Impressions created by TSC 2015 conference

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Abstract

Towards a Science of Consciousness conference (TCS 2015) was held in Helsinki June 8-13. In this article my impressions about the conference are described. They reflect only my limited scope of interest and not even this since the number of representations was so large that it was possible to listen only a minor fraction of representations.

1 Introduction

Toward a Science of Consciousness conference (TSC 2015) held in Helsinki during last week (June 8.-13.) Thanks are to my supporter for the possibility to participate. The first TSC was held 1994 so that this was the 21st conference. The conference was wonderfully organized, the content covered practically everything consciousness related, and lectures and talks were enjoyable. I have participated very few conferences during last decades after being forced to leave the university so that it was really inspiring experience to listen what others have to say instead of only reading or writing. Better vacation I cannot imagine.

I have also the luck of having people who appreciate my work and did their best to help me to cope in conference environment, which after almost four decades of life as an academic out-of-law induces deep fears that some-one might get the idea of ridiculing the old man. This even at this age when this kind of things should not matter anymore. The Pavlovian conditionings created by the local academic environment are really difficult to change and a long lasting therapy would be needed to overcome the avoidance behaviors, which were the best strategy to minimize suffering earlier but are not appropriate anymore. Maybe therapy could be same as applied to phobias: first I would imagine approaching a professor and saying something like "Hello, how are you. Do you have time? I would like to ask some questions." Eventually would come the moment when I approach in the presence of supporting person a real and living professor and represent the same question. Well, now the old man is day-dreaming...;-)

As a matter fact, the conference environment was extremely pleasant. People were friendly and I did not see any trace of the arrogant behaviors that I recall so well from some physics meetings in Finland.

I hasten to admit that the only manner that allows me to learn anything about lectures is to relate that what has been said to TGD. Basic questions are simple. Does this idea have a counterpart in TGD? How it would be realized in TGD framework? Usually this strategy is very fruitful and leads to progress in TGD. I hope that the reader can tolerate the impolite intrusions of TGD into the following considerations.

2 East and West - will they ever meet?

The topics of conference covered a lot of topics. Monday was devoted to the East-West division and made clear the basic problems of consciousness science. Eastern and western views could be oversimplified into two mirror image ontologies: western materialism/physicalism accepting only matter dominates in neuroscience and eastern idealism accepting only consciousness dominates in spiritual circles.

The explanation and also prediction of qualia as function of physical state is the killer challenge of materialism - this is the the hard problem discussed by Chalmers in his book. Eastern monism is plagued by the mirror image of this problem.

This is of course an over-simplification: dualistic attempts to get over this problem appear at both sides. Dualism however tends to reduce to materialism/physicalism if one demands consistency with physics as demonstrated by Chalmers, who has given up hopes about dualism and proposed his own quantum theory of consciousness in the conference - see comments below.

There were several parallel sessions and one had to make painful choice between what to take and what to leave.

Hagelin had an excellent and entertaining lecture about his consciousness as unified field approach.

1. The approach of Hagelin is monistic and tries to combine modern quantum field theoretic approach with the Eastern view. Consciousness is identified as unified field. The criticisms are obvious. First, reverse hard problem should be solved. Furthermore, consciousness is about something: quantum field or quantum states are not. This "aboutness" property leads in the interactive dualistic to materialism if 1-1 correspondence realizes it, and consciousness to matter rather than being about matter (and also mind!). Hagelin did not say anything about quantum measurement problem and how observers emerge. Evil physicalist would say that this kind of approach serves as a mantra: "consciousness is unified field" is a statement without real contents and just for this reason its repetition leads to empty mind and to meditative states just like producing Om sound.

2. Hagelin identifies unified field in terms of a particular super symmetric Grand Unified Theory (GUT) that he studied as he was particle physicist in CERN. To my humble opinion, the age of GUTs has been over long time ago. The main problem is the difficulty with fine tuning to get the lifetime of proton long enough and also the fine tunings in order to get mass scales correctly. $\mathcal{N} = 1$ supersymmetry was hoped to solve the problems but it is already now clear that it is not able to do this. The hope was that super string theory could give some GUT at low energy limit but now also super string theories continue to live only in grant applications, and super string conference talks rarely mentions superstrings.

   In TGD framework one cannot exclude a surprising solution to the problem. The masses of sparticles should not differ much from those of particles since right-handed neutrinos is responsible for least broken supersymmetry and has no weak or color interactions. Could one think that sparticles are dark matter in TGD sense - that is have non-standard value of Planck constant - and are therefore difficult to observe?

3. Hagelin mentioned also the newest fashion in theoretical physics: wormholes connecting distant blackholes identified as representations of quantum entanglement. It is also said that space-time emerges from entanglement. The basic objection is that wormholes in GRT are not stable. Personally I see blackholes and corresponding wormholes represent the failure of general relativity as a theory of gravitation. Super string theorists however continue to believe that blackholes and wormholes are real - what else they could do since this belief defines the long length scale limit of super string theory. Holography is essential part of this

picture too. The picture involving wormholes as counterparts of entanglement is actually GRT based variant of much older vision of TGD.

4. TGD view is that in order to overcome the problems of GRT one must replace space-times with a 4-surfaces in $M^4 \times CP_2$ determined uniquely by both physical and twistorial considerations [K33]. The GRT space-time emerges from the many-sheeted space-time of TGD as approximate description by lumping the different sheets to single sheeted region with gravitational and gauge fields represented as sums of those associated with different sheets [K21].

   In TGD blackholes are replaced with regions of space-time surface with Euclidian signature of induced metric and wormholes with magnetic flux tubes - stable if they carry monopole magnetic flux serve as space-time correlates for entanglement. Euclidian regions are TGD counterparts for the lines of Feynman diagrams [K33]. During last years it has become clear that magnetic flux tubes are accompanied by fermionic string world sheets in 4-D space-time, which itself is surface in 8-D imbedding space [K24].

   In TGD context holography is very much like the ordinary one and realized in terms of partonic 2-surfaces and string world sheets. Zero energy ontology (ZEO in the sequel) and quantum criticality predicting a hierarchy of effective Planck constants interpreted in terms of a dark matter hierarchy [K6, K29, K30] is an essential part of picture and leads to a precise identification for the notion of self. Quantum criticality and magnetic flux tubes carrying dark matter are in a key role in TGD inspired quantum biology and theory of consciousness.

