

Emotions as sensory percepts about the state of magnetic body?

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June 20, 2019

Abstract

What emotions are? How emotions are created? How they are represented: in brains, at body, or somewhere else? Emotions can be divided into lower level emotions and higher level emotions. What does this correspond to?

1. TGD inspired answer to the questions is that emotions are sensory percepts about the state of magnetic body (MB). Sensory-motor loop generalizes: various glands excreting hormones to blood stream and binding to receptors give rise to the analog of motor output.
2. Neural transmitters binding to receptors serve as bridges allowing to build connected networks of neurons from existing building bricks. They are accompanied by flux tube networks giving rise to tensor networks as quantum coherent entangled structures serving as correlates of mental images and allowing classical signalling with light velocity using dark photons.
In a similar manner hormones give rise to networks of ordinary cells implying in particular that emotional memories are realized in (biological) body (BB). Nervous system gives information about the state of these networks to brain. Hypothalamus serves as the analog of motor cortex excreting hormones controlling the excretion of hormones at lower level glands.
3. The hierarchy of Planck constants defines a hierarchy of dark matters and $h_{eff} = n \times$ defines a kind of IQ. The levels of MB corresponding to large/small values of n would correspond to higher/lower emotions.

MB decomposes to two basic parts: the part in the scale of BB and formed by networks having cells and larger structures as nodes (forming a fractal hierarchy) and the part in the scales larger than BB.

1. In the scales of BB (short scales) the dynamics involves topological dynamics of the flux tube network and sensory percepts can be accompanied by conscious-to-us desire to change the state of MB and thus of BB and could be seen as intentions induced by the comparison between what happened and what were the expectations. The outcome would be state function reduction replacing the behavioral pattern with a new one giving better hopes for achieving the goal. In zero energy ontology (ZEO) behavioral pattern is represented as quantum superposition of 4-D MBs so that time aspect is naturally involved with emotions.
2. In the scales larger than that of BB (long scales) the change the topology is not easy and the dynamics involves oscillations of MB - analogs of Alfvén waves - and analogs of ordinary motor actions changing the shape of flux tubes but leaving its topology unaffected.

Alfvén waves with cyclotron frequencies and generalized Josephson frequencies assignable to cell membrane as Josephson junction would be involved. The size scale of particular onion-like layer of MB corresponds to the wavelength scale for cyclotron frequencies and is proportional to $h_{eff}/h = n$ for dark photons. For instance, alpha band in EEG corresponds to the scale of Earth but the energy scale of dark photons is that of biophotons.

The TGD inspired model of music harmony gives as a side product a model of genetic code predicting correctly the numbers of codons coding for amino-acids for vertebrate code. The model allows to see sensory percepts about the dynamics in large scales as analog of music experience. The notes of 3-chords of the harmony correspond to light as dark photons and frequencies defining the notes of the chord: cyclotron radiation and generalized Josephson radiation from cell membrane would represent examples of dark light. Music expresses and creates emotions and music harmonies would correspond to various emotional states/moods realized at the level of DNA and its dark counterpart (dark nuclei represented as dark proton sequences). MB would be like a music instrument with flux tubes serving as strings. It is difficult to assign any specific desire to large scale sensory percepts about MB and the interpretation as higher emotions - or rather feelings - makes sense.

Contents

1	Introduction	3
2	Background	4
2.1	Some background from evolution	4
2.2	Some background from neuroscience and endocrinology	5
2.3	What emotions are and how do they emerge?	6
2.3.1	Basic facts about emotions	6
2.3.2	Are emotions percepts or analogs of motor actions?	7
3	TGD based interpretation for emotions	8
3.1	Basic notions of TGD inspired quantum biology	8
3.2	Sensory perceptions as artworks	9
3.3	Emotions as sensory percepts about the state of MB	10
3.4	Emotions and information	12
3.5	“Higher” emotions and music	12
3.5.1	Model for music harmonies and genetic code	13
3.5.2	How to realize emotions as music of genes concretely?	13
3.6	Support for the view that information molecules serve as bridges in flux tube networks	15
3.7	Getting memories by eating those who already have them	17
3.8	How brain selectively remembers new places?	18
4	The experiments of Masaru Emoto with emotional imprinting of water	19
4.1	The reception of the findings of Emoto	20
4.1.1	Criticism and “criticism”	20
4.1.2	Emoto is not the only victim of pseudo-skepticism	21
4.1.3	Analyzing the mindset of PS	21
4.2	TGD based model for Emoto’s findings	22
4.2.1	Basic ingredients of the model	22
4.2.2	TGD based mechanism for emotional imprinting	23
5	Emotions and RNA	25
5.1	Does RNA code for pain?	25
5.2	Did RNA replicate in codon-wise manner during RNA era?	27
5.3	How do slime molds learn?	30
5.4	How do slime molds learn?	32
5.5	Could also RNA and protein methylation of RNA be involved with the expression of molecular emotions?	34
5.5.1	Some background about modifications of the basic biomolecules	35
5.5.2	Methyl marks in synaptic connections from the TGD point of view	36
5.6	How does brain predict future?	36

1 Introduction

What emotions are? How emotions are created? How are they represented: in brains, at body, or perhaps somewhere else? One can consider these questions from the point of view of neuroscience, endocrinology, and quantum physics. Emotions can be divided to lower level emotions accompanied by intention/need/desire (hunger is accompanied by the need to eat) and thus distinguishing them from sensory qualia whereas higher level emotions like catharsis and the experience of beauty not accompanied by any desire. What does this division correspond to?

TGD inspired answer to the questions is following.

1. Emotions are sensory percepts about the state of magnetic body (MB). Also sensory-motor loop generalizes: various glands excreting hormones to blood stream and binding to receptors give rise to the analog of motor output. Neural transmitters binding to receptors serve as bridges allowing to build connected networks of neurons from existing building bricks. They are accompanied by flux tube networks giving rise to tensor networks [L7] as quantum coherent entangled structures serving as correlates of mental images, and allowing classical signalling with light velocity using dark photons. In a similar manner hormones would give rise to active networks of ordinary cells accompanied by tensor networks. Nervous system gives information about the state of these networks to brain and hypothalamus serves as the analog of motor cortex sending hormones controlling the excretion of hormones at lower level glands.
2. Emotions are sensory percepts about the state of magnetic body (MB) rather than those of biological body (BB). Also sensory-motor loop generalizes: various glands excreting hormones to blood stream and binding to receptors give rise to the analog of motor output.

Consider first neuronal level. Neural transmitters binding to receptors serve as bridges allowing to build connected networks of neurons from existing building bricks (flux tubes associated with axons in the case of nervous system) and accompanied by flux tube networks giving rise to tensor networks as quantum coherent structures serving as correlates of mental images and allowing classical signalling with light velocity using dark photons. These tensor networks represent our mental images only if they correspond to our sub-selves [L16].

In a similar manner hormones would give rise to tensor networks of ordinary cells accompanied by flux tube networks giving rise to quantum coherent structures, tensor networks serving as correlates of emotional mental images. Nervous system mediates information about the state of these networks to brain. Hypothalamus serves as analog of motor cortex excreting hormones controlling the excretion of hormones at lower level glands.

3. The hierarchy of Planck constants defines a hierarchy of dark matters and $h_{eff} = n \times h$ defines a kind of IQ. The levels of MB corresponding to large/small values of n would correspond to higher/lower emotions.

MB decomposes to two basic parts: the part in the scale of BB and formed by networks having cells and larger structures as nodes (forming a fractal hierarchy) and the part in the scales larger than BB.

1. In the scales of BB (short scales) the dynamics involves topological dynamics of the flux tube network and sensory percepts can be accompanied by conscious-to-us desire to change the state of MB and thus of BB and could be seen as intentions induced by the comparison between what happened and what were the expectations. The outcome would be state function reduction replacing the behavioral pattern with a new one giving better hopes for achieving the goal. In zero energy ontology (ZEO) behavioral pattern is represented as quantum superposition of 4-D MBs so that time aspect is naturally involved with emotions.
2. In the scales larger than that of BB (long scales) the change the topology is not easy and the dynamics involves oscillations of MB - analogs of Alfvén waves - and analogs of ordinary motor actions changing the shape of flux tubes but leaving its topology unaffected (these actions might represent or serve as templates for ordinary motor actions in body scale [K9]).

Alfven waves with cyclotron frequencies and generalized Josephson frequencies assignable to cell membrane as Josephson junction [K8, K2] would be involved. The size scale of particular onion-like layer of MB corresponds to the wavelength scale for cyclotron frequencies and is proportional to $h_{eff}/h = n$ for dark photons. For instance, alpha band in EEG corresponds to the scale of Earth but the energy scale of dark photons is that of bio-photons.

The TGD inspired model of music harmony [L2] gives as a side product a model of genetic code predicting correctly the numbers of codons coding for aminoacids for vertebrate code. The model allows to see sensory percepts about the dynamics in large scales as analog of music experience. The notes of 3-chords of the harmony correspond to light as dark photons and frequencies defining the notes of the chord: cyclotron radiation and generalized Josephson radiation from cell membrane would represent examples of dark light. Music expresses and creates emotions and music harmonies would correspond to various emotional states/moods realized at the level of DNA and its dark counterpart (dark nuclei represented as dark proton sequences). MB would be like a music instrument with flux tubes serving as strings. It is difficult to assign any specific desire to large scale sensory percepts about MB and the interpretation as higher emotions - or rather feelings - makes sense.

2 Background

2.1 Some background from evolution

It is good to list some basic data from evolution of nervous system (see <http://tinyurl.com/yabtfhy4>) first.

- Bacteria have no nervous system but already they are capable of simple sensory perceptions. Bacteria can move to the direction where the concentration of nutrients increases so that they probably perceive the concentration of nutrients. The feelings of hunger and satiety are perhaps the most primitive emotional states, one can think that these emotions/feelings were possessed also by bacteria. The need to get food is associated with hunger and it seems that the lower emotions induce desire/intention leading to goal directed behavior.
- Ladder-like nervous system is a primitive nervous system possessed by invertebrates and has at its end a bulge - ganglion - representing primitive brain. Anthropods, which include insects, belong to this class of animals.
- Brainstem and cerebellum developed from the ganglion and gave rise to what is called lizard brain. Brain stem controls the functioning of heart, lungs, stomach and other organs and cerebellum controls motor activities. Since the cortex allowing to decompose visual field into objects is missing, vision must be very primitive - including however detection of motion and distance for the target of attention. Maybe there is just the target of attention instead of the decomposition of the perceptive field into objects. Olfaction, hearing, and vision work together to identify the target of attention.
- Chordata (see <http://tinyurl.com/63af3ag>) consist of urochordata and cephalochordata preceding vertebrates.

Remark: Vertebrates have EEG, which must be a significant difference. In TGD framework scaled up variants of EEG are in principle with higher frequency ranges are possible with similar structure and correspond to smaller value of $h_{eff}/h = n$.

- Limbic system (see <http://tinyurl.com/ny2e8ff>) defines what is known as emotional brain. It contains hypothalamus as an analog for the highest motor areas in cortex. Hormone excretion is the tool of control. Using this tool hypothalamus controls the hormone excretion of lower level glands in brain and body in turn controlling the state of body. Hormone levels correlate strongly with emotions [J3].
- At the top is cortex containing sensory, motor and associative regions.

2.2 Some background from neuroscience and endocrinology

Also some data bits in neuroscience and endocrinology dealing with the endocrine system, its diseases, and its specific secretions known as hormones are in order. Endocrine system forms only part of cell signalling (see <http://tinyurl.com/yckwaaob>). One can classify the signalling according to the range of signals. Intracrine signals stay in target cells, autocrine signals affect the cell itself or of nearby cells via receptors. Juxtacrine signals affect adjacent (touching) cells. Paracrine signals target cells in the vicinity of the cell: nerve pulses correspond to this kind of signalling. Endocrine signals target distance cells and hormones reaching their target via blood stream serve as signal molecules.

Remark: In TGD framework the term “signal molecule” is misleading. Signal molecules bound to receptors would only serve as bridges/relays giving rise to networks in which dark photon signals would propagate and make possible classical communications. Also quantum entangled structures - tensor networks - would be formed.

1. Limbic brain (see <http://tinyurl.com/ny2e8ff>) would be the neural part for the system behind emotions and serve as the analog of cortex participating the neural processing related to emotions. Neural information would arrive from body to brain via nervous system and the analog of motor response from limbic brain would be based on endocrine system using hormones as a control tool (<http://tinyurl.com/l2pstuv>).
2. Endocrine system (see <http://tinyurl.com/l2pstuv>) involves several feedback loops via hypothalamus and pituitary. Hypothalamus plays a role analogous to that of the highest motor areas in cortex. Emotions are expressed via excretion of hormones by hypothalamus (see <http://tinyurl.com/hdt5t8g>) and the hormones from hypothalamus control the excretion of hormones by lower level glands. Besides hypothalamus also pituitary gland and pineal gland are brain glands.

The four most important glands outside brain are pancreas, ovaries/testes, thyroid gland, parathyroid gland, and adrenal glands: together with 3 brain glands this makes altogether 7 glands. Interestingly, this happens to be the number of chakras in the Eastern medicine. Besides this there are many other hormone secreting organs. The so called diffuse endocrine system involves hormone emitting cells heart muscle and epithelial cells in gut. Immune system excretes hormone and also skin can be regarded as a gland.

3. Hormones (<http://tinyurl.com/znk4tzn>) are used to communications between organs and tissues for physiological regulation and behavioral activities. Hormones have diverse chemical structures, most of which belong to 3 classes: eicosanoids, steroids, and amino acid/protein derivatives (amines, peptides, and proteins).

All vertebrates possess hypothalamus (see <http://tinyurl.com/hdt5t8g>). Hypothalamus is located below thalamus and serves as a link between neural system and endocrine system and regulates certain metabolic processes and other activities of the autonomic nervous system. Hypothalamus synthesizes and releases neural hormones in turn stimulating or inhibiting the secretion of pituitary hormones in turn controlling the secretion of hormones in lower level glands.

Hypothalamus controls body temperature, hunger, important aspects of parenting and attachment behaviors, fatigue, sleep and circadian rhythms. Hypothalamus consists of several nuclei. Hypothalamic-pituitary-adrenal axis is a complex set of direct influences and feedback between hypothalamus, pituitary and adrenal glands located in kidneys. Delta waves (in EEG) with frequencies in the range (.5,4) Hz - usually thought to arise either in cortex or thalamus - controls excretion of neural hormones from hypothalamus.

