Do the icosatedrahedral tessellation of H^3 and icosahedral H_2O supercluster correspond to each other?

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Contents

Abstract

The icosa tetrahedral tessellation (ITT) of H^3 has a vertex figure rhombicosidodecahedron (RID). Surprisingly, this corresponds to the third shell of the icosahedral supercluster (ISC) for water near freezing point and also metal glasses. The challenge is to understand how the complement of the vertex figure of ITT, which should be outside it, can correspond to the first and second shell of the ISC which are below the third shell.

The obvious guess is that the ITT realized at the field body of the ISC is related by inversion to ISC. M^8-H duality, as the TGD counterpart of the momentum position duality, involves inversion in $M^4 \subset M^8$, having interpretation as momentum space, mapping it to $M^4 \times CP_2$. Is M^8-H duality involved?

This question led to surprising developments suggesting deep connections between fundamental physics (M^8-H duality and the notions of gravitational and electric Planck constant as implications of number theoretic vision), physics of water (hydrogen bonded water clusters), consciousness theory (field body as controller of biological body forming sensory representations of biological body), biology (ITT view of the genetic code) and cosmology (generalization of Hubble's law to all scales).

1 Introduction

One of the oldest ideas of TGD inspired quantum biology and consciousness theory is that that sensory representations realized both at the level of the biological body and magnetic body and closely related to each other are central in the understanding of for instance EEG and nerve pulse [K11, K9, K15, K1, K14] [L18, L22].

Pollack effect [I2, L1, I5, I3] is in TGD framerwork assumed to transform ordinary protons and also alkali ions to dark particles with a large value of effective Planck constant h_{eff} at the field body [L1, L3, L20, L10, L21, L18]. The TGD inspired generalization of Pollack effect is in the central role in the realization of the representations at the level of the field body. The "dark" protons at the field body of DNA are assumed to give rise to a dark variant of the genetic code relying on icosa tetrahedral tessellation (ITT) of hyperbolic 3-space identified asw the light-cone proper time constant surface of causal diamond (cd).

The article by Thomas Brown [I4] (I am grateful to Esa-Juhani Ruoho for the link and also for inspiring discussions) discusses critically the interpretation of the Pollack effect. The vertex figure of ITT (IVF) [L17, L28] is rhombicosidodecahedron (RID). I have proposed that the ITT is behind the genetic code and to be associated also with the hydrogen bonded water molecule clusters. Surprisingly, RID is identical with the third shell of the so-called icosahedral supercluster (ISC) [I4]. This inspired the proposal about the duality between sensory representations realized by ISC at the level of the water and ITT realized at the level of the field body of the ISC.

The challenge is to understand how the complement of IVF, which should be outside RID, can correspond to the first and second shell of the ISC which are below the third shell. The obvious guess is ITT-ISC correspondences stating that the ITT realized at the field body of the ISC is related by inversion to ISC. M^8-H duality, as the TGD counterpart of the momentum position duality, involves inversion in $M^4 \subset M^8$, having interpretation as momentum space, mapping it to $M^4 \times CP_2$. Is M^8-H duality involved?

This question led to completely unexpected developments suggesting deep connections between fundamental physics (M^8-H duality [L29] and the notions of gravitational Planck constant [E1] [L14] and electric Planck constant [L18] as implications of number theoretic vision), physics of water (hydrogen bonded water clusters), consciousness theory (field body as controller of biological body forming sensory representations of biological body), biology (ITT view of the genetic code) and cosmology (generalization of Hubble's law to all scales).

In particular, a prediction for the ordinary Planck Hubble constant implies a predictions for the mass density of the Universe and prediction is consistent with the observed mass density including contributions of dark matter and energy if the value of the velocity parameter $\beta_0 \leq 1$ appearing in the formula for the gravitational Planck constant is equal to $\beta_0 \simeq 1$ and the very large system containing observable Universe as quantum coherence region with Hubble radius L_H is a blackhole-like object with Schwartschild radius $r_s = 2\beta_0 L_H \simeq 2L_H$ for $\beta_0 \simeq 1$. Hubble tension means that the value of the Hubble length $L_H = 1/H_0$ in short scales is roughly 10 percent smaller than its value in long length scales. Since L_H is proportional to $1/\beta_0$ this can be understood if β_0 in the early universe (long scales) is roughly 10 per cent larger than in the long scales. This would imply that $\beta_0 \simeq .92$ in long length scales $\beta_0 \simeq 1$ in short scales. The predictions for the fraction of baryons would be about 5 percent in short length scales and 7.4 percent in long length scales.

The article by Brown [I4] summarizes basic information about the Pollack effect. Pollack effect requires only the presence of hydrophilic polymer as a catalyst at the boundary of the water. I had erratically assumed that the gel phase is necessary. Concerning the TGD based notion of Pollack battery [L32] this finding was good news. Brown discusses Pollack's interpretation of EZs critically and this led to a more precise TGD inspired view about the realization of EZs and the genetic code at the level of water clusters to be discussed in this article.

2 Some background about TGD, TGD inspired quantum biology and TGD based theory of consciousness

The following represents the background needed to understand the proposal about the duality between sensory representations realized by the icosahedral supercluster (ISC) at the level of the water and icosa tetrahedral tessellation (ITT) realized at the level of the field body of the ISC. Quite surprisingly, the study of this relationship led to completely new insights about cosmology. In particular, Hubble's law generalizes to all scales and correctly predicts the density of matter under very mild assumptions.

2.1 $M^8 - H$ duality implies generalized Hubble's law

The attempt to understand how the icosa tetrahedral tessellation (ITT) of H^3 [L17, L28] has a vertex figure the third shell of the icosahedral supercluster (ISC) [I4]. The problem was to understand how the complement of the vertex figure of ITT, which should be outside it, can correspond to the first and second shell of the ISC which are below the third shell.

The obvious guess is that the ITT realized at the field body of the ISC is related by inversion to ISC. $M^8 - H$ duality, as the TGD counterpart of the momentum position duality, involves inversion in $M^4 \subset M^8$, having interpretation as momentum space, mapping it to $M^4 \times CP_2$. Is $M^8 - H$ duality involved?

This question led to surprising developments suggesting deep connections between fundamental physics ($M^8 - H$ duality and the notions of gravitational and electric Planck constant as implications of number theoretic vision), physics of water (hydrogen bonded water clusters), consciousness theory (field body as controller of biological body forming sensory representations of biological body), biology (ITT view of the genetic code) and cosmology (generalization of Hubble's law to all scales).

2.1.1 $M^8 - H$ duality

In TGD, geometric and number theoretic visions of physics are complementary [L23, L26]: $M^8 - H$ duality [L29, L27] in which M^8 is analogous to 8-D momentum space associated with 8-D $H = M^4 \times CP_2$ is a formulation for this duality and makes Galois groups and their generalizations dynamic symmetries in the TGD framework. This complementarity is analogous to momentum position duality of quantum theory and implied by the replacement of a point-like particle with 3-surface, whose Bohr orbit defines space-time surface.

The points of $M^4 \subset M^8$ having interpretation as quaternions with number theoretic inner product identified as the real part of the square of the quaternion. The points p^k of $M^4 \subset M^8$ having interpretation as 4-momenta are mapped to points m^k of $M^4 \subset H = M^4 \times CP_2$ having interpretation as points of Minkowski space by inversion

$$p^k \rightarrow m^k = h_{eff}\frac{p^k}{p^2} \quad .$$

Here h_{eff} is the effective Planck constant having a number theoretic interpretation. The proposal is that h_{eff} is a multiple of its minimal value h_0: $\hbar_{eff} = n\hbar_0$, $\hbar = n_0 h_0$. The assumption that CP_2 size scale $R(CP_2)$ is actually scaled up up Planck length $R(CP_2) = (\hbar/\hbar_0)l_P$, $l_P = \sqrt{\hbar G}$, gives the estimate $n_0 = (7!)^2$. This predicts also values $h_{eff} < h$ and there exists some evidence for them [D1] [L2].

There are at least two possible choices for h_{eff} if one assigns it to a field body mediating a particular type of interaction. The are at least gravitational [L16, L14] and electric [L18] Planck constants $\hbar_{gr}$ and $\hbar_{em}$. The gravitational Planck constant is given by

$$\hbar_{gr} = \frac{GMm}{\beta_0} = \frac{r_S m}{2\beta_0} \quad . \qquad (2.1)$$

Here M and $m$are two masses, typically m is much smaller than M. This is something new a possible interpretation is in terms of a generalization of ordinary Lie symmetry algebras to multi-local symmetry algebras known as Yangians. The bilocal Planck constant could take the role of the ordinary Planck constant for Yangians [B1] [L4].

