Some objections against TGD inspired view of qualia

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Abstract

In the TGD framework, state function reduction is identified as a moment of consciousness. The basic objection against the identification is that sensory mental images have a finite duration. One can imagine two ways of identifying qualia: as an outcome of quantum measurement or in terms of a change/transfer of quantum numbers. Both the resolution of the objection and the two alternative identifications of qualia will be discussed in the context provided by the recent view of TGD. For definiteness, the discussion will be restricted to color qualia since it provides an opportunity to discuss how the new physics predicted by TGD would be involved with qualia.

Contents

1 Introduction

I have considered the problem of qualia several times and have proposed several models for qualia [K2] [L2]. I have not been quite happy with the details of the original proposal. A lot of progress in the understanding of TGD has taken place since I considered qualia from the TGD point of view for the first time, and it is appropriate to take a new look at the situation.

The model of qualia relies on TGD inspired theory of consciousness [K7, K3], which relies on zero energy ontology [K9] [L3, L7, L11]. ZEO can be seen as a generalization of quantum measurement theory solving the basic problem of standard quantum measurement theory.

It is good to start by describing the basic ideas related to the TGD inspired view about qualia. The obvious idea is that qualia can be assigned with a state function reduction (SFR) as measurement of observables [K2].

1. The first class of basic qualia would correspond to infinitesimal generators of the fundamental symmetries. Spin, color and electroweak quantum numbers would represent fundamental qualia. Supersymplectic group for the product of light-cone boundary and CP_2 would act as isometries of the "world of classical worlds" and this would give rise to dynamical symmetry groups [K5] and corresponding qualia.

2. Momentum and position are certainly fundamental observables. $M^8 - H$ duality [L4, L5] has an interpretation as a generalization of momentum position duality of wave mechanics forced by the replaced of point like-particle with 3-surface whose orbit defines space-time surface as analog of Bohr orbit realizing holography forced by 4-D general coordinate invariance.

   The associativity of the normal space of the 4-surface of M^8, mapped by holography to H, is the number theoretic dynamical principle [L4, L5]. It is expected to fix the holography apart from a finite non-determinism suggested by the non-determinism of minimal surfaces of H proposed to be the images of the 4-surfaces of M^8 in H. The twistor lift of TGD at the level of H leads naturally to these minimal surfaces [K6] [L8]. The twistor lift of TGD emerged originally at the level of H but turned out to have a counterpart at the level of M^8. These minimal surfaces are also extremals of Kähler action except at the singularities, which are analogous to the frames spanning a soap film and serve as seats of non-determinism already in 2-D case.

   At the level of M^8 momentum eigenstates correspond to states for which mass shells are determined by the roots of the polynomial defining 4-D surface of M^8 by holography. This surface is mapped by $M^8 - H$ duality to a space-time surface in H as a minimal surface with singularities in H [L9, L10].

   Measurement of momentum produces a state localized to a set of points of mass shells of M^8 corresponding to quark momenta. The measurement of position as a dual variable for momentum gives rise to a superposition of this kind of states with coefficients $exp(ip \cdot m)$ mapped by $M^8 - H$ duality to a state within a single causal diamond (CD) H localized to the point. These two state bases correspond to H-picture and M^8 picture.

   Twistor lift of TGD generalizes this duality also to the spin and electroweak spin and one can say that spin 1/2 state with a given quantization axis corresponds in M^8 to either point defined by the discrete direction of quantization axes at unit sphere. In the twistor space of H it corresponds to a wave function at the twistor sphere CP_1.

3. There would also be geometric qualia related to the shape and size of objects. The flag manifolds defined by Cartan groups of symmetry groups and having interpretation as a space for the choices of quantization axes would represent example of geometric qualia, which I have called flag manifold qualia [K2] [L1]. The flag manifold $SU(3)/U(1) \times U(1)$ for color group defines twistor space for CP_2 and the model for honeybee dance involves this space as discovered by topologist Barbara Shipman [A2].

