MeshCODE theory from TGD point of view

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Abstract

Benjamin Goult has made an interesting proposal in an article *The Mechanical Basis of Memory the MeshCODE Theory* published in Frontiers of Molecular Neuroscience.

The proposal is that the cell - or at least synaptic contacts - realize mechanical computation in terms of adhesive structures consisting of hundreds of proteins known as talins, which act as force sensors. Talins are connected to integrins in the extracellular matrix, to each other, and to the actins in the cell interior. This proposal has far reaching consequences for understanding formation of memomies as behaviors at the synaptic level.

This proposal does not conform with the TGD vision but inspires a series of questions leading to a rather detailed general vision for how magnetic body (MB) receives sensory input from biological body (BB) coded into dark 3N-photons a representing genes with N codons and as a response activates corresponding genes, RNA or proteins as a reaction. Sensory input and the response to it would be coded by the same dark genes.

Since synaptic adhesion structures relate to memories as behaviors and since the TGD based view about memories distinguishes between memories as behaviours and memories as episodal/sensory memories, a discussion about memories according to TGD is included.

Contents

1 Introduction

Benjamin Goult has made an interesting proposal in the article *The Mechanical Basis of Memory the MeshCODE Theory* [J1] (`https://cutt.ly/WzlrmrM`) published in Frontiers of Molecular Neuroscience in 25 February 2021.

The proposal is that the cell or at least synaptic contacts realize mechanical computation in terms of adhesive structures consisting of hundreds of proteins known as talins, which act as force sensors. Talins are connected to integrins in the extracellular matrix, to each other, and to the actins in the cell interior.

This proposal does not conform with the TGD vision but inspires a series of questions leading to a rather detailed general vision for how magnetic body (MB) receives sensory input from biological body (BB) coded into dark 3N-photons representing genes with N codons and as a response activates same but differently realized genes, RNA or corresponding proteins as a reaction [L15, L1, L9, L11, L12]. This would mean a universal response function assigning to sensory input a unique response. Sensory input would code the response to it in terms of dark genes, which also generalize in TGD framework.

1.1 Some basic facts

The role of a protein known as talin [I7] (`https://cutt.ly/OzNTvPf`) is the topic of the article. Talin is associated with the cell-substratum contact and mechanically couples cytoskeleton and extracellular matrix (ECM) together. Adhesion units formed by integrin coupling to ECM, talin, and actin at cytoskeleton side form adhesion structures consisting of hundreds of adhesion units.

It is good to begin with by listing some basic definitions and facts.

1. Cytoskeleton [I2] (`https://cutt.ly/xzNTT8s`) consists of microfilaments (actin), intermediate filaments, and microtubules (MTs) which in neurons are called neurotubules. Neurons contain neurotubules (NTs) [I6] (`https://cutt.ly/BzNTZqY`) generated at MT organizing center (MTOC) and transferred to dendrites and axon, where they are parallel to the neuronal surface.

   The cytoskeleton of an ordinary cell has as basic building bricks MTs and microfilaments and intermediate filaments. Both MTs and NTs are polarized. The + ends of MTs are at MTOC. + ends of NTs point towards the axon terminal and - end to the parent neuron. NTs in dendrites have mixed polarities.

2. ECM [I3] (`https://cutt.ly/5zNYtP6`) is a three-dimensional network consisting of extracellular macromolecules and minerals, such as collagen, enzymes, glycoproteins and hydroxyapatite that provide structural and biochemical support to surrounding cells. Cell adhesion, cell-to-cell communication and differentiation are common functions of the ECM.

3. Integrins [I4] (`https://cutt.ly/xzNYk7n`) are transmembrane receptors that facilitate cell-cell and cell-extracellular matrix (ECM) adhesion. Upon ligand binding, integrins activate signal transduction pathways that mediate cellular signals such as regulation of the cell cycle, organization of the intracellular cytoskeleton, and movement of new receptors to the cell membrane. The presence of integrins allows rapid and flexible responses to events at the cell surface (e.g. signal platelets to initiate an interaction with coagulation factors).