$\beta_0 = v_0/c \leq 1$ is a velocity parameter. Number theoretical arguments [L6] leads to ask whether β_0 is inverse integer valued but also rational values are possible. This would imply that Lorentz boosts generated by β_0 define a discrete subgroup of the Lorentz group. The formula for $\hbar_{gr}$ generalizes to massless particles by replacing the rest mass m with the energy E of the particle.

One can assign to $\hbar_{gr}$ gravitational Compton length

$$L_H = \Lambda_{gr} = \frac{r_S}{2\beta_0} \quad .$$

which by Equivalence Principle is independent of the small mass m.

A natural identification of the gravitational Compton length $\Lambda_{gr}(M) = GM/\beta_0(M) = r_S/2\beta_0(M)$ is as the size scale of gravitationally quantum coherent regions associated with a pair of systems with mass M and m. Note that by Equivalence Principle there is no dependence on mass m. The large mass M would correspond to the mass associated with a system with mass M and typically with a size scale considerably larger than its Schwartschild radius r_S.

A good guess is that the size of the CD associated with a gravitational field body of mass M corresponds to $\Lambda_{gr}(M) = r_s(M)/2\beta_0$ for a larger system with mass M creating the gravitational field in which m moves. This poses a condition on the parameter $\beta_0(M)$. For the Earth $\Lambda_{gr} = r_s/2 \simeq .5$ cm is the size scale of a snowflake. For the Sun with $\beta_0 \simeq 2^{-11}$ (, which happens to be electron-proton mass ratio) $\Lambda_{gr} \simeq R_E/2$ is considerably smaller than the solar radius. That the value is one half of the Earth's radius is probably not an accident.

The notion of the gravitational Planck constant generalizes to the electric case [L18] by the replacement $GMm \rightarrow Qqe^2$ where Q and q are interacting charges expressed using elementary charged e as unit.

2.1.2 $M^8 - H$ duality generalizes Hubble law

TGD predicts a Russian doll hierarchy defined by CDs. This leads to a generalization of the Hubble law for both gravitational and electric Planck constants. A natural proposal is that the gravitational Compton length $\Lambda_{gr} = GM(CD)/\beta_0$ is identifiable as the size scale $L(CD)$ of the CD. Here $M(CD)$ has an interpretation as mass of the system defining the gravitational field in which the system corresponds to quantum coherence regions as a space-time sheet. CD would contain the quantum coherence regions whose M^4 projection is light-cone proper time= constant hyperboloid H^3.

Since the half-cones of CD are analogous to empty cosmologies, another natural proposal is that the size scale $L(CD)$ of CD is identifiable as the Hubble radius $L_H(CD) = c/H_0(CD)$ of CD and that the Hubble law holds true inside the sub-cosmology associated with the CD and is apart from small corrections a consequence of the hyperbolic geometry of light-cone proper time = constant surface H^3.

Gravitational $M^8 - H$ duality predicts $m^k = \hbar_{gr} p^k/p^2$. If applied to particle with mass m appearing in $\hbar_{gr} = GMm/\beta_0$, this gives

$$m^k = \frac{r_S}{2}\frac{\beta^k}{\beta_0} \ ,$$

where β^k is four-velocity of the particle. Four-velocity has unit length which fixes the value the light-cone proper time a as

$$a = \frac{r_S}{2\beta_0} \ .$$

The value of 3-dimensional M^4 distance r_3 is bounded by the condition

$$r_3 \leq L_H = \frac{r_S}{2\beta_0} \ ,$$

stating that the perceptive field of the system is bounded by causal diamond with radius L_H.

If the particle is allowed to have mass $m_1 \neq m$, where m defines $\hbar gr$, the outcome is different and summarized by the formulas

$$\begin{array}{l} m^k = \frac{r_S}{2}\frac{m}{m_1}\frac{\beta^k}{\beta_0} \ , \\ a = \frac{r_S}{2\beta_0}\frac{m}{m_1} \ , \\ r_3 \leq \frac{r_S}{2\beta_0}\frac{m}{m_1} \ . \end{array}$$

Particles with different masses would correspond to different values of light-cone proper time and Hubble constant would be inversely proportional to the particle mass. This would suggest a violation of the Equivalence Principle so that this option looks implausible.

The formula

$$\beta_3 = H_0(CD) r_3$$

looks like a generalization of the Hubble law with Hubble length $L_H(CD) = c/H_0(CD)$ given by the gravitational quantum coherence length

$$L_H = \Lambda_{gr} = \frac{r_S}{2\beta_0} \ .$$

For the Earth L_H would have the value of $\Lambda_{gr} = .5$ cm for $\beta_0 = 1$. For the Sun with $\beta_0 \simeq 2^{-11}$, L_H would in a good approximation equal $R_E/2$, where R_E is the Earth radius.

Hubble's law generalizes also in the case of electric Planck constant $\hbar_{em} = Q_1 q_2 e^2/\beta_0$. Electric Compton length identifiable as Hubble length $L_{H,em}$ is

$$\Lambda_{em} = L_{H,em} = \frac{Q_1 q_2 e^2}{\beta_0 m} = \frac{4\pi\alpha_{em}}{\beta_0} Q_1 q_2 \times \lambda_C \ .$$

Q_1 and q_2 are charges using e as a unit. Now the Hubble length is proportional to Compton length.

In both electric and gravitational cases the predicted redshift is rather large and it is interesting to see whether this is a testable effect. The redshift reflects the fact that the Lorentz invariant light-cone proper time is the natural time coordinate for the CD. Its presence could be seen as a support for the notion of CD and the notion of many-sheeted space-time. In the gravitational case all particles would have the same time coordinate. In the electric case the time coordinate would be inversely proportional to the particle mass.

It is interesting to look the situation from the point of view of zero energy ontology (ZEO) [K18] [L9, L19]. The value of the light-cone proper time for cd$\subset$ CD=cd$\times$ CP_2 is quantized and equal to Λ_{em} *resp.* Λ_{gr} in the electric *resp.* gravitational case. ZEO predicts that CD is identifiable as a perceptive field of a conscious entity, self. The subjective time evolution corresponds to a sequence of "small" state function reductions (SSFRs) defining the TGD counterpart of the Zeno effect. The size of the cd increases in a statistical sense. The simplest assumption is that during this sequence the boundary of cd is only scaled (this induces a conformal transformation leaving the 3-D quantum state at the boundary invariant). The value of the geometric time, for instance identifiable as the temporal distance between the tips, of cd increases.

The problem is that the identification $a = L_H$ as subjective time means that subjective time would not increase. This is not consistent with the TGD view of memories. The interpretation of subjective memories [L24] in terms of classical non-determinism would assign them to definite values of a in the geometric past characterizing the loci of non-determinism. If only a single value of β_0 is assumed, this is not consistent with $a = L_H$. Could the moments associated with loci of memories correspond to different values of β_0? Smaller values of β_0 would correspond to earlier memories. The higher the evolutionary level, the larger the number of values of β_0 would be. The spectrum of β_0 would be fixed by the non-determinism of the space-time surface.

2.1.3 Ordinary Hubble law follows from $M^8 - H$ duality

One can test the generalization of Hubble's law on cosmological scales. The proposal implies that the ordinary Hubble radius $L_H = c/H_0 = 1.44 \times 10^9$ ly can be identified as gravitational Compton length:

$$L_H = \frac{GM(CD)}{\beta_0(CD)} = \frac{r_S(CD)}{2\beta_0(CD)} \quad .$$

where r_S is the Schwartschild radius associated with the mass inside the cosmic CD containing the quantum coherence regions with size $L(CD)$ as the application to the cases of the Earth and Sun forces to conclude. This gives $r_S(CD) = 2\beta_0(CD)L_H$.

It is important to notice that the mass M is the mass inside CD_1 for which the visible Universe corresponds to the quantum coherence region with radius L_H. From the examples of the Earth and Sun, M is considerably larger than the mass within radius L_H. The examples provided by the Earth and Sun raise the question whether there is a hierarchy of CD sizes corresponding to planets, stars, galaxies and whether the spectrum of β_0 reflects this hierarchy and serves as measure for the complexity of space-time surfaces and associated failure of strict classical determinism.

