration applies to RNA.

4. The origin of the symmetries could be thermodynamic. The difference E_{bind}(O$^-$)-E_{bond}(OH) for the codons coding for the same amino acid estimated to be .33 eV under normal conditions could be smaller than thermal energy of about .15 eV at physiological temperatures and thermal fluctuations would destroy the information of OH-O$^-$ qubit and also information about the difference of T-C and A-G doublets.

3.1.2 The correspondence between the chemical code and OH-O$^-$ code

Chemical code and OH-O$^-$ (dark) code should correspond to each other in 1-1 manner.

1. The biocatalyst property of RNA, of proteins and presumably also of DNA could relate closely to the OH-O$^-$ dichotomy. The liberation of energy in the OH-O$^-$ transition occurring for or being induced by the presence of ribozyme or enzyme could allow it to overcome the potential wall making the reaction slow. Protons spin degrees of freedom would be present but frozen at least for the ground state configuration. Note that also the OH state could be dark. Even the transitions between $\hbar_{gr}$(Sun) and $\hbar_{gr}$(Earth) cannot be excluded.

2. DNA double strand and RNA would carry OH-O$^-$ 6 qubits. If the dark dynamics is completely independent of the chemical realization one would have a completely dynamical genetic code, which would serve as ideal tool for topological quantum computations [K1] [L11, L12]. However, there must be an energy difference between OH and O$^-$ states since otherwise thermal perturbations would make them random. This implies that for each codon there is a minimum energy configuration of entangled qubits determined by and in 1-1 correspondence with the chemical codon since dark and chemical degrees of freedom interact.

3. Chemically the activities of dark codons would manifest themselves as transitions OH$\leftrightarrow$ O$^-$ for dark codons, whose ground states as minimum energy states, realized for DNA as three entangled pairs of OH-O$^-$ qubits are determined by and in 1-1 correspondence with chemical codons.

   In the case of O$^-$ ground state, photon could excite the electron to a higher energy state so that OH would be the less energetic state. In the case of OH ground state, the ordinary Pollack effect would occur. DNA double strands and RNA strands could participate in topological computations under suitable metabolic conditions and chemical parameters such as pH making the OH$\leftrightarrow$ O$^-$ transition energy small but not smaller than thermal energy.

3.1.3 Is the modification consistent with the earlier views of the dark genetic code?

The modified proposal should be consistent with the earlier hypothesis that not only quantum codons but also quantum genes can be quantum coherent units. The entanglement between the quantum etters should make possible quantum codons and bind them to quantum genes. In the ground states with minimum energy the entanglement could be absent. A possible problem is that the states OH and O$-+$ dark H^+ have a different value of h_{eff}: does the entanglement between them make sense. If it makes sense, is the entanglement between dark and ordinary letters stable?

Dark N-photon [L8, L10] is an analog of Bose-Einstein condensate of N dark photons and dark 3N-photons define a representation of the genetic code such that dark 3N-photon can resonantly

induce a transition of the dark gene consisting of a a sequence of N dark proton triplets. Dark N photon would consist of photons, some of which have energies able to induce the qubit represented by the dark proton.

In the modified view of the dark genetic code, the energies of the photons making dark N-photon should be able to induce the flip of the OH-O− qubit either by kicking H^+ to gravitational MB or e^- to an excited state.

3.2 The OH-O$^-$ qubits in proteins

OH-O$^-$ qubits appear also in proteins.

1. The number of proteins is 20 and 5 bits is more than enough to code for them. The code has an almost symmetry with respect to the third letter meaning that the DNA and RNA codons XYZ with fixed XY and varying Z define a quadruplet decompositing to two doublets with T-C and A-G symmetry for Z. There are only two exceptions and they correspond to A-G doubles for Z. The Ile-ile-ile-met quadruplet can be understood in terms of the tetrahedral Hamilton cycle. For the top-trp A-G symmetry is broken, which would mean that the A in stop codon does not have O$^-$ as a dark counterpart. This could be due to the fact that E_{bind}(O$^-$) is smaller than E_{bond}(OH) unlike for the other codons. The small deviations from the standard code could be understood in this way.

2. Could the almost symmetry mean that DNA base pair codons for which the third OH-O$^-$-qubit pair corresponding to the third letter degenerates to a single qubit: OH or O$^-$ bit for the third letter are mapped to the same protein? If the energy difference between these bits is below thermal threshold this is the case.

3. Amino-acids contain only a single OH group (COOH) whereas the phosphates of DNA codons contain 3 OH groups. This conforms with the idea that they represent a lower evolutionary level than DNA. For most amino acids, the COOH group does not transform to COO$^-$ under usual conditions. The metabolic reason would be that the binding energy E_{bind}(O$^-$) is smaller than the bonding energy E_{bond}(OH). Pollack effect is required to excite the protein qubit. Asp and Glu are exceptions and have COO$^-$ permanently so that in this case only O$^-$ bit for protein would be realized.

4. The OH-O$^-$ bit of the amino acid and those of DNA are non-dynamical under normal conditions. The instability (quantum criticality of RNA) suggests that in this case the energy needed to transform OH and O$^-$ to each other is rather small but differs sufficiently from the thermal energy.