4. Actins [I1] (`https://cutt.ly/LzNYEo9`) are a family of globular multi-functional proteins that form microfilaments. It is found in essentially all eukaryotic cells, where it may be present at a concentration of over 100 μM; its mass is roughly 42-kDa, with a diameter of 4 to 7 nm. An actin protein is the monomeric subunit of two types of filaments in cells: microfilaments, one of the three major components of the cytoskeleton, and thin filaments, part of the contractile apparatus in muscle cells.

One can visualizetalin as a spring between cytoskeleton and ECM. Talincouples directly to integrins at ECM side and either indirectly or directly to actin at cytoskeleton side. Talin's role is to be a rope in a "tug-of-war" between integrins at ECM and actin and it acts as a force sensor and could give rise to a molecular sense of touch based on force.

The part of talin subject to forces from the cellular interior and environment consists of 13 proteins domains which can be in two thermodynamically stable states analogous to the opposite magnetizations of ferromagnet and the domain exhibits hysteresis curve under a varying external force. The phases correspond folded and unfolded configuration looking like a straight bar. The two phases can be labelled by a bit and the proposal is that the talin conformations define 13 bits.

The domains are not identical so that each equilibrium state under varying external net force could correspond to a unique configuration in which domains are folded or unfolded. If so, talin would serve as a 13-bit force sensor of external forces with finite resolution corresponding to 13 octaves in linear scale. It will be found that the response could actually be determined by 6 bits and correspond to genetic codon.

The abstract of [I8] summarizes the functions of talin.

> ... Talin forms the core of integrin adhesion complexes by linking integrins directly to actin, increasing the affinity of integrin for ligands (integrin activation) and recruiting numerous proteins. It regulates the strength of integrin adhesion, senses matrix rigidity, increases focal adhesion size in response to force and serves as a platform for the building of the adhesion structure. Finally, the mechano-sensitive structure of talin provides a paradigm for how proteins transduce mechanical signals to chemical signals.

It is clear that talin does not look only a passive sensory receptor. That integrins are not necessary for talins to function implies that they have emerged before integrins in the evolution. It is clear that talins are essential aspect of multicellular life.

1.2 Could adhesion structures act as classical computers?

The proposal of the article [J1] relies on computationalism and suggests that talin could be more than a sensory receptor and adhesion structures could act as a computer. The structures formed by the adhesion units consisting of integrin-talin-actin triplets would serve as 13-bit units. Adhesion units would perform mechanical computation based on what authors call MESHcode.

One can argue that mechanical computation requires that adhesion units are isolated from the environment during the computation. This is in conflict with the role as force sensors. A weaker proposal would be that computation occurs only in the synaptic contacts which should be isolated during the computation. The same could take place also in the contacts between neurons and glial cells.

Concerning the synaptic level, a more realistic view to my opinion is that learning as a strengthening of the synaptic strengths corresponds to a development of force equilibrium of adhesion units. Learning could be described as the change of the resting states of the talin units and lead to a higher tension and larger number of unfolded protein domains. Nerve pulse patterns could cause temporary changes of this pattern.

2 TGD interpretation of adhesion units as quantal force sensors

In the TGD framework all communications and control in biology should rely on genetic code whose fundamental realization would be at the level of dark proton sequences forming dark nuclei with $h_{eff} = nh_0 > h$ and dark photons.

Dark proton triplets - light 3-chords - would represent the counterparts for dark DNA, RNA, tRNA, and aminoacids and dark photon triplets could represent dark DNA codons [L1, L9, L11, L12]. Number theoretic vision [L5, L6] leads to a proposal that not only dark 3-photon 3-proton units act as single particle like units but also dark 3N-photons and 3-N protons do so and represent a gene consisting of N codons. Galois confinement would bind the photons and protons to larger particle units analgous to baryons as composites of 3-quarks.

