Article

Evolution in Many-Sheeted Space-Time: Big Vision

Matti Pitkänen [1]

Abstract

This article is third part of an article consisting of four parts and devoted to evolution in many-sheeted space-time. In the first part the basic facts believed to be known about pre-biotic evolution were discussed and the TGD inspired vision about prebiotic evolution was introduced. In the second part a physical model for the genetic code (not the only one) and its evolution was introduced and McFadden's views were compared with TGD views. In the third part a general vision about biological evolution, evolution of brain, and cultural evolution are discussed. In the fourth part quantum variant of expanding earth model and pre-cambrian evolution of continents, climate, and life will be developed. The considerations of all these articles rely heavily on the notion of magnetic body and dark matter identified as hierarchy of phases labelled by an effective value of Planck constant coming as an integer multiple of ordinary Planck constant. Also the idea about hierarchy of Josephson junctions (cell membrane would provide the basic realization) is central.

In the proposed model for the evolution great leaps in evolution would correspond to phase transitions in which the effective value of Planck constant - $\hbar_{eff}$ - assignable to an onion like layer of the magnetic body increases. This implies scaling up of quantum coherence lengths and - times and therefore macroscopic quantum coherence in arbitrarily long length scales. $\hbar_{eff}$ serves as a kind of intelligence quotient. Evolution would correspond to the emergence of new layers to the magnetic bodies of organisms. This would take place also for the magnetic bodies of populations making possible cultural evolution and the great differences between us and our ancestors and nearest species with almost the same genome might be due to the cultural evolution not reducible to the evolution of genome alone. Coherent collective gene expression would be one of the implications.

1 Introduction

The idea about magnetic body carrying macroscopic quantum phases characterized by a hierachy of effective values of Planck constants suggests that great leaps in evolution would correspond to phase transitions in which the effective value of Planck constant - $\hbar_{eff}$ - assignable to an onion like layer of the magnetic body increases. This implies scaling up of quantum coherence lengths and - times and therefore macroscopic quantum coherence in arbitrarily long length scales. $\hbar_{eff}$ serves as a kind of intelligence quotient. Evolution would correspond to the emergence of new layers to the magnetic bodies of organisms. This would take place also for the magnetic bodies of populations making possible cultural evolution and the great differences between us and our ancestors and nearest species with almost the same genome might be due to the cultural evolution not reducible to the evolution of genome alone. Coherent collective gene expression would be one of the implications.

When I started to develop the idea, several obvious questions popped up. The preferred values of (effective) Planck constant are assumed to be integer multiples of ordinary Planck constant: does this integer have preferred values? For eight years later I take the original speculative answer to this question with a grain of salt. Can one distinguish between evolution of biological and magnetic body and identify cultural evolution as evolution of magnetic body? EEG and its variants (and the predicted scaled variants of these) are expected to characterize living organisms, even super organisms like ant nest, bee hive, and bacterial colony: is this really the case? Does bee hive possess a long term memory and what is the role of the queen? One can also ask questions about the evolution of nervous system in the same conceptual

[1]Correspondence: Matti Pitkänen `http://tgdtheory.com/`. Address: Köydenpunojankatu 2 D 11 10940, Hanko, Finland. Email: matpitka@luukku.com.

framework. Are the magnetic bodies of neurons and larger structures characterized by $\hbar_{eff}$? What about collective and transpersonal levels of consciousness?

Sheldrake's vision [23] about species memory is also highly interesting from TGD point of view but is not considered in the article series about prebiotic evolution. The interested reader can however consult the article at [23]. The latest view about TGD inspired theory of consciousness justifying Sheldrake's vision in terms of negentropically entangled states defining representations invariant under quantum jump sequence and in this manner giving rise to "Akashi records" defining sensory - , memory - , etc. representations can be found at [22].