Remark: In TGD framework delta waves would be associated to the control by MB. Note that delta waves do not correlate directly with the contents of consciousness.

Endocrine system controls physiology and there are good reasons to think that at least some hormones are closely related to the control of simple emotions such as satiety, pleasure, hunger, fatigue, fear, aggression, and rage. Not all emotions involved need to be conscious to us. For instance, at the neural side autonomous part of the neural system is unconscious to us.

Remark: TGD inspired theory of consciousness [L16] predicts self hierarchy. The sub-selves of self give rise to mental images of self. Sub-sub-...-selves contribute a diffuse background to the experience of self. Emotions could correspond to this kind of background.

The book “Molecules of emotion” by Candace Pert [J3] gives a nice representation about peptides as molecules of emotions. Dopamine is one peptide acting both as both neural transmitter and hormone and positive emotions accompany its excretion.

2.3 What emotions are and how do they emerge?

2.3.1 Basic facts about emotions

One learns from Wikipedia (see <http://tinyurl.com/7m17vcs>) that there is almost endless variety of theories of emotion. For instance, in Scherer’s components processing model of emotion, five crucial elements of emotion are said to exist:

- Cognitive appraisal: provides an evaluation of events and objects.
- Bodily symptoms: the physiological component of emotional experience.
- Action tendencies: a motivational component for the preparation and direction of motor responses.
- Expression: facial and vocal expression almost always accompanies an emotional state to communicate reaction and intention of actions.
- Feelings: the subjective experience of emotional state once it has occurred.

This definition of emotion includes as its aspects cognitive processing (neural feedback), physiological correlates (hormone excretion), action tendencies (intentions/needs/desires/drives), bodily expression of emotion, and feeling. This classification assigns physiological activation patterns to all emotions (what about “higher” emotions?). Feeling forms only one aspect of emotion.

It has been also proposed that there are 6 basic emotions: anger, disgust, fear, happiness, sadness and surprise. One can wonder why pleasure and psychological pain are not counted as basic emotions: maybe they are associated with happiness and sadness. Neither hunger and satiety are included: since hunger induces goal directed behavior, it would seem natural to count it as emotion rather than sensory experience. It seems possible to assign to emotions positive/negative coloring, which would allow to see them as pairs analogous to pairs of color and complementary color.

Personally I would call emotions inducing desires primitive emotions perhaps possessed already by the simplest organisms - even those without nervous system. Certainly I would not try to reduce higher level emotions such as experience of beauty to these primitive emotions.

One can also distinguish emotions using as a criterion the time scale involved: feelings, moods, temperament, personality describe these time scales in increasing order.

1. Primitive emotions represent information in a very concise form. Just a single bit represented as emotional coloring of experience as positive or negative is enough and if it is negative/positive it induces an intention to change/continue the behavior. A very complex unconscious information processing can give rise to this bit and intuition and emotional intellect could summarize the outcome of this kind of processing.

Remark: In TGD framework this unconscious information processing could be assigned to the levels of self hierarchy below sub-selves identified as mental images.

2. It seems that simple emotions induce the need or desire to do something, an intention. This would naturally relate to the comparison of the expected state to the perceived one. If the result is not expected, the desire to change something is created: hunger → need to eat. Computer scientist would tend to see us as collection of behavioral programs (habits and routines) and emotional coloring would suggest how to change the routine to possibly achieve the desired result.

3. Low level emotions are holistic meaning that the physiological correlates cannot be localized in particular body part. One might however argue that a person fallen in love localizes this feeling with heart. Also hunger (if counted as emotion rather than sensory experience) can be localized to stomach. In any case, emotions as mental images would be holistic and physiologically assignable to a rather large part of body. One can argue that higher level emotions such as feeling of beauty cannot be localized to body.
4. There are also experiences what one might call higher level emotions and they perhaps relate to emotional intellect and intuition. They can be created in by many manners: say by art: catharsis - experience of beauty - or by meditation - experience of bliss. It is difficult to associated this kind experiences with particular physiological events. Interestingly these emotions do not seem to induce any desire or intention.

Music creates this kind of emotions. Simplest emotions are feeling of joy and sadness correlating with the harmony of music but in general music harmony defies characterization in terms of language and in terms of emotions of real life. To my opinion this correlation is a valuable guide line as one tries to understand correlates of emotions and feelings.

2.3.2 Are emotions percepts or analogs of motor actions?

Concerning the generation of emotions there has been debate between proponents of two alternative visions.

1. Brain expresses emotions using body as a tool so that emotions (e-motion) would be analogous to motor activities. The problem is that emotions are not intentional actions and one cannot control them. The explanation could be that the activities generating emotions are unconscious to us. This argument might make sense: we have autonomic nervous system too.

Remark: In TGD framework self hierarchy could solve the problem. An action unconscious would be conscious at some lower level of the self hierarchy. Emotions would be our perceptions about what has happened at lower levels of self hierarchy and the outcome would be statistical.

This view is supported by the existence of endocrine system. Glands excreting hormones would generate the emotions as analogs of motor actions. Hormones diffuse via blood circulation and induce emotional expression. Hormones serve as molecules of emotion and information. Hypothalamus plays the role of the highest motor area controlling by hormones the hormone expression of lower glands.

Hypothalamus, pituitary, and pineal gland are brain glands. The glands in body can also control emotions. In particular, heart muscles and epithelial cells in gut could independently express emotions by emitting hormones. Reflex action serves as an analogy for this.

2. Philosopher James proposed an alternative interpretation: body produces emotions and brain perceives them: this would explain why emotions are not under volitional control. This interpretation as such has been show to be wrong by an experiment in which the generation of physiological correlate of emotion was prevented in gut: the emotion was however felt. It is however true that there is neural feedback giving information about the physiological state.

Candace Pert proposes in her book [J3] a compromise between these views. There is the analog of sensory-motor loop involved and one cannot actually say that emotion would be associated with brain or with body: it is assignable to both of them.

Remark: Quite recent observation (see <http://tinyurl.com/pzfhw9d>) is that so called vagus nerve traverses all organs and couples nervous system, endocrine system, and immune system together. In TGD picture this nerve would build bridges between neurons of these systems and couple them to single quantum coherent system and allows communications with dark light between these organs.

3 TGD based interpretation for emotions

In TGD framework the interpretation of the transmitters involved (such as hormones) would not be as signal but as a tool creating the channels making signals propagating with light velocity (dark photons transforming to ordinary photons identified as bio-photons) and giving rise to quantum coherent active networks of cells (tensor networks) giving rise to conscious entities at some level of self hierarchy and possibly our mental images as sub-selves.

Signal molecules bound to receptors would act as small bridges connecting existing pieces of network to larger networks. These pieces would be flux tubes associated with axons in the case of nerve pulse transmission and neurotransmitters would give rise to the bridges. Synchronous neuronal firing would be a signature of the connected flux tube network. In [L12] and [L11] TGD inspired view about nervous system is discussed. This view has a natural generalization to the case of other signalling systems.

The dynamics for the topology (reconnections, braiding) of MB would induce the dynamics of biomolecules, cells and larger structures at the nodes of the fractal network.

3.1 Basic notions of TGD inspired quantum biology

It is good to list the basic notions of TGD inspired biology once again. They are magnetic body (MB), dark matter as $h_{eff} = n \times h$ phases of ordinary matter with n having non-standard value having first principle description in terms of adelic physics [L14], and zero energy ontology (ZEO).

1. The basic distinction between TGD and Maxwell's electrodynamics and gauge theories is that every system as field identity in TGD Universe as separate space-time sheets, topological field quanta correspond to magnetic flux sheets or tubes and also to electric field has topological quanta. This follows from the notion of induced gauge field. In Maxwell's theory fields of different systems interfere, in TGD they correspond to separate space-time sheets but particle experiences the sum of the forces caused by them since it touches these space-time sheets.

This forces the replacement organism + environment \rightarrow magnetic body (MB) + organism + environment. MB receives sensory input from biological body (BB) and controls BB. Sensory input to MB can be in terms of generalized Josephson radiation from cell membrane acting as generalized Josephson junction and coding nerve pulse patterns to frequency modulations. The control by MB can be realized in terms of cyclotron radiation to DNA (accompanied by what I call dark DNA [L5]).

2. The hierarchy $h_{eff} = n \times h$, $n = 1, 2, 3, \dots$ of Planck constants gives rise to a hierarchy of dark matters. $h_{eff} = n \times h$ labels the onion like layers of MB. The size scale of give layer is by uncertainty principle of order of cyclotron wavelength $\lambda \propto m/eB$ and thus proportional to particle mass m . The value of Planck constant determines the hierarchy level: n measures the complexity of the algebraic extension associated with the dynamics as dimension of extension of rationals involved with the dynamics at basic level, and serves as a kind of IQ. Evolution corresponds to a gradual and unavoidable increase of $h_{eff}/h = n$ in statistical sense.
 - (a) At the atomic level the value of n seems to be $n = 6$ rather than $n = 1$ [L13, L8]. For valence bonds the value of n is already larger and increases along the rows of the periodic table being largest for the molecules containing atoms towards the right end of the period: biologically important atoms C, N, O, S, P are examples associated with valence bonds with large n .
 - (b) For protons at hydrogen bonds the value of n is much higher than for electrons of valence bonds and the generation of hydrogen bonds could be seen as a crucial aspect of bio-chemistry. Metabolic energy is measured as the difference of the energy of bond for ordinary value of h_{eff} from the real one and one can say that metabolic energy provides for the system ability to increase its negentropy. Metabolic energy increases h_{eff} resources: this is why we must eat.
 - (c) An important additional hypothesis generalizes the notion of gravitational Planck constant due to Nottale [E1]. The hypothesis [K16, K17] states that at the flux tubes mediating gravitational interactions (propagation of gravitons) one has

$$\hbar_{eff} = n\hbar = \hbar_{gr} = \frac{GMm}{v_0} ,$$

where M and m are the masses associated with the ends of the flux tube and $v_0 < c$ has dimensions of velocity. This formula holds true if Mm/v_0 exceeds Planck mass squared and implies that the coupling parameter GMm in perturbation series is replaced with $v_0/c < 1$ so that one achieves convergence.

For large values of M the value of \hbar_{gr} can be very large, which means that long range gravitational interaction can give rise to systems with very high cognitive resources. This hypothesis generalizes also to other interactions in rather obvious manner and the phase transition increasing the value of \hbar_{eff} leads to dark phase in which perturbation theory converges (the value of the coupling strength $\alpha \propto 1/\hbar_{eff}$ is reduced).

The value of M depend on the state of the network defined by the flux tubes mediating gravitational interaction. At the limit of ordinary quantum gravity M would be mass of elementary particle. There is however entire dynamical fractal hierarchy of gravitational flux tubes completely analogous to those postulated flux tube hierarchies in neural system and in endocrine system. For instance, the fountain effect of superfluidity could correspond to a situation involving large value of \hbar_{gr} . In living matter the mass of large neuron is of order Planck mass and defines kind of critical mass in the sense that gravitational interaction between two large neurons could correspond to \hbar_{gr} .

3. Zero energy ontology (ZEO) essential for TGD inspired theory of consciousness is the third basic notion. In ZEO quantum states have as classical correlates 4-D space-time surfaces rather than time=constant snapshots of time evolution as in standard physics. They can be identified as preferred extremals of action principle analogous to Bohr orbits. Following biologists and neuroscientists one could speak about the generalization of the notion of behavioral pattern or biological function. Computer scientist talks about programs.

The act of free will is analogous to a replacement of a deterministic program with a new one in ZEO. ZEO is actually forced by the acceptance of the fact that we have free will which must be consistent with the determinism of field equations. At quantum level, classical program as preferred extremal is replaced with a quantum superposition of classical programs, which in some resolution cannot be distinguished from each other.

System must have sensory percepts about the state of MB. If the percept is not consistent with the expectation, the perception is accompanied by negative emotional coloring.

3.2 Sensory perceptions as artworks

TGD view about neural system differs in several aspects from that of neuroscience.

1. Sensory organs are assumed to serve as carriers of sensory percepts: qualia [K5] are not associated with sensory areas but with sensory organs [L10, L12]. ZEO providing a new view about time and memory allows to solve the basic objection related to phantom limb phenomenon: pain in phantom limb would be sensory memory and realized as 4-D sensory percept having contributions from geometric past.
2. The distinction between experienced time - identified as a sequence of small state function reduction identifiable as analogs of weak measurements (generalized Zeno effect) - and geometric time identifiable as distance between the tips of causal diamond (CD) is essential for understanding this view about memory [K1].
3. The assumption that sensory percepts are artworks rather than passive records of sensory input requires virtual sensory input from brain to sensory organs and build-up of the final standardized percept by pattern recognition - an iterative procedure involving very many forth-and back signals. Nerve pulse transmission is quite too slow process to allow this and dark photon signals propagating with maximal signal velocity between brain and sensory organs are suggestive [L12]. Dark photons decay to ordinary photons in energy conserving manner and identifiable as bio-photons and having energy spectrum in visible and UV range [K14, K15].

4. Nerve pulses and neurotransmitters would not represent real communication but give rise to temporary intra-brain communication lines along which communications as dark photon signals would take place with maximal signal velocity using dark photons (characterized by $h_{eff}/h = n$) transforming to biophotons in an energy conserving manner. Neurotransmitters and also other information molecules (hormones,..., messengers) attached to receptors would serve as bridges fusing permanent but disjoint communication lines along axons to a connected temporary communication line for dark photons to propagate. Nerve pulses would also generate generalized Josephson radiation allowing communications between biological body (BB) and magnetic body (MB) using EEG. Meridian system would be permanently connected system of communication lines.
5. This picture leads to a concrete proposal [L10, L12] about the roles of DMT and pineal gland concerning imagination and dreams and hallucinations. Pineal gland would indeed serve as third eye (it serves quite concretely as an eye in some lower organisms) but receives dark photon radiation from MB. This give rise to imagined sensory percepts. DMT attaching to the receptors can lead to continuation of flux tubes down to sensory organs and this in turn would generate sensory percepts identifiable as dreams, hallucinations, psychedelic experiences, mystic experience, even encounters with extraterrestrial life-forms.

3.3 Emotions as sensory percepts about the state of MB

The model of emotions relies on the identification of sensations as sensory percepts about the state of magnetic body so that the same mechanisms would be involved. In particular, the percepts at the level of brain would involve iterative fourth-and-back signalling using dark photons building emotions as standardized mental images.

Consider first the view about sensory perceptions and motor actions.