All communications to MB would use dark 3N-photons coupling to corresponding dark 3N-proton by cyclotron resonances [L15, L13, L14]. Therefore 3N-photon as a dynamical gene with N codons would define its own address. Frequency modulation of frequencies of 3N-photon would give rise to a sequence of resonance peaks and the continuous signal would be transformed to a signal analogous to nerve pulse sequence and could realize motor action as a response.

2.1 Magnetic body containing dark matter as the master

MB has a hierarchical onion-like structure with levels labelled by the value of $h_{eff} = nh_0$ giving rise to increasing scales. The dark analogs of DNA, RNA, tRNA, and amino-acids define flux tubes accompanying their ordinary variants with codons realized as dark 3-proton units.

In TGD genetic code in terms of 3-chords would be realized in a universal manner for the simplest tesselation of hyperbolic space known as icosa-tedrahedral honeycomb involving icosahedrons and tetrahedrons (also octahedrons are involved but they would be in passive role) [L12]. This would suggest that genetic code using dark proton- and dark photon triplets is realized at all layers of MB. Chemical realization would represent the lowest level in the hierarchy.

The layers of MB with increasing value of h_{eff} would define a hierarchy of abstractions. There is evidence for an effective statistically determined hyperbolic geometry [J3] in the sense that neurons functionally but not necessarily spatiall near to each other are near to each other in this effective geometry. This hyperbolic geometry would be realized quite concretely at the level of MB [L10] for which hyperbolic geometry of proper time constant hyperboloid of the light-cone gives a concrete meaning.

One particular implication could be that sensory receptors of a given structure (say adhesion units of given cell-environment pair) could communicate their sensory data to neighboring icosa-tetrahedral units of the honeycomb of some layer of MB representing the codons of genetic code. The states of the icosahedrons and tetrahedrons of the honeycomb would be dynamical and selected by the 3-chord (actually pair of 3-chord and conjugate) to actualize genetic codon as 3-quark units assignable to the corresponding triangle of icosahedron or tetrahedron.

This would define sensory representation at MB, and the simplest option is that it automatically determines motor response as a sequence of resonance peaks communicated back to the biological body (BB) where they would initiate gene expression, RNA or protein activity, MT activity, or nerve pulse activity. The feedback would be directly to DNA (or RNA, amino-acid of protein, or even tRNA, microbuli, or cell membrane).

The biochemical motor actions of MB would be realized as bursts of dark cyclotron 3N-photons induced by the cyclotron resonances at MB transforming to ordinary photons (biophotons or IR photons with energy above thermal energy) controlling biochemistry by inducing molecular transitions.

This condition constrains the value of h_{eff} for a layer of MB. The size of the layer should be of the order of wavelengths involved.For valence bonds the values of $h_{eff} = h_{em}$ would be rather small and assignable with small layers of MB. For frequencies in EEG range the large value of gravitational Planck constant $h_{eff} = h_{gr}$ [L7, L15] assignable to the gravitational flux tubes would guarantee that the energies are in the required range.

The following picture about how sensory input induces gene expression or some other activity with communication and control realized in terms of genetic code might apply completely generally, not only in the case of adhesion units.

1. Suppose the sensory receptors of a given structure (say adhesion units of a given cell) are organized into coherent structures in the sense that the signals from them go along flux tubes to nearby cells of icosa-tetrahedral honeycomb at some layer of MB.

   Adhesion structures consting of few hundred adhesion units are indeed connected to each other. Coherence would be forced by the quantum coherence at the level of MB as a forced coherence. One could assume that the cells of the honeycombinvolved are organized linearly but even 2-D and 3-D structures are possible.

   For a structure consisting of N units, the dark 3N-photon signal would define a dark gene of N codons. The nice feature of the representation is that there is no need to organize the sensory receptors (say adhesion units) linearly at the level of the cell. The level of ordinary biomatter would be like RAM with ordering realized at the level of MB.