Dark photons characterized by the value of $\hbar_{eff}$ and transforming to ordinary photons with the same energy identified as biophotons are becoming a central element of TGD inspired quantum biology [21]: in particular the non-destructive conscious reading of the memories represented in terms of negentropically entangled states by interaction free measurement is very attractive idea [22]. The communications by dark photons might have been present already during the prebiotic era before the emergence of biochemical signalling and neural communications. The role of dark photons is not discussed in the vision as it was formulated for more than five years ago.

2 Great vision about biological evolution and evolution of brain

The following great vision about evolution is not perhaps strictly about hierarchy of EEGs. The hierarchy of dark matter and EEGs however leads to this vision naturally. The first part of vision relates to biological evolution. Second part is about the evolution of brain. Here the key thread is evolution of two kinds of intelligences, the ordinary fast intelligence evolving via the emergence of fast computation type activities and emotional slow intelligence developing via the emergence of higher levels of dark matter hierarchy. The latter intelligence is what distinguishes us from animals.

2.1 Basic assumptions

The great vision about evolution and brain relies on two several new notions and ideas.

1. Life as something in the intersection of real and p-adic worlds making possible negentropic entanglement-both space-like and time-like. This makes possible to understand what conscious intelligence is and NMP reduces evolution to a generation of negentropic entanglement. DNA as topological quantum computer hypothesis [15] finds also a justification.

2. The notion of many-sheeted space-time implying a universal hierarchy of metabolic energy quanta, and the notion of magnetic body.

3. Communication and control based on Josephson radiation and cyclotron transitions crucial for understanding biophotons and EEG and its fractal generalization as a key element of bio-communications.

4. Zero energy ontology and the closely related notion of causal diamond (CD) assigning a hierarchy of macroscopic time scales to elementary particles coming as octaves of the basic time scale and justifying p-adic length scale hypothesis. Zero energy energy ontology also justifies the vision about memory and intentional action and the idea that motor action can be seen as time reversal of sensory perception.

5. The hierarchy of Planck constants and the identification of the fundamental evolutionary step as an increase of Planck constant. Evolutionary steps mean migration to the pages of the Big Book labeled by larger values of Planck constant and living system can be regarded as a collection of pages of the Big Book such that a transfer of matter and energy between the pages is taking place all the time. The change of the Planck constant implies either reduction or increase of the quantum scales-this leads to a model for biocatalysis and a model of cognitive representations as scaled down or scaled up "stories" mimicking the real time evolution.

6. A resonant like interaction between hierarchy of Planck constants and p-adic length scale hierarchy favoring the values of Planck constant proportional to powers of two, and idea that weak and color interactions are especially important in the length scales which correspond to Mersenne primes and Gaussian Mersennes. The simplest option is that weak bosons have their standard masses but appear as massless below their Compton length which scales up like $\hbar$ and preferred p-adic length scales correspond to Mersenne primes. Also copies of weak bosons and gluons with ordinary value of Planck constant and reduced mass scale can (and will) be considered.

2.1.1 How to identify the preferred values of Planck constant?

The basic problem is to identify the preferred values of Planck constant and here one can only make theoretical experimentation and all what follows must be taken in this spirit. One can consider assumptions which become increasingly stronger.

1. If only singular coverings of CD and CP_2 are possible Planck constant is a product of integers. Algebraic simplicity of algebraic extensions of rationals favors ruler and compass integers (Appendix). This includes powers of two.

2. A resonant interaction between the dark length scales and p-adic length scales with ordinary value of Planck constant favors Planck constants coming as powers of two.

3. An even stronger assumption would be that p-adic length scales coming as Mersennes and Gaussian Mersennes are especially interesting.