2.1.4 Estimate for the density of the Universe

The proposed picture predicts that the mass of the visible Universe inside CD using solar mass as a unit is

$$\frac{M(CD_1)}{M_{Sun}} = \frac{2\beta_0(CD)L_H(CD)}{r_S(Sun)} .$$

Here $r_S(Sun)$ equals 3 km. Assume that the radius of CD_1 is given by $L_H(CD_1) = xL_H(CD)$ so that one has $V(CD_1) = x^3V(CD)$.

This gives the estimate for

$$M(CD_1) \sim 2 \times 10^{22} \times x^{-3}\beta_0^4(CD)M_{Sun} \quad .$$

Here the mass $M(CD_1)$ corresponds to the mass within CD_1. $M_{Sun} \sim 1.88 \times 10^{57}m_p$, where m_p is proton mass. This predicts the average density

$$\rho \sim \beta_0^4 x^{-3} \times 12 \times 10^2 m_p/m^3 \quad .$$

The density of baryons is estimated to be $5.9 - 6$ protons per cubic meter (see this). The density ρ_B of ordinary (baryonic) matter is believed to be about $p = 1/20$ that is 5 percent of the total density: $\rho \sim \rho_B/p = 20\rho_B \simeq 120 m_p/m^3$. This gives $\beta_0^4 x^{-3} \sim 1/10$.

p-Adic length scales are good candidates for the size scales of CDs and seem to correspond to octaves $p \simeq 2^{2k}$ so that minimal scaling relating the sizes of CD and CD_1 containing CD should correspond to $x = 2$. For $\beta_0 = 1$ the Universe would be a blackhole-like object with $L_H = r_s/2\beta_0 = r_s/2$. For $(p = 1/20, x = 2)$ would predict $\beta_0 \simeq .95$. $(\beta_0 = 1, x = 2)$ would predict $p \simeq 6.1$ per cent.

Hubble tension means that the Hubble length in short scales is 5-10 percent shorter than in long scales. This requires that in short scales β_0 is 5-10 per cent smaller than in long scales. By $\beta_0 \leq 1$ $\beta_0 = 1$ cannot be true in long scales ($\beta_0 = 1, x = 2$) could be true in short scales (the rough estimate for $\hbar_{gr,E}$ gives $\beta_0 \simeq 1$) and ($\beta_0 = .95, x = 2$) in long scales would predict difference 7.5 per cent $\Delta H_0/H_0$ and resolve the Hubble tension.

$\beta_0 = 1$ in short scales as opposed to $\beta_0 = .95$ in long length scales would require the scaling of baryon fraction from 5 percent in short scales to 6.1 percent in long scales. One would have $L_H = r_s/2$ and the Universe could be seen as a blackhole-like system for which the quantum coherence region would have radius $L_H = r_s/2$. This would give a p-adic fractal hierarchy of blackhole-like objects, which are quantum coherence regions of blackhole-like objects.

Why should the fraction of baryons be smaller in short scales than in long scales? A possible explanation is the transfer of baryons to dark baryons at monopole flux tubes, reducing the fraction of baryons in short scales (recent universe) from 6.1 percent to 5 percent. The cosmic evolution as an unavoidable increase of algebraic complexity would generate large h_{eff} phases and would also manifest as the formation of gravitational bound states such as galaxies, stars and planets.

2.1.5 Some implications of the generalized Hubble law

The generalized Hubble law gives for the 4-velocity $\beta_4^k = (m^k/H_0(CD))$. $\beta_4 = 1$ fixes the value light-cone proper time to $a = H_0(CD)$ and also the size of the CD. For 3-velocity β_3 Hubble law gives $\beta_3 = L_H r_3 \leq 1$, which implies

$$r_3 \leq L_H(CD) = \frac{r_S(CD)}{2\beta_0} = \frac{GM(CD_1)}{\beta_0} \quad .$$

The interpretation is in terms of a maximal value for the size of the CD coming from the mass $M(CD)$ and $\beta_0(CD)$. Note that the mass $M(CD_1)$ is for CD_1 for the object containing CD in its gravitational field.

In the case of the Sun with $\beta_0 \simeq 2^{-11}$, one has $L_H(Sun) \simeq 6,000$ km to be compared with the radius of the solar core about 139,000 km, which is roughly twice the value of $L_H(Sun)$. Note also that $L_H(Sun)$ is not far from the radius of Earth and also of the maximal radius of a solar spot: this plays a key role in the TGD based model of the Sun [L25].

In the case of Earth, L_H is of order .5 cm, much smaller than the size of Earth. From this one can conclude that the mass $M(CD)$ cannot be the mass assignable to the CD but to a larger system: for instance, the mass of the Sun or Earth. The maximal size of the CD is fixed by the gravitational field of a larger object.

$L_H(CD)$ as an analog of the event horizon defines an upper boundary of some object in the gravitational field of an object with mass M. One can consider two options.

1. L_H is a bound on the size of a space-time sheet interpreted as the size of quantum coherence regions.

2. L_H is a bound on the size of a CD defining the perceptive field of some object.

Consider now the interpretation as the size of the quantum coherence region.

1. Does L_H give an upper bound for the size of the Sun or of the quantum coherent objects inside the Sun and even outside it. Note that the rocky planets (Mercury, Venus, Earth and Mars) satisfy the condition $R \leq R_E$, whereas the outer planets fail to satisfy it. One can also consider the interpretation of space-time sheets as analogs of blackhole-like entities. The bound on M^4 radius r_3 would state that radiation cannot escape from this region.

2. The original model of Nottale for the planetary orbits as Bohr orbits assumes that the value of the velocity parameter β_0 for the outer planets is by factor 1/5 smaller than for the inner planets. This would increase the value of L_H as upper bound for their size to $5R_H$. For Jupiter, Saturn , Uranus and Neptune the values of R/R_E are 11.2, 9.5,4.0, and 3.88. For Jupiter and Saturn, which are gas planets, this proposal fails.

3. It is also possible that the value of β_0 is the same for the entire solar system: in this case only the principal quantum number n determining the Bohr radius for outer planets would be 5 times larger than for the first option. For this option Jupiter and Saturn should have an inner rocky core, which is not larger than Earth. This conforms with their character as gas planets.

The simplest interpretation is that the Sun and solar system decompose into space-time sheets with a size not exceeding $L_H(Sun)$. The notion of the many-sheeted space-time however allows us to ask whether there is a space-time sheet corresponding to the solar core topologically condensed at a larger connected space-time sheet identifiable as a quantum coherence region corresponding to the solar exterior or some other system, such as the field body of the Sun?

How to increase the value of L_H for the larger space-time sheet?

1. One could increase the mass M. In the case of the solar exterior, the increase of M would be small. Second option is that the value of $\beta_0 = 1/n$ is reduced. This would predict a spectrum of H_0 as integer multiples of a minimal value.

   Could the value of n label the onion-like layers of the field bodies with different values of the light-cone proper time a? Could they correspond to a hierarchy of values of $H_0(CD)$ coming as multiples of n? Note that some special values of n such as powers of 2 inspired by the p-adic length scale hypothesis can be considered.

2. Could the variation of n also resolve the Hubble tension: could the different values of the Hubble constant would correspond to different values of β_0. values of Hubble constant (10 per cent different) in long and short scales can be understood in terms of different values of β_0 but now one one must assume that $\beta_0 = 1/n$, with $n \sim 10$ or assume quantization as rational numbers.

3. There is evidence that the values of the cosmic recession velocities for distant astrophysical objects along lines of sight, originally discovered by Halton Arp, are quantized as multiples of n [E2, E3]. $\beta_0 = 1/n$ would predict subharmonics of the standard redshift rather than harmonics. Hyperbolic tessellations of H^3 could explain these mysterious 'God's fingers' as sequences of identical look stars or galaxies of hyperbolic tessellations along the line of sight [L13] [K16].

4. The notion of gravitational Planck constant makes sense only if one has $\hbar_{gr} \geq \hbar$. Could one assume that the upper layers of the solar surface have $h_{gr} = h$? This does not conform with the TGD based model for the surface layer of the Sun [L25], which assumes that the quantum coherence regions are of size of $L_H(Sun)$.

2.2 Are sensory representations at the field bodies realized in terms of tessellations of H^3

There are very general objections against the idea that ultimate sensory representations are realized inside the brain. For instance, any computer scientist, unless informed about materialistic dogmas, would argue that the processing of the sensory data must be separated from its representation. How this could occur if sensory and other representations are realized inside the brain, is however difficult to see.