   Side remark: strings bring in oscillations of the relative positions of points of partonic 2-surfaces that they connect. A highly attractive identification is as a fundamental correlate for sound qualia. These oscillations would represent classical communication at basic level and sound would be much more fundamental than condensed matter phenomenon.

Second highly interesting talk was by Bandyopadphyay about his latest work. Unfortunately, I was not able to follow since he talked very fast and covered large amounts of material with a lot of figures whereas I am used to text based representations. Also abstract was lacking.

1. What I can recall was the proposal that there exists experimental evidence coming from neuronal, microtubular, and DNA level for a hierarchy of frequency scales coming as powers of 10^3. At least 6 levels, 1 Hz, kHz, MHz,GHz, THz, and PHz which corresponds to UV light, would be involved. Triads of subsequent scales would appear at given level. One would have 1 Hz, kHz, MHz in neuroscience MHz, GHz, THz at microtubular level and GHz, THz, PHz at DNA level.

   As a matter fact, it seems that also DNA level involves 1 Hz scale: cyclotron frequencies of DNA sequences in endogenous magnetic field of .2 Gauss are around 1 Hz. Therefore all these frequency scales seems to be present (and probably many others).

   As I started to work with the hierarchy of Planck constants I assumed that Planck constants come as powers of 2^{11}. Later it became clear that also powers of $2^{10} = 1024$ could be there and eventually I accepted $h_{eff} = n \times h$ hypothesis. I have discussed a vision in which there is kind of resonance between dark phase for given p-adic prime and larger prime for which p-adic length scale corresponds to the dark scale and scalings by 2^{20} appear in this framework.

2. Bandyopadphyay represented also arguments that primes are somehow important but I failed to understand. In any case, p-adic physics and real physics extended to adelic physics provides correlates for cognition and imagination in TGD framework and I am eagerly waiting when this mathematics enters to consciousness theorizing.

3 What did I learn from neuroscience?

There were many talks about neuroscience. Unfortunately, I did not have opportunity to hear many neuroscience lectures.

1. I missed the talk by brothers Fingelkurtz (`http://schd.ws/hosted%20files/tsc2015/61/Filgelkurts%20et%20al%20new%2017.3.2015.pdf`) working in Finland and studying

EEG as correlate of consciousness. I have however written an article (`http://tgdtheory.fi/public_html/articles/Fingelkurts.pdf`) about their work (`http://dx.doi.org/10.1016/locate/j.chaos.2013.02.007`) earlier.

2. I received from Samu Mielonen material about the talk of Schröder with title "Irreducibility of the logic of integrated information- quantum coherence to unity of consciousness and beyond" (%20). It is a pity that I missed this talk.

   They basic question is how smaller conscious units integrate to larger ones. There are many approaches. Consider two neuroscience based approaches as example.

   (a) Holography is the proposal of Pribram. In TGD framework this generalizes to strong form of holography, which is quantum theoretic notion and completely universal physical principle actually following from strong form of general coordinate invariance [K2].

   (b) It seems clear that an integration of informations associated with various kinds of sensory inputs to conscious experience does take place. The notion of integrated information is Tononi's proposal in this respect. Consciousness would corresponds to a capacity to integrate information. Conscious system is structurally rich meaning large number of different states but it cannot be decomposed to causally independent subsystems. This approach leaves the mechanisms of integration open.

3. Quantum consciousness theorists would identify also the mechanism and say that macroscopic quantum coherence and quantum entanglement guarantee these two characterizing properties. For the simplest systems like Bose-Einstein condensate the structural richness would be of course lost. The question is how macroscopic coherence and long range entanglement can be generated and how they can be stable.

   (a) Microtubular networks and Orch Or is the proposal of Penrose and Hameroff. Also in TGD framework microtubules define an important level in the biological self hierarchy [K14, K17], [L1].

   (b) TGD inspired proposal relies on several new ingredients. The generalization of the space-time concept leading to the notion of magnetic body, a generalization of quantum physics by introducing the notion of quantum criticality implying the hierarchy of effective Planck constants labelling phases of ordinary matter behaving like dark matter, the replacement of the positive energy ontology with ZEO, strong form of holography, and self hierarchy with self emerging as a basic notion from the generalization of quantum measurement theory. Networks of magnetic flux tubes carrying dark matter characterized by the value of effective Planck constant are responsible for the generation of larger structures.

   TGD inspired quantum measurement theory assumes that quantum measurements occur everywhere. For given entangled subsystem-complement pair the density matrix is the universal observable. The measurement of the density matrix occurs for that pair for which the maximal negentropy gain is largest among sub-system-complement pairs. Therefore spontaneously occurring self measurement selects uniquely single sub-system-complement pair. The weak form of NMP however allows some freedom since negentropy gain can be also non-maximal. This is essential for understanding evolution and basic aspects of consciousness and allows to understand the emergence of ethics and moral [K23] with negentropy growth as the fundamental "good".

   Negentropic entanglement (NE) for which number theoretic Shannon entropy is negative serves as a measure for information content. Negentropy Maximization Principle (NMP) [K11] serving as the basic variational principle for consciousness theory guarantees that NE tends to increase. NE corresponds to a density matrix, which is projector so that all states are its eigenstates with same eigen value so that this sub-space or any of its sub-spaces can be an outcome of the quantum measurement of this density matrix. In the ordinary quantum measurement theory it would be 1-dimensional ray of state space.

   When the outcome of the reduction is n-dimensional space one has special kind of state. Any state could have been selected so that one has an analog of Schrödinger cat in

meditative state: which is half dead and half alive (exactly one half of each!). Any choice of state basis analogous to choice of quantization axes of spin is possible for enlightened cats!

Unitary entanglement gives n-dimensional projector as density matrix. In practice unitary entanglement is impossible in usual physics but the quantum criticality of TGD Universe makes it possible. The emergence of n *discrete* degrees of freedom related to $h_{eff} = n \times h$ having interpretation in terms of n-fold branching of space-time surfaces at the opposite boundaries of CD, is essential: NE would be in these degrees of freedom. This branching is the essence of quantum criticality. It is unstable and t implies non-determinism of quantum criticality manifesting itself as space-time branching.