   (a) If weak bosons can appear with the ordinary value of Planck constant only in the p-adic length scale $k = 89$, one obtains the condition

   $$k_d = k - 89 \quad , \quad k \in \{89, 107, 113, 127, 151, 157, 163, 167\} \tag{2.1}$$

   for the values of of $r = 2^{k_d}$ allowing dark weak bosons in p-adic length scales assignable to Mersennes. These values of k_d assign to electrons and quarks dark p-adic length scales $L(k_{eff}) = \sqrt{r}L(k)$, $r \equiv \hbar/\hbar_0 = 2^{k_d}$. The scales could correspond to size scales of basic units of living systems.

   (b) If weak bosons and possibily also gluons with ordinary value of Planck constant are possible in all p-adic length scales $L(k)$, $k \in \{89, 107, 113, 127, 151, 157, 163, 167\}$, one obtains much richer structure. This hierarchy defines defines secondary dark matter hierarchies from the condition that the scaling the p-adic length scale $L(k_1)$ in this set by $\sqrt{r}$, $r \equiv \hbar/\hbar_0 = 2^{k_d}$, gives a p-adic length scale equal to another p-adic length scale $L(k_2)$ in this set. This requires $k_d + k_1 = k_2$ so that the values

   $$k_d = k_2 - k_1 \tag{2.2}$$

   are favored for the scaling of $\hbar$. In this case the hierarchy of dark scales assignable to quarks and leptons is much richer. The tables below demonstrate that electron appears as its dark variant for all Mersennes and also in atomic length scales $k = 137, 139$ so that this option puts electron in a completely unique position.

4. Also other scales are possible. For instance, $r = 2^{47}$ required by 5 Hz Josephson frequency gives dark weak scale which corresponds $k = 136$ as a p-adic scale. The stages of sleep can be understood in terms of scaling of $\hbar$ by factor 2 and 4 so that also the atomic length scale $k = 137$ and the scale $k = 138$ are involved.

Since the experimental input is rather meager, one is forced to do theoretical experimentation with various hypothesis. The quantitative experimental tests are rather primitive but basically quantal.

1. The time scales assignable to CDs of leptons and quarks and their scaled up counterparts for the preferred values of Planck constant should define biologically important time scales. One might even speak about evolutionary level of electron. These time scales could define fundamental biorhythms and also time scales of long term memory and planned action.

2. Josephson frequencies and cyclotron frequencies scaling like $1/\hbar$ (if magnetic field scales down like $1/\hbar$) charactering biologically important ions and elementary particles. With inspiration coming from the quantum criticality of living matter one can ask whether cell membrane can also correspond to almost vacuum extremal so that besides classical em force also the classical Z^0 force would be an essential element of the model [16]. Also corresponding cyclotron and Josephson frequencies should define fundamental bio-rhythms and characterize the evolutionary level of cell. Experimentally of special importance are the cyclotron frequencies assignable to Ca^{++} ions.

3. The amplitude windows for electric field scaling like $\hbar$ for a particular cyclotron frequency define a basic prediction.

2.1.2 Tables about predicted time and length scales

The following tables summarize various predictions for time scales and length scales. They correspond to the most general assumption that exotic bosons with the ordinary value of Planck constant are possible in all length scales associated with Mersennes and Gaussian Mersennes.

k_d	p_1	p_2		k_d	p_1	p_2
4	163	167		38	**89**	127
6	107	113		38	113	151
6	151	157		40	127	167
6	157	163		44	107	151
10	157	167		44	113	157
12	151	163		50	107	157
14	113	127		50	113	163
16	151	167		54	113	167
18	**89**	107		56	107	163
20	107	127		60	107	167
24	**89**	113		62	**89**	151
24	127	151		68	**89**	157
30	127	157		74	**89**	163
36	127	163		78	**89**	167

Table 5. The integers k_d characterizing the preferred values of $r = \hbar/\hbar_0 = 2^{k_d}$ identified from the condition that the dark variant of p-adic length scale $L(p_1)$ corresponding to some ordinary p-adic length scale defined by Mersenne prime M_p or Gaussian Mersenne $M_{G,p}$, $p \in \{89, 107, 113, 127, 151, 157, 163, 167\}$ corresponds to similar p-adic length scale $L(p_2)$. If one assumes that weak bosons can appear with ordinary value of Planck constant only in the p-adic length scale $k = 89$, only the rows with $p_1 = 89$ of the table are possible: in these cases p_1 is in boldface and the row has double underline. The corresponding values of k_d are in the set $\{18, 24, 38, 62, 68, 74, 78\}$.