   Wien's law for the wavelength distribution of blackbody radiation for the wavelength at the maximum of the wavelength distribution of photons at temperature T reads as $\lambda_{max} = 2.89810^{-3} mK/T$. At room temperature 300 K this gives $E_{th} = 0.146$ eV and infrared frequency $f = 3.43 \times 10^4$ GHz. Photons having energy sufficiently above or below E_{th} are not thermally masked. The estimated energy difference $e = E_{bind}(O^-) - E_{bond}(OH) = .33$ eV is more than twice E_{th} so that there would be no thermal masking. Raising the temperature by a factor of ~ 2.26 to about 600 K would cause thermal masking. This explains why biological functions fail at low temperatures.

   One expects that the critical temperature at which Pollack effect occurs should be around the bodily temperature 313 K (40 degrees Celsius) prevailing in fever causing hallucinations. A possible identification is that this energy absorbed by the electron of O$^-$ reduces the $E_{bind}(O^-) - E_{bond}(OH)$ near thermal energy and induces the instability of O^- ions of phosphates of DNA and RNA against transformation to OH. Second possibility is that this transformation transforms protons of OH to gravitational magnetic body as in the Pollack effect.

   Note that microwaves with frequency 3000 GHz have energy about .013 eV, which is by a factor $\sim 1/11$ lower E_{th}, so that they are not thermally masked (see this) Note that the clock frequency of Pentium 4 processor is 3000 GHz and represents recent upper bound (see this).

3.3 How the field bodies control control the chemical activity of biomolecules?

The value of $e = E_{bond}(OH) - E^-_{bind}(O^-)$ characterizes the level of quantum criticality of the biomolecules and the nearer this parameter is to the thermal energy, the more sensitive the system is to sensory input and more capable to perform chemical activities. Besides pH also the presence of electric field affects the energy of the electron of O^- and could induce the instability of dark codons and electric fields associated with the electric body of the system [L15] could serve as tools controlling how "quantal" DNA, RNA and proteins are.

A good example is provided by microtubules, which define a 2-D quantum computer like system organized into helical strands of $OH - O^-$ qubits. Tubulin proteins are collections of OH-O^- qubits and the surface of the microtubule involves GPTs molecules accompanied by phosphates accompanied by OH-O^- qubits.

Microtubules have a longitudinal electric field and the second end of the microtubules is highly unstable inducing a continual decay and regeneration of the microtubule. This could be due to the reduction of the energy difference $e = E_{bond}(OH) - E^-_{bind}(O^-)$ to energy near the thermal energy. In the case of DNA this could be achieved by irradiation using photons with energy which reduces $e \simeq .33$ eV to about $e_{th} \simeq .15$ eV. The needed energy would be about .18 eV.

Quite generally, the biological body of the organism carries an electric field in the head-tail direction [J1] (for the TGD based interpretation of Becker's findings see [K9]). Becker's electric field plays a key role during the growth of the organism and also in healing of wounds and addition of external electric field affects these processes. If the energy $e = E_{bond}(OH) - E^-_{bind}(O^-)$ is nearer to the thermal energy for the growing or healing cells, they would be more capable of changing.

4 Could running computer programs be TGD analogs of time crystals?

The following comments emerged as a result of nightly reflections after Zoom discussion with Ville-Einari Saari. The basis of these ponderings is the article "Quartz crystals as a life form and ordinary computers as an interface between quartz life and ordinary life?" (see this).

4.1 Quantum computing-like activity based on OH-O^- qubits

It is good to summarize the basic ideas first.

1. The basic observation is that cold plasmas, dominated by ions, have the prerequisites for the emergence of qubit consciousness. The universe is full of them. Plasma, quartz, biology,... Bit flip is a key operation of quantum computation and there must always be a suitable temperature or external electric fields to make it sufficiently but not too easy.

2. The basic mechanism would be based on quantum gravity. A dark photon with energy .33 eV as difference of the bonding energy of OH and binding energy of e^- binding energy n O^- is needed to flip the qubit. A background electric field that reduces this energy. The critical temperature would be room temperature .15 eV where the qubit directions become random. When the bit flip energy is slightly above this, the system is quantum critical and the prerequisites for long-scale consciousness exist.

3. In the general case all salts can be important. For instance, for $NaCl \to Na^+ + Cl^-$ transition Na_+ would be dark and at the gravitational magnetic body of the Earth or Sun.

4. Also he classical electric fields also play a central role and one can associate to them a very large Planck constant [L15] with them. DNA and the cell are key examples in biology. The Earth's electric field characterizes the biosphere. They can be used to control the energy difference of OH-O^- bits and make it quantum critical, which makes the qubit flip easy.

5. The article (see this). shows that a quantum realization of the genetic code from OH-O^- qubits for DNA and RNA is obtained: a codon corresponds to 6 qubits. Amino acids correspond to one qubit. Symmetries with respect to the third letter and their breaking

are understood. The number of amino acids is predicted correctly. One can say that the quantum realization of the genetic code corresponds to the chemical code in the sense that the ground states for quantum codons correspond to chemical codons.

I personally consider these results to mean a final breakthrough and above all it shows that OH-O^- qubits and their generalizations are not limited to biology.