4. The talks about sleep, dreaming, and nightmares studied in the group of Revonsuo (`https://tsc2015.sched.org/event/d0f100ddbab716da8a03398586e4d07c#.VX%20K8etl9Rw`) were very interesting. The goal is to test and develop theories explaining the function of dreaming. The basic idea is that dreams are simulations of real life situations. One hypothesis is that we learn to cope in difficult situations by simulating them. Second hypothesis is that we also learn social skills - to which difficult situations often relate - by simulations. This explains why there are also pleasant dreams: dreams try to encourage us.

   Personally I however believe that there are also dreams which one might call mystic. They have deep meaning, they are very pleasant, and its is very difficult to see how these dreams could try to teach me what to do if I am mountain climber who realizes that he cannot go neither upwards or downwards or refine my social skills.

   There is also the question about a possible connection of nightmares and depression.

   I had not realized that there are also non-REM dreams as dream research has demonstrated. They do not last so long as REM dreams. I have proposed that REM might be induced by the virtual sensory input to eyes from brain or perhaps even magnetic body. This input would be present as a feedback during wake-up periods and allow to transform visual input to a kind of artwork consisting of well-defined objects in action. During non-REM dreams this input would not perhaps be so strong and long-lasting enough to induce REM as motor response.

   In TGD framework there are fascinating questions to be answered. p-Adic space-time surface is the number one candidate for an imagined time evolution [K32]. Second candidate is as almost realized motor actions and virtual sensory percepts. In REM dreams they could be induced by virtual visual sensory inputs to retina coming as feedback from brain or even magnetic body. In non-REM dreams the inputs could begin also from the upper levels of visual pathways in non-REM dreams. These two identifications should be mutually consistent.

   (a) The key observation is that strong form of holography for adelic space-time having space-time surfaces in various number fields (reals and p-adic number fields associated with an algebraic extension of rationals appear as pages of a book like structure having extension of rationals as a back) can be possible in p-adic sectors but not in the real sector.

   p-Adic continuations of string world sheets and partonic 2-surfaces to 4-D space-time surfaces representing preferred extremals of Kähler action would be possible because of the possibility of p-adic pseudo constants replacing integration constant with piecewise constant functions depending on finite number of pinary digits. String world sheets and partonic 2-surfaces in the intersection of reality and various p-adicities could be thus continued to p-adic space-time surfaces but not necessarily to real space-time surfaces. In the case of imagination the strong form of holography would work only for p-adic sectors representing imagination (`http://tgdtheory.fi/public_html/articles/padimag.pdf`) [L2]!

   (b) There is long list of questions waiting for an answer. Could REM dreams be realizable as virtual world visual signals propagating to retina and stimulating mental image and non-REM dreams (also these are possible!) are not? Or could the realization as real space-time surface be only partial: for instance, imagined motor actions would not be

realized since there is no space-time surface in which neural signal wold be conducted down to the muscles?

5. Transcranial magnetic stimulation (TMS) was second topic that I listened (https://tsc2015.sched.org/event/f159e6033fd820c0d332b5fe733c4c3f#.VX%20KMOtl9Rw). The idea is to perturb brain by magnetic pulses with field strength up to 2 Tesla and lasting about .2 microseconds and to see what happens. The magnetic field generates a rotational electric field pulse and its is easy to believe that this affects membrane resting potential and can least to a generation of nerve pulse. By applying these pulses to suitable parts of brain one can induce changes in consciousness, and also see which parts of brain are responsible for "our" consciousness. Frontal lobes certainly contribute directly to "our" consciousness. In TGD framework one would have a hierarchy of selves so that in all cases there could be conscious experience at some level of hierarchy.

   One can of course wonder whether TMS could affect also microtubular level: the duration is of same order of magnitude as the lowest GHz frequency scale for the AC stimulation of microtubules. Transcranial ultrasound (TUS) (http://schd.ws/hosted%20files/tsc2015/06/Abstracts%20Consciousness%20and%20Transcranial%20Ultrasound.pdf) is another analogous perturbation method. Now transcranial ultrasound with frequencies which can be chosen to be those assignable to microtubules are applied to the brain. The claim by Hameroff and coworkers is that TUS has positive effects on mood.

6. Susan Blackmore talked about OBEs (http://schd.ws/hosted%20files/tsc2015/b8/Abstracts%20East%20vs.%20West%20on%20the%20Hard%20Problem.pdf) in light of the newest results from neuroscience. It is possible to induce these experiences by brain stimulation. The region of cortex is the boundary of temporal and parietal cortex believed to be responsible for building the self model. This excludes the idea that OBEs could be real in the sense that "soul" with eyes would leave the body and be able to check whether there is still beer in the refrigerator.

   One has to explain why the OBE and why we have a third person perspective about our body. My own proposal is that the notion of personal magnetic body could explain OBEs [K20]. Nerve pulse patterns would not be enough: brain and body would be only a factories of standardize mental images and somewhere these mental images should be represented in integrated form. Magnetic body could be the intentional agent receiving sensory input from biological body and controlling it, and be responsible for the third person view. This explains EEG - not as a metabolically costly side effect of neural activity - but as a communication and control tool [K19]. One has fractal hierarchy of EEGs and its variants such as EKG involving all scaled variants of EEG - at least those with scaling by factor 10^3.

   OBEs and NDEs occur often in situations when ordinary sensory input and motor activity are absent, which suggests that in this kind of situation the motion of magnetic body defining a representation of biological body. Magnetic body would be able to change its shape and move with respect to the biological body and in this manner generates the sensations as virtual world experiences. Also illusions like train illusion (when neighboring train starts to move you feel that it is you who is moving) and the nasty feeling in stomach as you see some-one to go near the border of cliff.

   Various motor actions of magnetic body (contractions and expansions of magnetic flux tube by h_{eff} changing phase transitions, reconnections of flux tubes, replication, etc..) are indeed fundamental for understanding what happens in TGD based quantum biology at the deeper level [K28, K27, K26].

4 What did philosophers say?

There were many philosophical talks about various basic notions such as self, attention, perception, hallucination, cognition, intentionality, memory, sleep and dreaming, time, volition, intentional action, language, etc.... I had to however make a choice and since I have worked with these topics and had the expectation that there would not be much resonance I decided to listen lectures more

nearer to concrete world. I regret that I did not have opportunity to listen the talk of finnish philosopher Jaakko Hintikka.