Note that the table above include only the dark length scales associated with $k = 89$ gauge bosons.

Z, W	d	u	e	k_d
89	120	124	127	**0**
93	124	127	131	4
95	126	129	133	6
99	130	133	137	10
101	132	135	139	12
103	134	137	141	14
105	136	139	143	16
107	138	141	145	**18**
109	140	143	147	20
113	144	147	151	**24**
119	150	153	157	30
125	156	159	163	36
127	158	161	165	**38**
129	160	163	167	40
133	164	167	171	44
139	170	173	177	50
143	174	177	181	54
145	176	179	183	56
149	180	183	187	60
151	182	185	189	**62**
157	188	191	195	**68**
163	194	197	201	**74**
167	198	201	205	**78**

Table 6. The dark p-adic length scales $\sqrt{r}L(k) = L(k_{eff})$, $k_{eff} = k + k_d$, of intermediate gauge bosons Z, W, d and u quarks, and electron for the values $r = 2^{k_d}$ of Planck constant defined in Table 5. The uppermost row gives the integers characterizing the p-adic length scales of the particles for the standard value of Planck constant. k_{eff} characterizes also the CD times scale through the formula $T(CD, k_{eff}) = 2^{k_{eff}-127} \times .1$ seconds. The rows which correspond to the less general option for which only M_{89} corresponds to weak bosons with ordinary value of Planck constants have double underline and the corresponding values of k_d are in boldface.

k_1	k_M		k_1	k_M		k_1	k_M		k_1	k_M
113	89		113	107		163	127		163	157
127	89		119	107		167	127		169	157
151	89		123	107		133	127		173	157
157	89		113	107		139	127		163	157
163	89		117	107		143	127		167	157
167	89		111	107		133	127		161	157
95	89		175	113		137	127		169	163
109	89		181	113		131	127		183	163
133	89		187	113		225	151		207	163
139	89		191	113		229	151		213	163
145	89		119	113		157	151		219	163
149	89		133	113		171	151		223	163
103	89		157	113		195	151		177	163
127	89		163	113		201	151		201	163
133	89		169	113		207	151		207	163
139	89		173	113		211	151		213	163
143	89		127	113		165	151		217	163
113	89		151	113		189	151		187	163
119	89		157	113		195	151		193	163
125	89		163	113		201	151		199	163
129	89		167	113		205	151		203	163
95	89		137	113		175	151		169	163
101	89		143	113		181	151		175	163
105	89		149	113		187	151		179	163
95	89		153	113		191	151		169	163
99	89		119	113		157	151		173	163
93	89		125	113		163	151		167	163
145	107		129	113		167	151		187	167
169	107		119	113		157	151		211	167
175	107		123	113		161	151		217	167
181	107		117	113		155	151		223	167
185	107		195	127		235	157		227	167
113	107		201	127		163	157		181	167
127	107		205	127		177	157		205	167
151	107		133	127		201	157		211	167
157	107		147	127		207	157		217	167
163	107		171	127		213	157		221	167
167	107		177	127		217	157		191	167
121	107		183	127		171	157		197	167
145	107		187	127		195	157		203	167
151	107		141	127		201	157		207	167
157	107		165	127		207	157		173	167
161	107		171	127		211	157		179	167
131	107		177	127		181	157		183	167
137	107		181	127		187	157		173	167
143	107		151	127		193	157		177	167
147	107		157	127		197	157		171	167

Ǐ

Table 9. The table gives all weak boson length scales -both non-dark and dark implied by the assumption that all Mersennes primes and their Gaussian counterparts and their dark counterparts defined $k_d = k_i - k_j$ them are possible.

particle	Z, W	d	u	e
k	89	120	123	127
f(CD)/Hz	2.7488×10^{12}	1280	160	10

Table 8. The fundamental frequencies associated with the CDs of intermediate gauge bosons Z, W, d and u quarks, and electron. Note that for intermediate gauge bosons the frequency of CDs corresponds to energy $E = 1.13 \times 10^{-2}$ eV and wavelength $\lambda = 1.01 \times 10^{-4}$ m (size of a large neuron).