   The twistor space CP_3 for Minkowski space has interpretation as a choice of the origin of Minkowski coordinate and spin quantization axis. Points of M^4 separated by light-like distance would be equivalent. The product of these twistor spaces appears in the twistor lift of TGD [K8, K6] [L9, L10]. The space of the quantization axis for weak isospin corresponds to a sphere but the breaking of weak isospin symmetry at the level of geometry of CP_2 could fix the quantization axis.

4. What about qualia such as acceleration? Acceleration corresponds to the rate of change for momentum. Momentum is a relative notion by Lorentz invariance and always relative to some system. This requires two systems. I have proposed that the relative motion of the magnetic body and biological body is behind the experience of acceleration that is force.

In wave mechanics, force would be represented as a commutator of the Hamiltonian of the system representing the magnetic body (MB) and biological body with the momentum related to relative motion. The measurement would give an eigenstate of this operator with a constant force. If the scaling for the entire system determines the analog of the time evolution, one should decompose this scaling to single particle operators associated with the magnetic and biological body and the part representing the force when time evolution corresponds to scaling instead of translation. Eigenstates of this term would result in the measurement of force.

The basic objection against the identification of state function reduction (SFR) as a moment of consciousness is that sensory mental images have a finite duration. One can imagine two ways of identifying qualia: as an outcome of quantum measurement or in terms of a change/transfer of quantum numbers. Both the resolution of the objection and the two alternative identifications of qualia will be discussed in the context provided by the recent view of TGD. For definiteness, the discussion will be restricted to color qualia since it provides an opportunity to discuss how the new physics predicted by TGD would be involved with qualia.

2 How can the perception of quale have a finite duration?

There is a philosophical problem related to the fact that the experience of, say, color has a duration. One could argue that the idea that color sensations correspond to SFRs, that is, a single moment of consciousness, is not consistent with this. One can imagine two ways to overcome this objection.

2.1 First option

One could argue as follows.

1. It is not possible to experience that one is not conscious so that the illusion of finite duration of sensory quale is created.

2. The "small" SFR as the TGD counterpart of a weak measurement in quantum measurement theory based on zero energy ontology (ZEO) begins as a cognitive measurement cascade in a Galois group of extension of rationals associated with a rational polynomial defining a given space-time region [L6, L11].

   This cascade corresponds to a decomposition of the representation of Galois group for a functional composite polynomial $P_1 \circ ... \circ P_n$ for which Galois group of the algebraic extension has decomposition to a semidirect product of relative Galois groups G_i associated with pairs P_i, P_{i+1}. This yields a product of irreps of G_i.

3. The cognitive cascade as a quantum correlate of analysis, is followed by measurements in quark spin and momentum degrees of freedom for the quark states defining the irreps of G_i. One can argue that the duration of the qualia mental image corresponds to the geometric lifetime of this sequence since eventually a BSFR, which means the death of the qualia mental image occurs. By the above argument, the steps in this sequence would not be experienced separately.

4. There is an objection against this view. ZEO [L3, L7] motivates the proposal is that we are during sleep living in an opposite direction of time and *classically* it is impossible to receive signals from that period since the signals travel in an opposite time direction (TGD predicts that also signals with "wrong" time direction can be received and sent but are rare and the process involves BSFR at the level of system representing mental images as subself). However, when we wake up in the morning, we remember that we were conscious yesterday and realize that we do not remember anything about the period of sleep. Could the same argument apply to mental images related to qualia?

2.2 Second option

One could also argue as follows.

1. State function reductions (SFRs) (actually "small" SFRs (SSFRs) responsible for the "flow of consciousness") *initiate* a conscious experience of say some quale realized as subself, mental image. The next "small" SFR would end this experience and initiate a new one. If SFR is "big", the mental image dies and reincarnates with the opposite arrow of time and experience disappears from the consciousness of self.

   Mathematicians would say that a delta function is replaced with a step function as far as interpretation is considered. Nothing at the level of mathematical formalism has changed.

   The structure of conscious experiences reflects the structure of the physical states. In this spirit, one could argue that SFRs serve as a holographic data at the ends of the duration of the conscious experience, which determine the conscious experience associated with the duration itself. One would have have holography of consciousness.