1. One can argue that ordinary sensory percepts are basically observations about the state of BB. For instance, retina is part of body affected by the incoming light signal. Nerve pulses from sensory organs generate transmitters, which produce bridges connecting existing flux tubes to connected flux tube networks assignable to networks of active neurons. The activity manifests as synchronous firing. This makes possible communications with light-velocity and quantum entanglement for the network possible so that it become tensor network [L7]. These network give rise to sensory mental images representing objects of the external world.

Remark: Cortex is essential for this process: this would mean that organisms without cortex should not be able to decompose perceptive field to objects. Is midbrain able to achieve targeted attention to some feature of perceptive field and how much does the information processing in retina contribute? Note that frogs have no cortex and are able to perceive only the motion of the target and presumably also its distance.

2. Motor action can be seen as a response to sensory percept. In ZEO motor action has interpretation as time reversed sensory perception mathematically. This is suggested by Libet's classical discovery [J1] that the decision to perform motor action is preceded by neural activity in brain. TGD based interpretation is that the decision induces a classical signal proceeding to geometric past or that it replaces superposition of space-time surfaces with a new one so that the "average" geometric past changes.

This view generalizes to emotions.

1. Emotions would be seen as sensory percepts about the state of MB rather than that of BB. For the part of MB inside BB the topology of MB is under continual change and lower level emotions would characterize the state of this part of MB. Not all these emotions need be conscious to us and this might relate to diffuse de-localized character of emotions. The most important contribution to the bodily emotion would come from the dynamical pattern for the topology of MB regarded as 4-D object in ZEO.

Also now emotional mental images would be assignable to MB and would naturally be artworks involving forth-and-back signalling with light-velocity.

2. Hormones as molecules of emotion excreted to blood flow as an analog of motor response would replace neural transmitters and serve as bridges allowing to build networks of cells and possibly larger structures. Hormones would serve as tools for changing the topology of the network in body length scales and the topology would depend on the distribution of hormones. One would have the analog of sensory-motor loop involving feedback in terms of neural signals.

Hypothalamus would serve in the role of motor area in cortex and control other glands by excreting hormones controlling their hormone excretion. The neural input to brain and eventually to limbic brain would lead to the hormonal response of hypothalamus and other glands. Also MB would control the response.

As already noticed, delta waves in frequency range [.5,4] Hz (not correlating directly with our conscious experience) are involved with the control the excretion of hormones from hypothalamus. Neuroscientist would assign these waves to cortex and thalamus, In TGD framework these waves would come from appropriate layer of MB but could have also brain counterparts since the interaction between MB and BB requires resonance and therefore same frequencies [L17].

3. The connected networks of cells - or more precisely, their 4-D time evolutions as space-time surfaces analogous to Bohr orbits - would give rise to emotional mental images. The 4-D nature of basic objects could explain why emotions involve temporal aspect. Their size scale of networks would be typically rather large so that emotions or more precisely feelings associated with them would be holistic and would not allow localization to any part of body. In smaller scales they would be probably unconscious to us: this could provide an alternative explanation for the diffuse nature of emotions. Besides transmitters and hormones there are also other information molecules responsible for the generation of tensor networks inside cell and in the vicinity of cells.
4. There are also sensory percepts from the part of MB outside BB. There are no nodes defined by cells or larger structures of organism and the dynamics could involve motions of biological body perhaps representing this dynamics as a template or mimicry.

Remark: Since the magnetic bodies of organisms can have sizes of order Earth size and even larger different organisms - in particular those of the same species - could appear as nodes of flux tube network. This might related to the findings of Sheldrake [I15, I16] about species learning [L6].

Also oscillations of this part of MB - analogs of Alfven waves (see <http://tinyurl.com/7ekxqt2>) propagating with light velocity and analogous to oscillations of strings in the case of flux tubes - should contribute to sensory percepts about MB. EEG and its possibly existing fractal counterparts at higher frequency scales have natural identification as the analogs of Alfven waves and cyclotron frequencies are favoured frequencies in the control of gene expression by MB as also their differences modulated by nerve pulse patterns in the case of communication of sensory data from cell membrane to MB [K8]. These oscillations could correspond to higher emotions since these parts of MB have the largest values of $h_{eff}/h = n$. In feelings generated by music time is indeed essentially involved and one can say that these experiences are non-local in time.

It would seem that emotions, which do not involve any obvious goal or desire - such as happiness or sadness - correspond to higher level emotions assignable to the part of MB outside MB. Note that the parasympathetic part of autonomic system - rest-and-digest mood - involves also goals/needs/desires such as sexual arousal, salivation, lacrimation, urination, digestion, and defecation so that these emotions do not correspond to "higher" ones. The sympathetic part - fight-or-flight mood - obviously involves desires and goals.

Remark: One of the basic paradoxes related to time is how it possible to become conscious of entire music piece in single moment as for instance Mozart did. The explanation relies on the distinction between subjective time and geometric time.

The idea the part of MB with the scale of BB stores emotional memories raises interesting questions. Could also immune system involve flux tube network? Could the meridian system of

Chinese medicine (see <http://tinyurl.com/cwwggkw>) be a flux tube network having acupuncture points as nodes. Is this network rather static and based solely on signalling with dark photons? The reports that heart transplants can transfer the memories of the donor to the receiver conform with the proposed vision. The claim that eating meat causes violent nightmares is supported also by my own experiences.

3.4 Emotions and information

It is known that emotions correlate strongly with information although emotions and rational thinking are often seen as diametrically opposite to each other. One however speaks of intuitive feelings and emotional intelligence is now a generally accepted notion.

1. Negentropy is a measure for the amount of conscious information having no counterpart in standard physics, where one can define only ensemble entropy and entanglement entropy. Entanglement negentropy is defined in p-adic sectors of the adele and although it obeys generalization of Shannon formula it can have positive values unlike the negative of the ordinary Shannon entropy.

Remark: Adelic physics [L14] [L15] fuses real number based physics for sensory experiences (physics of matter) and various p-adic physics as physics of cognition to single structure.

2. The values of $h_{eff}/h = n$ for given system is bound to increase in statistical sense since there exists infinite number of extensions with dimension higher than given extension and only finite number of them with dimension smaller. The increase of n does not imply increase of negentropy: it only gives prerequisites for generating larger negentropy and the system can decide whether to do this.
3. Metabolic energy feed provides system with molecules having valence bonds with values of n larger than for atoms. Hydrogen bonds and their generalization have even larger n . To gravitational flux tubes one can assign even larger n . Reality as zero energy state wants to understand itself and this leads to an increase of its negentropy in statistical sense and at the same time makes reality algebraically more complex giving rise to evolution in this manner. Note that metabolic energy does not generate negentropy as I have claimed earlier - it only makes possible to generate negentropy.

Emotions - at least those assigned to BB in the proposed model - have positive/negative coloring. What could be the interpretation of this bit.

1. Could this bit tell whether the state function reduction meaning a replacement of zero energy states as a kind of behavioral pattern with new one led to increase or decrease of negentropy?
2. Or could the color of emotion tell whether the state function reduction led to the increase or decrease of n characterizing the ability to generate negentropy.

3.5 “Higher” emotions and music

Music expresses emotions and also create higher level emotions. As all art, it also induces experience of beauty. Since $h_{eff}/h = n$ serves as a kind of IQ in the evolutionary hierarchy, there are good reasons to expect that the emotions/feelings induced by music and other art forms are assignable to MB.

The dynamics of MB involves oscillations characterized by frequencies and in EEG frequencies are of key importance for the part of MB outside biological body. The communications from cell membrane to MB involve modulation of EEG frequencies identified as generalized Josephson frequencies by nerve pulse patterns [K8] and would define a coding of sensory data to higher level emotions. The control signals from MB via DNA inducing gene expression would use dark photons at cyclotron frequencies to control BB.

3.5.1 Model for music harmonies and genetic code

For few years ago I ended up with a model of music harmonies leading also to a model of genetic code as a side product [L2].

1. The idea was that the 12-note scale could allow mapping to a closed path (octave equivalence) going through all vertices of icosahedron having 12 vertices and not intersecting itself. Also the idea that the triangles defining the faces of the icosahedron have interpretation as 3-chords defining the notion of harmony for a given chord deserves study. The paths in question are known as Hamiltonian cycles and there are 1024 of them [A2]. These paths can be classified topologically by the numbers of triangles containing 0, 1, or 2 edges belonging to the cycle representing the scale. Each topology corresponds to particular notion of harmony and there are several topological equivalence classes.
2. In the article [L4] I introduced the notion of Hamiltonian cycle as a mathematical model for musical harmony and also proposed a connection with biology: motivations came from two observations. The number of icosahedral vertices is 12 and corresponds to the number of notes in 12-note system and the number of triangular faces of icosahedron is 20, the number of amino-acids. This led to a group theoretical model of vertebrate genetic code and replacement of icosahedron with tetra-icosahedron to explain also the 21st and 22nd amino-acid and solve the problem of simplest model due to the fact that the required Hamilton's cycle does not exist. The outcome was the notion of bio-harmony.
3. All icosahedral Hamilton cycles with symmetries (Z_6, Z_4, Z_2^{rot} and Z_2^{refl}) turned out to define harmonies consistent with the genetic code. In particular, it turned out that the symmetries of the Hamiltonian cycles allow to predict the basic numbers of the genetic code and its extension to include also 21st and 22nd amino-acids Pyl and Sec: there are actually two alternative codes - maybe DNA and its conjugate are talking different dialects! One also ends up with a proposal for what harmony is leading to non-trivial predictions both at DNA and amino-acid level.
4. The conjecture is that DNA codons correspond to 3-chords perhaps realized in terms of dark photons - music of light - or even ordinary sound. 256 different bio-harmonies are predicted and these harmonies would give additional degrees of freedom not reducing to biochemistry. Music expresses and creates emotions and a natural conjecture is that these bio-harmonies are correlates of emotions/moods at bio-molecular level serving as building bricks of more complex moods. Representations of codons as chords with frequencies realized as those of dark photons and also sound is what suggests itself naturally. This together with adelic physics involving hierarchy of algebraic extensions of rationals would explain the mysterious looking connection between rational numbers defined by ratios of frequencies with emotions.
5. In fact, also the emotions generated by other art forms could be realized using music of dark light. Dark photons in various wavelength ranges and correspond to various values of h_{eff} would correspond to various sensory qualia and are represented at pineal gland (“third eye”) as imagined sensory percepts [L12]. They can be transformed to real sensory percepts at sensory organs by using DMT molecules as bridges allowing the propagation of dark photons (or the bio-photons resulting in their energy conserving transformation to ordinary photons) to sensory organs, where they generate genuine sensory experience identified as dream, psychedelic experience, hallucination, etc...

3.5.2 How to realize emotions as music of genes concretely?

How to realize the music of genes represented as sequences of 3-chords of dark light as a communication tool between dark and ordinary DNA/RNA and possibly even dark and ordinary variants of tRNA and amino-acids?

1. Communication between ordinary and dark matter levels must be possible. This is guaranteed if the transition energy spectra at different levels of $h_{eff}/h = n$ hierarchy contain common transition energies so that a resonant interaction by exchange of dark photons becomes

possible. This condition is extremely demanding and could explain why basic bio-molecules are selected amongst numerous alternatives [L17] - this is indeed one of the hen-egg problems of pre-biotic evolution.

2. A hypothesis worth of studying is that the cyclotron transition energies of both ordinary DNA and RNA nucleotides and their dark variants represented as dark proton sequences are same [L17]. Cyclotron transition energies should cover several octaves and the natural proposal is that magnetic field strength associated with the flux tube codes for the notes. In music experience roughly 10 octaves are needed corresponding to the range of audible sounds.
3. The cyclotron frequencies of DNA nucleotides A, T, C, G are very nearly the same and near 1 Hz for $B = B_{end} = .2$ Gauss since their masses do not differ much. Since the nucleotides are negatively charged, also the cyclotron energies for codons and codon sequences are around 1 Hz. $h_{eff} = h_{gr}$ hypothesis states that the cyclotron energies of DNA are in the energy range of bio-photons in visible and UV.

There should be correspondences between a) the 64 ordinary DNA codons and allowed 3-chords and b) 64 dark variants of DNA codons and allowed 3-chords. These correspondences fix that between ordinary and dark codons. One would have triality.

1. To realize music of genes one the value of B must have values in a range of several octaves. The magnetic field strengths B associated with the flux tubes accompanying DNA strand should have a spectrum given by 12-note scale. Both 64 dark DNA codons and $4^3 = 64$ ordinary DNA codons should correspond to $20 + 20 + 20 + 4 = 64$ allowed 3-chords formed from the notes of 12-note scale.
2. Dark codons correspond to entangled states of 3 dark protons. The positions of dark protons are different so that ermutations of the positions of dark protons are involved. The invariance of 3-chord under permutations of notes would correspond to fermionic statistics. These permutations are lifted to braidings if dark protons are connected by flux tubes to some other system, for instance ordinary DNA.

If the dark protons are ordered linearly along flux tube, it would seem that these these positions correspond to those of ordinary code letters. This does not make sense. If the letters of codon are connected to the dark protons by flux tubes, the permutations of dark codons induce braiding of the flux tubes but do not affect the order of the letters of the ordinary codon. Braiding would become an essential part of the correspondence between ordinary and dark codons.

3. One should understand the correspondence of dark codons with the allowed 3-chords of a given harmony and also with the ordinary DNA codons. Bio-harmony is defined as a composite of 3 harmonies with 20 allowed 3-chords and having symmetries Z_6 , Z_4 , and Z_2 and of tetrahedral harmony with 4 chords. Tetrahedron can be regarded as disjoint object or attached to DNA, and this gives two variants of code.

How could these the icosahedra-tetra-hedral Hamilton cycles relate to the physical realization of dark proton triplets? Each icosahedral cycle should give rise to 20 dark proton triplets. Why the icosahedral geometry with Hamiltonian cycle should make itself manifest in the quantum physics of dark proton triplet?

4. Could icosahedral geometry quite concretely correspond to a tensor network? The vertices of the icosahedron would be connected by a sequence of flux tubes connecting nearest neighbors to form a Hamiltonian cycle. Dark proton triplets would quite concretely be localized at the triangular faces of the icosahedron.

Braided triplet of flux tubes would emerge from the vertices of an icosahedral triangle defining 3-chord and would connect it to the nucleotides of the corresponding ordinary DNA codon. Magnetic field strengths at these flux tubes would correspond to the notes of 12-note scale as defined by the Hamiltonian cycle in question. The permutations of the dark proton states at the vertices of the triangle would induce braidings of the flux tube triplet actually defining

minimal braid in topological quantum computation (sic!) The braiding accompanying the states of 3 dark protons would make the correspondence with ordinary ordered DNA codons possible.