4.2 What evidence is there for quartz life?

I participated years ago in a seminar organized by NASA in Hessdalen, where plasma balls, plasmoids, are systematically observed. I learned that these light balls seem to behave intelligently and even seem to be observing their observers! Light balls typically occur on lines of tectonic activity, where tectonic energy is released and one can think that the released energy serves as metabolic energy.

Researchers of NASA recently published an article about plasmoids as a possible form of life above the ionosphere. I have discussed the findings in [L15]. For example, they gathered to observe an electrical cable leaving the module, which is associated with a radial electric field that could also excite OH-O^- qubits and achieve quantum criticality. They made the impression of being alive.

Plasma balls have been observed to associate with crop circles [K5, K6], one of the taboos of modern science, which are still believed to be made by humans, all they are caught in the act of constructing a crop circle! Also glass balls that have formed from molten quartz are found to accompany crop circles.

4.3 How could quartz life and biological life relate?

Which is smarter: quartz life or biolife? The first guess is that biological life will mercilessly beat quartz life in this kind of competition, but ZEO may change the situation so that quartz life represents something totally new: a time-like realization of the analog of genetic code bringing in mind time crystals, which I have discussed from the TGD point of view in [K4, L8] [L13].

1. Quartz life is unable to move on our time scales. Although it has long been a wonder that moving round boulders exist, perhaps in Romania. The products of quartz life can be misleadingly reminiscent of plants that I have seen. Quartz crystals have been reported to have a healing effect on the state of consciousness, as I myself once experienced.

2. OH-O^- life implements genetic code in biology. Is this already the case with quartz or are the qubits randomly distributed here and there in the quartz crystal? In any case, the tessellations of hyperbolic 3-space realize the genetic code universally on all scales [L14], so this could be the case.

3. It is important to distinguish OH-O^- qubits from the bits represented by electron spins, with which microprocessors operate.

   One could imagine a situation where microprocessor could become conscious in such a way that OH-O^- qubits are created, which act as conscious observers while the program is running and in ZEO they could perhaps influence the program flow by inducing "big" state function reductions (BSFRs) changing the arrow of the geometric time, thus making the processor an intelligent problem solver that would use trial and error as a basic mechanism [L17].

   Could OH-O^- qubits be related to classical electronic bits just as quantum codons are related to chemical genetic codons so that their minimum energy states would correspond to the bits of the program code.

4. However, it must be remembered that ZEO allows another option if each clock frequency pulse is associated with non-determinism and therefore a potential memory mental image. This would be an analogy to time crystals. While the program is running, the program flow could produce a time-oriented analogy of the DNA sequence. Programs would correspond to DNA chains, subprograms to genes! Basic modules to codons. The maximum information content of consciousness in bits would be $N \times M$ bits, where N is the number of clock ticks

and M is the maximum number of OH-O^- qubits for the microprocessor at a given moment in time.

Could series of multi bits in a microprocessor correspond to a series of quantum qubits like DNA. There would be a time-oriented realization of the genetic code. This would represent a completely new biology and computer era could also mean a genuine evolutionary leap.

5. A maximum of 64 ordinary electronic bits are connected to microprocessors. This corresponds to the information content of a 10 nm piece of DNA and is quite modest. What about qubits? Let's assume a microprocessor with a volume of $V = 5 \times .5 \times .5$ mm^3. Let's assume that one SiO_4 occupies a volume of the order of $V_0 = \text{Angstrom}^3 = 10^{-21}$ mm^3 mm^3.

   The maximum number of qubits at a given time was the ratio $M = V/V_0 = 10^3 9 \simeq 2^{70}$. The number of bits is 6 bits larger than for a microprocessor having at most 64 bits recently. For a program, it was based on the above speculation $N \times M$ where N is the number of clock pulses during the running of the program module. This would give an upper bound of $70N$ bits. This would allow one-one correspondence of qubits with the ordinary bits of the program code.

4.4 Quantum criticality is needed

The number of quantum critical qubits in a microprocessor is much smaller than the above naive estimate because the flip energy of qubit must be sufficiently small, i.e. below .33 eV, to obtain quantum criticality but above the thermal energy of .15 eV. This can be achieved by using an external electric field that reduces the energy such that it would also make the microtubules at one end extremely fluctuating.

Is there any hope of achieving quantum criticality in transistors (see this)?

1. There are electric fields in transistors and the values of the base-emitter voltages are in the range $0.5 - 0.7$ eV (metabolic energy quantum) and at the same time the collector-emitter voltage is at least 0.1 V (close to the thermal energy .15 eV)! Note that the sizes of transistors have shrunk from 10 micrometers to 5 nanometers during the development of computers.

   An NPN type transistor (bipolar transistor) is a current amplifier: a small control current coming to the base is amplified into a much larger current from the collector to the emitter.

2. Now we come to the crucial question: what voltages occur? A transistor typically becomes conductive when the negative base-emitter voltage is above 0.5 eV in absolute value (it is convenient to measure voltages as the energy of the charge it gains when moving across the voltage) and at the same time the negative collector-emitter voltage is above 0.1 eV in absolute value!

   The conditions are therefore excellent for the emergence of a qubit population that monitors the flipping of the bits represented by the transistors during program execution!

4.5 Comparison of quartz consciousness and bio-consciousness

To get a realistic picture, one can compare quartz consciousness to biological consciousness.