2. Is this interpretation consistent with the fact that change is necessary for qualia as already basic physiological facts show? For instance, if the saccadic motion of the eye is prevented, the perceptive field becomes dark first and after that the visual consciousness disappears. This finding can be consistent with the new view since the lifetimes of the qualia mental images as subselves are certainly finite.

Critical reader could ask whether the two options are only slightly different verbalizations of the same basic intuition and perhaps regard the latter verbalization as mathematically clearer. The latter option looks clearer than the first one although it does not literally conform with what I have been telling for three decades about SFRs as basic building bricks of conscious experience! It can take decades to express really clearly what you have understood!

2.3 How can qualia be reliable if they are associated with quantum jumps?

The popular article "Scientists Quantified The Speed of Human Thought, And It's a Big Surprise" (see this)) tells about the article "The unbearable slowness of being: Why do we live at 10 bits/s?" of Zheng and Meister [**?**]. The speed of human thought would be 1 step per .1 seconds. This time interval corresponds to 10 alpha rhythm.

The conclusion is rather naive and reflects the failure to realize that consciousness is a hierarchical structure. This failure is one of the deep problems of neuroscience and also of quantum theories of consciousness. Although the physical world has a hierarchical structure and although the structure of consciousness should reflect this, it seems impossible to realize that it indeed does so!

TGD view about conscious experience, predicts this hierarchy [K3, K2, **?**]. Only a very small part of this hierarchical structure is conscious to us. Conscious entities, selves, have subselves (associated with physical subsystems), which they experience as mental images. Also subselves have subselves as sub-subselves of us. The hierarchy continues downwards and upwards and the latter predicts collective levels of consciousness.

TGD assumes that the period of subjective time between two "small" state function reductions gives rise to a moindent of consciousness with an experienced duration and that these moments integrate to a flow of consciousness. The objection is that the contents of conscious experience would be highly random. How to overcome this objection?

We do not experience these subsubselves as separate entities but only their statistical average [K2, **?**]. This makes possible statistical determinism of mental images so that they do not fluctuate randomly. For instance, this statistical averaging explains the summation of visual colors. This conforms with the fact that there is a large number of sensory receptors.

This applies also to cognition and quantum computation-like processes in which the outcomes are sub-sub-selves giving rise to cognitive mental image, self, as a conscious average. This averaging applies also in time direction since zero energy ontology [L3, L19] predicts a slight failure of classical non-determinism, which makes possible conscious memories containing information about previous

state function reductions [?, L16]. Averaging as a basic operation in quantum theory computations giving rise to predictions would have a counterpart at the level of conscious experience.

The view is discussed in more detail in the article [L17] proposing that life could be universal in the sense that it can emerge in all systems involving cold plasmas and involving quantum computation like-processes and memory based on the classical non-determinism of TGD. At the neuronal level various EEG rhythms would define analogs of the computer clock and each tick of the clock would define a potential seat of memory.

3 Two alternative identifications of qualia

One can consider two alternative identifications of qualia: as an outcome of quantum measurement or as a change/transfer of quantum numbers.

3.1 Quale as an outcome for a measurement of quantum numbers?

Quantum measurement theory suggests the identification of qualia as resulting in quantum measurement and therefore labelled by eigenvalues of the measured observables. Qualia would therefore characterize the quantum state emerging in SFR (most naturally SSFR) and one might say that qualia are determined by the properties of the state.

How does this relate to the long held TGD based view that since SFRs are the basic building bricks of conscious experience, conscious experience cannot be regarded as a property of a physical state as physicalists argue. Hence "consciousness" is a misleading term. Holography of consciousness suggests the interpretation that conscious experience and qualia are about the properties of the state emerging in SFR but are not its properties.

There is a finite classical non-determinism associated with the space-times surfaces as analogs of 4-D soap films. A possible interpretation is as a correlate for the intentional component of the conscious experience. This would fit with the vision that life and intentionality, which is essential for life, emerge at quantum criticality. SSFRs would be behind sensory experience and classical non-determinism behind the intentional component of the experience.

Consider color vision as an example.