2. The naive picture is that if the dynamical gene realized in this manner has a dark counterpart at the level of flux tube accompanying DNA, gene expression could be initiated automatically as a feedback signal realized as a sequence of resonance peaks. Also RNA, proteins or MTs could be activated in an analogous manner.

There would be a one-one correspondence between sensory inputs to MB and corresponding gene expressions and give a meaning for the genetic code. All sensory inputs to MB would be realized as N-genes in terms of generalized Josephson radiation which is frequency modulated and generates a sequence of resonance peaks inducing gene expression or RNA and protein activation.

3. The dynamical gene at MB need not correspond to an existing or expressible gene so that the response is not possible. This would give rise to an evolutionary pressure. Epigenesis controlled by MB could make the gene expressible. Also a suitable mutation for existing gene or emergence of new gene could produce the needed gene. Whether MB is able to induce this kind of mutations is an interesting question. Could a dark gene as a flux tube containing dark proton sequence representing the desired gene pair with ordinary DNA codons and give rise to a new gene?

   Or could MB "use scissors" to replace codon-anticodon pairs in an existing gene: this would mean reconnection of a closed flux tube pair containing the codon-anticodon pairs of the added gene fragment. Could a piece of dark DNA as a flux tube carrying the dark proton sequence pair with ordinary DNA codons and give rise to a new gene? Or could one add to an existing gene a piece represented as a dark DNA paired with the ordinary DNA. Most viruses have single stranded RNA genomes. Bacteriophages have double stranded DNA genomes. They are known to give rise to the modifications of the genome. Could these DNA modifications be induced by a reconnection of darkmagnetic flux tubes.

2.2 Universality of the genetic code and its higher dimensional representations

If genetic code at space-time surface is induced from a universal code assignable to the icosatetrahedral honeycomb of hyperbolic 3-space, representations of genetic code with dimensions $D = 0, 1, 2, 3$ are possible as induced representations. The codons associated with the cells of honeycombes projected to the space-time surface would define the induced codons [L12].

tRNA would be a 0-D representation and DNA, RNA, amino acids would be 1-D representations of the code. Also higher-dimensional representations are possible and could be associated with the basic biological structures.

1. I have proposed that cell membrane defines a 2-D representation of the genetic code [L12]. Also microtubuli could define a 2-D representation of genetic code. These 2-D representation could be dynamical and independent of genome and make genome dynamical. This would be a biological analog for AI able to write genes as program modules needed in a given situation.

2. Could a 3-D representation of genetic code be associated with the ECM and make it possible for MB to receive sensory input from ECM and control it? This layer of MB could also receive sensory information also from adhesive structures. The frequency range involved would be probably below EEG frequencies or at least below conscious frequencies since we do not experience the interior of body consciously and the time scale of dynamics is slow as compared to EEG scales.

   Hydrozyapatite molecules are present in bones forming a part of ECM. Fisher has proposed that the Posner molecules associated with hydroxyapatite molecules could have important role in quantum biology [L2]. This inspired the proposal that they provide a realization of genetic code [L2]. One cannot exclude the possibility that the code is 3-D. This would fit with the general idea that the genetic code serves as a universal code for communications and control.

2.3 Some TGD inspired numerology

If one takes the proposed general picture seriously, one must ask how the 13-bits codons assignable to talins and MTs could reduce to genetic codons. It is good to start with numerology or should one call it physics inspired poor man's number theory.

1. The number of protein domains in talin is 13. Also the number of tubulin dimers in 13-tubulin unit of MT/neurotubule appearing in cytoskeleton is 13. Could one think of communication between MTs and talins using 13 bit code? Or could the code using 13 bits be for some reason special? Could this code somehow reduce to the proposed universal 6-bit code defined by genetic code?

2. There are 4 protein domains consisting of 4 alpha helices and 9 domains with 5 alpha helices. This gives 61 alpha helices altogether. Numerologist might notice that 61 is the number of DNA codons with stop codons excluded. Could one assign to helices genetic codons and could these configurations labelled by 61 bits code for genes with length not longer than 61 units?