Z, W	d	u	e	k_d
3.64e-13	7.81e-04	6.25e-03	1.00e-01	**0**
5.821e-12	1.25e-02	1.00e-01	1.60e+00	4
2.31e-11	5.00e-02	4.00e-01	6.40e+00	6
3.73e-10	8.00e-01	6.40e+00	1.02e+02	10
1.49e-09	3.20e+00	2.56e+01	4.10e+02	12
5.97e-09	1.28e+01	1.02e+02	1.65e+03	14
2.38e-08	5.12e+01	4.10e+02	6.55e+03	16
9.54e-08	2.05e+02	1.64e+03	2.62e+04	**18**
3.81e-07	8.19e+02	6.55e+03	1.05e+05	20
6.10e-06	1.31e+04	1.05e+05	1.68e+06	**24**
3.91e-04	8.39e+05	6.71e+06	1.07e+08	30
2.50e-02	5.37e+07	4.30e+08	6.87e+09	36
1.00e-01	2.15e+08	1.72e+09	2.75e+10	**38**
4.00e-01	8.59e+08	6.87e+09	1.10e+11	40
6.40e+00	1.37e+10	1.10e+11	1.76e+12	44
4.10e+02	8.80e+11	7.04e+12	1.12e+14	50
6.55e+03	1.41e+13	1.13e+14	1.80e+15	54
2.62e+04	5.63e+13	4.50e+14	7.21e+15	56
4.19e+05	9.01e+14	7.21e+15	1.15e+17	60
1.68e+06	3.60e+15	2.88e+16	4.61e+17	**62**
1.07e+08	2.31e+17	1.84e+18	2.95e+19	**64**
6.87e+09	1.48e+19	1.18e+20	1.89e+21	**74**
1.10e+11	2.36e+20	1.89e+21	3.02e+22	**78**

Table 9. The $\hbar$-scaled fundamental time scales $T(CD, k_{eff}) = 2^{k_{eff}-127} \times .1$ seconds associated with the CDs of intermediate gauge bosons Z, W, d and u quarks, and electron for the values $\hbar/\hbar_0 = 2^{k_d}$ of Planck constant defined in Table 5. The scales are expressed in seconds. The uppermost row gives the time scales of CDs for the standard value of Planck constant. The rows which correspond to the less general option for which only M_{89} corresponds to weak bosons with ordinary value of Planck constants have double underline and the corresponding values of k_d are in boldface.

2.1.3 Electron and u quark are different

Before continuing an important observation is in order. Electron is exceptional when compared to quarks. It appears as a dark particle in all p-adic length scales defined by biologically important Gaussian Mersennes and also in atomic length scales $k = 137$ and $k = 139$. The reason is trivial: by the basic assumptions electron must appear at same length scales as weak bosons above $k = 127$ since it corresponds to Mersenne prime. Also for the less general option (exotic intermediate gauge bosons are possible only as the dark variants of the standard ones) it appears at cell membrane length scale $k = 151$, which is due to the fact that one has $113 - 89 = 151 - 127 = 24$. Also u quark can appear with $k_{eff} = 137, 139, 163, 167$ and also this is an accident. The light invariants of intermediate gauge bosons appearing in long p-adic length scales would naturally correspond to almost vacuum extremals making possible the criticality as the basic aspect of life. One must of course be very cautious about the masses of exotic counterparts of u and d quark: one can also consider the possibility that masses are identical.