My general feeling is that materialism/physicalism, idealism, and various variants of dualism cannot serve as a basis for a theory of consciousness. Furthermore, philosophers seem to be attached to language, which lacks the needed concepts, and reflects wrong implicit assumptions about consciousness so that the real problem is transformed to a bunch of pseudo-problems. Maybe a good dose of modern quantum physics for any philosopher might help to develop more up-to-date concepts.

It is easy to list some wrong assumptions if one accepts the insights provided by TGD.

1. Philosophers and also other scientists typically identify the time of physicists measured by clocks with subjectively experienced time. This despite the fact that the two times are clearly different (reversibility/irreversibility, arrow of time, etc...). In quantum measurement theory this identification leads to paradox and in Copenhagen interpretation one gives up ontology altogether and says that there is only epistemology - knowledge about something which does not exist.

   Giving up the identification of the two times one ends up with a more general view involving two times and two causalities and avoids reduction to materialistic view with its problems. The challenge is to explain why the two notions of time are so closely correlated. The attempt to meet this challenge has taken decades but to my opinion the recent view about quantum measurement theory in ZEO allows to understand the relationship rather elegantly.

2. Second implicit assumption is that there is only single direction of psychological time definable in terms of thermodynamics. Already Fantappie [J3] realized that living systems show the presence of both arrows of time and introduced the notion of syntropy as time reversed entropy. In TGD framework ZEO leads to the prediction of time reversed mental images and other rather dramatic predictions such as the possibility that biological death involves re-incarnation as time reversed self [K1]. This conforms with the Buddhist view about re-incarnations. This Karma's cycle stops if the self after state function reduction is fused with another larger self. For subselves this cycle corresponds to repeated birth and death of mental images.

3. The third implicit assumption is that in brain science there is only one self to consider, our self. The talks about attempts to define what consciousness taking into account that it has both reflective (kind of unchangeable basic self as observer) and attention related contributions made it clear how fatal consequences this assumptions is. Already Freud proposed a hierarchy consisting of superego, ego, and id.

   In TGD one has self hierarchy with self experiencing its subselves as mental images so that also we would be mental images of a larger self [K10]. In ZEO one can understand the reflective and attention related contributions to conscious experience in terms of figure-background dichotomy. The reflective contribution - background - representing static self corresponds to the boundary of causal diamond (CD), which - as also the part of zero energy state associated with it - remains unaffected in the reductions (Zeno effect).

   The attentional contribution represents sensory input at the second changing boundary - the figure. In the quantum jump in which self dies the state function reduction at opposite boundary produces from the attentional contribution a new reflective contribution by state function reduction. One becomes conscious about what one *was* (rather than *is*) conscious so that infinite regress is circumvented by transforming it to evolution [K18, K13].

4. The implicit assumption of neuroscience is that brain is the seat of consciousness and that one can assign consciousness to some part of brain as its property. This might be a reasonable practical assignment but in TGD framework basically wrong. It indeed leads to hard problem also discussed in many talks of TSC2015. In TGD based ontology consciousness not a property and is not representable geometrically. Its contents are about some region of space-time but as something between two realities, which are - not only representable but also identifiable as zero energy states (modes of classical WCW spinor fields) - it itself is outside the realms of space-time and state space.

Patricia Churcland had a talk related to modal logic (http://schd.ws/hosted%20files/tsc2015/a0/Abstract%20Churchland.pdf). During the lecture I had difficulties to understand what this relationship was and only reading the abstract help to get the gist of the talk - at least I hope so. I greatly enjoyed about concrete examples discussed in the lecture but I cannot agree with what Churchland was suggesting.

1. As a neurophilosopher Churchland wants to identify consciousness with neural activity. One can however argue that brain consciousness could be rather specific phenomenon and that consciousness might appear in very different systems, maybe everywhere in the Universe. Hence one should try to develop a general approach trying to understand the general features of consciousness holding true in all situations.

   Indeed, scientific identity (say identity of electromagnetic radiation and of light) according to modal logic requires that it is true in all situations - or putting it less mundanely: in all possible worlds. Churchland protests. She says that the notion of all possible worlds is not well-defined.

2. I have been talking about the "world of classical worlds" (WCW) and dare to claim that WCW is a mathematically well-defined concept [K31]. For instance, it decomposes into a union of constant curvature spaces with maximal symmetries for each of which all points are geometrically equivalent. These conditions are extremely powerful and dictate the geometry of WCW highly uniquely so that quantum physics identifiable as classical physics in WCW is unique solely from the condition that it exists. Probably also quantum field theorists could argue that the space of classical fields is also well-defined enough notion and has identification as the world of classical worlds. Hence I cannot agree with Churchland. As a physicist I can also say that the symmetries of WCW are universal and dictate the physics in all possible classical worlds.

3. If I want to talk seriously about consciousness, I must define it as a universal property holding in the entire WCW. This requirement is extremely powerful. I end up to talk about selves, sub-selves, self hierarchies, NMP, ZEO, state function reductions, quantum criticality, p-adic physics as physics of cognition, number theoretical universality adelic physics, etc... I can also speculate about forms of consciousness which are not restricted to living matter as we understand it. For these reasons I want to include modal logic in TGD Universe although I understand very little about its technicalities.

Deepak Chopra had a very elegant talk (https://tsc2015.sched.org/event/3b20f28584f77ce393435e7a828.VX%20Ldetl9Rw) about consciousness according to Eastern vision.

1. I mostly agreed with what Deepak Chopra said about consciousness. I cannot however believe that consciousness alone is enough to explain the fact that we have a successful physics. We should explain why the notion of matter emerges from conscious experience and this leads to the reverse hard problem. To my view physicalism is needed but in a generalized sense. Standard physics says nothing about observer and is certainly not enough to achieve this. The question is also about what consciousness and biology can give to physics. This forces much humbler attitude than the typical particle physicist believing in vulgar length scale reductionism has. I have the feeling that the failure of superstring program attempting the reduction of physics to Planck length scale must sooner or later change the attitudes of also particle physics.

2. The basic challenge is to understand observer as part of quantum physical systems: physics would reduce to a theory of consciousness. In TGD based proposal the reduction of moment of consciousness to a state function reduction and following so called U-process is what would take place [K25]. In ZEO there are two kinds of state function reductions: the repeated reductions to same boundary of causal CD defining self and the reductions to opposite boundary meaning death and possible re-incarnation of self. One can understand the flow of geometric time and arrow of time as well as sensory and motor actions, sleep-wake cycle, and memory in this framework as universal aspects of consciousness.