1. Sensory receptors (such as the eye) could be seen in this framework as a collection of subsystems (rods and cones), which together form a quantum coherent state. SFR would produce a collection of different outcomes and the experienced quale would be a statistical average of the outcomes. In the ensemble interpretation, the probabilities of various quantum number combinations (basic colors) would be given by the reduction probabilities. This explains color summation. In holography with a slight failure of determinism, one cannot exclude temporal averages.

2. "Color symmetry" was originally a joke inspired by the algebraic correspondence with visual colors. The proposal was that visual colors could correspond to quark colors. Perception would be measurement of color quantum numbers. This would predict 3 colors for quarks and 3 complementary colors for antiquarks. White and black are also considered as colors.

3. This sounds outlandish but makes sense in the TGD framework, where quarks are the only fundamental fermions in the recent formulation of TGD. Moreover, TGD predicts a hierarchy of effective Planck constants $h_{eff} = nh_0$, where n has a number theoretic interpretation as dimension of an extension of rationals associated with a polynomial defining a space-time region considered. n measures the algebraic complexity and serves as a kind of IQ.

   $h_{eff} = nh_0$ labels phases of ordinary matter and these phases behave like dark matter relative to each other. Field bodies carry these phases and magnetic bodies MBs with various values of h_{eff} can act as "bosses" controlling lower levels, in particular the ordinary matter at the bottom of the master-slave hierarchy.

4. Compton lengths are scaled up by n and MBs can carry dark quarks and gluons even in cellular length scales. Below the confinement scale which is the natural scale now quarks and gluons are effectively massless. One could say that we directly see quarks!

This is true also also for the weak interactions and the presence of dark weak variants of weak bosons at magnetic body (MB) could explain the chiral selection in living matter, which is very difficult to understand in the standard model because the violation of parity in weak interactions is extremely small above Compton length of weak bosons. In living matter the Compton length would scale up at MBs and MBs acting as "bosses" would induce large parity violation even in cell scale.

3.2 Quale as a change of quantum numbers?

An alternative option has been that the classical flows of color quantum numbers could correspond to qualia. This led to the sensory capacitor model of cell membrane [K2, K4].

1. Since the changes for quark quantum numbers correspond to gluons, there would be 3+3 colors corresponding to color charged gluons. Classically one could think that the flow of color quantum numbers between two subsystems in a sensory receptor could give rise to an experience of quale such as color. This led to the sensory capacitor model of cell membrane [K2, K4].

2. At elementary particle level, the change of color quantum numbers for a single particle could be induced by an exchange of a gluon between quarks. But can one associate this flow with a quantum measurement of something? For quantum groups and Yangians the color charge operators are sums of single particle contributions and many particle contributions. Two-quark contributions would make possible opposite change of color quantum numbers for the members of a quark pair. Could the measurement of the quantum group counterpart of color charge give rise to this kind of change? The first option is the simpler and more natural one.

3. In the sensory capacitor model, one could model the situation as a pair of harmonic oscillator wells representing the plates of a capacitor characterized by Hamiltonian $H = H_0 + V$. The presence of the capacitor plates would be described by a sum $H_0 = -\hbar^2\partial_x^2/2m + kx^2/2 + k(x-d)^2/2$ of harmonic oscillator Hamiltonians describing a double potential well. The potential driving the particles between the plates would be described by $V = -qEx$.

   The commutator $[H, V] = \hbar^2\partial_x E/m = i\hbar Ep$, $p = i\hbar\partial_x/m$ and non-hermitian in plane wave basis at the limit of infinite distance between the plates.

4. p is a linear combination of creation and annihilation operator for the harmonic oscillator quanta and one can ask whether the analogs of eigenstates of p correspond to coherent states for the annihilation operator having in general complex eigenvalues. Instead of eigenstate, a coherent state for the negative energy part of force could be created at the plate which contains the particle in the initial state. The coherent state would be a harmonic oscillator state for which the origin would be shifted along the line connecting the plates. The probabilities for eigenstates would be given by the overlap of the coherent states as Gaussian with the original ground state or excited state at either plate.