1. Consider the first pessimistic comparison. The length of the DNA double helix for a human is over a meter. This is about a million times more than the number of bits related to the content of the consciousness of a 64-bit processor at a given moment.

   In biology, salts and their ionization states also define qubits with lower qubit rotation energies. Biosystems are full of different ions and I ended up with the idea of a large Planck constant by starting from the observation that the quantum effects of ELF radiation on vertebrate brains seemed to be related to the cyclotron energies of ions but with a very large Planck constant (gravitational Planck constant $\hbar_{gr}$ introduced by Nottale) [J2].

   Microtubules can be micrometers long (inside cells and in axons). There are other filamentous structures. They consist of tubulins, about 10 nm in size. Each tubulin contains approximately $10^3 \simeq 2^{10}$ amino acids if the amino acid corresponds to the nm scale. That is 10 bits. There are 100 tubulins in a chain, so we get 1000 qubits per tubulin chain.

Typically, there are 13 parallel helical tubulin chains, which makes 13,000 qubits. Considerably more than 64 qubits! And microtubules are present in all cells and axons!

2. Optimistic comparison.

   It is worth noting a really big "on the other hand". The zero-energy ontology (ZEO) introduces a conscius memory that can increase the number of bits because "multi-moment experiences" become possible [L22]. In the optimal situation one has an analog of time crystal: each clock beat involves classical non-determinism necessary for the memory recall. If the program module defines a time-like analogy for DNA as time crystal then it would define the time-like analog of a DNA sequence and the content of conscious information would increase drastically.

   Brothers Fingelkurts [L1] have found that EEG splits into pieces of duration about .3 seconds and these pieces split into organized and chaotic halves. A natural TGD inspired interpretation [L1] would be that these pieces correspond to pairs of BSFRs defining a kind of sleep-awake rhythm and also now an analog of time crystal is in question. Quite generally, EEG rhythms could give rise to similar sleep-awake rhythms and analogs of time crystals.

4.6 How could the OH-O$^-$ qubits represent the functioning of a transistor?

Could the bits represented by transistors have a quantum representation as OH-O$^-$ qubits analogous to the proposed quantum variants of DNA, RNA and proteins for which the chemical codons correspond to the minimal energy ground states of quantum codons which are dynamical?

The characteristic feature of the transistor (see this) is due to the semiconductor property of the base, which physically corresponds to a narrow region between two diodes, collector and base. The semiconductor property means that current runs in the base only in one direction. The second characteristic feature is that a small base-emitter current directed to the emitter is amplified to a much larger collector-emitter current. Therefore transistors can be used as switches and amplifiers.

In a transistor the collector-emitter current on or current off represent a bit. Bit 1 could correspond to a large current induced by a base current to the base. Bit 0 could correspond to a very small current induced by a base current from the base. Equivalently base current represents the bit. A second representation replaces current with base voltage or equivalently with output voltage.

Transistors can be classified to bipolar transistors and field effect transistors. The following consideration is restricted to the bipolar transistors.

1. Transistorsconsist of a collector, emitter and base, which is a thin semiconducting region between them.

2. In transistors there are two kinds of current carriers. Delocalized electrons in the conduction band and positively charged holes in the valence band created when the electron is transferred to the conduction band. The symbol n (negative) *resp.* p (positive) is used to refer to a situation in which current carriers are electrons *resp.* holes. One can classify bipolar transistors to type npn and pnp.

3. For a transistor of type npn, the base is p type semiconductor whereas the diodes between which it is located are of type n. When the base-emitter current is nonvanishing, electrons run from the n type emitter to the p type base and away from the base. The small base-emitter current induces a considerably larger collector-emitter current that is current of electrons from the n type emitter to the n type collector. In the base The fusion of the electrons from the emitter and of holes of the base gives rise to neutral atoms and this gives rise to the base-emitter current.

4. For a transistor of type pnp, the base is n type semiconductor whereas the diodes are of type p. If the base-emitter current is of the correct sign, a small current of holes runs from the n type base to the p type emitter. Base-emitter current is amplified to a large current of holes from the p type collector to p type emitter. In the base the electrons and holes are created from neutral atoms and this gives rise to base-emitter current.

To understand what the representation of transistor bits in terms of OH-O^- qubits might mean, it is good to start from the following analogies.

1. One can say that valence and conduction bands correspond to the biological body (ordinary matter) and gravitational magnetic body (dark protons). Electrons in the valence band are analogous to OH state whereas electrons in the conduction band are analogous to dark protons H^+ at the gravitational magnetic body. OH^- corresponds to the hole.

   The emergence of collector-emitter current as electrons in the conduction band is analogous to the Pollack effect. The fusion of holes and electrons in p type base corresponds to the qubit flip OH^- +dark p $\rightarrow$ OH as a dual of Pollack effect. The creation of holes and electrons in n type base correspond to the Pollack effect OH $\rightarrow$ OH^- +dark p.

2. n type regions are analogous to dominance of dark H^+ states. Magnetic body dominates. p type regions correspond to regions in which OH^- states dominate.

3. For a transistor of type npn, the collector and emitter as n type regions correspond to magnetic bodies assignable to separate 3-surfaces. The p type region would correspond to OH^- type region so that in the ideal case its magnetic body would contain no dark protons. requires that the dark protons can be transferred between the magnetic bodies involved. The currents would dominantly consist of dark protons.