5 Quantum consciousness

I found the talks related to quantum consciousness were the most interesting from my perspective. It is a pity that I did not have opportunity to listen the talk of Basil Hiley about weak measurements. I have been very skeptic about the notion but maybe the talk might have forced to change my views.

5.1 Orch OR

Penrose and Hameroff however accept the challenge of making observer a part of physical world. Hameroff promoted vigorously Orch OR (`http://schd.ws/hosted%20files/tsc2015/9b/Abstracts%20Brain%20networks%20anesthesia_and%20quantum%20evolution.pdf`). In Orch OR consciousness is identified with Orch OR whereas in the older approach by von Neumann, Wigner and others consciousness induces state function reduction and remains outsider to the physical system in the sense that there is not attempt to describe observer as a conscious entity. Also I see the theoretical physics of future as a theory of consciousness. This is of course not physicalism in the standard sense of the word.

Orch OR [J2] (`https://en.wikipedia.org/wiki/Orchestrated%20objective%20reduction`) - assuming it makes sense mathematically - would introduce new kind of state function reduction as a deterministic but non-computable and therefore also non-predictable process - "O" is indeed for "objective".

1. In the classical field theory framework with Schrödinger amplitude replacing classical field one could argue that the its presence contributes to the energy momentum tensor, which in turn affects space-time curvature via Einstein's equations. The superposition of two Schrödinger amplitudes localized around different positions generates that for curvature meaning presence of two spatially separate mass concentrations. The analog of state function reduction realized in terms of the dynamics of general relativity would lead to a situation in which either one is selected. Penrose proposes also Uncertainty Principle giving lower bound for the time scale in which Orc-OR occurs in terms of gravitational self energy associated with the separation.

2. Skeptic could argue that there are very meagre hopes that Orch-OR could obey the universal rules of state function reduction. Skeptic might also insist that the presence of curvature around the two positions represents the analog of two-particle state, which should be represented as tensor product rather than superposition of two differently localized single particle states.

3. The correct quantal treatment could be quantum superposition of 3-geometries with the classical fields and curvature concentrated around different points in the superposition. In GRT framework it is however very difficult to realize this mathematically because one cannot have common coordinatization for the 3-geometries in the superposition.

   In sub-manifold gravity of TGD one can characterize the positions of the mass concentrations in terms of imbedding space coordinates. Of course, Orch OR is not needed in TGD. I might of course have misunderstood something. Hameroff represented a visualization of the idea but it did not help.

To sum up, to me the idea of replacing state function reduction with a classical, possibly deterministic, process does not look physically sound. I have similar problem with the multiverse interpretation of quantum theory.

I however believe that state function reduction and even the non-determinist evolution by state function reductions could have classical space-time correlates in TGD framework made possible by the huge non-deterministic vacuum degeneracy of the fundamental variational principle dictating space-time surfaces as preferred extremals, and in the holographic framework realized as non-uniqueness of the construction of space-time surfaces from string world sheets and partonic 2-surfaces [K13] [L2]. I also agree with the vision about the central role of microtubules in the molecular self hierarchy.

5.2 Quantum cognition

The talks related to quantum cognition produced a pleasant surprise - I had thought that I am working completely alone with quantum cognition. Indeed I am still along in some respects: there was still nothing about p-adic numbers, adelic view about imagination, negentropic entanglement, or realization of Boolean cognition in terms of quantum version of Boolean algebra based on many-fermion states [K13, K3]. It is a pity that I lost most of the opening talk of Harald Atmanspacher (`http://schd.ws/hosted%20files/tsc2015/f1/Abstracts%20Quantum%20ideas%20in%20Consciousness%20Studies.pdf`).

The general idea is to look whether one could take the formalism of quantum theory and look whether it might allow to construct testable formal models of cognition. Quantum superposition, entanglement, and non-commutativity are the most obvious notions to be considered. The problems related to quantum measurement are however present also now and relate to the basic questions about consciousness.

1. For instance, non-commutativity of observables could relate to the order effects in cognitive measurements. Also the failure of classical probability to which Bell inequalities relate could have testable quantum cognitive counterpart. This requires that one should be able to speak about the analog of quantization axis of spin in cognition. Representation of Boolean logic statements as tensor product of qubits would resolve the problem and in TGD framework fermionic Fock state basis defines a Boolean algebra: fermions would be interpretation as quantum correlates of Boolean cognition.

2. The idea about cognitive entanglement described by density matrix was considered and the change of the state basis was suggested to have interpretation as a change of perspective. Here I was a little bit puzzled since the speakers seemed to assume that density matrix rather than only its eigenvalue spectrum has an independent meaning. This probably reflects my own assumption that density matrix is always assignable to a system and its complement regarded as subsystems of large system in pure state. The states are purifiable - as one says. This holds true in TGD but not generally.

3. The possibility that quantum approach might allow to describe this breaking of uniqueness in terms of entanglement - or more precisely in terms of density matrix - was considered. If the density matrix is purifiable cognitive state function reduction reduces it in the generic case to a 1-D density matrix representing one of the meanings.

   The situation with several meanings would resemble that in hemispheric rivalry or for illusions in which two percepts appear as alternatives [K13]. One must be of course very cautious with this kind of models: the spoken and written language do not obey strict rules. I must however admit that I failed to get the gist of the arguments completely.

One particular application discussed in the conference was to a problem of linguistics.

1. One builds composite words from simpler ones. The proposed rule in classical linguistics is that the composites are describable as unique functions of the building bricks. The building brick words can however have several meanings and meaning is fixed only after one tells to which category the concept to which the world refers belongs. Therefore also the composite word can have several meanings.

2. If the word has several meanings, it belongs to at least $n = 2$ two categories fixing the meaning of the word as a member of some bigger class of words. For $n = 2$ the category associated with the word is like spin, and one can formally treat the words as spins, kind of cognitive qubits. The category-word pairs - cognitive spins- serve building bricks for 2 composite worlds analogous to two-spin systems.

3. A possible connection with Bell's inequalities emerges from the idea that if word can belong to two categories it can be regarded as analogous to spin with two values. If superpositions of the same word with different meanings make sense, the analogs for the choice of spin quantization axis and measurement of spin in particular quantization direction make sense. A weaker condition is that the superpositions make sense only for the representations of the

words but not their meanings. In TGD framework the representations would be in terms of fermionic Fock states defining quantum Boolean algebra.