5. A more realistic formulation could be as a quantum phase transition for a cyclotron condensate of quarks and antiquarks assignable to the opposite layers of the sensory capacitor carrying opposite color charges. This phase transition is analogous to a spontaneous magnetization, or rather its reversal, and would emit a burst of gluons changing the quantum numbers of cyclotron condensates at the layers.

   The TGD view about dark matter leads to the notion of dark N-particle as an analog of a Bose-Einstein condensate. A dark N gluon would be emitted.

   The description of the dynamics of this transition could involve the bilinear coupling of classical induced color field components $G^A_{\alpha\beta} = H_A J_{\alpha\beta}$ proportional Kähler form and Hamiltonians of color isometries with gluon field, and associated with a "massless" extremal (ME) connecting the plates. ME or MEs would serve as a classical space-time correlate for a mode of a generic radiation field with a fixed polarization and direction of propagation.

4 Zero energy ontology, holography = holomorphy vision and TGD view of qualia

Zero energy ontology (ZEO) and holography = holomorphy vision providing an exact solution of classical field equations allow to solve some earlier problems of TGD inspired theory of consciousness and to sharpen earlier interpretations. Holography = holomorphy vision generalizes 2-D conformal invariance to 4-D situation and provides a universal solution of field equations in terms of minimal surfaces defined as roots for pairs of generalized analytic functions of the generalized complex coordinates of $H = M^4 \times CP_2$ (one of the coordinates is hypercomplex coordinate with light-like coordinate curves) [L12, L15].

Consider first the implications of ZEO [L3] [K9].

1. ZEO predicts that in "big" state function reductions (BSFRs) as counterparts of ordinary SFRs the arrow of time changes. "Small" SFRs (SSFRs) are the counterpart for repeated measurements of the same observables, which in standard QM leave the system unaffected (Zeno effect). In SSFRs, the state of the system however changes but the arrow of time is preserved. This has profound implications for the understanding of basic facts about consciousness.

2. The sequence of SSFR corresponds to a sequence of delocalizations in the finite-dimensional space of causal diamonds $CD = cd \times CP_2$ [L14] and consists of delocalizations (dispersion) followed by localizations as analogs of position measurements in the moduli parameterizing the CD. This sequence gives rise to subjective existence, self.

3. BSFR has interpretation is accompanied by reincarnation with an opposite arrow of geometric time. BSFR means the death of self as a sequence of "small" SFRs (SSFRs) and corresponds to falling asleep or even death. Death is therefore a completely universal phenomenon. The next BSFR means birth with the original arrow of time: it can be wake-up in the next morning or reincarnation taking place considerably later, life time is the first guess for the time scale. This follows from the fact that causal diamond $CD = cd \times CP_2$ increases in size during the sequence of SSFRs.

4. What forces the ZEO is holography which is slightly non-deterministic due to the classical non-determinism of an already 2-D minimal surface realized as a soap film for which the frame spanning it does not fix it uniquely. This means that the 4-D space-time surface located inside CD and identifiable as the analog of Bohr orbit determined by holography must be taken as a basic object instead of a 3-surface. In SSFRs, the state at the passive light-like boundary of CD is unaffected just as in Zeno effect but the state at the active boundary changes. Due to the dispersion in the space of CDs the size of CD increases in statistical sense and the geometric time identifiable as the distance between the tips of CD increases and correlates with the subjective time identifiable as sequence of SSFRs.

5. In standard quantum theory, the association of conscious experience with SFRs does not allow us to understand conscious memories since the final state of state function reduction does not contain any information about the earlier states and state function reductions. Zero energy ontology leads to a concrete view of how conscious memories can be realized in the TGD Universe [L16]. The superposition of space-time surfaces between fixed initial state and changing final state of SSFR contains the classical information about previous states and state function reductions and makes memory possible. The slight non-determinism of the classical time evolution implies loci of non-determinism as analogs of soap film frames and memory recall corresponds to a quantum measurement at these memory seats.