3. Numerologist might also notice that both $M_{13} = 2^{13} - 1$ and $M^{61} = 2^{61} - 1$ are Mersenne primes. If one has n bits and does not count the configuration with all bits 0 but assuming that at least single bit is always equal to 1, one has 2^{n-1} full bits.

   For M_{13} this corresponds to 12 full bits which corresponds to 2 genetic codons. To obtain 2 codons, single fixed talin should be unfolded and represent 1. Could this have interpretation in terms of a force threshold? One can argue that there is some minimal force unfolding some fixed talin. If the force is below the threshold, there is no need to communicate. Also in the case of MT the conformation of preferred tubulin, say the first or last one in 13-unit should always correspond to 1.

4. One cannot exclude the possibility that the responses of talin units correspond to two independent codons. This could be true also for13-bit units MTs.

   The alternative option is that both talins and 13-tubulin units of MT correspond to codon-anticodon pairs so that information content would reduce to that of single DNA codon. Half of the bits would serve as check bits. Also the purpose of the conjugate strand of DNA would be to serve as check codons.

   If this is the case, the adhesion unit would have only 2^6 different responses and would represent a genetic codon. The number of talins is few hundred that this would correspond to a DNA sequence of length of order 10^{-7} meters. In the case of MT 6 bits would be check bits.

5. The proposal would have far reaching consequences: the genetic code realized by MTs and talins would be dynamical rather than fixed and could represent a step to a higher evolutionary level.

6. The dynamics of the codon or of a pair of pair of independent codons assignable to the adhesion unit would mean change of the "sensory codon" possibly corresponding to a real codon assignable to it. The slow time variation of the gene assignable to the collection of adhesion units could define varying gene expression or some other activations (of say microtubuline).

These speculations encourage the question whether the codon-anticodon pairs possibly assignable to adhesion units integrate to sequences or perhaps even 2-D structures representing 2-D adhesion structures of DNA codon-anticodon pairs defining genes.

If these 2-D honeycomb structures at the level of MB decompose to piles of 1-D structures as microtubules do, they could even induce the expression of gene groups. Also 2-D gene expression in terms of microtubules modifying the cytoskeleton can be considered. Note that the honeycomb structures are not needed at the level of ordinary biomatter.

2.4 A simple model for the adhesion units

In TGD framework magnetic body (MB) containing dark matter controls ordinary living matter. MB receives sensory input from organism in terms of dark Josephson radiation arriving from cell membranes acting as generalized Josephson juctions. Sensory information is coded by the modulation of membrane potential. For ordinary cells only small modulations of membrane potential would induce modulations of Josephson frequency. For neurons nerve pulse patterns introduce more drastic modulation.

1. The two states of the protein domains could correspond to different values of h_{eff}. The reduction of h_{eff} at the magnetic flux tube accompanying the protein would induce the shortening of the flux tube associated with the unfolded protein to the folded configuration.

2. Cohesion units would aserve as sources of sensory information about the net force acting on the cohesion unit and coded by 13 bits unless the bits are independent. For instance, different bits would correspond to different signals, say different frequencies of dark photons. If one takes the interpretation as a pair of codons seriously, the signal could consist of a dark 3-chord and its conjugate 3-chord sent to MB and defining at the MB a representation of gene to be possibly activated.

3. Josephson radiation as dark 3-photons from the part of the cell membrane considered would mediate the 13 bit signal defined coded to a local change of membrane potential with 2^{12} values defining 12 octaves if there is threshold corresponding to activation of a preferred talin. Note that the frequencies audible for humans are in the range 20 Hz- 20 kHz and correspond to 10 octaves.

4. MB would receive the sensory input and react by possibly sending control signal to DNA inducing gene expression or inducing activity of proteins or RNA. This means that talin molecules would not be active but MB receiving the sensory input from adhesion units.