(a) Consider first a situation in which one has two spin measurement apparatus A and B with given spin quantization axes and A′ and B′ with different spin quantization axis. One can construct correlation functions for the products of spins s_1 and s_2 defined as outcomes of measurements A and A′ and s_3 and s_4 defined as outcomes of B and B′. One obtains pairs 13, 14, 23, 24.

(b) Bell inequalities give a criterion for the possibility to model the system classically. One begins from 4 CHSH inequalities [A1] (`https://en.wikipedia.org/?title=CHSH_inequality`) follow as averages of inequalities holding for individual measurement always (example: $-2 \leq s_1s_3 + s_1s_4 + s_2s_3 - s_2s_4 \leq 2$) outcomes by *assuming* classical probability concept implying that the probability distributions for s_is_j are simply marginal distributions for a probability distribution $P(s_1, 2_2, s_3, s_4)$. CHSH inequalities are necessary conditions for the classical behavior. Fine's theorem [A2] (`http://arxiv.org/pdf/1403.7136v2.pdf`) states that these conditions are also sufficient. Bell inequalities follow from these and can be broken for quantum probabilities.

(c) Does this make sense for cognitive spins? Are superpositions of meanings possible? Are conscious meanings analogous to Schrödinger cats? Or should one distinguish between meaning and cognitive representation? Experienced meanings are conscious experiences and consciousness identified as state function reduction makes the world look classical in standard quantum measurement theory. Or is there a preferred choice for cognitive quantization axes so that it is not possible to talk about state basis with states representing partially dead and alive cat? I allow the reader to decide but represent TGD view below.

What about quantum cognition in TGD framework? Does the notion of cognitive spin make sense? Do the notions of cognitive entanglement and cognitive measurement have sensible interpretations? Does the superposition of meanings of words make sense or does it make sense for representations only?

1. In TGD quantum measurement is a measurement of density matrix defining the universal observable leading to its eigenstate or eigen space in final state. In the generic case the state basis is unique as eigenstates basis of density matrix and cognitive measurement leads to a classical state.

   If the density matrix has degenerate eigenvalues situation changes since state function can take place to a sub-space instead of a ray. In this sub-space there is no preferred basis. Maybe "enlightened" states of consciousness could be identified as this kind of states carrying negentropy (number theoretic Shannon entropy is negative for them and these states are fundamental for TGD inspired theory of consciousness.

   Note that p-adic negentropy is well-defined also for rational (or even algebraic) entanglement probabilities but the condition that quantum measurement leads to an eigenstate of density matrix allows only projector as a density matrix for the outcome of the state function reduction. In any case, in TGD Universe the outcome of quantum measurement could be enlightened Schrödinger cat which is as much dead as olive.

   Entangled states could represent concepts or rules as superpositions of their instances consisting of pairs of states. For NE generated in state function reduction density matrix would be a projector so that these pairs would appear with identical probabilities. The entanglement matrix would be unitary. This is interesting since unitary entanglement appears also in quantum computation. One can consider also the representation of associations in terms of entanglement - possibly negentropic one.

2. Mathematician inside me is impatiently raising his hand: it clearly wants to add something. The restriction to a particular extension of rationals - a central piece of the number theoretical vision about quantum TGD [K32] - implies that density matrix need not allow diagonalization. In eigen state basis one would have has algebraic extension defined by the characteristic

polynomial of the density matrix and its roots define the needed extension which could be quite well larger than the original extension.

If this entanglement is algebraic, one can assign to it a negative number theoretic entropy. This NE is stable against NMP unless the algebraic extension associated with the parameters characterizing the string world sheets and partonic surfaces defining space-time genes is allowed to become larger in a state function reduction to the opposite boundary of CD generating re-incarnated self [K23, K11] and producing eigenstates involving algebraic numbers in a larger algebraic extension of rationals. Could this kind of extension give rise to an eureka experience meaning a step forwards in cognitive evolution?

If this picture makes sense, one would have both the unitary NE with a density matrix, which is projector and the algebraic NE with eigen values and NE for which the eigenstates of density matrix outside the algebraic extension associated with the space-time genes. Note that the unitary entanglement is "meditative" in the sense that any state basis is possible and therefore in this state of consciousness it is not possible to make distinctions. This strongly brings in mind koans of Zen Buddhism. The more general algebraic entanglement could represent abstractions as rules in which the state pairs in the superposition represent the various instances of the rule.

3. Can one really have superposition of meanings in TGD framework, where Boolean cognitive spin is represented as fermion number (1,0), spin, or weak isospin in TGD, and fermion Fock state basis defines quantum Boolean algebra.

   In the case of fermion number the superselection rule demanding that state is eigenstate of fermion number implies that cognitive spin has unique quantization axis.

   For the weak isopin symmetry breaking occurs and superpositions of states with different em charges (weak isospins) are not possible. Remarkably, the condition that spinor modes have a well-defined em charge implies in the generic case their localization to string world sheets at which classical W fields carrying em charge vanish. This is essential also for the strong form of holography, and one can say that cognitive representations are 2-dimensional and cognition resides at string world sheets and their intersections with partonic 2-surfaces. Electroweak part of quantum cognitive spin would have a unique quantization axes.

   But what about ordinary spin? Does the presence of Kähle magnetic field at flux tubes select a unique quantization direction for cognitive spin as ordinary spin so that it is not possible to experience superposition of meanings? Or could the rotational invariance of meaning mean SU(2) gauge invariance allowing to rotate given spin to a fixed direction by performing SU(2) gauge transformation affecting the gauge potential?

4. A rather concrete linguistic analogy from TGD inspired biology relates to the representation of DNA, mRNA, amino-acids, and even tRNA in terms of dark proton triplets [K12, K9]. One can decompose ordinary genetic codons to letters but dark genetic codons represented by entangled states of 3 linearly order quarks and do not allow reduction to sequence of letters. It is interesting that some eastern written languages have words as basic symbols whereas western written languages tend to have as basic units letters having no meaning as such. Could Eastern cognition and languages be more holistic in this rather concrete sense?

5.3 Chalmers: do we need also m-particles and c-particles besides the ordinary particles?

In his book about hard problem Chalmers based his attempt to build a dualistic theory of consciousness on classical physics. Chalmers takes quantum consciousness seriously now as his talk demonstrated (). The birth of quantum biology must have been one motivation for changing the views.