6. SSFRs correspond to repeated measurements of the same observable and the eigenvalues of the measured observables characterize the conscious experience, "qualia", partially. Also new commuting observables related to the non-determinism can appear and the set of observables can be also reduced in size. The superposition of the space-time surfaces as analogs of non-deterministic Bohr orbits however changes in the sequence of SSFRs and the associated classical information changes and can give rise to conscious experiences perhaps involving also the qualia remaining constant as long as self exists.

The eigenvalues associated with the repeatedly measured observables do not change during the sequence of SSFRs and one can ask if they can give rise to a conscious experience, which should be assignable to change. Could these constant qualia be experienced by a higher level self experiencing self as sub-self defining a mental image? This higher level self would indeed experience the birth and death of subself and therefore its qualia.

The observables at the passive boundary of CD correspond qualia of higher level self and the additional observables associated with SSFRs correspond to those of self. They would be associated with self measurements.

7. Note that self dies when the measured observables do not commute with those which are diagonalized at the passive boundary. It is quite possible that these kinds of temporary deaths take place all the time. This would allow learning by trial and error making possible conscious intelligence and problem solving since the algebraic complexity is bound to increase: this is formulated in terms of Negentropy Maximization Principle [L13].

ZEO and holography = holomorphy vision allow us to understand some earlier problems of TGD inspired theory of consciousness and also to sharpen the existing views.

4.1 Two models for how sensory qualia emerge

Concerning sensory qualia [K2] I have considered two basic views.

1. The first view is that the sensory perception corresponds to quantum measurements of some observables. Qualia are labelled by the measured quantum numbers.

2. The second, physically motivated, view has been that qualia correspond to increments of quantum numbers in SFR [K2]. This view can be criticized since the quantum numbers need not be well-defined for the initial state of the SFR. One can however modify this view: perhaps the redistribution of quantum numbers leaving the total quantum numbers unaffected, is what gives rise to the sensory qualia.

   The proposed physical realization is based on the sensory capacitor model of qualia. Sensory receptors would be analogous to capacitors and sensory perception would correspond to dielectric breakdown. Sensory qualia would correspond to the increments of quantum numbers assignable to either cell membrane in the generalized di-electric breakdown. The total charges of the sensory capacitor would vanish but they would be redistributed so that both membranes would have a vanishing charge. Membranes could be also replaced with cell exterior and interior or with cell membrane and its magnetic body. Essential would be emergence or disappearance of the charge separation.

   This picture conforms with the recent view about the role of electric and gravitational quantum coherence assignable to charged and massive systems. In particular, electric Planck constant would be very large for charged systems like cell, neuron, and DNA and in the dielectric breakdown and its time reversal its value would change dramatically. If this is the case the dynamic character of effective Planck constant involving phase transition of ordinary to dark matter and vice versa would be essential for understanding qualia.

3. As the above argument demonstrated, the qualia can be decomposed to internal and external qualia. The internal qualia correspond to self-measurements of sub-self occurring in SSFRs whereas the external qualia correspond to the qualia measured by self having sub-self as a mental image. They are not affected during the life-time of the mental image. Whether the self can experience the internal qualia of subself is far from clear. The sensory capacitor model would suggest that this is the case. Also the model for conscious memories suggests the same. The internal qualia would correlate with the classical dynamics for the space-time surfaces appearing in the superposition defining the zero energy state and make possible, not only conscious memory and memory recall based on the failure of precise classical determinism, but also sensory qualia as subselves experienced as sensory mental images.

4.2 Geometric and flag manifold qualia and the model for the honeybee dance

One can decompose qualia to the qualia corresponding to the measurement of discrete observables like spin and to what might be called geometric qualia corresponding to a measurement of continuous observables like position and momentum. Finite measurement resolution however makes these observables discrete and is realized in the TGD framework in terms of unique number theoretic discretization of the space-time surface.

Especially interesting qualia assignable to twistor spaces of M^4 and CP_2.

1. Since these twistor spaces are flag manifolds, I have talked about flag-manifold qualia. Their measurement corresponds to a position measurement in the space of quantization axes for certain quantum numbers. For angular momentum this space would be $S^2 = SO(3)/SO(2)$ and the localization S^2 would correspond to a selection of the quantization axis of spin. For $CP_2 = SU(3)U(2)$ the space of the quantization axis for color charges corresponds to 6-D $SU(3)(U(1) \times U(1)$, which is identifiable as a twistor space of CP_2.