In TGD framework field bodies with rather large value of effective Planck constant h_{eff}, accompanying biological bodies as space-time surfaces with ordinary value $h_{eff} = h$ of the effective Planck constant, are proposed to give rise to sensory and cognitive representations. The representations can be realized at both levels and there could be correspondence between them. These ideas are in [K12, K11, K17]. In particular, EEG can be interpreted in terms of these representations. The communications to and control by the magnetic body would be realized in terms of dark photons characterized by h_{eff}. One of the implications is the possibility of plasma life in ionosphere [L18].

Especially interesting values of h_{eff} correspond to the gravitational Planck constant h_{gr} [K13, K3, K4, K5, K6] [**?**] and its electric counterpart h_{em} [L18]. This leads also to the proposal suggesting that the tessellations of H^3 identifiable as light-cone proper time of causal diamond (cd) of M^4

could be relevant for these representations. In particular, the completely unique icosa tetrahedral tessellation (ITT) [L12, L17, L28] could be involved with genetic code suggested to be universal and appear in arbitrarily long length scales. For instance, I have proposed the application of ITT to explain the features of DMT experiences [L15].

The magnetic flux tube structures associated with the primary sensory organs and higher levels of central nervous system are proposed to define a hierarchy of sensory and other representations outside brain with magnetic flux tubes serving as the sensory canvas to which place coding by magnetic transition frequencies generates sensory sub-selves and associates with them various sensory qualia and features by quantum entanglement. Thus brain could be much like a RAM memory containing a collection of features in random order and the ordering would be induced by the sensory map to the magnetic sensory canvas. MEs define the sensory projections and EEG MEs correspond to our level in this hierarchy of projections. The sizes of these sensory selves are of order ME sizes ($L(EEG) = c/f(EEG)$) and thus could be of the order of the Earth size and even larger. Thus TGD based view about sensory representations is a diametrical opposite of the standard view in which sensory representations are miniatures.

2.2.1 Inversion of as a map between system and its field body

Holography = holomorphy vision extends infinite-D group of 2-D conformal symmetries to infinite-D group of 8-D generalization of conformal transformations acting in H and giving rise to a generalization of 4-D conformal invariance. Ordinary conformal symmetries of M^4 leave the half-cone of the CD invariant. They involve special case inversion.

The condition fixing the inversion is that the hyperboloid of the half-cone of the CD with light-cone proper time $a = \Lambda_{gr}$ remains invariant in the inversion. This is true for $m^k \to \Lambda_{gr}^2 m^k/m^2 = (GM/\beta_0)^2 m^k/m^2$. Could this inversion define a correspondence between the field body and its magnetic body mapping long and short scales to each other?

A possible application would be ITT-ITC correspondence. The problem is that the ITT has as its vertex figure RID. RID is the lowest shell of IIT whereas the ISC has RID as its highest shell. The inversion would change the order of the shells.

2.2.2 "Microchips" at plasma sheet as sensory representations

There is a fascinating finding about the "memory chip" character of the organization of the ionic velocity distribution in the plasma sheet [F1] at the night side of the Earth's magnetosphere. The belief was that the distribution is a Maxwellian thermal distribution but a complex organization of the number of ions as a function of speed and direction relative to the direction of the local magnetic field has been detected [F1]. By coloring the bins representing small volumes of the velocity space, one finds that 3-dimensional features like "eyes" and "wings" appear!

The proposed interpretation [K12, K11] is that these features code the history of ionic currents. One cannot exclude the possibility that these ionic currents could reflect even our sensory experiences. The prediction is that also other transition regions (in particular magneto-pause) should exhibit similar complex self-organization patterns.

Religions could correspond to collective levels of consciousness having a rich repertoire of mental images like Maria and saints represented at the magnetic bodies [K12].

Inversion maps to each other the layers of the field body, having different values of the generalized Hubble constant H_0 labelled by integer n. This could allow us to interpret these strange findings in terms of a map from the biological scales to the scale of the magnetosphere of the Earth.

2.2.3 Crop circles as sensory and cognitive representations

Crop circles are a phenomenon, which has remained a taboo for physicists. They might be however real and some biologists have had the courage to consider the facts related to the crop circles and to propose a mechanism possibly generating them [H1, H3, H2]. Crop circles fit very nicely to the TGD view of consciousness and biology and I have not been able to resist the temptation to ponder what they might be [K7, K8, K17]. These ideas, represented decades ago, fit nicely with the recently reported evidence about plasmoid-like life forms in the ionosphere discussed from the TGD point of view in [L18].

If the field body is the "boss" controlling the biological body, one might see the crop circles as representations of geometric information communicated by the field body, possibly assignable to the crop field. The mechanism creating the crop circles would be dark photon radiation arriving from the magnetic body at microwave energies inducing a local boiling of the crops. Crop circles involve regular polygons as basic structures and are often interpreted as "sacred geometries". Crop circles could be analogous to the neural activity patterns in the brain giving rise to sensory and cognitive representations. Note however that they are static and more like remnants of the analog of neural activity.

A natural guess is that the generation of crop circles involves regions of gravitational quantum coherence with $\Lambda_{gr} = GM/\beta_0$, with $\beta_0 = 1/n$. $n = 1$ gives $\Lambda_{gr} \sim .5$ cm. The mysterious snowflakes having the hexagonal symmetry of ice have this size scale. The first guess for the value of β_0 is $\beta_0 \simeq 2^{-11}$ characterizing solar gravitational flux tubes. This implies $\Lambda_{gr} \sim .10$ m, which is the scale of the crop circles.

3 Icosa tetrahedral model of the genetic code and icosahedral super cluster

3.1 TGD based view of genetic code briefly

The TGD based model for the genetic code [L17] relies on icosa tetrahedral tessellation (ITT) realized in the hyperbolic 3-space H^3 representable as a light-cone proper time constant hyperboloid of light-cone of M^4 or as a mass shell in momentum space.

1. The general idea that genetic codons as 6-bit units of ordinary "bitty" intelligence are accompanied by emotional intelligence represented in terms bio-harmonies serving as correlates for emotions. Music indeed expresses and creates emotions [K10] [L5, L11, L12, L17]. This view has far reaching implications. In particular, it means that emotions are present already at the biomolecular level. In the TGD Universe, life is universal and can appear in very many scales. This would be true also for the genetic code realized in terms of the icosa tetrahedral tessellation of H^3 which can appear in arbitrary scales.

2. This interpretation of the genetic code belongs to the category of the intuitive "must-be-true" hypothesis of TGD, whose status has remained unclear. One reason for this is that I am not a specialist in the field of hyperbolic tessellations. Once again I realized that my understanding is far from perfect and decided to clarify my thoughts once again.

3. Hamiltonian cycles (HCs) are an essential element in the ITT based model of the genetic code. HC does not intersect itself and goes through every vertex. Icosahedron allows a large number of HCs characterized by its symmetry group, which is Z_6, Z_4, Z_2 or Z_1 (no symmetries). Tetrahedon allows only single HC. In the case of a dodecahedron, with maximal symmetry group as icosahedral group, there is only a single HC.

4. ITT involves tetrahedra (T), octahedra (O) and icosahedra (I). Genetic code would correspond to a fusion of 3 properly chosen icosahedral Hamiltonian cycles representing 12-note scale (there are many options) and one tetrahedral Hamilton cycle (HC), which is unique. I have an intuitive geometric interpretation for this 3-1 structure: 3 I:s share 3 faces of T. This leaves one free face of T serving as an additional codon. This gives 20+20+20+1=64-3 codons and the missing 3 codons could correspond to stop codons. Also O:s are involved and the intuitive idea is that O is passive in the sense that it represents a void in the sense that the vertices, edges and faces of the octahedron can be regarded as those of octahedron or I. How to make this idea more concrete?

There has been a dramatic evolution in the basic understanding of TGD during 2024-2025 and it is time to update the views of ITT and also to summarize the recent overall TGD based view about quantum biology.

3.2 Icosa tetrahedral model of the genetic code and ISC

ITT realized at the field body at H^3 and ISC at the level of water molecule clusters. Both have the icosahedral group as symmetries and both involve RID. There are 60=20+20+20 icosahedral codons. A given icosahedral codon can be assigned to one of the icosahedra assignable to the 3 shells of ISC. This raises questions.

1. Is it possible to map the ITT vertices to water molecules?
2. Could an icosahedral HC bind the pentagons as analogs of icosahedral vertices together? What would this mean from the point of view of the edges of HC perhaps realized in terms of hydrogen bonds? Could the symmetries of the HC characterize the hydrogen bonding structure of a given shell of ISC? For icosahedral/dodecahedral HC a given pentagon/triangle connects to one of its 5 neighbors by a square which is in the role of icosahedral edge. Does it correspond to hydrogen bond connection

   The monopole flux tube as the counterpart of the hydrogen bond would be at the level of the magnetic body, which can have a much larger scale if MB acts as the "boss" controlling ISCs.
3. At the level of ITT (ISC), the genetic codon would correspond to some triangle of the icosahedron with "dark" protons (water molecules) at its vertices. Could the genetic code be represented at the level of ISC.