Maybe Chalmers is now in roughly in the same position as I was twenty years ago and also the same attitude as I had. To understand quantum consciousness it is best to try to construct a quantum theory of consciousness. First attempts are not usually successful, but my luck was that I was not famous then (nor now) so that I did not even try to publish my first trials (I still get ashamed as I think about what I was ready to consider!). Chalmers discussed an idea which looks

unfeasible to me and in full accord with the cherished tradition of visionaries concluded that his idea solves all imaginable problems related to consciousness.

What does Chalmers say?

1. Chalmers likes to see consciousness as a property - somewhat like various quantum numbers - and introduced two new properties besides the property P of being just an ordinary elementary particle. First he introduced m-property (m refers to measurement) stating that particles with m-property induce quantum measurement if entangled with ordinary particles. The states with m-property would be very special: when entangling with ordinary matter enjoying P-property they would force a collapse to a product state. m-particles would be microscopic observers.

2. Chalmers also introduced c-property and property of being conscious. I understood that also particles with c-property cannot appear in quantum superpositions and this statement is nonsensical unless on introduces a preferred state basis. Entanglement with c-particle would also force a state function reduction and to me m- and c-property look identical. Consciousness would be classical and consciousness would not superpose.

3. One could see the approach of Chalmers as a modification of the idea about conscious observer inducing quantum measurement. Now observers would be replaced with m- or c-particles or both. I was baffled but maybe the introduction of these various kinds of properties is natural for a philosopher. Physicist gets however scared by this kind of conceptual lavishness.

Personally I see quantum measurement as a completely universal phenomenon occurring everywhere. Density matrix is the fundamental observable. For any system, which is not entangled with the external world state function reduction can occur and would occur for that pair of subsystems for which the maximal entanglement negentropy gain is largest. If system is negentropically entangled NMP guarantees its stability. This guarantees the stability of that part of self, which defines the self model as something unchanging and remaining when sensory and motor contributions to experience are subtracted by say meditation.

Weak form of NMP [K11] would be the variational principle of consciousness in TGD Universe. Strong form of NMP would require that negentropy gain is always maximal: we would live in the best possible world, which obviously is not the case. Weak form of NMP says that the actual final state can also be subspace of the space for which the negentropy gain is maximal. This means free will in sense that one can do also stupid things, which we certainly do. Also the notions of good and evil emerge. Doing evil is to make a state function reduction not giving rise to maximal negentropy gain. Complete reduction of entanglement means minimal negentropy gain and punishment as a separation from the environment and loneliness: not nice at all. There is an obvious resemblance with the maximal pleasure principle proposed by Hameroff (`http://schd.ws/hosted_files/tsc2015/9b/Abstracts%20Brain%20networks%20anesthesia%20and-quantum%20evolution.pdf`). NMP is however much more general and quantitatively precisely defined unlike pleasure principle.

Side remark: "consciousness" is to my opinion misleading if taken literally: "-ness" refers to a property and -at least according to TGD - consciousness is not a property something but more analogous to action (adjective is replaced with verb in linguistic analogy). Finnish world "tajunta" would express rather nicely what I mean. This view is in accordance with the identification of moment of consciousness as quantum jump in which the universe is re-created, which was the starting idea of TGD inspired theory of consciousness. Gradually this naive idea has developed to the recent ZEO based view involving also the identification of self as a sequence of repeated reductions at the same boundary of CD.

In TGD Universe all quantum states would have only the P-property. The hierarchy of Planck constants related to quantum criticality however brings in NE, which tends to be stable under NMP and this is essential for having self-hierarchy.

5.4 Connections with TGD

The ideas of TGD inspired theory of consciousness seem to be gradually popping up in various contexts. The following examples suggest that I am not completely alone anymore.

1. Hagelin talked about wormhole throats and blackholes at brain level including holography. Partonic 2-surfaces and magnetic flux tubes accompanied by fermionic strings and strong form of holography are the TGD counterparts. This holography would give rise to conscious holograms in TGD inspired theory of consciousness and would generalize Pribram's old idea.

2. Some lecturers talked about quantum like aspects of cognition that is quantum superposition and entanglement of cognitive states and quantum measurement. NE brings in the integration of information.

3. To my great surprise, Walter Freeman (maybe also Giuseppe Vitiello) talked about signals propagating backwards in time (ZEO) and what he called "double" as a kind of copy of self (`http://schd.ws/hosted%20files/tsc2015/8d/DISSIPATIVE%20MODELS%20AND%20CHAOS.pdf`). ZEO leads to the prediction that self can re-incarnate as its time reversal as it "dies" [K23, K1]. But maybe times are changing.

   I introduced originally the negative energy signals propagating backwards in time as counterparts of phase conjugate laser beams. Now they correspond to time reversed selves (time-reversed subselves correspond to time reversed mental images). For instance, TGD based model of memory relies on signals reflected from past brain in time direction. Its realization in ZEO involves death of self and its re-incarnation in past boundary of CD, and its further re-incarnation as self with original arrow of time. This occurs for some subself in the hierarchy.

4. The proposal of maximization of pleasure by Hameroff (`http://schd.ws/hosted_files/tsc2015/9b/Abstracts%20Brain%20networks%20anesthesia%20and-quantum%20evolution.pdf`) as a variational principle of consciousness is the counterpart for Negentropy Maximization Principle of TGD [K11] as already mentioned.

5. Bandyopadphyay talked about primes and scale hierarchy (p-adic length scale hierarchy and hierarchy of Planck constants).

6. There was also a proposal by Maurice Goodman (`http://schd.ws/hosted%20files/tsc2015/4b/Abstracts%20Decoherence%20and%20Microtubules.pdf`) that neutrinos might be important for consciousness. Neutrino Compton wavelength indeed corresponds to cell length scale. I proposed for long time ago the notion of cognitive neutrino pair carrying zero energy: this notion was however still artificial and involved model dependent assumptions. In ZEO I would talk neutrino Cooper pairs and Boolean cognition realized in terms of fermionic Fock basis defining a realization of Boolean algebra. Neutrinos have the smallest mass among elementary particles and this could make them representatives for the highest level of Boolean cognition.

   The basic problem is of course the short range of weak interaction but large value of Planck constants would imply that below the Compton length of weak bosons with same mass but scale up Compton length weak interactions would be very similar to electromagnetic ones [K15, K7, K4]. This applies also to color interactions expected to be also important in living matter. The presence of weak interactions would explain chiral selection which represents large parity breaking.