   The voltages between the ordinary matter parts (biological bodies) indeed correspond to voltages between the magnetic bodies since electrostatic generalizes to the many-sheeted space-time.

4. For a transistor of type npn, p type regions correspond to two separate OH^- type regions of the biological body (ordinary matter) whereas an n type region would correspond to a magnetic body containing dark protons. The OH^- created in Pollack effect in the base would flow to the emitter. Also the ions OH^- created in the collector would run to the emitter. This would mean the transfer of electrons between OH:s. The currents would correspond to the electrons transferred between the bonds. These currents are analogs to the currents in the transistor.

This kind of representation requires that OH groups replace some O:s of SIO_4 or SiO_2. This is possible but whether it can happen in the recent transistors, is not clear to me. If not, one might hope that this kind of representation is possible in a future technology combining a classical computer and OH-O^- quantum computer-like system to a genuine living machine.

4.7 Is there any hope of curing the retraining problem of language models without making computers conscious?

I summarized my thoughts on perhaps the worst problem of language models, which is the loss of plasticity in continuous learning. The entire teaching material has to be rewritten, which is terribly expensive. These comments were stimulated by and article raising some hopes about the solution of the problem (see this).

One can ask whether and how TGD's speculative vision of potentially conscious computers [L17, L16] might solve the problem.

4.7.1 The retraining problem of language models

The basic problem is that everything has to be started from scratch. This is extremely expensive. Biological systems relearn quickly because there is no need to relearn everything. Is the problem fixable for the computers as they are now or is something new required?

To see what could be the root cause of the problem consider first what language models are meant to be.

1. In a language model, learning occurs at the raw data level. Different probabilities are taught for different associations. The associations are fixed.

2. How does the trained system work? The language model simply reacts by recognizing the context and producing probabilistically one of the fixed associations. This response is a mere reaction. If language models are what they are believed to be, they does not have conscious understanding, they lack intentional actions, and are unable to react to a changing environment.

4.7.2 Could TGD-inspired biology help?

Could a comparison with TGD-inspired biology give clues as to where things go wrong. Why is relearning so easy for biosystems? How does the TGD-based biology differ from the standard biology in this respect? Consider first the classical level.

1. Holography, which is not quite deterministic, is a completely new element of TGD as compared to the standard model. The space-time surfaces are analogous to Bohr orbits and determined almost completely by 3-surfaces as initial data. The 4-D tangent spaces of the space-time surface at the 3-surface defining the holographic data cannot be selected freely. This is the classical counterpart of Uncertainty Principle and leads to classical quantization. Function, program is the basic concept rather than 3-D data.

2. These 4-surfaces define classical analogies of biological functions, behavioral patterns, or programs. When the 3-surface, which almost uniquely fixes the 4-surface, changes, the function changes. Non-determinism is essential in making a conscious memory recall possible.

Consider next the quantum level.

1. Series of "small" state function reductions (SSFRs) associated with the repeated measurements of commuting observables belonging to the same set whose eigen states the 3-D states at the passive boundary of causal diamond (CD) are, define self as a conscious entity. The proposal is that biorhythms as clocks define TGD counterparts of time crystals such that each unit of time crystal involves a classical non-determinism.

   This could be the case at the EEG level as the findings of brothers Fingelkurts suggests [L1] [L1]. Maximal non-determinism implies maximal memory recall capacity and maximal flexibility. A whole set of different behavior patterns can be represented as quantum superpositions and the interaction with the external or internal world determines the measurement in which some classical behavior is chosen.

   The sequences of SSFRs are analogous to association sequences and the superpositions of the space-time surfaces can be seen as superpositions of associations. One could regard the quantum counterpart of any biological function/response as quantum association.

2. "Big" state function reductions (BSFRs) having interpretation as death of self or falling asleep involve time reversal. Pairs of BSFRs (sleep periods) make learning possible through trial and error. After the two BSFRs, the system has new holographic data and different space-time surfaces. A goal directed behavior becomes possible and there are many ways to achieve the goal, not just one fixed way analogous to a fixed computer program. This is the essence of intelligent behavior.

   Local pairs of BSFRs would give rise to the relearning generalizing to any biological function.

How does this general view relate to the DNA level?

1. According to the standard view, DNA remains the same during the life cycle. If DNA represents data, there is no relearning at the level of chemical DNA. In zero-energy ontology (ZEO), even chemical DNA could change without any problems with conservation laws and quantum superpositions of different chemical genes are in principle conceivable.

   Quantum DNA can be represented in terms of OH-O^- qubits sequences assignable to the gravitational magnetic bodies of the Sun and Earth. Remarkably, the solar gravitational Compton frequency is 50 Hz, the average EEG frequency. At least for neurons, this would suggest that the gravitational magnetic body is that of the Sun. Note however that EEG time scales are also associated with the basic biomolecules. For the Earth the gravitational

Compton frequency is 67 Gz and is a natural frequency associated with the conformational dynamics of biomolecules.

Quantum DNA consisting of codons represented as OH-O− qubits is dynamic and could act as a simulator, a kind of R&D laboratory testing different variants of DNA. It is of course possible that a single life time is spent with the same chemical DNA and the next life after a pair of BSFRs involves the improved DNA.