   If so, the 12 icosahedral vertices would correspond to barycenters of 12 pentagons and the 20 triangular faces to its 20 triangles. Icosahedral face could correspond to 3 neighboring pentagons of RID one hand and to a triangle of RID one the other hand. Does this mean that each triangle is surrounded by 3 pentagons and is therefore analogous to a barycenter of triangular face? This conforms with the finding that the RID is obtained is analog of icosahedron obtained from the ordinary icosahedron by replacing its 12 vertices with 12 disjoint pentagons, its 20 faces with disjoint 20 triangles, and its edges with 30 octahedrons.

3.2.1 Rhombicosidodecahedron

Rhombicosidodecahedron (RID) is an Archimedean solid with 62 faces in total, comprising 20 triangles, 30 squares, and 12 regular pentagons. It features 60 vertices and 120 edges. Each of its 60 vertices is identical, where one triangle, one pentagon, and two squares meet. RID involves both scaled icosahedron and dodecahedron besides 30 squares in between. Both pentagons and triangles are bounded by squares. RID has full icosahedral symmetry.

If one identifies triangles of RID as faces, squares as edges and pentagons as vertices, one obtains icosahedron. Changing the roles of faces and vertices one obtains a dodecahedron. I have considered this kind of fractalization already earlier [L17, L28].

3.2.2 Can ISC correspond to the basic structural unit of ITT?

The third shell of the icosahedral supercluster is RID (see this). Also the vertex figure (VF) of icosa tetrahedral tessellation (ITT) [L17, L28], call it IVF iso RID.

This suggests that the icosahedral supercluster (ISC) with 280 water molecules is a representation for the basic structural unit of the ITT consisting of 3 icosa tetrahedrons, tetrahedrons and octahedrons as counterparts of the void regions of void regions of ICT containing free water.

ITT is a tessellation of hyperbolic 3-space H^3 realized as light-cone proper time constant hyperboloid of the future light-cone (half-cone of the causal diamond cd of M^4) and is most naturally realized at the magnetic body of the system, which can have much larger size scale than ISC. This suggests that the correspondence between the basic unit of ITT and ISC is not geometrically 1-to-1 and that the correspondence could be non-local.

1. In the TGD framework, this kind of non-local correspondence would not be new. In the framework of TGD inspired theory of consciousness, I have proposed that the neurons of the brain, which are functionally near to each other, send information to the nearby points of the magnetic body of the brain [L15]: this would explain why the evidence that in the topology defined by functional nearness, the brain seems to obey hyperbolic geometry.

2. Could this non-local correspondence apply already at the level of water molecules instead of neurons? Could hydrogen bonding, which in the TGD framework suggests a generalization allowing also long hydrogen bonds could serve as the geometric correlate for the functional nearness?

3. The simplest hypothesis is that the number $N = 280$ of water molecules of ISC equals the number of vertices of the basic structural unit of ITT. The 3 icosahedrons defined by the 3 shells of the ISC would therefore correspond to the 3 disjoint icosahedrons of ITT characterized by 3 different Hamiltonian cycles essential for the ITT based model of the genetic code.

3.2.3 Possible problems related to ITT-ISC correspondence

If the ITT corresponds to ISC in this way, the water molecules for the two lower shells of ISC would correspond to 100 ITT vertices not visible RID containing 180 vertices. The number of missing vertices would be 20+80=100.

1. The third shell identifiable as RID contains 20 triangles, 30 squares and 12 pentagons. There are 20+30+12 =62 faces, 60 vertices and 120 edges. Neither triangles nor pentagons have common vertices whereas neighboring squares have a single common vertex. Therefore the number of triangular -, square-, and pentagonal vertices are the same square identifiable as the VF of an icosahedron would correspond to the vertices of a single icosahedron at the field body.

2. The third shell of ISC would correspond to a single icosahedron defined by the barycenters of the disjoint pentagons consisting of water molecules. The lower shells of ISC would give two additional icosahedra so that there would be 3 icosahedra, as the model of the genetic code based on ITT indeed predicts.

   The water molecules of the disjoint pentagons separated by squares in the VF (the squares would represent void in ITT!) would be functionally near to each other if the notion of topology at the field body realizes functional nearness as a metric nearness. Note that the topology at the level of ISC would be effectively p-adic.

3. The 100 water molecules for the first and second shell should correspond to vertices of ITT not visible in RID. The number of vertices of ITT should be the same as the number 280 of water molecules of ISC. Note that the identification of ITT with ISC cannot be isometric; the 3 orthogonal quadrilaterals [I4] used to construct are not squares since the sides are in the ratio $1 : \phi$.

A possible problem is that the vertex of the vertex figure of ITT cannot correspond to a single vertex at the level of ISC.

1. The triangles of IVF correspond to tetrahedra emanating from the vertex of ITT defining IVF at the level of the field body. Can it correspond to a single vertex assignable to a water molecule at the origin? There seems to be no such molecule.

   The VF of the tetrahedron is a triangle. The maximal number of missing vertices of RID associated with its triangles is 20. Could this number correspond to the 20 water molecules located at the vertices of dodecahedron at the lowest shell of ISC? The idea of 20 edges emanating from a single water molecule could be realized as hydrogen bonds looks unrealistic.

   Should the vertex of ITT be replaced with a dodecahedron with 20 vertices at the level of ISC? Could this be interpreted in terms of a fractal generalization of the notion of a point-like particle in the sense that point is replaced with a dodecahedron? Could p-adic fractality explain why a single vertex is replaced by the vertices of a dodecahedron?

Octahedral VF is a square. The total number of octahedrons as representations of voids emanating from a given vertex of ITT is 30. The neighboring octahedrons share a 1 single vertex so that there are $30 \times 4/2 = 60$ lines connecting the 30 squares of RID to the 20 vertices of a dodecahedron. This allows us to consider 2 options in ITT-ISC correspondence.

1. If the dodecahedron corresponds to the lowest shell of ISC, this gives 3 lines emanating from a water molecule as a dodecahedral vertex with a possible interpretation in terms of hydrogen bonds.

2. If the dodecahedron, serving as an effective vertex in the fractal view, corresponds to the second shell of ISC, containing tetra-isomers as analogs of vertices, 3 water molecules would have a single hydrogen bond connecting it to the square. The 4^{th} water molecule would have a hydrogen bond with the lowest shell of ISC. These 4 hydrogen bonds would be enough to realize the edges leading to the third shell since each vertex of pentagon and triangle at the third shell is also a vertex of a square.

The 2 lower shells of ISC must correspond to the 100 vertices of ITT missing from the IVF with 180 vertices. The hierarchical structure of ISC should have a counterpart at the level of ITT. There is however a problem.

1. Intuitively it seems clear that the 100 vertices missing from the IVF should be above the IVF as it is usually defined. Now they are below it!

2. Is an inversion leaving the IVF invariant and transforming outer vertices to inner vertices involved with the map of ITT to ISC. This kind of inversion is involved with the $M^8 - H$ duality mapping momentum space tessellations of M^8 to spatial tessellation of H [L29]. As already found, one can generalize the inversion to the level of H where it would map the space-time sheet of a field body (not ITT) to the "biological body" (now ISC).

3.3 ISC and the ITT based model of genetic code

The article "The Living Geometry of Water: Coherent Domains, Sacred Geometry, and the Architecture of Life" of Thomas Brown [I4] provides a lot of new information helping to develop the TGD view of the genetic code and the DNA model.

3.3.1 Could genetic code have realization at the level of ISC?

The Universality of ITT inspires the question whether the genetic code and ITT-ISC correspondence could be realized in terms of water molecule ISCs and even more general ISCs. I have already worked with a model of the DNA based on ITT realization of the genetic code [L28] but did not realize that RID as ITF corresponds to the third shell of ISC.

1. The observation that the top shell of the 3-shelled ISC corresponds to the vertex figure of ITT would support the idea that the ITT is realized at the level of a magnetic body that controls clusters of water molecules, which need not to exactly correspond to the ITT. The field body of ISC could correspond to a completely different length scale than ISC.