Of special interest from TGD point of view were the talks of Hameroff and Bandyopadphyay, who talked about aromatic rings (ARs, [D2]) `https://en.wikipedia.org/wiki/Simple_aromatic_ring`) (`http://schd.ws/hosted%20files/tsc2015/9b/Abstracts%20Brain%20networks%20anesthesia%20and%20quantum%20evolution.pdf`). I have also wondered whether ARs might give rise to a lowest level in the molecular self hierarchy with motivations coming from several observations.

1. In photosynthesis ARs are a central element in the energy harvesting system, and it is now known that quantum effects in longer length and time scales than expected are involved [I1]. This suggests that the ARs in chlorophyll fuse to form a larger quantum system connected by flux tubes, and that electron pair currents follow along the flux tubes as supra currents.

   DNA codons involve ARs with delocalized pi electrons [D1] (`https://en.wikipedia.org/wiki/Pi_bond`), neurotransmitters and psychoactive drugs involve them, 4 amino-acids Phe,

trp, tyr and his involve them and they are all hydrophobic and tend to be associated with hydrophobic pockets. Phe and trp appear in hydrophobic pockets of microtubules.

2. The notion of self hierarchy [K18] suggests that at molecular level ARs represent the basic selves. ARs would integrate to larger conscious entities by a reconnection of the flux tubes of their magnetic bodies (directing attention to each other!). One would obtain also linear structures such as DNA sequence in this manner. In proteins the four aromatic amino-acids would represent subselves possibly connected by flux tubes. In this manner one would obtain a concrete molecular realization of self hierarchy allowing precise identification of the basic conscious entities as aromatic rings lurking in hydrophobic pockets.

3. Given AR would be accompanied by a magnetic flux tube and the current around it would generate magnetic field. The direction of the current would represent a bit (or perhaps even qbit). In the case of microtubules the phe-trp dichotomy and direction of current would give rise to 4 states identifiable as a representation for four genetic letters A,T,C,G. The current pathways proposed by Hameroff [J1] consisting of sequences of current rings (`http://anesth.medicine.arizona.edu/system/files/pdfs/Why%20anesthetic%20mechanism%20research%20has%20failed.pdf`) could define the counterparts of DNA sequences at microtubule level.

   For B type microtubules 13 tubulins, which correspond to single 2π rotation, would represent basic unit followed by a gap. This unit could represent a pair of helical strands formed by flux tubes and ARs along them completely analogous to DNA double strand. This longitudinal strand would be formed by a reconnection of magnetic flux tubes of the magnetic fields of ARs and reconnection occurring in two different manners at each step could give rise to braiding.

4. The magnetic flux tubes associated with the magnetic fields of nearby aromatic rings could suffer reconnection and in this manner a longitudinal flux tubes pair carrying supra current could be generated by the mechanism of bio-superconductivity discussed in [K16] and working also for the ordinary high T_c super conductivity. The interaction of microtubule with frequencies in the scales kHz, GHz, and THz scales would induce longitudinal superconductivity as a transition to phase A from phase B meaning generation of long super-conducting wires.

   This view suggests that also DNA is superconductor in longitudinal direction and that oscillating AC voltage induces the superconductivity also now. Bandyopadphyay indeed observed the 8 AC resonance frequencies first for DNA with frequency scales of GHz, THz, PHz, which suggests that dark photon signals or AC voltages at these frequencies induce DNA superconductivity. According to the model of DNA as topological quantum computer DNA is superconductor also in the transversal degrees of freedom meaning that there are flux tubes connecting DNA to a lipid layer of the nuclear or cell membrane [K5, K22].

5. Interestingly, the model of Hameroff for the helical pathway assumes that there are three aromatic rings per $d = 1$ nm length along microtubule. This number is same as the number of DNA codons per unit length. It is however mentioned that the distance between aromatic rings trp and phe in MT is about $d = 2$ nm. Does this refer to average distance or is $d = 1$ nm just an assumption. In TGD framework the distance would scale as h_{eff} so that also scaling of DNA pathway by a factor 6 could be considered. In this case single tubulin could correspond to a genetic codon.

   If $d = 1$ nm is correct, these helical pathways might give rise to a representation of memetic codons representable as sequences of 21 genetic codons meaning that there are 2^{126} different memetic codons [K8]. DNA would represent the lowest level of hierarchy of consciousness and microtubules the next level. Note that each analog of DNA sequences corresponds to different current pathway.

6. What is especially interesting, that codon and its conjugate have always altogether 3 aromatic cycles. Also phe and trp appearing in MTs have this property as also tyr and his. Could these 3 cycles give rise to 3-braid? The braid group B_3 which is covering of permutation group of 3 objects (`https://en.wikipedia.org/wiki/Braid_group`). Since B_2 is Abelian

group of integers, 3-braid is the smallest braid, which can give rise to interesting topological quantum computation.

B_3 is also the knot group of trefoil knot (`https://en.wikipedia.org/wiki/Trefoil_knot`), and the universal central extension of the modular group PSL(2,Z) (a discrete subgroup of Lorentz group playing a key role in TGD since it defines part of the discrete moduli space for the CDs with other boundary fixed [K25]). Quite generally, $B(n)$ is the mapping class group of a disk with n punctures fundamental both in string model: in TGD where disk is replaced with partonic 2-surface.

6 Are we ready for a science of consciousness?

Are we ready for a science of consciousness? This was the title of the panel discussion at the end of of the conference. The panelists - most of them organizers of the conference - had different opinions about the question.

Personally I have been ready for two decades of TGD inspired theory of consciousness and quantum biology. But if "we" refers to the science community, the answer might be "No" . Maybe "No" for several decades.

At least my physicist colleagues seem to be totally unaware that there even exist something, which might be regarded as a serious attempt to understand consciousness scientifically, and the opinions that I have seen in blogs are extremely skeptic, even cynical. Most participants of the conference have of course different point of view. Furthermore, quantum biology is now a branch of science and should raise the question whether consciousness could be an exception. It is difficult to say how many decades is required before a typical particle physicists is ready to regard the idea about theory of consciousness as anything but pseudoscience.

The organizers of the conference are however optimistic. Indeed, the title of the next TSC will be SC2016 without the "Toward" .

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