Note that each dark proton triplet could be also connected (without braiding) to its conjugate dark proton triplet by a triplet of flux tubes so that one would obtain closed flux loops and one could speak of knots instead of braids.

Remark: Braiding brings strongly in mind the many TGD inspired proposals for DNA as topological quantum computer [K3, K10]: maybe DNA as topological quantum computer could be (also?) realized in this manner.

What physical objects could the 20 vertices of icosahedron correspond to? Hydrogen bonded water clusters give rise to both tetrahedral and icosahedral structures. Could one associate dark proton triplets to the dark parts of these structures? Could one try to experimentally identify possible sequence of icosahedral water molecule clusters with vertices connected by hydrogen bonds associated with the DNA sequence? If the hydrogen bonds correspond to flux loops as suggested, they can be rather long (proportional to $h_{eff}/h = n$) so that even distant water molecules can become hydrogen bonds and one could have a fractal hierarchy of icosahedra.

5. Resonance condition suggests that at the level of ordinary DNA double strand the cyclotron energies of dark protons associated with the hydrogen bonds connecting DNA nucleotides correspond to those of flux tube triplets connecting ordinary and dark DNA codons. The magnetic field strengths associated with the dark flux tubes accompanying hydrogen bonds would correspond to those associated with the triangles of icosahedral triangle. This would make possible communication between the two dark sectors by dark-photon triplets as music of genes.

This leaves unanswered questions.

1. Why the $20+20+20=60$ 3-chords from 3 harmonies with different icosahedral symmetries (Z_6, Z_4, Z_2) and 4 chords from tetrahedral harmony would combine to form single bio-harmony with 64 chords? This requires the presence of 3 Hamiltonian cycles with different symmetries. Why all three different symmetry types for DNA and RNA? Could the 20 amino-acids correspond to single symmetry type? Could tRNA codons correspond to two symmetry types?
2. How the 3-chords of dark photons could be played? 3-chord should be a collective effect affecting both dark and ordinary codon by inducing emission of 3-photon state like - like playing a chord by string instrument. The notes of the light chord need not emerge simultaneously but as arpeggios. Could there be a pulse travelling along the Hamiltonian cycle and picking all the cyclotron notes at the vertices containing dark proton and sending a cyclotron signal along flux tubes to ordinary DNA codon. This pulse would travel along dark DNA and play the music defined by dark DNA sequence.

3.6 Support for the view that information molecules serve as bridges in flux tube networks

I have discussed information molecules from TGD point of view for for the first time about two decades ago [K7]. It was amusing to find that this discussion highlighting the interpretational problems related to information molecules is still very topical. These strange findings give direct support for the view that information molecules serve as bridges making possible the formation of networks of cells interpreted in terms of flux tube networks in TGD framework. For this reason I glue below the earlier discussion followed by the recent comments.

Central nervous system (CNS), endocrine system and immune system are three basic systems involved with bio-control and -communication. The work of Candace Pert and other neuroscientists has led to a general notion of information molecule described in popular manner by Candace Pert [J3]. Neural transmitters and modulators associated

with CNS are only special cases of information molecules. Also neuropeptides and various hormones are involved. It has become clear that emotions are closely related with the activity of information molecules and that both brain, endocrine system and immune system communicate intensively with each other. One could regard even brain as a big gland. Of course, one could also consider various glands and organs as mini-brains.

The interactions of the information molecules involve the formation of receptor-information molecule complex either at cell surface or in the cell plasma inside cell. Receptor-information molecule complex inside cell can move to genome and induce gene transcription. In case that the complex is formed at the surface of cell, second messenger action is involved. One can also speak about N :th messenger action. There are many poorly understood aspects related to the mechanisms of information molecule action [I13].

1. There are only few second messenger pathways and relatively few receptors but large number of different functions. This phenomenon is known as pleiotropy or multi-functionality. For instance, given second messenger causes different effects depending on the hormone that activated it (the phenomenon is somewhat analogous to the phenomenon in which message can be understood in several manners depending on the state of receiver). At purely chemical level the problem is how second messenger knows what hormone activated it? In steroid action the complex formed by information molecule and receptor in turn activates some gene. Now the question is: How the activated RNA polymerase knows which gene has to be activated? Pleiotropy appears also at level of hormones. Same hormone can have multiple effects and the border between hormone, neuropeptide or even neurotransmitter is unclear. For instance, hormone which by definition transmits long distance communications, can have effects in nearby cells and thus acts like a neuropeptide. How hormone knows what function it must perform? Also drugs and treatments can have different effects and side effects.
2. There is also functional redundancy: the same function is performed by several second messenger molecules. For instance, glucagon, growth hormone, adrenaline and corticosteroids elevate glucose levels. This suggests that there is deeper level of communication involved and that second messenger molecules are more like computer passwords than subprogram calls. Now the question is: What these subprogram calls do correspond physically?
3. Biological functions can be initiated also in non-chemical manner. The phenomena of healing by touch and the effects of meditation and biofeedback are examples of biological self-organization processes are initiated in non-chemical manner. Even other treatments like massage, acupuncture or meditation can decrease or inhibit pain. These observations suggest that chemical level is not the deepest level involved with biological functions and the question is: What is this deeper control level?

Simple lock and key mechanism cannot provide answer to the questions raised above. Rather, computer password might provide better metaphor for the second messenger action whereas receptor-information molecule complex would effectively generate subprogram call perhaps carried by the second messenger molecule or possibly broadcasted. It seems that information molecules act more like signs or symbols rather than being purely chemical agents. These symbols are interpreted by cell level intelligences and the interpretation depends on context.

The mysterious looking finding is that the cell activated by information molecules somehow knows, which information molecule did the activation. This can be understood if the information molecule attached to the receptor serves as a bridge so that the cell becomes part of a flux tube network to which information molecule characterizes. The recent interpretation is in terms of a generation of a flux tube network. Information molecule characterizes the network which is formed. The information storage capacity of these networks - allowing quantum entanglement - is

exponentially large than that of state of the nodes: hence the naive AI based idea about copying consciousness to diskette by assigning a bit to each neuron is extremely unrealistic.

3.7 Getting memories by eating those who already have them

While writing this article I learned about extremely interesting findings. I have already earlier written about the finding that both pieces of a split planaria inherit the memories (identified as learned skills or conditionings) of the original planaria [K12]. One possibility is that the bodies rather than brains of the planaria carry the memories. Second possibility is that the splitting of planaria involves the replication of its magnetic body carrying at least some of the memories. The news at this time was that planaria get the memories of planaria that they have eaten!

To begin with, one must carefully distinguish between genuine memories and memories as behavioral patterns (conditionings, skills).

1. Cognitive memories as behavioral patterns are assumed to be due to the strengthening of synaptic contacts (long term potentiation (LPT, see <http://tinyurl.com/yafzovyk>) giving rise to nerve circuits, which are active or easily activated.

In TGD framework activation means formation of a flux tube network giving rise to quantum entangled state with neurons at the nodes: neural activity generates transmitters serving as bridges between flux tubes associated with axons and create flux tube network carrying a conscious mental image. A quantum coherent entangled tensor network is formed and also classical communications using dark photons are possible in this state. These neurons are firing synchronously. Nerve pulses would not be signals between neurons but would induce communications to magnetic body in scales even larger than body.

2. Genuine memories - say episodal memories - would in TGD (zero energy ontology, ZEO) correspond to neural activities in geometric past: kind of seeing in time direction. These are typically verbal memories but also sensory memories are possible and can be induced by electric stimulation of brain.

Consider now the experiments discussed in the popular article “*Somewhere in the brain is a storage device for memories*” (see <http://tinyurl.com/y8ejpcho>). They all relate to the identification of memory as a behavioral pattern induced by conditioning and are therefore emotional memories.

1. In one experiment sea slugs learned to avoid painful stimulus. This led to a generation of synaptic contacts between neurons involving increased synaptic strength - long term potentiation (LPT). Then some drug was used to destroy the LPT. The problem was that the lost contacts were not those formed when the memory was formed!
2. In second experiment mice were used. A conditioned fear (LPT) was induced in mice and again the generation of synaptic contacts was observed. Then the contacts - long term potentiation - was destroyed completely. Memories as conditioned fear however remained!

It was an amusing accident to learn about this just when I was building a model for emotions as sensory percepts about the state of magnetic body (MB) fundamental in TGD inspired quantum biology.

1. In the recent case the memories are definitely emotional memories and in TGD framework they would be naturally at the level of body and generated as mental images associated with large numbers of ordinary cells appearing as nodes of quantum entangled flux tube networks giving rise to tensor networks [L7]. Hormones would be the tool to generate and modify these networks.
2. Emotional memories would be represented by the conditioning and analog of LPT at the level of body rather than at the level of brain! Hormones like also other information molecules would act as relays connecting existing pieces of network to larger ones! The neural activity would be involved only with the generation of memories and induce hypothalamus to generate the fear network using the hormones controlling hormonal activities of lower level glands.

3. The model could also explain the finding that in the splitting of flatworm the both new flatworms inherit the memories and that even non-trained flatworms eating trained flatworms get their memories (defined as behavioral patterns involving emotional conditioning).

3.8 How brain selectively remembers new places?

Emotions are involved with memory storage and memory recall. Limbic brain, in particular hippocampus, plays a key role in these processes but what really happens is not really understood. The notion of memory has two basic meanings. Memory can mean learned skills and emotional conditionings: one can argue that memory is not correct word in this case. Long term potentiation (LTP) strengthening synaptic contacts is known to be the key mechanism in the formation of memories in this sense. Memory can also mean memory recall: what happens in genuine memory is not understood and it is difficult to understand episodal memories in terms of conditioning and synaptic contacts.

In TGD framework one might say that LTP makes possible generation of cognitive (emotional) mental images as quantum entangled flux tube networks and also signalling using dark photons between neutrons (cells) of the network. In TGD framework memory recall means seeing in time direction making possible to retrieve information about the mental images in the geometric past and even to re-experience them.

There was a very interesting link in Minding Brain (see <http://tinyurl.com/y8w2zyus>) related to the storage of new memories. The title of the popular article (see <http://tinyurl.com/yap3dzuk>) is “*How brain selectively remembers new places?*”. The research article by the research group led by Nobelist Susumu Tonegava is published in PNAS [J7] (see <http://tinyurl.com/yak262hu>). The following represents TGD based view about what might happen.

1. In TGD framework brain/body corresponds to 4-D geometric object classically - a space-time surface with complex topology (zero energy ontology, ZEO). Brain and biological body are accompanied by magnetic body (MB) defining a topological time evolution of flux tube network having neurons (and also body cells) as its nodes and it is MB, which seems to be of fundamental significance [L12, L19] (see <http://tinyurl.com/y8mpo7mb>) and <http://tinyurl.com/ydhxen4g>). Memories are located in 4-D brain (body) for the first time to the time-place, where they were formed, later successful memory recalls form new copies of them.
2. To remember is to see in time direction to geometric past. The signal sent from hippocampus backwards in geometric time scatters back in standard time direction: this is nothing but seeing in 4 dimensions. 4-D memory storage means that there is practically no limitations on memory storage since new storage capacity is created all the geometric time! Making careful distinction between experienced and geometric times allows to both avoid paradoxes and solve the paradoxes of existing theory.

Remark: Also the possibility of quantum entanglement also increases exponentially the memory storage capacity (and destroys the dreams of AI aficionados about copying human consciousness as bits telling whether neuron fires or not to a computer file!).

3. Brain is able to detect whether the sensory percept - say completely new place - is indeed new. Brain acts as novelty detector. This requires scanning of 4-D brain to see whether there are sensory percepts in geometric past, which share common features with the recent sensory percept. This requires high level conceptualization so that perceptive field is decomposed to objects with some attributes. If common objects are not found, the percept is regarded as something new. In this case a new symbolic memory representation about perceptive field is formed.
4. This strongly suggests that the signal sent from hippocampus scatters back from brain of past and is then compared with the recent sensory percept. If they the signals are very similar - this might give rise to some kind of resonance - the experience is “I have seen this before”. The information provided by the already existing memory is utilized. If not then sensory percept is regarded as new and memory representation is formed.

Where is this new memory representation constructed?

1. The article suggests that locus coeruleus (LC) and area CA3 of hippocampus are involved. It was found that the modulation of CA3 by LC is was involved in the formation of new memory: if the modulation was prevented, no new memory was formed and the mice behaved next day as if the place were still new.
2. In ZEO the new memory would correspond to a collection of activated neurons in LC and CA3 accompanied by connected flux tube structure represented the new mental image as a quantum entangled structure - tensor network. This kind of mental images would have formed for some period of time in the brain of the mice and given rise to a 4-D representation of new place to be read later by sending signals backwards in geometric time.

4 The experiments of Masaru Emoto with emotional imprinting of water

Sini Kunnas sent a link to a video telling about experiments of Masaru Emoto (see <http://tinyurl.com/pqy57jj>) with water, which is at criticality with respect to freezing and then frozen. Emoto reports is that words expressing emotions are transmitted to water: positive emotions tend to generate beautiful crystal structures and negative emotions ugly ones. Also music and even pictures are claimed to have similar effects. Emoto has also carried out similar experiments with rice in water. Rice subjected to words began to ferment and water subject to words expressing negative emotions began to rotten.

Remark: Fermentation is a metabolic process consuming sugar in absence of oxygen. Metabolism is a basic signature of life so that at least in this aspect the water+rice system would become alive. The words expressing positive emotions or even music would serve as a signal “waking up” the system.

One could define genuine skeptic as a person who challenges existing beliefs and pseudo-skeptic (PS in the sequel) as a person challenging - usually denying - everything challenging the mainstream beliefs. The reception of the claims of Emoto is a representative example about the extremely hostile reactions of PSs as aggressive watchdogs of materialistic science towards anything that challenges their belief system. The psychology behind this attitude is same as behind religious and political fanaticism.

I must emphasize that I see myself as a thinker and regard myself as a skeptic in the old-fashioned sense of the word challenging the prevailing world view rather than phenomena challenging the prevailing world view. I do not want to be classified as believer or non-believer. The fact is that if TGD inspired theory of consciousness and quantum biology describes reality, a revolution in the world view is unavoidable. Therefore it is natural to consider the working hypothesis that the effects are real and see what the TGD based explanation for them could be.