2. The top shell of ISC identifiable as RID, is associated with 12 pentagons and 20 triangles whose sides are limited to 30 squares. The 12 pentagons correspond to the vertices of the icosahedron.

   The lowest level would correspond to the dodecahedron or its dual icosahedron, whose vertices would correspond to pentagons. The next level would correspond to the dodecahedron, whose vertices would correspond to 4 tetrahedron units. Here too, the dual is the icosahedron.

   The genetic code model assumes 3 (!) icosahedral HCs and one tetrahedral HC and the proposed hypothesis is that the dark genetic code is universal, induced from ITT realized at the level of field bodies, and realized already at the level of water clusters. This provides evidence for the TGD picture.

3. Hamiltonian cycles play an essential role in the TGD based model of the genetic code and the edges of HC correspond to pentagons (the vertices of the icosahedron) as squares connecting them. The symmetry group of the cycle would be Z_6, Z_4 or Z_2 and one can think of the 3 shells of the supercluster as corresponding to these symmetry groups. The genetic codon as an icosahedral face would be associated with one of these 3 icosahedra. The largest symmetry group Z_6 would be also associated with ice. Z_4 and Z_2 would correspond to the second and third shell. The interpretation would be in terms of symmetry breaking.

4. A further amazing observation is the existence of chains of ISCs, super strands (see the Appendix). The length 10-12 nm would correspond to 10 DNA codons in a closed double helix and 12 DNA codons in an opened one. This structure is also predicted in the TGD model for the realization of genes in terms of DNA [L28].

5. TGD suggests that ITT and the genetic code are universal. In fact, the icosahedral supercluster is very common and occurs also outside the biology, for instance for metal glasses (see the Appendix). Could genetic code have realizations in non-biological systems realize in terms of ITT-ISC correspondence.

3.3.2 HCs associated with the shells of ISC

A model for the music harmony in terms of icosahedral and tetrahedral Hamilton's cycles led to the model of the genetic code based on ITT [L11, L12, L17, L28, L30, L31].

1. Hamiltonian cycles, proposed to have a fundamental realization at the field body of ISC, are something totally new from the perspective of standard hydrodynamics and biology and are proposed to make possible a large number of realizations of the genetic codes. One could even say that the genetic code assignable to the ITT is universal. Genetic codons would correspond to the faces of icosahedron and tetrahedron and to triplets of cyclotron frequencies for the 3 protons associated with the triangular face. Codon and its conjugate would be associated with a given icosahedron.

2. The icosahedral HC going through all 12 vertices with scaling of 3/2 of the frequencies modulo octave equivalence gives rise to harmonies realized in terms of 20 3-chords of light assigned with the faces carrying 3 dark protons, when active. The three icosahedra and tetrahedron give bioharmony with 20+2+0+20+4=64 chords. Each selection of 3 HCs with Z_6, Z_4 and Z_2 as symmetry groups gives rise to a bioharmony. Since music expresses emotions and induces them, the proposal is that bioharmonies serve as correlates for emotions. Both bit intelligence and emotional intelligence would be possible.

3. The interpretation of the bioharmony in terms of emotions is interesting [L7, L8]. Z_6, Z_4, and Z_2 symmetries of the icosahedral HCs (HCs) as subgroups of I_h identifiable as alternating group A_5. The HC with Z_6 symmetry is unique. There would be only a single mood. There are two HCs with Z_4 symmetry. There would be two moods. The number HCs with Z_2 symmetry is considerably larger and the spectrum of molecular moods is much richer. Apart from symmetry breaking effects there are 10 2-cycles for a given icosahedral HC.

4. Amino acids are identified as orbits of triangular faces under the symmetry group of HC and this predicts almost correctly the numbers of codons coding for a given amino-acid.

Since the magnetic body serves as a "boss" of a system, one can ask whether ITT could have ISC as a kind of mirror image. What could be the interpretation of the 3 shells in the 3-levelled hierarchy defined by the ISC?

1. Could the 3 shells of ISC realize the HCs in terms of hydrogen bonds and possess these symmetries? Ordinary ice has Z_6 symmetry acting on water molecules as also the proposal of Pollack for the fourth phase of water based on effective $H_{1.5}O$ stoichiometry realized in terms of Pollack effect.

2. At the level of the genetic code the Z_n, $n \in \{2, 4, 6\}$ orbits would be realized as orbits of the triangular faces of the icosahedron. Their ISC counterparts would involve, instead of a single water molecule, 3 water molecules at the vertices of the tetramer as a representation of the codon. This would mean a distinction between ice and the lowest shell of ISC.

   For Z_6 this would give 3 amino-acids coded by 6 codons and represented by $6 \times 3 = 18$ water molecules and 1 amino acid involving $2 \times 3 = 6$ water molecules coded by 2 codons. For Z_4 there would be 5 counterparts of amino acids involving $4 \times 3 = 12$ water molecules and for Z_2 they would involve $2 \times 3 = 6$ water molecules. Z_4 would naturally correspond to the second shell and Z_2 to the third shell.

3. It seems that pentagonal symmetry for water molecules is favoured by the hydrogen bonded water clusters [I4]. This challenges Pollack's interpretation of the EZ in terms of Z_6 symmetry at the level of water molecules. Could Pollack phase correspond to 3 shells of ISC with Z^6, Z_4 and Z_2 symmetries acting on water molecule triplets associated with the shells of the ISC rather than on water molecules as in the case of ice?

3.3.3 Questions related to tetrahedral codons

The realization of the genetic code in ITT involves, besides 3 icosahedral HCs, the unique tetrahedral HC and would give 4 codons such that 3 of them could correspond to stop codons.

1. If the ITT tetrahedron correspond at the level of ISC to a tetrahedral isomer of 4 water molecules, there is a single tetrahedron per icosahedral face for the second and third shell.

2. If a given triangle of the third shell is interpreted as a representation of the tetrahedral VF, it should correspond to a tetrahedral isomer at the level of ISC and should have one water molecule at the first or second shell. The second shell looks more plausible than the first and would give 20 tetrahedral isomers altogether.

3. The 4 tetrahedral faces of ITT have an interpretation as representations of 4 genetic codons when the vertices contain dark protons. They would originate by Pollack effect from the H_2O tetrahedral isomer. Could the dropping from the magnetic body to tetramer by a reverse Pollack effect could take place in the translation of mRNA?

4. Since only a single tetrahedral HC is possible and since only a single icosahedral or tetrahedral face can be selected as a codon, there are only 4 different choices, if the position of the tetrahedral codon does not matter.

   There are 3 stop codons. Could they correspond to the faces of the tetrahedron dimer not in the plane of the second shell? Stop codon property is seen only in translation or mRNA to amino acids. Do only the tetrahedral dark codons activating a triangle in the tangent plane of the second shell have a tRNA counterpart involving amino acid and counterpart of codon?

5. There are 20 positions for the active tetrahedral isomer at the dodecahedron. One can argue that this matters unless one poses additional conditions. Could the tetrahedral isomers form an analog of a Bose-Einstein condensate with the same active face of the dimer so that the activation of a stop codon in translation would activate all 20 isomers and mean a reverse Pollack effect destroying quantum coherence?

4 Exclusion zones and Pollack effect

The article by Thomas Brown [I4], discussing critically the interpretation of Pollack exclusion zones (EZs), gave rise to this article.

4.1 Reality of the exclusion zone

The exclusion zone (EZ) is a region of water, typically 100-400 micrometers thick, that forms adjacent to hydrophilic surfaces such as Nafion membranes, gels, certain proteins, and biological tissues. Within this zone, Pollack's laboratory has documented the following reproducible phenomena:

1. Particle exclusion: Suspended microspheres are physically repelled from the EZ region, being pushed outward to create a clear, particle-free zone.

2. Solute exclusion: Not only particles but dissolved molecules and ions are excluded, suggesting the EZ has a fundamentally different structure from bulk water. UV absorption peak at 270 nm: EZ water exhibits a characteristic absorption maximum at approximately 270 nanometers (corresponding to 4.59 eV photon energy), indicating altered electronic structure.

3. Charge separation: The EZ region develops a net negative charge, while the water beyond the EZ becomes positively charged (lower pH, indicating excess protons).

4. Increased viscosity: EZ water flows more slowly than bulk water, suggesting increased internal structure or hydrogen bonding.

5. Higher refractive index: Light bends differently when passing through EZ water compared to bulk water.

6. Birefringence: The EZ exhibits optical anisotropy—polarized light behaves differently depending on its orientation, indicating ordered, directional structure.

These observations are real, reproducible, and independently verified. Multiple laboratories have confirmed the existence of EZs. The question is: what structural interpretation is the best explanation for these observations?