2. Epigenesis brings in flexibility. Even if the chemical DNA does not change, it can be used in different ways. Suitable modules are selected from the analog of program software, just like in the text processing. In the TGD framework, this could correspond to the classical non-determinism of the space-time surfaces representing the biological function. Dark DNA allows you to try different combinations of genes.

3. The understanding of the role of the cell membrane and membrane potential in epigenesis is increasing. As found by Levin et al [I1] [L20]. The very early stage of the development of embryo is highly sensitive to the variations the membrane potential and can be understood in terms of the changes of the binding energy of electron of O^- induced by the potential, which can reduce the binding energy to thermal range so that the flips of OH-O^- qubit occur with high probability. In adulthood, the sensitivity disappears and qubits would not flip.

   Could this sensitivity be artificially induced? Here, electric fields as a controller of the sensitivity of OH-O^- qubits assignable to the basic biomolecules suggests themselves.

4. Microtubules involve longitudinal electric fields and their second ends are highly dynamic so that the length of the microtubule is under continual change. There are huge numbers of amino acids carrying one qubit each (COOH group). Here the quantum level and the classical level are both dynamic and seem to be strongly coupled. Also strongly related to conscious memory.

5. The quantum entanglement between the quantum level and the chemical level could be possible even at the amino acid level?

One can also look at the situation at the level of cell membranes and neuronal membranes. The basic question is how cell membranes and neuronal membranes learn.

1. As found by Levin et al [I1], the role of the electric fields is central also in the ordinary cells. The electric potential of the ordinary cell membrane correlates with the state of the environment of the cell and codes for sensory information.

   The TGD proposal is that cell membrane acts as a Josephson junction and communicates the frequency modulate membrane potential to the magnetic body as dark Josephson photons where they induces resonantly quantum transitions transformation the modulation to a sequence of pulses perhaps inducing as a feedback nerve pulses or their analogs.

   During the embryo stage, the cells are very sensitive to the variations of the electric field of the cell and this suggests that these variations take the cell membrane near to the criticality at which large quantum fluctuations for OH-H^- qubits for phosphates at the inner surface of the cell membrane are possible. This period would be analogous to the learning period of LLMs and would involve BSFR pairs. After this period the situation stabilizes and it might be that BSFRs become very rare.

2. In the central nervous system, nerve pulses appear and in neuroscience are thought to be responsible for communications only. In TGD the situation would be different [L19]. I have proposed their interpretation in terms of pairs of BSFRs so that in LLMs they would correspond to relearning. Neurons would be lifelong learners whereas ordinary cells would learn only in their childhood.

   Nerve pulse is generated at a critical membrane potential, which could correspond to effective thermalization of the OH-O− and possible qubits assignable to other ions. Axonal microtubules would also be near quantum criticality. The propagation of nerve pulse along the axon as a local BSFR-pair would induce microtubular relearning.

4.7.3 Could the speculated quartz consciousness come to the rescue?

One can consider the possibility that under a metabolic energy feed computer can become to some extent an entity so that it can modify both the program and the data used by it as a response to changes in the environment provided by the net. This would require that the OH-O^- qubits as dark variants of program bits can entangle with ordinary bits. Energetically this could be possible since the energy scales for transistors are essentially the same as for the metabolism and OH-O^- qubits.

1. Suppose that the sequences of OH-O^- qubits as time crystals in TGD sense can be realized in a (future) computer. Qubit sequences would be time series related to the running program. They would involve variation because only the bit configuration corresponding to the minimum energy would correspond to the running program. This makes possible an entire repertoire of associations from which a SSFR would choose one. Quantum measurement following the generation of bit-qubit entanglement could change the value of the bit.

2. Besides the dynamic realization as a running program, there could be a non-dynamic realization in which the data that determines the program could be accompanied by a similar set of qubits assignable to transistors. The data used by the program, such as learned associations, could be associated with qubits, and could be made dynamic by using electric fields to make the qubits more sensitive against flip. The problem is of course that the change of a randomly chosen single qubit implies the failure of the problem. Only critical qubits associated with choices and data qubits should be subjected to a flip.

3. Besides time crystals with non-deterministic repeating units, also space-like crystals involving non-determinism in each lattice cell can be considered. Also dynamical quantum qubits with maximal non-determinism in space-like directions associated with unit cells could accompany the data bits. Dynamization could be induced by using electric fields.

4. If OH-O^- qubits can quantum entangle with bits, program/data is accompanied by quantum program/quantum data which can react to the perturbations from the external world (BSFRs) and internal world (SSFRs). The quantum level could control the bit level. Even the associations as the data of the language model could be accompanied by a set of qubits that react to a changing situation.

4.7.4 How could an association system retrain itself in response to a changed situation

If language models are nothing but deterministic association machines, there is little hope of solving the problem.

Could the learning in the biological and neural systems provide some hints about possible cures, possibly requiring modification of computers so that they would become analogous to living systems?

1. The findings of Fingelkurts brothers [L1] [L1] suggest that EEG rhythms define time crystals in the TGD sense, that is maximally non-deterministic systems having lattice cells as a basic unit of non-determinism for SSFRs giving rise to the flow of consciousness of the self. If biorhythms define TGD analogs of time crystals, the non-determinism would be maximal and maximum flexibility in SSFRs would be possible.