The Wikipedia article about Masaru Emoto (see <http://tinyurl.com/pqy57jj>) provides a good summary of the experiments of Emoto and provides a lot of links so that I will give here only a brief sketch. According to the article Emoto believed that water was a “blueprint for our reality” and that emotional “energies” and “vibrations” could change the physical structure of water. The water crystallization experiments of Emoto consisted of exposing water in glasses to different words, pictures or music, and then freezing and examining the aesthetic properties of the resulting crystals with microscopic photography. Emoto made the claim that water exposed to positive speech and thoughts would result in visually “pleasing” crystals being formed when that water was frozen, and that negative intention would yield “ugly” crystal formations.

In 2008, Emoto and collaborators published an article titled “Double-Blind Test of the Effects of Distant Intention on Water Crystal Formation” about his about experiments with water in the Journal of Scientific Exploration, a peer reviewed scientific journal of the Society for Scientific Explorations (see <http://tinyurl.com/y99ko12e>). The work was performed by Masaru Emoto and Takashige Kizu of Emoto's own IHM General Institute, along with Dean Radin and Nancy Lund of the Institute of Noetic Sciences, which is on Stephen Barrett's Quackwatch (see <http://tinyurl.com/y99ko12e>) blacklist of questionable organizations. PSs are the modern jesuits and for jesuits the end justifies the means.

Emoto has also carried experiments with rice samples in water. There are 3 samples. First sample “hears” words with positive emotional meaning, second sample words with negative emotional meaning, and the third sample serving as a control sample. Emoto reports (see <https://youtu.be/Wc-ZmvxfBxE>) that the rice subjected to words with positive emotional content began to ferment whereas water subject to words expressing negative emotions began to rotten. The control sample also began to rotten but not so fast.

In the sequel I will consider the working hypothesis that the effects are real, and develop an explanation based on TGD inspired quantum biology [K13, K12, K11]. The basic ingredients of the model are following: magnetic body (MB) carrying dark matter as $h_{eff}/h = n$ phases of ordinary matter; communications between MB and biological body (BB) using dark photons able to transform to ordinary photons identifiable as bio-photons; the special properties of water explained in TGD framework by assuming dark component of water implying that criticality for freezing involves also quantum criticality, and the realization of genetic code and counterparts of the basic bio-molecules as dark proton sequences and as 3-chords consisting of light or sound providing a universal language allowing universal manner to express emotions in terms of bio-harmony realized as music of light or sound. The entanglement of water sample and the subject person (with MBs included) realized as flux tube connections would give rise to a larger conscious entity expressing emotions via language realized in terms of basic biomolecules in a universal manner by utilizing genetic code realized in terms of both dark proton sequences and music of light of light and sound.

4.1 The reception of the findings of Emoto

The findings of Emoto challenge the materialistic world view and have received both genuine criticism and “criticism”.

4.1.1 Criticism and “criticism”

Commentators have criticized Emoto for insufficient experimental controls and for not sharing enough details of his approach with the scientific community. Prof. emeritus William A. Tiller, a researcher featured in the documentary “*What The Bleep Do We Know?*”, states that experiments of Emoto fall short of proof, since they do not control for other factors in the supercooling of water. It is easy to agree that scientific proof is not in question. William Tiller claims that supercooling of water involved with the experiments might have delicate effects difficult to control.

Remark: Supercooling of water makes it critical system, even quantum critical and in TGD Universe, and this makes it ideal target of remote mental interactions.

A lot of experiments are needed: in particular, the possible dependence on the person who utters the words with emotional content, deserves to be studied. Just taking randomly chosen group of people and control system might not be enough to achieve a significant effect. Situation could be similar to that in the recent double slit experiments of Radin [L9] (see <http://tinyurl.com/y72b87p7>), in which subject person tries to intentionally affect the interference pattern for light travelling through slits. The effect is clear in the case of experienced meditators. That very few of us are not concert pianists, cannot be used to argue that there are no concert pianists.

There is also the authoritative “criticism”, which carefully avoids stating anything about contents of the work and directs the efforts on rhetoric tricks. These “criticisms” do not deserve serious attention except as perfect examples of the empty rhetorics so typical for PSs. The following examples are citations from the Wikipedia article (see <http://tinyurl.com/pqy57jj>).

Emoto has been criticized for designing his experiments in ways that leave them prone to manipulation or human error influencing the findings. Biochemist and Director of Microscopy at University College Cork William Reville wrote, “*It is very unlikely that there is any reality behind claims of Emoto.*”. Reville noted the lack of scientific publication and pointed out that anyone who could demonstrate such a phenomenon would become immediately famous and probably wealthy.

Remark:The absence of scientific publication (in respected journal of course) often reflects the fact that PSs have reached their goal to prevent publishing anything challenging their beliefs. I have experienced this myself during four decades very concretely. At nineties it became even impossible to get anything into arXiv.

Writing about Emoto's ideas in the *Skeptical Inquirer*, physician Harriet A. Hall concluded that it was "hard to see how anyone could mistake it for science". Commenting on Emoto's ideas about clearing water polluted by algae, biologist Tyler Volk stated, "What he is saying has nothing to do with science as I know it." Stephen Kiesling wrote in *Spirituality & Health Magazine*, "Perhaps Emoto is an evangelist who values the message of his images more than the particulars of science; nevertheless, this spiritual teacher might focus his future practice less on gratitude and more on honesty."

Needless to restate that these comment say nothing about contents.

4.1.2 Emoto is not the only victim of pseudo-skepticism

The criticism of the experiments of Emoto mostly reflects the prevailing materialistic dogmas, which do not allow these effects so that depending on the authority Emoto is concluded to be mad, charlatan, or evangelist. The rage of PSs is really frightening and demonstrates how powerful effects ideology can have.

Emoto shares the fate of experimenters studying water memory and homeopathy. "Homeopathy" is indeed a word making skeptic growl and drool: one can hardly imagine a more impressive demonstration of words on water than this! An almost- Nobelist Benveniste was labelled as swindler as he announced about experiments providing support for water memory and homeopathy. Magician Randi - Randi again(!) - participated the investigation of the mind-police of science, in which Benveniste and laboratory staff was treated like criminals unless otherwise proven.

There is a lot of support about the representation of water memory as extremely low frequencies (ELF) of radiation associated with water [I4, I5]. These ELF frequencies can be stored electronically and they produce the same effects as the bio-active chemical, whose presence induced these frequencies in water. These facts PSs simply neglect because they do not fit the belief system of PSs dating back to 18th century. At the age of IT the idea about the existence of representations of bio-active molecules as frequency patterns able to induce the biological effects of molecules without the presence of molecules should not raise aggressions.

Few years ago HIV Nobelist Montagnier did experiments giving support for water memory and the procedure involved a part very similar to that used in preparing homeopathic remedies [I9] [L1]. In TGD framework these frequencies would correspond to cyclotron frequencies assignable to MBs of molecules, and immune system is proposed to have emerged from the ability of water to mimic the magnetic bodies of invader molecules and learning to recognize them [K6]. This interpretation could mean a breakthrough in biology but unfortunately the time is not mature for this yet.

Remote mental interactions/paranormal phenomena [K13] belong also to the pariah phenomena having no place in materialistic world and people having the courage to challenge this view are labelled as science criminals by PSs.

4.1.3 Analyzing the mindset of PS

People calling themselves skeptics are rarely skeptics in the original meaning of the word but believers, even fanatic believers. The basic un-challengeable belief is materialism stating that consciousness is only an epiphenomenon - illusion as David Dennett puts it without explaining what he means with the claim that consciousness does not exist but is only one particular phenomenon of consciousness - namely illusion. There is no free will and there are no genuine intentional actions. Moral and ethics are illusions. And certainly, human can have no intentional effects on water since even genuine intentional effects on our own body are impossible. This leads to the notion of objectivity as PS understands it.

This notion of objectivity implies that the outcome of given experiment cannot depend on who carries it or on who the subject persons are. If this turns out to not be the case, the experiment is not well-done and experimenter can be ridiculed. Water is dead matter for PS, even the PS himself should be dead matter if the materialistic logic is taken to its bitter end. I dare guess that most PSs privately believe - without even realizing that this is the case - that their intentions genuinely affect the sack of water with some chemicals that is called their body. It is extremely difficult pretend that one is not conscious when one is conscious.

The conclusion of the PS is that the outcome of Emoto's experiments with water and rice cannot depend at all on the person who utters the words expressing positive or negative emotions.

PS calls this assumption objectivity but is actually only an assumption that there is no such thing as intentional free will and that we live in a deterministic world of billiard balls. This view is known to be wrong: quantum entanglement has been verified for cell sized system in macroscopic scales and quantum world is non-deterministic - mentioning this fact is carefully avoided in text books. PSs also unashamedly put under the rug hundreds of anomalies related to the physics of water.

If human intention and emotion can have effects on water, the first question is whether the intention and emotion of some humans these effects are stronger. Belief moves mountains and since Emoto believes that intention can have effects, it would be only natural that the effects are stronger. If this is true, one cannot demand the repeatability of the experiment anymore. In paranormal research the experimenter effect is well-known - some experimenters are more successful than others without being charlatans - as also in medicine. This is the case always when living systems are involved. There is another amusing example demonstrating the shallowness of the thinking of PSs: PSs love to say that the effects of healing practices produce nothing but placebo effects without realizing that placebo effect as such is a fascinating mind-over-matter effect begging for explanation!

Of course, if Emoto believed that the emotions have effects on water, his desire to prove this belief might have produced these effects - not by cheating but by intentional rather than emotional imprinting based on remote mental interactions affecting water. The words as such need not have caused the effect. This would represent an example of remote mental interactions. Note however that also music and even pictures were reported to have effects on water and it is not easy to explain this as experimenter effect.

An amusing "experiment" on rice was carried out by a hard-nosed skeptic Carry Poppy (see <http://tinyurl.com/y8g9jgal>). The extremely nasty tone of the article reveals the hatred of Poppy towards Emoto and people challenging the materialist world view. The outcome of the "experiment" carried by Poppy was of course negative. Perhaps not surprising, the outcome would express faithfully the real intention and desire of the experimenter!

4.2 TGD based model for Emoto's findings

In TGD based view the notion of magnetic body (MB) is central [K12, K11]. MB carries dark phases of matter identified as phases of ordinary matter with $h_{eff}/h = n$ making possible macroscopic quantum coherence explaining the coherence of living matter not understandable in the biochemistry based approach. The interactions between MB and biological body (BB) are essential remote mental interactions based on signalling using dark photons. Therefore the basic mechanisms of quantum biology would be also mechanisms of remote mental interactions - only the target would be non-standard. We are mostly water and it would not be surprising if these mechanisms would allow intentional and emotional imprinting of also water outside our body and in quantum critical state.

4.2.1 Basic ingredients of the model

In TGD universe water is very special substance in that it contains both ordinary water and its dark variant. What makes it dark is that dark magnetic flux tubes representing long hydrogen bonds are present for some portion of water [L21] (see <http://tinyurl.com/y8fvwbp9>): the length of bonds scales as n or perhaps even n^2 . The presence of these flux tubes makes any liquid phase a network like structure and one ends up with a model explaining an anomaly of thermodynamics of liquids at criticality known already in Maxwell's time. This leads to a model explaining the numerous anomalies of water in terms of the dark matter.

For instance, the dark part of water with non-standard Planck constant transforms to ordinary water in freezing. As a consequence, a large amount of energy is liberated. This explains why water has anomalously large latent heat of fusion. One can also understand why the volume of water increases in freezing and decreases in heating in the interval 0-4 °C. The anomalies of water are largest at physiological temperature $T_{phys} \sim 37$ °C suggesting that the dark portion of water is largest at T_{phys} . Dark fraction of water would be essential for life.

Dark protons sequences at flux tubes representing genetic code and the analogs of basic biomolecules are realized in water. Pollack effect [L3] (see <http://tinyurl.com/oyhstc2>) re-

quiring feed of energy - as IR radiation for instance - generates so called exclusion zones (EZs), which are negatively charged regions. A fraction of protons from water must go somewhere and the TGD inspired proposal [L3] (see <http://tinyurl.com/gwasd8o>) is that the protons transform to dark protons at magnetic flux tubes. The dark variants of particles quite generally have higher energies than ordinary ones and energy feed provides the needed metabolic energy go make the protons dark. In the case of homeopathy and water memory mechanical agitation creates provides the metabolic energy and would generate EZs accompanied by dark proton sequences at flux tubes [K6].

Remote expression of emotions as crystal patterns - emotional imprinting - is required and communication requires a code so that receiver and sender have same interpretation for the signal. Genetic code would provide the fundamental code making possible universal meanings. TGD leads to two basic proposals predicting the numbers of DNA codons coding for given AA rather successfully.

1. The first proposal [L5] relies on TGD view about dark matter as $h_{eff}/h = n$ phases of ordinary matter [K4, K16, K17] motivated by adelic physics extending physics to include also the correlates of cognition [L14, L15] (see <http://tinyurl.com/ycbhse5c> and <http://tinyurl.com/ybzkfevz>). The empirical motivation comes from several sources, in particular from the findings of Pollack.

Dark genetic code would be realized in terms of dark proton sequences at flux tubes- dark nuclei. The model predicts dark counterparts of DNA, mRNA, tRNA, and AA as dark proton sequences which codons identifiable as dark proton triplets. Bio-chemistry would emerge as a shadow of the much simpler dynamics of dark matter at flux tubes and genetic code would be induced by dark code code.

2. Second model of genetic code emerged accidentally from a geometric model of music harmony [L2, L20] (see <http://tinyurl.com/yad4tqw1> and <http://tinyurl.com/yd8d8x6j>) involving icosahedral (12 vertices-12-note scale and 20 faces-number of AAs) and tetrahedral geometries leading to the proposal that DNA codons and possibly also AAs correspond to 3-chords defining the harmony and obtained as unions of 20+20+20 3-chords associated with icosahedral 20-chord harmonies with symmetries Z_6, Z_4, Z_2 plus tetrahedral 4-chord harmony. There is large number of these harmonies bringing in additional degrees of freedom.

Remark: This model has obviously analogies with the notion of wave genome introduced by Peter Gariaev [I6, I7, I12].

Since music both expresses and creates emotions, the proposal is that these harmonies assigning additional hidden degrees of freedom to the MBs of dark variants of DNA, RNA, etc... serve as correlates of emotions also at the molecular level. This emotional context could also give rise to context dependence of the code if several harmonies are realizable chemically. Taking seriously TGD inspired theory of consciousness [L16] (see <http://tinyurl.com/yxcm2tpd>) and model of emotions [L19] (see <http://tinyurl.com/ydhxen4g>), one might say that the details of the code might depend slightly on the "emotional" state of DNA, RNA, and possibly other molecules.