4.2 Hexagonal Hypothesis of Pollack

The proposal of Pollack is that the water inside EZ represents a fourth phase, which is neither fully liquid nor fully solid, but something intermediate. Pollack suggests that EZ water obeys molecular formula of $H_3O_2{}^-$. This is not standard H_2O, but a structure containing extra hydrogen and oxygen atoms, with a net negative charge. One could also speak of effective stoichiometry $H_{3/2}O^{-1/2}$.

1. Stacked sheets of hexagonal rings, similar to ice but 'out of register' —aligned so oxygens of one shell lie next to hydrogens of adjacent shells. Formation mechanism would be proton ejection.

2. As the hexagonal lattice forms, it expels protons (H^+), leaving behind the negatively charged $H_3O_2{}^-$ structure.

Pollack's reasoning is internally coherent: the 270 nm UV absorption could arise from the electronic structure of hexagonal sheets; birefringence indicates anisotropic ordering consistent with shelled geometry; proton ejection explains the observed charge separation; and the ice-like structure would naturally exclude particles and solutes.

It is a plausible hypothesis given the observations but is subject to criticism. Consider now the criticism of Pollack's proposal from the TGD point of view.

1. The $H_3O_2^-$ molecular formula is problematic. $H_3O_2^-$ eists as a molecule in $OH^-{+}H_2O\rightarrow H_2O{+}OH^-$ reactions. The time scale of this reactions is femtosecond. If Pollack's interpretation is correct, these molecules should be long-lived.

   In TGD, these reactions could have following interpretation. The second -OH of the second water molecule becomes OH^- + dark proton at the field body. Assume a pair (S_1, S_2) of this kind of systems. The dark proton of S_1 can drop in the reverse Pollack effect and bind to S_2.

2. The femtosecond timescale would apply to the normal water. Inside EZ the situation could be different: the dark protons would form chains as dark nuclei with much lower nuclear binding energy as normal nucleons have. This could hower energetically stabilize EZ: the dropping of dark protons would be energetically prevented. At least in the case of the cell and DNA/RNA this would happen and give them stable negative charge density.

3. Hexagonal structure with Z^6 symmetry would usually mean ice, not liquid. Now hexagonal structure would consist of 3 triplets of water molecules at tetrahedral isomers. EZ water is viscous but flows. Fixed structure would at the level of magnetic body as ITT.

   The hexagonal symmetry of HC could be apparent (silhouette). The Hamilton cycle would bind the 12 vertices of icosahedra to a coherent unit and has Z_6, Z_4, Z_2 or Z_1(no symmetry) as a symmetry group. The Z_6 orbit for an icosahedral vertex in dual 1-1 correspondence with the pentagon is hexagon.

   Could one assume that water molecules are not at the vertices of the dodecahedron but at the center points of pentagons defining the icosahedron. Z_6 would be associated with the lowest shell of the icosahedral supercluster. At higher shells Z_6 symmetry would break down to Z_4 and Z_2 above the boiling point. This would correspond to the weakening of long range correlations in liquid phase.

4. Hydrogen bond dynamics is too fast for stable structures. In TGD framework, the formation of dark proton nuclei (chains of dark codons consisting of 3 protons) could stabilize the hydrogen bonds energetically.

5. The proposal that protons are thrown out of EZ is subject to criticism. In TGD, the Pollack effect would involve a new view about space-time and classical fields and of quantum theory. Photons would kick protons to the field body, where they would become "dark" protons with a large value of h_{eff}. The mechanism would be -OH $\rightarrow$ -O$^-$ + dark proton at the field body. I have proposed a generalization of this mechanism [L18].

4.3 Coherent domain framework

Del Giudice, Giuliano Preparata, Giuseppe Vitiello

Dielectric constant, absorption at specific frequencies, strange boundary behavior. D=100 nm 12.06 eV Charge separation. EZ behavior. Quantum coherence (dark protons, large h_{eff}).

Supercoherence Evanescent photons: dark photons in TGD.

5 Appendix: Hydrogen bonding and water molecule clusters

The following provides basic information about water clusters. I am not a specialist and have used Google AI to gather the needed information. Also the material from the article of Thomas Brown [I4] have been useful.

5.1 Dimensions of the water molecule

A water molecule has an approximate diameter of 0.275 to 0.28 nanometers. Because atoms are not solid spheres but clouds of electrons, the exact "size" can vary depending on how it is measured.

Molecular diameter is roughly 0.275 nm (275 pm). This takes into account the electron cloud surrounding the nuclei. Bond length as the distance between the oxygen and hydrogen nuclei is approximately 0.096 nm (0.96Å). Van der Waals radius as the effective radius of the molecule is about 0.14 nm. Hydrogen bonding distance is defined for liquid water as the the distance of closest approach between two hydrogen-bonded molecules is about 0.28 nm (2.8Å).

5.2 Dodecahedral water cluster

The radius of a dodecahedral water cluster is approximately 3.9Ångstroms (0.39 nm). This structure is a common feature in clathrate hydrates, where water molecules form a cage-like "guest" host. The specific radius can be understood through the following dimensions:

Circumradius R) is the distance from the center of the cage to the oxygen atom at any vertex. Depending on the specific environment (such as in a methane hydrate), the oxygen-oxygen (O-O) edge length is typically between 2.76Åand 2.85Å. Applying the geometric formula for a regular dodecahedron:

$$\frac{R}{a} = \frac{\sqrt{3}}{4} \times (1+\sqrt{5}) \ ,$$

where a is the edge length, the radius is between 3.87Åand 3.99Å. Effective Internal Cavity Radius: In clathrate science, the "internal radius" is often cited as slightly smaller—roughly 3.91Å— to account for the space available for a guest molecule like methane.

The dodecahedral cage is the smallest of the common clathrate cages, known as the (5, 12) cavity (12 pentagonal faces).

5.2.1 ISCs appear also in other quantum critical systems besides water near freezing point

Icosahedral superclusters are complex, ordered structural units found in nanomaterials, metallic glasses, and molecular chemistry represent a medium-range order. They are formed by assembling multiple icosahedral-like clusters (often 12 or 13-atom units) into a larger, stable, and often five-fold twinned structure. The TGD interpretation is in terms of quantum criticality associated with glasses, which are between solid state and liquid-like phase.

These structures, often found in Zr-Cu-Al and Au-based metallic glasses, act as stable, low-energy nuclei that inhibit crystallization. They are often characterized as "clusters of clusters" of interpenetrating icosahedra. Glasses are between solid and liquid states as are also hydrogen bonded water molecule clusters. In metallic glasses, short-range icosahedral order grows into superclusters as the material cools, influencing its structural properties. A specific 127-atom supercluster is described as an icosahedron composed of smaller icosahedral clusters. In metallic glasses such as $Cu_{64}Ze_{36}$, icosahedral superclusters (like Bergman-type clusters) are common, featuring Cu-centered icosahedra.

Gold nanoclusters are linear, rod-shaped gold superclusters (e.g., Au_{37}) consist of multiple icosahedral Au_{13} units linked together. Silver superclusters are similar linear structures like Ag_{61} featuring 4 icosahedral Ag_{13} units. These structures are essential for understanding the stability of amorphous alloys and the transition between liquids and glasses. In nanotechnology, they are used to create materials with specific optical properties, such as near-infrared (NIR) absorption.

5.3 Icosahedral supercluster

The article [I4] provides the following summary of the icosahedral supercluster. The icosahedral supercluster (ISC) of 280 water molecules, often described in theoretical water models (e.g., by Martin Chaplin [D3, D2, ?]) as a "monster" or "magic" cluster, has radius $R \simeq 1.5$ nm. This cluster consists of nested icosahedral shells containing 20 water molecules as the lowest shell, 80 molecules at the next shell and 180 molecules at the third shell. It is formed by 20 tetrahedral units (each with 14 molecules) arranged in an icosahedral network, where each water molecule is coordinated with four others.

ISC is used to describe the local, fluctuating structure of liquid water and has been related to the size of balloelectric nanoparticles (often measured at 2.2–2.7 nm). This is a theoretical structural model used to explain the anomalous properties of water. It is a highly symmetrical, 3-nm diameter "monster" network of nested icosahedral shells. Theoretical superclusters of water molecules can form icosahedral arrangements, with large structures like $(H_2O)_{1820}$ containing 13 interpenetrating icosahedra.