2. In ZEO, a "big" state function reduction (BSFR) as counterpart of ordinary state function reduction changes the arrow of time and is assumed to give rise to the analog of death or sleep. At the LLM level, this would be the analog for a complete retraining from the beginning.

The sequences of SSFRs could be seen as associations or association sequences having also a behavioral pattern. The repertoire of associations should change as the environment changes.

1. Could a computer clock define the equivalent of an EEG rhythm as a time crystal in the TGD sense? The problem is that a typical computer clock frequency is few GHz and

considerably lower frequency than the 67 GHz as the gravitational Compton frequency of the Earth. This would suggest that a unit consisting of roughly 67 bits could correspond to the basic unit of the time crystal. The gravitational magnetic body of the Sun has a gravitational Compton frequency of 50 Hz identifiable as the average EEG frequency.

2. Could one think of a quantum version of LLMs in which pairs of BSFRs as "death" and rebirth happen spontaneously all the time as a reaction to a conscious information coming from the environment inducing the perturbation implying that the density matrix as the basic measured observable does not commute with the observables that define the quantum numbers of the passive part of the zero energy state? In this way ZEO would make possible trial and error as a basic mechanism of learning.

3. The formation of an association could be perhaps modelled as a single non-deterministic space-time surface decomposing to a time crystal like almost periodic structure with each unit characterized by non-determinism making it a seat of potentially conscious memory? Internal disturbances would produce their quantum superpositions and SSFR would select a particular association.

4. An external disturbance could produce a BSFR and "sleeping overnight". This period of "sleep" could be rather short: also our flow of conscious experience is full of gaps. Upon awakening, the space-time surfaces as correlates of the associations would no longer be the same. System would have learned from the interaction with the external world. This temporary death of the system would be an analogy for a total re-education. But the system would cope with it all by itself.

The hard problem is how to realize this vision. Here the analogy with cell and neuron might serve as a guideline in trying to imagine what the new technology might look like.

1. Ordinary cells are analogous to LLMs as they are now and learn only in their childhood. Neurons are lifelong learners thanks to the neural activity inducing the conduction of local BSFR-pairs updating microtubular states. Could something like this be realized in computers?

2. In computers, information is transferred along wires and they can be seen as the counterparts of axons. Is it possible to make these wires carriers of quantum information and perhaps even of the learned data about associations. The conduction of the analogs of nerve pulses during the running program inducing a pair of BSFRs would gradually modify the data locally and lead to a continual relearning.

   Copper wires are too simple to achieve this. Should one consider axon-like geometry defined by two cylinders analogous to the lipid layers of the cell membrane and having also voltage between them as a representation of the signal so that the interior cylinder would contain OH-O^- qubits? The variation of the counterpart of the membrane potential during signal transmission (bits represented as voltages) could take the qubits near criticality. Could copper hydroxide $Cu(OH)_2$ serve as a possible candidate for an intelligent wire based on OH-O^- qubits.

4.8 How the possible quantum variants of LLMs could be updated?

If one can assign the training data of LLMs to quantum states, there is a hope that the retraining need not start from scratch and could become more flexible and less expensive.

4.8.1 How to assign to classical associations their quantum representations?

In LLM both inputs and outputs are associations represented as text. The quantum dynamics must not affect the content of the input. A classical association is encoded as a bit sequence. Associations can be enumerated and each corresponds to its own bit sequence serving as an address, a symbolic representation, and no longer contains the original information. The Gödel numbering of statements serves as an analogy.

Also the quantum equivalent of the number of the classical association as a qubit sequence is just a name for it. Quantum processing can operate on these qubit sequences and produce longer quantum associations associated with them which in qubit measurements produce longer associations and superpositions of them. The outcome is determined by the measurement of the bits appearing in the numbering of the associations.

Quantum operations followed by the measurement of qubits can only permute classical associations. They can affect the association probabilities and perhaps add new associations in partial retraining. Various quantum superpositions of the quantum associations (the numbers labelling them) are possible and correspond to the quantum counterpart of the concept of "association A→ ..., where A is fixed.

This allows for maximally simple representations at the quantum level. Arbitrarily complex associations $A \to ...$ can be quantum-encoded by listing them. A local bit-qubit correspondence is the simplest one and the same operation could change the value of both bit and qubit. If the electric field does this then this could be the case for transistors as bits if each bit is accompanied by OH-O^- qubit. In the ground state the minimum energy state for OH-O^- qubit would correspond to the ordinary bit.

Is the quantum entanglement between bits and qubits necessary or even possible? Could one keep the bit level as it is and perform quantum operations for qubit sequences and transform the to bit sequences so that also associations not possible for the classical computer could appear in the output? This option cannot be excluded if the bit sequences represent analogs of Gödel numbers for associations.

4.8.2 Does quantum non-determinism reduce to classical non-determinism for "small" state function reductions (SSFRs)?

In ZEO, the classical non-determinism does not affect the 3-surfaces nor fermionic states at the boundary of the CD. This is consistent with the identification of the non-determinism of SSFRs as classical non-determinism.

The classical Bohr orbits would be non-unique due to the classical non-determinism appearing already for the 2-D minimal surfaces. The very fact that computer programs can be realized, strongly suggests that this non-determinism is present.