   MB could also send control signal to microtubuli if MT contains a sequence of 13-tubulin units corresponding to the dynamical gene [I5] (`https://cutt.ly/MzNYBsZ`). This would reflect itself in the dynamics of MTs. This control loop would modify the force equilibrium by a modification of the shape of the cell.

5. MTs could represent an evolutionary step making the genome dynamical and independent of genes and extending ordinary genome as the microtubular response possible for eukariotes suggests. Also the long MTs inside axons conform with this interpretation.

6. MTs are highly dynamical. Their lengths are continually varying. According to "search-and-catch" model MTs inside cells are scanning their 3-D environment and whey the find a target attach to it and MT is stabilized. This conforms with general vision about U-shaped dynamical flux tubes serving as tentables and forming a reconnection with a similar U-tube of the target. Immune system would be rely on this mechanism at the fundamental level and allow the system to detect and catch invader molecules on basis of their cyclotron energy/frequency spectrum [K1, L15].

7. The general vision suggests that the feedback loop should involve also microfilaments and intermediate filaments. It would be interesting to see whether the the structure of microfilaments and intermediate filaments could allow realization of the counterpart of genetic code. The basic signature are GTP and ATP molecules providing metabolic energy for motor action.

3 An application to memory and learning

Since the increase of synaptic strengths is believed to be behind the formation of memories as behaviors and habits, it is appropriate to discuss the notion of memory in TGD framework and consider connections with the model for the adhesion units at synaptic contacts.

The major issue with memory is potentiation (repeat of same memory which facilitatesmemory recall and learning) and amnesia, Alzheimer disease and memory when dreaming. There should be a compatible explanation for these phenomena.

In TGD one distinguishes between two kinds of memories. Episodal-/sensory memories and memories as associations/learned behaviors.

3.1 Memories as learned behaviors

Neuroscience explains learned behaviors in terms of strengthening of synaptic contacts and I believe that this is part of the story.

The formation of associations in conditioning is a highly emotional process and here the surprising finding [J2] (see `http://tinyurl.com/ycqxyeqk`) few years ago (roughly) was helpful. The popular article " *Scientists Sucked a Memory Out of a Snail and Stuck It in Another Snail*" tells about the finding (see `http://tinyurl.com/y92w39gs`).

The RNA of a sea snail which had learned by (presumably painful) stimulus a behavior was scattered on the neuronal tissue of another sea snail in a Petri dish. The neuronal tissue learned the same behavior!

The TGD based explanation is following.

1. Emotions are realized already at the molecular level [L8] in terms of music of light - bioharmony [L1, L9, L11, L12]. The emotional stimulus at the MB of RNA induced learning by changing the allowed 3-chords of bioharmony. Also the sequences of 3-chords characterizing 3N-genes and other basic linear biomolecules changed. The resonant couplings to the basic biomolecules changed so that also chemical behavior changed.

2. The emotional state of the conditioned seanail RNA infected the RNAs and probably also DNAs and proteins of neurons and induced learning.

3. Synaptic strengths had to change and the molecular emotions as music of light would have induced this.

   If the idea about mechanical control of synaptic strengths by talin molecules by push and pull from ECM and cytoskeleton is correct, the molecular mood had to induce a strong force changing the talin conformations. Emotion would quite concretely correspond to a force!

   This would have induced a reaction at the level of microtubules with the mediary of MB as a response making the change permanent. Neurotubules of the cytoskeleton in dendrites and axons would be involved in realizing the learning as a permanent change.

3.2 Potentiation and two kinds of memories

The notion of potentiation applies to both kinds of memories.

1. The repetition of stimulus generating the learned behavior increases the synaptic strength. Perhapsby inducing a memory recall of the emotional experience at molecular level.

2. Potentiation for sensory memories creates an almost copy of sensory memory mental image at "geometric now": the re-experience and the more one has these almost copies in the geometric future of "geometric now", the higher the probability that the attempt to remember by sending dark photon signals to the future hits the memory mental image are successful. The latest memory recalls create memories mental images nearest to "geometric now" and the probability for memory recall is highest for them.