In the TGD framework, the fluctuations would correspond to long range quantum fluctuations at quantum criticality and would involve large values of h_{eff}. The quantum criticality would be associated with the melting of the ice. The crucial role of this quantum criticality for lie has been discussed in [L14]. The findings of Emoto about what happens in the freezing of water have been also interpreted in terms of quantum criticality making water a living system near the freezing point [L8].

5.3.1 Connection with Golden Mean

Chaplin's complete icosahedral cluster contains 280 water molecules organized in a highly specific geometry. This duality reflects the reciprocal relationship of icosahedron and dodecahedron inherent in the Golden Mean ϕ. In a dodecahedron with edge length 1, the dual icosahedron has edge length ϕ. In an icosahedron with edge length 1, the dual dodecahedron has edge length $1/\phi$. Since $1/\phi = \phi - 1$ (a property unique to ϕ), this creates a self-similar, recursive scaling relationship.

The 280-molecule icosahedral cluster can be geometrically constructed from three mutually perpendicular golden rectangles. These are rectangles whose long side is ϕ times the length of the short side. Place three such rectangles perpendicular to each other like the x, y, and z coordinate planes, and their twelve outer corners define precisely the twelve vertices of an icosahedron. This construction—known since antiquity—reveals icosahedral geometry as a pure expression of ϕ relationships in three-dimensional space.

5.3.2 Structural hierarchy

The 280-molecule icosahedral supercluster (ISC) can be modelled as a series of nested geometric shells, similar to an onion, where each shell is a Platonic solid or a derivative of one. Every water molecule in ISC is tetrahedrally coordinated, meaning each oxygen atom is hydrogen-bonded to exactly 4 neighbors, maintaining a stable network even at this massive scale. ISC possesses high icosahedral symmetry, meaning it can be rotated or reflected in numerous ways without changing its appearance.

The cluster is organized into three primary shells of water molecules.

1. The core, referred to in this article as the first shell of the central dodecahedron made of 20 water molecules. In the article of Brown [I4] the core is not regarded as a shell.

2. The second shell is an 80-molecule shell that surrounds the core, forming a combined H_2O_{100} cluster.

3. The outer shell is the third shell of 180 molecules that completes the H_2O_{280} structure. The third shell an Archimedean solid known as rhombicosidodecahedron (RID) (see this). Dodecahedron is the lowest shell, the second shell contains 80 water molecules. This would correspond to an icosahedron having tetrahedra at vertices, and RID at the 3 third level.

The shells form a geometric hierarchy. The "sacred geometry" of this cluster is built using 14-molecule tetrahedral units as the basic building blocks effectively replacing the vertices of icosahedron. These units align into 20 sub-clusters to create the final icosahedral shape.

1. The basic 14-molecule unit has a 4 tetramer at core and 10 molecules around it. Each vertex and each edge of the tetramer corresponds to a water molecule, which gives 4+6 molecules. Within this unit, every molecule is four-coordinated (hydrogen-bonded to four neighbors), making it a very rigid and stable arrangement.

   The 14-molecule units do not form a perfect tetrahedra but rather a slightly flattened one, allowing three edges to be about 5 percent shorter than the other three. Within the unit, 10 molecules form an adamantane-type cage (similar to a adamantane-type ring) (see this), while the remaining molecules align to form specific boat-form hexamers and cyclic pentamers. A "puckering" occurs in these ring structures as the water network transitions between higher and lower density forms.

   The "puckering" acts as a form of fluctuation between states. This involves bending, but not breaking, the hydrogen bonds. This allows the 14-molecule units to accommodate the strain required for icosahedral curvature (curving into a sphere-like shape) rather than forming the flat sheets or open cages of normal hexagonal ice.

2. 14-molecule tetrahedral units as analogs of icosahedral vertices are needed because in the geometry of the 280-molecule supercluster, 20 of these tetrahedral units (4+10 tetrahedrons each) are fitted together. Because they share faces and edges when they merge, they perfectly tile the space to form the 20 faces of an icosahedron. 20 units (minus the molecules shared at the boundaries) equals the total 280-molecule count. Essentially, these 14-molecule "bricks" allow the water network to curve into a sphere-like shape while keeping the preferred tetrahedral bonding angle of ice.

5.3.3 Empty volume of ISC

ISC has an empty volume of 26 per cent. This reflects the fact that pentagonal and icosahedral structures cannot tile Euclidean 3-space. Five-fold symmetry is mathematically incompatible with complete space-filling tessellation in three- dimensional Euclidean space. The consequence for the water structure is striking: icosahedral clusters, when packed together, leave approximately 26% void volume.

In the TGD framework, the empty volume would correspond to octahedrons of the ITT of H^3 as a missing volume. In the case of water this space is not empty space but occupied by interstitial water molecules: H_2O molecules that are not fully integrated into any cluster's hydrogen bond network. These molecules are present, weakly bonded, transient, and mobile. They are 'passing through' — not committed members of the structured clusters but bridges between them. The interstitial water molecules serve multiple crucial functions.

1. They provide fluidity. The clusters themselves are relatively stable (on picosecond to nanosecond timescales), but the interstitial molecules can move freely, allowing water to flow despite its internal structure.

2. They create solvation spaces. Dissolved ions and molecules occupy these interstitial cavities rather than disrupting cluster geometry. This is why water is such an exceptional solvent—it has pre-existing spaces designed to accommodate solutes.

3. The 26 % void enables dynamic reorganization required by the fluctuations associated with quantum criticality. Clusters can expand, contract, overlap, and interpenetrate. They can exchange molecules at their boundaries. They can respond to external fields, to dissolved solutes, to temperature changes. The void is not a flaw in water's structure but the very feature that distinguishes life-enabling liquid from life-suspending ice.

5.3.4 Super strands and other networks

When icosahedral superclusters link together, they form super-strands and larger structured matrices through a process of tessellation. The basic way to connect is through the outer pentagonal rings on the surface of the icosahedral shell. In these super-strands, the icosahedral units are often overlapping rather than just touching, which minimizes the number of strained hydrogen bonds. The clusters remain connected by the same four-coordinate hydrogen bonding found within the individual clusters, creating a continuous, coherent network.

Depending on how they link, these clusters can form different geometries.

1. A "super-strand" can consist of 8 super icosahedra linked in a line, containing approximately 1,750 water molecules.

2. Icosahedral super-clusters, such as a thirteen-cluster super-icosahedron, can form, containing up to 1,820 water molecules.

3. Extended matrices: These clusters can interlink and tessellate throughout space to form ordered or random 3D matrices.

These extensive networks are most likely to form under specific conditions:

1. As water is supercooled, it encourages the "expanded" icosahedral structures to increase their degree of ordering and link into strands.

2. These structures can be stabilized at surfaces, such as near hydrophilic or hydrophobic macromolecules, where the surface provides a template for the cluster to grow.

3. In standard liquid water, these strands are transient and dynamic, with bonds breaking and reforming every few picoseconds.

4. Each molecule within this network is coordinated to four others, mimicking the tetrahedral bonding found in bulk water but within a higher icosahedral symmetry.

The 280 H_2O model is used to reconcile water's behavior across different temperatures and pressures.

1. Density anomalies of water related to the superclusters. The cluster can exist in two forms—expanded (less dense, favored at low temperatures) and collapsed (more dense, favored at higher temperatures). This transition helps explain why water is most dense at 4 °C.

2. The addition of each shell increases the stability of the cluster due to cooperative many-body interactions, where hydrogen-bond strength increases as the assembly grows.

3. These clusters can interlink and tessellate to form even larger structures, such as strands or super-strands containing thousands of molecules.

   While these clusters are extensively studied theoretically and can be mapped to experimental data for supercooled water or water-encapsulating macromolecules, they remain part of a dynamic, fleeting network in liquid water where bonds break and reform every few picoseconds.

A typical super-strand composed of eight icosahedral superclusters has an estimated length of approximately 10 to 12 nanometers. In the TGD based model of the ITT realization of the genetic code at the level of DNA, the length scale of 10 nm corresponds to 10 DNA codons for double strand. For an opened double strand the length is 12 nm! Direct correspondence with DNA. This would mean that 8 icosahedral clusters correspond to 10 DNA codons.

This estimate is based on the following structural data from the water cluster.

1. A single icosahedral supercluster has a diameter of roughly 3 nm.
2. In a super-strand, the clusters do not sit end-to-end but instead overlap significantly to share water molecules and minimize bond strain.
3. Because of this overlapping, the total length of a strand containing eight complete clusters (roughly 1,750 water molecules) is roughly 3.5 to 4 times the diameter of a single cluster, rather than 8 times.

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