4.2.2 TGD based mechanism for emotional imprinting

One must not forget that as a passionate researcher Emoto probably had very intimate relationship with water! As we all have with one particular water volume, which we call our body! I can intend raising my hand and it raises. Also my emotions are expressed in this personal bag of water containing also some fraction of biomolecules. I doubt that even the most fanatic PS would not try to tell me that I am performing a sleight of hand as I do this. But they should do this in order to take their materialistic logic to its bitter end.

One can perhaps say that Emoto extended his body by fusing with the MB of water, which in turn controls the ordinary part of water just like it controls our own body. The reports of experiences about extension of body are not unheard in the spiritual practices. Not even in everyday life. If you touch ground with a stick, you experience the touch as if the stick were part of your body. Could the stick really become part of your body in some sense?

What could be the precise mechanism for emotional imprinting (as analog of intentional imprinting that Tiller talks about [J8])?

1. The basic vision is that living matter is a quantum critical system making it extremely sensitive to perturbations (actually TGD Universe is quantum critical in well-defined sense [L22] (see <http://tinyurl.com/yakz111k>). This makes biological system an ideal sensor and motor instrument. In particular, intentions can affect body water at quantum criticality optimally. At quantum criticality phases with several values of Planck constant $h_{eff}/h = n$ are present and correspond to dark matter which is the key player in TGD inspired model of living systems. As already noticed, the dark portion of water would be maximal at physiological temperature.
2. In the system studied by Emoto the subject person and water must form an entangled quantum critical system. Water - or rather, the MB of water - must have part of it in $h_{eff}/h = n$ dark phase becoming in certain sense part of subject person. Magnetic flux tubes connecting subject person to a sample of water (or of rice and water) and carrying dark matter would serve as correlates of attention.

What might be called loving attention would provide metabolic energy to the target and might be essential element in generating the dark phase giving rise to the beautiful crystal patterns. $h_{eff}/h = n$ can be seen as kind of universal IQ: the more the system contains subsystems with large n , the higher its ability to generate conscious information, negentropy, is.

Therefore choosing randomly a subject person who just says a word with positive or negative meaning but without emotion might not be enough to reproduce Emotos findings. It is also quite possible that the outcome of the experiment is a realization of subject person's intention/desire to have the desired effect. This would not however reduce the profound implications of the findings of Emoto if they are true.

3. Thanks to the presence of dark portion of water, super-cooled water is quantum critical system in TGD Universe. In supercooling the temperature can become considerably lower than in the usual freezing and means that also the dark portion of water stays dark. This dark portion would react to the intentions of subject person. The crystal structures would serve as kind of photograph is of the representations of mental images of the system subject person + dark portion of water.

Remark: Water normally freezes at 273.15 K (0 °C), but it can be supercooled at standard pressure down to its crystal homogeneous nucleation at almost 224.8 K.

What about the effects of music and even visual pictures on water? Also these effects are in principle possible and would rely on universal representation of emotions in living matter at molecular and maybe even at higher levels. Since music represents and creates emotions, the natural assumption is that the collection of allowed 3-chords express emotions both at the molecular level and at the level of MB.

1. The resonant interaction by 3-chords made of photons is possible between any pair formed by taking given member to be either DNA, RNA, tRNA or its dark variant. Dark counterparts of AAs would couple resonantly to the frequencies defined as sums of the frequencies of 3-chords. These dark variants of bio-molecules are present also in water if TGD based explanation of Pollack effect is correct. One actually ends up to a model for prebiotic evolution involving dark nuclei made from dark proton sequences in an essential manner [L17, L20](see <http://tinyurl.com/yalny39x> and <http://tinyurl.com/yd5t82gq>).
2. The frequencies of visible light are rather high for the ordinary value of Planck constant. The original motivation for the hierarchy of Planck constants was the finding that ELF em fields have quantal effects on living matter [J4]. This led to a proposal in which bio-photons at visible and UV frequencies are dark photons at ELF frequencies transformed to ordinary photons [K14]. Also the reverse transformation taking ordinary photons to dark photons is possible so that dark matter - dark variants of AAs responding resonantly to single frequency - at the flux tubes can "see".

3. The effect of words expressing positive emotions would initiate metabolism based on fermentation. The spoken words must serve as encouraging of dis-encouraging control signal just as music of light. The meaning of the words should be same for the subject person and the system rice + water. This can be the case if the systems entangle to single system via flux tube bridges.

This relates interestingly to the theory of Russian biologist Peter Gariaev based on the assumption that genes define a language in rather concrete sense [I14, I11, I10]. I have developed these ideas from TGD point of view in [L20] (see <http://tinyurl.com/yd5t82gq>): dark variants of genes identified as dark proton sequences - essentially dark variants of nuclei - define a universal language.

4. In the model the 3-chords in question are made of light. In the case of music as we understand it they would be made of sound. In living matter sounds can be transformed to em oscillations by piezo-electric effect. The resulting em oscillations would be accompanied by both ordinary and dark photons, and both the 3-chords and melody of the music would couple to dark dark proton triplets at flux tubes serving as counterparts of DNA, RNA, tRNA, and AAs. If the same mechanism is involved with Emoto's experiments, the sounds should transform to light or they should induce at flux tubes vibrations - dark phonons - at the same frequencies that realize the representation of biomolecules and their dark variants as 3-chords.

Remark: In TGD Universe physical state as a collection of particles is replaced with a network of flux tubes having particles at its nodes [L7] (see <http://tinyurl.com/y9kwnqfa>). Therefore sound as vibrations of the length of flux tube accompanied by fermionic string connecting pair of nodes becomes fundamental excitation rather than something emerging only at condensed matter physics.

Ugly crystals are assigned with negative emotions and emotions are assigned with harmonies. Harmonies - also those, which are sad (consider only passions of Bach) - are however usually thought of as something beautiful. Can negative emotions really correspond to any bio-harmonies characterized by symmetries. In a discussion with Sini Kunnas I realized that also the notion of disharmony could make sense. There are indeed 6 Hamiltonian cycles without any symmetries [A2, A3, A1]. I neglected them in the model of harmony because they would represent which one might call disharmony. Could one of the contributing 3 Hamiltonian cycles in bio-harmony correspond to this kind of dis-harmony and bring in 20 3-chords without any symmetries? If so the relationship between geometry and aesthetics would become very concrete. The alternative view would be that there are several harmonies realized simultaneously and thi creates disharmony.

5 Emotions and RNA

In the following fascinating findings related to RNA and possibly expression of emotions at molecular level are discussed.

5.1 Does RNA code for pain?

I learned about an extremely interesting finding [J5] (see <http://tinyurl.com/ycqxeyek>) in neuroscience. The popular article "*Scientists Sucked a Memory Out of a Snail and Stuck It in Another Snail*" (see <http://tinyurl.com/y92w39gs>) tells that the conditionings of snails produced by painful sensations can be transferred to other snails or even snail neurons in Petri dish by adding just the RNA of the conditioned snails to the dish!

Let us summarize the findings.

1. RNA from snails is transferred to snails or to even populations of snail neurons in Petri dish!
2. The effect involves epigenetic changes in DNA by methylation induced by RNA somehow. The reaction is to the serotonin informing for the stimulus. Avoidance behavior emerges as a response.

3. How does RNA induce the epigenetic change? RNA should couple to a specific part of DNA and induce the effect. A pairing of DNA with RNA in question occurring also in transcription suggests itself strongly.
4. What in the RNA of the conditioned snail is different? RNA should somehow code for the conditioning induced by a painful sensory experience. RNA of sensory receptors should change somehow and communicate this change to DNA in brain by some mechanism. DNA-RNA pairing does not seem plausible. Could the pairing occur by some other means?

Before continuing it is good to summarize the TGD based models for music harmony providing also a model of genetic code (see <http://tinyurl.com/yad4tqwl>), for sensory perception (see <http://tinyurl.com/yczv2o5b>), for emotions (see <http://tinyurl.com/ydhxen4g>), and for imprinting of emotions in water (see <http://tinyurl.com/ycdywctw>).

1. TGD based model for emotions and communication of emotions suggests that the communication takes place in terms of what I call music of light (also sound might be involved). Music expresses and creates emotions. Emotional state, mood, is coded by harmony or disharmony for music of light.

12-note is fundamental for music and is represented as a closed self-non-intersecting path (Hamilton cycle) at icosahedron having 12 vertices. Icosahedron has 20 faces (triangles) and for given Hamilton cycle one can assign a 3-chord to each triangle. This gives 20-chord harmony (or disharmony). There is quite large number of 20-chord harmonies and those allowing Z_6 , Z_4 and Z_2 as symmetries is quite large. Besides this there 6 cycles with no symmetries and these could be identified as dis-harmonies.

2. 20 is also the number of amino-acids so that it is not totally surprising that the model for bioharmony as a union of 3 different 20-chord harmonies plus 4-chord harmony assignable to tetrahedron turns out to give a model of genetic code as 64 chord bioharmony. There are 64 basic 3-chords in one-one correspondence with DNA and RNA codons. tRNA corresponds to a union of 2 20-chord harmonies. Given amino-acid corresponds to the orbit of 3-chord under symmetries of the harmony so that number of 3-chords at the orbit is the number of DNAs coding for the amino-acid. These numbers come out correctly.
3. There are two other representations of genetic code. The ordinary chemical representation and the representation in terms of dark proton sequences at magnetic flux tubes. The model for dark proton triplet predicts that its states divided to 64 analogs of DNA codons, 64 analogs of RNA codons, 40 analogs of tRNA codons, and 20 analogs of amino-acids. Genetic code comes out correctly also now by a natural pairing of dark proton triplets. One must couple these 3 representations of genetic code with themselves and with each other.
4. There is indeed resonant coupling by 3-chords realized in terms of free frequencies of dark photons. The frequencies are rather low ($E = h_{eff} \times f$, $h_{eff}/h = n$) but energies are same as for biophotons with energies in visible and UV range.

Also dark variants of DNA, etc couple with each other via dark photon resonance. Dark DNA, etc couple with ordinary DNA, etc.. by energy resonance to form double strands. This means that dark photon transforms to ordinary photon in the coupling. Amino-acid couples to single frequency, which is the sum of codon frequencies coding for it.

There is quite large number of 3-chord 3-harmonies defining DNA and RNA moods, and 3-chord 2-harmonies tRNA moods, and amino-acid 1-chord harmonies. There also 6 disharmonies with 20 chords each possible assignable to negative moods such as those generated by pain.

So: Is the communication chemical by DNA-RNA pairing or by some other means? TGD based model suggests "some other means".

1. Pain in sensory receptor is certainly involved. In TGD based model differs from neuroscience view in that for sensory experiences sensory receptors are seats of the sensory qualia and brain only forms cognitive representations about them and also entangles with sensory receptors to share the pain. Somehow pain must affect RNA in sensory receptors? How?

2. In this framework the stimulus in nociceptors would induce a disharmony expressed in terms of the disharmony associated with the expression of RNA in terms of 3-chords. The dark variant of RNA in pain receptors would entangle with the dark DNA in certain neurons in brain of the snail. Nerve pulse patterns from the nociceptors would generate also magnetic flux tube connections parallel to the sensory pathway in question and make possible the communication by dark biophoton triplets to brain possible. The dark variant of DNA in brain would have resonant coupling with ordinary DNA and induce the epigenetic change by methylation as a response to the negative mood with the mediary of biophotons. After this the organism would have avoidance behaviour towards the stimulus inducing the pain.
3. The presence of mere RNA and associated dark RNA dis-harmonious mood would do the same for any neuron by the resonance mechanism. This would allow to transfer emotions even to snail neurons in Petri dish, not only those in living snails.

The proposed mechanism provides insights to many other poorly understood problems.

1. This mechanism also allows to understand how the transfer of emotions conditioning induces epigenetic change also in the germ cell DNA: this is not easy to understand in the standard framework requiring chemical communication through the germ cell membrane.
2. The models for learning (memories restricted to conditionings) based on formation of synaptic contacts on one hand and involving RNA are seen as exclusive in standard neuroscience. In TGD framework the formation of synaptic contacts might rely at the fundamental level on the same epigenetic mechanism. Neuromodulators might induce the emotional states in RNA in turn doing the epigenetic editing.

In human brain the genomes differ in various neurons and epigenetic editing by the proposed mechanism might cause this. An interesting question is whether humans could edit their genomes intentionally. All conditionings are not useful and maybe it becomes someday possible to affect these conditionings at the level of dark DNA.

3. Squid and octopus are known to be able to edit their mRNA (see <http://tinyurl.com/m7m6c28>). Instead of DNA the mRNA produced in the transcription so that the translation produce different protein. The effect of emotional states of the dark variant of RNA associated with mRNA could be the mechanism involved.
4. The strong emotional state of single individual induces very effectively the same emotional state in people around: consider only concert as an example. Could the "music of dark light" mediate the emotions from the dark RNA of individual - say artist - to people around. If so all art would be basically music of light!

To sum up: this finding provides rather concrete support for the vision that emotions are coded by the music of light at molecular level.

5.2 Did RNA replicate in codon-wise manner during RNA era?

There was an interesting popular article in Spacedaily with title "*Scientists crack how primordial life on Earth might have replicated itself*" (see <http://tinyurl.com/y92ng5vd>). The research paper [18] is titled "*Ribozyme-catalysed RNA synthesis using triplet building blocks*" and published in eLife (see <http://tinyurl.com/ya5qyjfn>).

It is possible to replicate unfolded RNA strands in Lab by using enzymes known as ribozymes, which are RNA counterparts of enzymes, which are amino-acid sequences. In the presence of folding the replication is however impossible. Since ribozymes are in general folded, they cannot thus catalyze their own replication in this manner. The researchers however discovered that the replication using RNA triplets - genetic codons - as basic unit can be carried out in laboratory even for the folded RNA strands and with rather low error rate. Also the ribozyme involved can thus replicate in codon-wise manner. For units longer than 3 nucleotides the replication becomes prone to errors.

These findings are highly interesting in TGD framework. In TGD the chemical realization of genetic code is not fundamental. Rather, dark matter level would provide the fundamental

realizations of analogs of DNA, RNA, tRNA, and amino-acids as dark proton sequences giving rise to dark nuclei at magnetic flux tubes [L17] (see <http://tinyurl.com/yalny39x>). Also ordinary nuclei correspond in TGD Universe to sequences of protons and neutrons forming string like entities assignable to magnetic flux tubes.