Why oldest sensory memories are those which survive when one begins to lose memories at old age?

1. There are a lot of almost copies about the oldest memories: does this mean that the memory recall has a higher probability to be successful?

2. One can also argue that the memory mental images of young age have also gone through a long sequenceof re-incarnations which have gradually increased the value of h_{eff}.

   Large h_{eff} means that the frequency f needed to produce a dark photon with energy $E = h_{eff}f$ in biophoton range is lower and therefore the period $T = 1/f$ is longer. Uncertainty Principle says that the time period over which memories are optimally recalled is of order$T = 1/f$.

3.3 Amnesia,Alzheimer, and why we forget dreams so fast

Amnesia might relate to the inability to recall sensory memories by sending signals with a correct frequency to the memory mental images. The energy of the dark photons is proportional to h_{eff} and if it is reduced in the recalling end as tends to happen in the absence of metabolic energy feed, the ability to recall memories is weakened or lost. For instance, alcoholism can lead to a loss of memory recall and this could be the reason.

Alzheimer means a loss of memories as behaviors and inability go generate new ones. In TGD framework [L4] the weakening of the synaptic connections would make the build up of connection between magnetic flux tubes associated with presynaptic dendrite and postsynaptic axon and the dark photon signal could not propagate because the connection is broken.

Also the propagation along axonal flux tubes could be impossible or highly attenuated if the value of h_{eff} for them is reduced. Also the energy for a given freqeuency would be reduced below the biophoton energy range.

Why do we forget dreams so fast? We do not remember anything about sleep without dreams. In ZEO this can be understood if sleep corresponds to "small death" for an appropriate layer of MB meaning re-incarnation with an opposite arrow of time. Dreams would correspond to states in which part of the brain is awake and possibly receives information from the sleeping part of the brain realized as a dream. Dream would be due to a communication of virtual sensory input from MB with opposite arrow of time to sensory organs.

This does not yet explain why we forget dreams so fast. As the memory image ages, it shifts to the future of "geometric now" in CD, and the needed frequency as inverse of the age decreases. Could it be that we cannot generate the frequencies of dark photons needed for the memory recall.

3.4 Memories change

Episodal memories are not carved in stone. They are modified in memory recalls. In TGD framework, the modification of (episodal) memory mental images is unavoidable. Memory mental images are living entities and evolve re-incarnation by re-incarnation. Memory recalls are basically analogous to quantum measurements of memory mental images induced BSFR and quantum measurement indeed changes the state of the system measured.

1. The sub-selves of self as mental images continue to live at sub-CDs which in the proposed model drift to the geometric future of CD increasing SSFR by SSFR. These sub-CDs experience BSFRs and evolve incarnation by incarnation. In general evolution happens and they become smarter and wiser. Memories are indeed said to grow sweeter in time.

2. Each memory recall must take the memory subself to a state in which it has arrow of time opposite to that of recaller so that the signal about the memory propagates to the geometric past to "geometric now" [the ball at center of CD at which future and past directed cones glued together].

   The BSFR for memory subself with the same arrow of time as recaller induces memory recall. Memory recall is a murderous process. If the memory recall occurs spontaneously, the murder is not not the recaller.

3.5 Confabulation

The phenomenon of confabulation relates most probably to episodal/sensory memories, not memories as behaviors and habits. Confabulation could be understood in the following manner. Memory mental images are just glimpses about what happened since only those aspects of the event which receive the attention form memory mental images. Memory recaller builds a logical sounding story around these glimpses so that confabulation is unavoidable.

Even our sensory perception is fabrication of stories [L3]. Sensory organs are seats of primary sensory experience and there is feedback from MB and brain to sensory organs as virtual input. This feedback loop generates standardized mental images by pattern completions and recognition.

If the sensory input is meager the story can be non-realistic as I know as a person with a poor eye sight. REM dreams and hallucinations are an excellent example of this: in this case there is only virtual sensory input present.

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