2. The twistor space of M^4 can be identified locally as $M^4 \times S^2$, where S^2 is the space of light-like rays from a point of M^4. This space however has a non-trivial bundle structure since for two points of M^4 connected by a light-like ray, the fibers intersect.

What is the corresponding flag manifold for M^4?

1. The counterpart of the twistor sphere would be $SO(1,3)/ISO(2)$, where $ISO(2)$ is the isotropy group of massless momentum identifiable as a semidirect product of rotations and translations of 2-D plane. $SO(1,3)/ISO(2)$ corresponds to the 3-D light-cone boundary (other boundary of CD) rather than S^2 since it has one additional light-like degree of freedom. Is the twistor space as a flag manifold of the Poincare group locally $M^4 \times SO(1,3)/ISO(2)$. This is topologically 7-D but metrically 6-D. Since light rays are parametrized by S^2 one can also consider the possibility of replacing $M^4 \times SO(1,3)/ISO(2)$ with S^2 in which case the twistor space would be 6-D and represented a non-trivial bundle structure.

2. Could one restrict M^4 to E^3 or to hyperbolic 3-sphere H^3 for which light-cone proper time is constant? In these cases the bundle structure would trivialize. What about the restriction of M^4 to the light-like boundaries of CD? The restriction to a single boundary gives non-trivial bundle structure but seems otherwise trivial. What about the union of the future and past boundaries of CD? The bundle structure would be non-trivial at both boundaries and there would also be light-like rays connecting future and past light-like boundaries.

   The unions $\cup_i H_i^3(a_i)$ of hyperbolic 3-spaces corresponding different values $a = a_i$ of the light-cone propert time a emerge naturally in $M^8 - H$ duality and could contain the loci of the singularities of space-time surfaces as analogs of frames of soap filmas. Also these would give rise to a non-trivial bundle structure.

   These identifications differ from the usual identification of the M^4 twistor space as CP_3: note that this identification of the M^4 twistor space is problematic since it involves compactification of M^4 not consistent with the Minkowski metric. Holography = holomorphy vision in its recent form involves a general solution ansatz in terms of roots of two analytic functions f_1 and f_2 and $f_2 = 0$ [L15], which identifies the twistor spheres of the twistor spaces of M^4 and CP_2 represented as metrically 6-D complex surfaces of H. M^4 twistor sphere corresponds to the light-cone boundary in this identification. This identification map also defines cosmological constant as a scale dependent dynamical parameter.

A basic application for the twistor space of CP_2 has been in the TGD based model [K2, K1] for the findings of topologist Barbara Shipman [A2, A3, A4, A5, A1], who made the surprising finding that the twistor space of CP_2, naturally assignable to quarks and color interactions, emerges in the model for the dance of honeybee. This kind of proposal is nonsensical in the standard physics framework but the predicted hierarchy of Planck constants and p-adic length scales make possible scaled variants of both color and electroweak interactions and there is a lot of empirical hints for

the existence of this hierarchy, in particular for the existence as a scaled up variants of hadron physics leading to a rather radical proposal for the physics of the Sun [L18].

Shipman found that the honeybee dance represents position in $SU(3)/U(1) \times U(1)$ coding for the direction and distance of the food source in 2-D plance! Why should this be the case? The explanation could be that the space-time surfaces as intersections of 6-D counterparts of the twistor spaces $ISO(2) \times \cup_i H^3(a = a_i)$ *resp.* $SU(3)/U(1) \times U(1)$ identified as a root of analytic function f_1 *resp.* f_2 [L15] have space-time surface as 4-D intersection so that honeybee dance would map the point of the flag manifold $SU(3)/U(1) \times U(1)$ to a point of $M^4 \times S^2$ or $\cup_i H^3(a = a_i) \times ISO(2)$ (locally). The restriction to a 2-D subset of points could be due to the measurement of the distance of the food source represented by the point of H_i^3 (or M^4).

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