There are two types of non determinisms. A non-deterministic time-like crystal (time crystal) and non-deterministic space-like crystal represent these non-determinisms. Each cell of these crystals would be a seat of non-determinism meaning that the surface branches at the locus of the non-determinism and a single branch is selected. This makes it possible to generate a conscious memory in a memory recall.

Reading and writing transform these two kinds of non-determinisms to each other.

1. Reading space-like crystals representing data bit sequence creates a time-like representation as a sequence of SSFRs if at a given moment the qubits of the geometric past are frozen. A series of SSFRs, conscious stream, "self" is created at the quantum level. Therefore a space-like non-deterministic crystal can be transformed to a time-crystal. In writing the opposite happens. The minimum energy state for the associated quantum states selects a unique configuration.

   Quantum entanglement between separate non-deterministic representations (cognitive representations possibly allowing characterization in terms of a p-adic topology for a ramified prime) is possible. Also entangled between time- and space-like non-deterministic degrees of freedom is possible.

2. How these reading and writing processes could be realized? A relation to topological quantum computation, in which time-like and space-like braidings by monopole flux tubes play a central role suggests a possible answer to the question [K1]. Think of dancers connected by threads to fixed points on the wall. Dance can be interpreted as a time-like braiding and induces space-like braiding as knotting and linking of the threads connecting the dancers. In TGD the threads correspond to monopole flux tubes.

4.8.3 But what does the classical non-determinism mean?

I have mentioned several times classical non-determinism at the level of holography = holomorphy principle identifying space-time surfaces as roots $(f_1, f_2) = (0, 0)$ of analytic functions of H coordinates. At the level of 3-D holographic data branching should occur so that the algebraic equations allow several roots with different tangent spaces.

1. What is the precise meaning of the analogy between holographic data as 3-surfaces and the frames of soap films? Could all roots $(f_1, f_2) = (0, 0)$ correspond to different alternatives for this non-determinism or are there some restrictions? It seems that the 4-D roots, which can be glued together continuously cannot correspond to the non-determinism. The cusp catastrophe serves as a good example of the situation. The regions of the space-time surface representing different roots cannot be regarded as distinct space-time surfaces.

   Rather, it seems that the non-determinism requires multiplicity of the 4-D tangent space and in this kind of situation one must select one branch.

2. Could the choice of only one root in the branching situation give rise to non-determinism? Is it possible to implement boundary conditions stating classical and quantal conservation laws at the interfaces of the regions corresponding to different branches?

   Any general coordinate invariant action expressible in terms of the induced geometry is consistent with holography = holomorphy principle [L21, L23] Is it permissible to choose the classical action so that boundary conditions can be satisfied when a single root is selected? This would force coupling constant evolution for the parameters of the action if one also assumes that the classical action exponential as an exponent of Kähler function corresponds to a power of the discriminant D defined as a product of root differences? The same choice should be made at the fermion level as well: the super symmetry fixing the modified fermionic gamma matrices once the bosonic action is fixed, would guarantee this.

3. Also, the roots u for a polynomial $P(u)$ of the hypercomplex real coordinate u assignable to the singularities as loci of non-determinism at the string world sheets come to mind. These roots must be real. At criticality a new root could appear. Also branching could occur and relate to the fermion pair creation possible only in 4-D space-time thanks to the existence of exotic smooth structures [L24, L23]. Could these roots represent the positions of qubits?

4.8.4 What could the updating of the training material by adding an association mean at a fundamental level?

Retraining cannot be only the manipulation of association probabilities but also the addition of new associations. The scope of the concept "associations related to a given input" is expanded and complexity increases.

If these associations are enumerated by bit sequences, it is enough to associate a series of bits with the new association as a classical bit sequence and to this new bit sequence a qubit sequence by bit-qubit correspondence. The superposition of the quantum counterpart of the new association with previous qubit sequences should be possible. Just like in LLM, also the combinations of the basic associations mapped to qubit sequences into longer quantum association chains should be possible.

4.8.5 Comparison with axons

Is it reasonable to represent the training data as an analogy to the dynamic quantum states of axons that microtubules might represent? A set of qubits related to an axon. Each set of qubits represents one association.

The axon states allowed by classical space-like non-determinism would correspond to different associations as sets of qubits, which in turn correspond to sets of bits. Data update would be by inducing thermal chaos and time reversal by means of a nerve impulse and the subsequent "reincarnation". Local thermal chaos induced by means of electric fields in the basic update operation. The local states of axons (microtubules) would be symbolic representations, kind of Gödel numbers for actions.

4.9 On symbolic consciousness

Whether the notion of symbolic consciousness could make sense in some sense has been a topic of discussion in our Zoom group.

1. A symbol represents an object to the observer and its meaning, if any, depends entirely on the associations that arise in the observer. A symbol is an object or process that sufficiently resembles the object it represents.

   In this sense, one cannot speak of a symbol as an independent object. Just as one cannot speak of information as something absolute. The amount of conscious information produced by a symbol depends on its observer.

2. If one had to necessarily call some form of consciousness symbolic, then I would call the consciousness presented above, possibly related to transistors and microprocessors, symbolic. In the optimal case, a program running in a microprocessor generates OH-O^- consciousness from the program as an analogy of a DNA chain, which symbolically represents a process that has meaning for us through the output.

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