The basic unit representing DNA, RNA and tRNA codon and amino-acid would consist of 3 entangled dark protons. The essential aspect is that by entanglement the dark codons do not decompose to products of letters. This is like words of some languages, which do not allow decomposition to letters. This representation is holistic. As we learn to read and write, we learn the more analytic western view about words as letter sequences. Could the same hold true in evolution so that RNA triplets would have come first as entities pairing with dark RNA codons from from dark proton triplets as a whole? Later DNA codons would have emerged and paired with dark DNA codons. Now the coupling would have been letter by letter in DNA replication and transcription to mRNA.

It is intriguing that tRNA consists of RNA triplets combined from amino-acids and analogs of mRNA triplets! The translation of mRNA to amino-acids having no 3-letter decomposition alone forces the holistic view but one can ask whether something deeper is involved. This might be the case. I have been wondering whether during RNA era RNA replicated using a prebiotic form of translational machinery, which replicated mRNA rather than translated RNA to protein formed from amino-acids (AAs) with AA serving as a catalyst.

1. During RNA era amino-acids associated with pre-tRNA molecules would served as catalysts for replication of RNA codons. The linguistic mode would have been “holistic” during RNA era in accordance with the findings of the above experiments. RNA codon would have been the basic unit.
2. This would have led to a smaller number of RNAs since RNA and RNA like molecules in tRNA are not in 1-1 correspondence. A more realistic option could have been replication of subset of RNA molecules appearing in tRNA in this manner.
3. Then a great evolutionary leap leading from RNA era to DNA era would have occurred. AA catalyzed replication of RNA would have transformed to a translation of RNA to proteins and the roles of RNA and AA in tRNA would have changed. [Perhaps the increase of h_{eff} in some relevant structure as quantum criticality was reached led to the revolution]
4. At this step also (subset of) DNA and its transcription to (a subset of) mRNA corresponding to tRNA had to emerge to produce mRNA in transcription. In the recent biology DNA replicates and is transcribed nucleotide by nucleotide rather than using codon as a unit so that helicases and DNA and RNA polymerases catalyzing replication and transcription should have emerged at this step. The ability of DNA to unwind with the help of helicase enzyme helping DNA to unwind is essential for the transcription and translation of DNA. Therefore helicase must have emerged together with the “analytic linguistic mode” as an analog of written language (DNA) decomposing codons to triplets of letters. This would be a crucial step in evolution comparable to the emergence of written language based on letters. Also the counterpart of RNA polymerase and separate RNA nucleotides for transcription should have emerged if not already present.

An alternative option would involve “tDNA” as the analog of tRNA and the emergence of helicase and polymerases later as the transition from holistic to analytic mode took place.

The minimal picture would be emergence of a subset of DNA codons corresponding to RNAs associated with pre-tRNA and the emergence of the analogs of helicase and DNA and RNA polymerases as the roles of amino-acid and RNA codon in tRNA were changed.

5. How DNA could have emerged from RNA? The chemical change would have been essentially the replacement of ribose with de-oxiribose to get DNA from RNA and $U \rightarrow T$. Single O-H in ribose was replaced with H. O forms hydrogen bonds with water and this had to change the hydrogen bonding characteristics of RNA.

If the change of $h_{eff} = n \times h_0$ was involved, could it have led to stabilization of DNA? Did cell membrane emerge and allow to achieve this? I have proposed [L17] (see <http://>

//tinyurl.com/yalny39x) that the emergence of cell membrane meant the emergence of new representation of dark genetic code based on dark nuclei with larger value of h_{eff} .

Remark: One has $h = 6 \times h_0$ in the most plausible scenario [L8, L18] (see <http://tinyurl.com/goruuzm> and <http://tinyurl.com/y9jxyjns>).

The communication between dark and ordinary variants of biomolecules involves resonance mechanism and would also involve genetic code represented as 3-chords, music of light, and it is interesting to see whether this model provides additional insights.

1. The proposal is that 3-chords assignable to nucleotides as music of light with allowed 64 chords defining what I have called bio-harmony is essential for the resonance [L19, L20, L18](see <http://tinyurl.com/ydhxen4g>, <http://tinyurl.com/yd5t82gq>, and <http://tinyurl.com/y9jxyjns>). The 3 frequencies must be identical in the resonance: this is like turning 3 knobs in radio. This 3-fold resonance would correspond to the analytic mode. The second mode could be holistic in the sense that it would involve only the sum only the sum of the 3 frequencies modulo octave equivalence assigning a melody to a sequence of 3-chords.
2. The proposal is that amino-acids having no triplet decomposition are holistic and couple to the sum of 3 frequencies assignable to tRNA and mRNA in this manner. Also the RNAs in tRNA could couple to mRNA in this manner. One could perhaps say that tRNA, mRNA and amino-acids codons sing whereas DNA provides the accompaniment proceeding as 3-chords. The couplings of DNA nucleotides to RNA nucleotides would rely on the frequencies assignable to nucleotides.
3. If the sum of any 3 frequencies associated with mRNA codons is not the same except when the codons code for the same amino-acids, the representation of 3-chords with the sum of the notes is faithful. The frequencies to DNA and RNA nucleotides cannot be however independent of codons since the codons differing only by a permutation of letters would correspond to the same frequency and therefore code for the same amino-acid. Hence the information about the entire codon would be needed also in transcription and translation and could be provided either by dark DNA strand associated with DNA strand or by the interactions between the nucleotides of the DNA codon.
4. The DNA codon itself would know that it is associated with dark codon and the frequencies assignable to nucleotides could be determined by the dark DNA codon. It would be enough that the frequency of the letter depends on its position in the codon so that there would be 3 frequencies for every letter: 12 frequencies altogether.

What puts bells ringing is that this the number of notes in 12-note scale for which the model of bio-harmony [L2, L19] (see <http://tinyurl.com/yad4tqw1> and <http://tinyurl.com/ydhxen4g>) based on the fusion of icosahedral (12 vertices and 20 triangular faces) and tetrahedral geometries by gluing icosahedron and tetrahedron along one face, provides a model as Hamiltonian cycle and produces genetic code as a by-product. Different Hamiltonian cycles define different harmonies identified as correlates for molecular moods.

Does each DNA nucleotide respond to 3 different frequencies coding for its position in the codon and do the 4 nucleotides give rise to the 12 notes of 12-note scale? There are many choices for the triplets but a good guess is that the intervals between the notes of triplet are same and that fourth note added to the triplet would be the first one to realize octave equivalence. This gives uniquely $CEG\sharp$, $C\sharp FA, DF\sharp B\flat$, and $DG\sharp B$ as the triplets assignable to the nucleotides. The emergence of 12-note scale in this manner would be a new element in the model of bio-harmony.

There are $4! = 24$ options for the correspondence between $\{A, T, C, G\}$ as the first letter and $\{C, C\sharp, D, D\sharp\}$. One can reduce this number by a simple argument.

- (a) Letters and their conjugates form pyrimidine-purine pairs T, A and C, G . The square of conjugation is identity transformation. The replacement of note with note defining at distance of half-octave satisfies this condition (half-octave - tritonus - was a cursed interval in ancient music and the sound of ambulance realizes it). Conjugation could correspond to a transformation of 3-chords defined as

$$CEG\sharp \leftrightarrow DF\sharp B\flat, \quad C\sharp FA \leftrightarrow D\sharp GB .$$

(b) One could have

$$\begin{aligned} \{T, C\} \leftrightarrow \{CEG\sharp, C\sharp FA\} , \quad \{A, G\} \leftrightarrow \{DF\sharp B\flat, D\sharp GB\} , \\ \text{or} \\ \{T, C\} \leftrightarrow \{DF\sharp B\flat, D\sharp GB\} , \quad \{A, G\} \leftrightarrow \{CEG\sharp, C\sharp FA\} . \end{aligned}$$

(c) One can permute T and C and A and G in these correspondences. This leaves 8 alternative options. Fixing the order of the image of (T, C) to say $(C, C\sharp)$ fixes the order of the image of (A, G) to $(D, D\sharp)$ by the half-octave conjugation. This leaves 4 choices. Given the bio-harmony and having chosen one of these 4 options one could therefore check what given DNA sequence sounds as a sequence of 3-chords [L2].

That the position the frequency associated with the nucleotide depends on its position in the codon would also reflect the biochemistry of the codon and this kind of dependence would be natural. In particular, different frequencies associated with the first and third codon would reflect the parity breaking defining orientation for DNA.

5.3 How do slime molds learn?

Quanta Magazine is a treasure trove of popular articles about hot topics in basic research and biology and neuroscience are the hottest topics now. The popular article "*Slime Molds Remember but Do They Learn?*" about learning of slime molds (see <http://tinyurl.com/ydc8gh4d>) serves as a good example of pleasant surprises popping up on weekly basis. There are several research articles referred but the related to the following comments are about the work of Dussutour and others [I2, I3] (see <http://tinyurl.com/hbo88c> and <http://tinyurl.com/y83o5sfs>).

1. The popular article tells that slime molds are monocellulars - for long time believed to belong to fungi - but actually somewhat like amoebas. They have neither neurons nor brains. The neuroscientific dogma says that neurons are necessary for learning so that slime molds should not learn. They should only adapt by selecting behaviors from a genetically inherited repertoire. Same would be true about plants, which are also known to learn.

For physicist these beliefs look strange. Both animals and plants and also slime molds share the basic aspects about what it is to be alive, why should they be unable to learn? The research of biologist Audrey Dussutour and her team described in the article indeed shows that slime molds are indeed able to learn.

2. Conditioning is the basic mechanism of learning, which by definition leads to a creation of a new kind of behavior rather than selecting some behavior from an existing repertoire as happens in adaptation. Typically the conditioning is created by associating unpleasant sensory stimulus such as electric shock to some other stimulus, which can be pleasant, say information about the presence of food. This leads to avoidance behavior and the mere presence of food can induce the avoidance behavior.
3. It was found that slime mold [I2] learns a habit of avoiding the unpleasant stimulus - habituation is said to take place. Habituation involves generation of new behavior and is not mere adaption. For instance, habituation can mean stopping noticing stimulus like smell if it is not dangerous or important for survival. In the experiments the slime molds were conditioned to avoid noxious substances (having bitter "taste") and they remembered the behavior after a year of physiologically disruptive enforced sleep as the technical terms expresses it. This learned behavior was also transferred in cell fusion to individual that had not learned the behavior [I3].
4. Central nervous system has been believed to be responsible for habituation since neurons receive and process the sensory the stimuli, build kind of cognitive representations about them, and generate motor response. Neuroscientist believe that learning means strengthening

of synaptic contacts eventually giving rise to a learned motor response to a sensory stimulus by a sequence of associations

Against this background the ability of slime molds to learn looks mysterious. How do they perceive the stimulus, how do they process it, how do they respond to it? We know actually little about cognition and learning: we know a lot about the neural correlates of cognition but not what cognition is.

Forgetting the question about what cognition is, one can just ask what could lead to the change of behaviour of the slime mold. Some time ago I learned about another fascinating finding related to learning from the article “*Scientists Sucked a Memory Out of a Snail and Stuck It in Another Snail*” (see <http://tinyurl.com/y92w39gs>). What was found that one can take RNA of a snail that has been conditioned by some painful stimulus and transfer it to another snail by scattering RNA on its brain neurons! Same can be achieved also by feeding snail with the conditioned snail. RNA must somehow represent memories. If this is true for snail it can be true also for the slime mold.

Usually learning is assigned with cognition regarded as kind of linguistic cognition. One speaks also of emotional intelligence: could learning be based on emotions? The TGD based model for emotions (see <http://tinyurl.com/ydhxen4g>) inspired by the model of music harmony [L2, L23] (see <http://tinyurl.com/yad4tqw1> and <http://tinyurl.com/y8njuctq>) leading to a model of genetic code predicting correctly vertebrate coderelies on this idea and leads to a model for what learning could be also in the case of slime molds.

1. Music expresses and creates emotions coded in its harmony (think of major and minor scales as simple examples). This could be true in much more general sense. Not only music made of sound but also of light - dark photons in TGD framework - could realize these functions of music. DNA would have a representation in terms of a collection of 3-chords made of three dark photons with frequencies in proportions allowed by the harmony.
2. The model of harmony based on icosahedral and tetrahedral geometries predicts a large number of harmonies representing emotional states, moods. The music of light makes possible communication between DNA, RNA, amino-acids (AAs), even tRNAs and their dark variants DDNA, DRNA, DAA, DtRNA. Communications are possible if the three chords can resonate note by note: ideal situation occurs if the harmony defining the mood is same in sender and receiver. Emphatics are those, who experience also the sufferings of the other people. Moods can be transferred from RNA to DNA and here they can induce epigenetic change leading to a change in behavior.
3. The painful conditioning of snail would induce a new mood of RNA of snail (probably rather depressive!) and this would in turn infect the DNA of the snail (strong emotions are infective) and the mood of DNA would induce the epigenetic change leading to the avoidance behavior (see <http://tinyurl.com/yb4numr> and <http://tinyurl.com/ydhxen4g>). Emotions would be behind the learning and learning would take place at DNA level as epigenetic changes changing the gene expression. Habituation would involve epigenetic changes and adaptation involve only activation of appropriate inherited genes.

It must be added that TGD also leads to a vision about the role of neurons in many aspects different from the neuroscientific view although agreeing with the basic facts and explaining quite a number of anomalies [L12] (see <http://tinyurl.com/yczv2o5b>).

1. The notion of magnetic body (MB) containing dark matter as $h_{eff}/h_0 = n$ phases of ordinary matter is central. The networks having as nodes objects consisting of ordinary matter (molecules, organelles, organs, even organisms) connected to a network made of flux tubes containing dark matter would give rise to both cellular and neuronal networks. Magnetic flux tube connecting two nodes would serve as a correlate of attention and communication pathway using supra currents or dark photons. Also classical signals can propagate along it.
2. The primary function of nerve pulse activity at the level of CNS would not be communication between neurons but building of communication pathways from flux tubes along which dark

photon signals can propagate with maximal signal velocity. The situation would be same in travel phone connections: the communication pathway would be created first and only then the communications with light velocity would begin. Synaptic transmission would build a bridge between otherwise non-connected flux tubes. This would give rise to long waveguides. Dark photons transforming to ordinary photons would yield bio-photons, which have remained mysterious in standard bio-chemistry since their spectrum is not consistent with the discrete spectrum of lines produced if they were generated in molecular transitions.

3. Sensory experiences would be basically at the level of sensory organs and sensory percepts would involve pattern recognition involving repeated feedback signal from brain an leading a standard perception nearest to the sensory input. The new view about time provided by zero energy ontology allows to circumvent the counter argument inspired by phantom leg phenomenon.
4. Nerve pulse patterns would frequency modulate the generalized Josephson frequencies assignable to the membrane proteins acting as Josephson junctions and generating dark Josephson radiation as part of EEG propagating to the MB of the system. Thus nerve pulse patterns would code information but this information would be sent to MB.
5. It is quite possible that the proposed RNA level mechanism is the microscopic mechanism behind strengthening of synaptic connections believed to be behind neuron level learning although also here new findings suggests that situation is not quite it has been believed to be (see <http://tinyurl.com/ybglebph>).

This did not say anything about cognition yet. TGD leads also to a view about mathematical correlates of cognition requiring profound generalization of the mathematical structure of theoretical physics. Real number field is tailor made for the description of the sensory world but how to describe the correlates of cognition. Here p-adic number fields come in rescue and in TGD framework one ends up to a unification of real physics and their p-adic analogs to what I call adelic physics (see <http://tinyurl.com/ybepht6d> and <http://tinyurl.com/ybzkfevz>).

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5.5 Could also RNA and protein methylation of RNA be involved with the expression of molecular emotions?

Some time ago I wrote an piece of text [L19] (see <http://tinyurl.com/ydhxen4g>) about learning of slime molds [I2, I3]. The proposal was based on the vision inspired by the model of bio-harmony [L2, L23] and stating that harmony of music of light (and maybe of also sound) realized as 3-chords of dark photons with frequencies of 12-note scale expresses and creates emotions and that each harmony corresponds to a particular mood. The painful conditioning of the slime mold would generate a negative mood which would infect DNA and induce epigenetic change. This picture conforms also with the finding that RNA can induce learning of conditionings in snails [J5] (see <http://tinyurl.com/ycqxyeqk>) [L19]. Slime mold does not have central nervous system but a natural guess would be that also synaptic learning involves similar mechanism.

One can ask whether also RNA and protein methylation could be involved with learning. If molecular moods correspond to bio-harmonies and if the conditioning by say painful stimulus involves a change of the emotional state of RNA inducing that of DNA, it must change some of the chords of the bio-harmony. Since bio-harmony is essential for communications by dark photons between dark proton triplets representing dark variants of the basic biomolecules and also between communications between bio-molecules and their dark variants, one expects that the change of

the harmony occurs for all dark analogs of biomolecules and also for their ordinary biomolecules. Some chords represented by DNA-, RNA-, and tRNA codons, and amino-acids - briefly basic bio-molecules - would be affected in the change of mood.

The recent finding (see <http://tinyurl.com/y9qsnfeo>) that synaptic connections involve more methyl marks of RNA than other parts of neurons and that the RNA marks tend associated with genes coding for proteins associated with synapses provides support for this view that emotions expressed as modifications of the basic biomolecules. The emotional states would have epigenetic effects changing the gene expression and inducing learning as modification of synapses in turn modifying the behavior. This picture provides also a mechanism for the inheritance of epigenetic modifications: what would be inherited would be emotional states represented in terms of bio-harmonies the level of magnetic body carrying dark protons.

5.5.1 Some background about modifications of the basic biomolecules

To get a some perspective consider first some background about the modifications of the basic bio-molecules.

1. In the case of DNA epigenetic modifications (see <http://tinyurl.com/kdd3qmp>) affect mRNA and thus also protein expression. There are two basic mechanisms involved. Methylation of C nucleotide of DNA and protein modification for histone.

Methylation (addition of CH_3 to N) of C nucleotide leads to a silencing of gene expression. Methylation occurs typically for CpG pairs and for both strands. Before embryogenesis demethylation occurs for the entire DNA (stem cell state) but cell differentiation means methylation of genes not expressed. In vertebrates 60-80 percent of CpG is methylated in somatic cells. CpG islands form an exception involving no methylation. Demethylation (see <http://tinyurl.com/ybg3mz6v>) as the reversal of methylation occurs either spontaneously or actively.

The effects on gene expression can be also inherited to next generations. The mechanism of inheritance is poorly understood. The epigenetic change should be also somehow communicated to the DNA of germ cells but this seems impossible. The mystery is deepened because before embryogenesis demethylation occurs for the entire genome. It is difficult to understand how the chemical storage of the information about methylation patterns to be transferred to the next generation is possible at all.

The TGD view about emotional expression inducing epigenesis by communications via dark photons between basic biomolecules and their dark variants suggests an elegant mechanism. What would be inherited would be the emotional states represented by bio-harmonies assignable to the dark variants of biomolecules.

2. In the case of pre-RNA post-transcriptional chemical modifications (see <http://tinyurl.com/y8c4w4mp>) - in particular methylation, are known to occur, and they affect RNA splicing rates and change the distribution of mRNAs and thus of proteins. The modifications affect also un-translated RNA (UTR) but not the protein translation from mRNA.
3. Protein modifications (see <http://tinyurl.com/jtczea5>) in turn affect the dynamics of proteins - in particular their properties as enzymes by affecting therefore the rates for various basic processes.

As already noticed, protein modifications are important in epigenesis by histone modification. Wikipedia article mentions lys acetylation by adding $\text{CH}_3=\text{O}$ group (see <http://tinyurl.com/yd2y7s2m>), lys and arg methylation (see <http://tinyurl.com/ybxgdwhz>), ser and thr phosphorylation, lys ubiquitination and sumoylation. For N-terminus (H_2 group in the start of protein) the process is irreversible and new amino acid residues emerge. Methylation in C terminus ($\text{O}=\text{C}-\text{OH}$ end of protein) can increase chemical repertoire. Note that the methylation occurs at the ends of the protein just like it tends to occur in the case of RNA as will be found.

RNA modifications deserve to be discussed in more detail. This field of study is known as epitranscriptomics (see <http://tinyurl.com/y8c4w4mp>) . These chemical modifications does not

affect protein expression except in the case that they affect the rates of various alternative pre-RNA splicing so that the distribution of alternative protein outcomes changes. Clearly, the effect is somewhat like the effect of mood on overall activity. There are also many other modifications of RNA (see <http://tinyurl.com/y8c4w4mp>). One of them is A-I de-amination which changes in RNA but does not affect protein expression.

The methylation of RNA is the most common and best understood modification of RNA.

1. The modelling of the methylation of both DNA and RNA is based on writer-reader-eraser model. Writing corresponds to methylation. Reading corresponds to attachment of enzymes involved in the splicing or protein synthesis with higher rate to methylated sites. Demethylation is example of erasing.
2. Methylation is known to occur for various variants of RNA (ribosomal rRNA, tRNA, mRNA, and small nuclear RNA snRNA related to metabolic machinery) after transcription. The biochemical modifications of RNA are called epitranscriptomes (see <http://tinyurl.com/y8c4w4mp>). N⁶-Methyladenosine (m⁶A) is the most common and best understood modification of RNA. m⁶A tells that nitrogen in position 6 of adenosine (A) is methylated by adding group CH₃. m⁶A sites are often located in the last exon near the end of mRNA, in untranslated RNA (UTR) at 3' end, and inside long exons.

It has been found that 3 members of so called YTH domain protein family acting as readers have larger affinity to bind to methylated sites. One of them shortens the lifetime of mRNA after translation.

3. Methylation in general shortens the UTR (un-translated regions) of mRNA in its 5' and 3' ends (head and tail of mRNA)). One speaks of alternative poly-adenylation (APA, see <http://tinyurl.com/y7aratpv>) of the tail of the mRNA: poly-adenylation (PA) adds A-sequences to the end of mRNA affecting its dynamics: shortening of UTRs means shortening of PAs.
4. Methylation affects the rates in the dynamics of translation but does not affect the product of translation itself. A-sequences shields mRNA and during its life cycle its length is reduced somewhat like telomere (see <http://tinyurl.com/jpbkzcc>) consisting of a repeated sequence TTAGGG and also shortening during the life cycle of DNA. APA affects rates for the dynamics of translation. Also stem loops of pre-RNA can be methylated and this can increase the rate of an alternative splicing and thus change relative rates of alternative gene expressions.

5.5.2 Methyl marks in synaptic connections from the TGD point of view

What inspired this piece of text was a highly interesting popular article “Methyl marks on RNA discovered to be key to brain cell connections” about methylation of RNA in brain (see <http://tinyurl.com/y9qsnfeo>). The research article [J6] (see <http://tinyurl.com/ybg92nyd>) by Daria Merkuvjev et al has title “Synaptic N⁶-methyladenosine (m⁶A) epitranscriptome reveals functional partitioning of localized transcripts”. The researchers isolated brain cells from adult mice and compared epitranscriptomes found at synapses to those elsewhere in the cells. At more than 4,000 spots on the genome, the mRNA at the synapse was methylated more often. In more than half of genes the epitranscriptomes were found in genes coding for proteins found mostly in synapses. If the methylation was disrupted, the brain cells did not function normally. It was concluded that the methylation probably makes signalling faster.

These findings conform with the idea about representation of molecular emotions as bio-harmony. Synaptic contacts are the places where emotions should be expressed to give rise to learning by conditioning realized in terms of changed synaptic strengths. If the communication between dark and ordinary biomolecules relies on resonance frequencies, it is preserved only if the resonance frequencies for ordinary biomolecules are modified. Methylation would be one particular mechanism for changing some 3-chords of the harmony (in the simplest model only one of the 3 notes of 3-chord corresponding to A in various position). The methylations of DNA, RNA and proteins should also correlate if they are in common mood dictated by the bio-harmony.

5.6 How does brain predict future?

Quanta Magazine is a real treasure trove. The gem was at this time titled “*To Make Sense of the Present, Brains May Predict the Future*” (see <http://tinyurl.com/yb84wn7u>). The article gives links to various research articles: here I mention only the article “*Neural Prediction Errors Distinguish Perception and Misperception of Speech*” by Blank et al [J2] (see <http://tinyurl.com/y7edd3v>) .

According to the article, brain acts as a prediction machine comparing predictions with what happened and modifying the predictions accordingly. Sensory perception would not be mere 3-D sensory time=constant snapshot as believed in last century but include also a prediction of future based on it that would be outcome of sensory perception and brain is able to modify the prediction by using the difference between prediction and reality.

In TGD framework one can go even further [L12] (see <http://tinyurl.com/yczv2o5b>). Sensory organs are the seats of sensory mental images constructed by repeated signalling between brain (maybe also magnetic body) and sensory organ using dark photons propagating forth and back with maximal signal velocity and contributing to the sensory input a virtual part. Nerve pulses would create by synaptic bridges connecting flux tubes to longer flux tubes acting as waveguides for dark photons to propagate. Sensory mental image would be essentially self organization pattern nearest to the actual sensory input. The percept itself would be artwork, a caricature selecting and emphasizing the features of sensory input important for the survival.

The term predictive coding used about the process reveals that the view about how brain achieves this relies on computational paradigm. This is one possible view. Personally I do cannot regard classical computation as a plausible option. A more neutral view relies on rather obvious assumption that that temporal sequences of associations giving rise to predictions. But how does this happen?

Neuroscientists speculate about deep connections between emotions and learning: the dopaminergic neurons are indeed very closely related to the neural reward system. If the difference between the predicted and actually perceived is large the reward is small - one might also call it punishment. “Surprise” would be rather neutral word to express it. Big discrepancy causes big surprise. The comparison of predicted and what really happened would be essential. This is was one of the first predictions of TGD and might apply to simple emotions but - as I have proposed - emotions such as experience of beauty, compassion or love need not correspond to emotions need not be mere reactions.

The finding suggests a connection with the ideas about the fundamental role of emotions in learning. I have already developed this theme in this article.

1. The first finding made for snails [J5] (see <http://tinyurl.com/ycqxyeqk>) was that RNA somehow codes the experience and induces epigenetic change at the level of DNA in turn inducing a change in behavior. 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>).

This led to a TGD based model based on the notion of bio-harmony for music of dark photon triplets representing 3-chords predicting genetic code correctly. Music expresses and creates emotions: same would happen already at RNA level. DNA would get in the same mood and by resonating with the 3-chords of RNA music and changing its harmony/mood coded by resonance frequencies of nuclei, which would slightly change. Epigenetic change would take place as a consequence and change the genetic expression in turn changing the behaviour.

This brings in something genuinely new: TGD based view about dark matter, realizations of genetic code by dark proton sequences defining the dark analogs of DNA, RNA, tRNA, and amino-acids at the magnetic flux tubes of magnetic body of living system plus realization of the genetic code.

It must be emphasized that magnetic body is 4-D and corresponds to a preferred extremals connecting to two 3-surfaces at the boundaries of causal diamond. Hence the basic objects are deterministic time evolutions, analogous to programs or behavioral patterns. The sequence of associations assignable to percept could be seen as space-time surface, a predicted space-time time evolution.

2. Just a couple of days before writing this I learned about slime molds (see <http://tinyurl.com/ydc8gh4d>), which are monocellulars, which contrary to expectations learn new behaviours [I2, I3]. Nervous system is not therefore necessary for learning. Emotional RNA could be at work also here.
3. RNA would be naturally also behind the learning in CNS as a change of synaptic strengths generating effectively different synchronously firing neuron groups representing mental images and new sequences of associations providing predictions. The mismatch between prediction and real percept would be represented in terms of dopamine concentration and this in turn would generate at RNA level emotion, which would be negative for mismatch and induce corresponding DNA emotion generating epigenetic change in turn changing synaptic strengths in turn changing the prediction as a sequence of associations regarded as temporal sequence in turn changing the behavior! Long sequence of causations!

Also the speculated unification of motor control and sensory perceptions is mentioned in the popular article. In sensory perception internal environment as a model for external environment is updated. In motor action it is external environment. Connection with arrow of time? Motor action as perception of changing environment where own biological body is part of environment. In TGD framework sensory perception and motor action would be time reversals of each other at the level of sensory mental images. This view is allowed by ZEO and encouraged by the discovery of Libet that volitional act is preceded by neural activity by a fraction of second.

Motor action would be generated by a negative energy signal to the geometric past which would correspond to mental images with reversed arrow of time in TGD inspired theory of consciousness. This duality would mean that in opposite time direction motor action would be a perceptions about say hand moving in desired direction! The counterpart of predictive coding would take care of comparisons and modifying the predicted "sensory percept" so that it corresponds to reality. This sounds strange but maybe the motor actions is just passive perception from the point of view of time reversed self!

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