2.2 Dark matter hierarchy and big leaps in evolution

Dark matter hierarchy leads to an amazingly concrete picture about evolutionary hierarchy allowing to identify the counterparts for concepts like mineral, plant, and animal kingdom that we learned during schooldays and ceased to take seriously as students of theoretical physics as we learned that other sciences are just taxonomy. Even more, a view about what distinguishes between prokaryotes, eukaryotes, animal cells, neurons, EEG, and even about what makes cultural evolution, becomes possible. This view is also very useful when one tries to understand the role of microtubules.

The appearance of CDs scaled up in size by $r = \hbar/\hbar_0$ and space-time sheets scaled up in size by $\sqrt{r}$ means the emergence of new levels of structure and it is natural to identify big leaps in evolution in terms of emergence of new larger matter carrying space-time sheet magnetic flux sheets and corresponding magnetic bodies. If magnetic flux quanta are scaled by r magnetic flux quantization conditions remain unaffected if magnetic field strengths scale down by $1/r$ so that the energies of cyclotron photons are not affected. The thickness of flux tubes can remain unchanged if the currents running at the boundaries of the flux quantum cancel the magnetic flux. As already found, this mechanism must be at work inside living organisms wheras in far away region flux quanta are scaled up in size.

The attractive hypothesis is that the leaps in evolution correspond to the emergence of dark variants of weak and possibly also color interactions in dark p-adic length scales which correspond to ordinary p-adic length scales characterized by Mersenne primes. These leaps would be quantum leaps but in different sense as thought usually. The emergence of higher dark matter levels would basically mean the integration of existing structures to larger structures. A good metaphor are text lines at the pages of book formed by magnetic flux sheets whose width is scaled up by r as the new level of dark matter hierarchy emerges. The big leaps can occur both at the level of organism and population and organisms with rather low individual dark matter level can form societies with high dark matter levels and high collective intelligence (honeybees and ants are good example in this respect).

Certainly also other scalings of Planck constant than those summarized in tables are possible but these scalings are of primary interest. This intuition is supported by the observation that electron is completely exceptional in this framework. Electron's dark p-adic length scales corresponds to p-adic length scales $L(k)$, $k = 167, 169$, assignable to atomic and molecular physics and to the Gaussian Mersennes $M_{G,k} = (1+i)^k - 1$, $k \in \{151, 157, 163, 167\}$, assignable to the length scale range between cell membrane thickness 10 nm and nucleus size 2.58 μm. The corresponding p-adic length scales, the number of which is 23, are excellent candidates for the scales of basic building brickes of living matter and vary from electron's p-adic length scale up to 1.25 m ($k = 167$ defining the largest Gaussian Mersenne in cell length scale range) and defining the size scale of human body. The corresponding p-adic time scales are also highly interesting and vary from .1 seconds for electron defining the fundamental biorhythm to 9.6×10^{14} years which is by 4-5 orders longer than the age of the observed Universe. For $k = 167$ the time scale is 1.1×10^{11} years and is by one order of magnitude longer than the age of the observed Universe estimated

to be 1.37×10^{10} years [3] .

This conceptual framework gives rather strong guidelines for the identification of the levels of evolutionary hierarchy in terms of dark matter hierarchy. The outcome is a more detailed vision about big evolutionary leaps. Note that in the sequel only the general option is considered: the justification for this is that for this option electron appears as a dark particle for all length scales defined by Gaussian Mersennes as well as in atomic length scales. The basic vision in nutshell is that evolution means the emergence of dark weak and gluonic physics in both dark and ordinary length scales and that the size scales of the basic biostructures correspond to Mersenne primes and their Gaussian variants.

2.2.1 A sketch about basic steps in evolution

The vision about evolution depends on what one assumes about the initial state.

1. If one assumes that weak bosons with ordinary value of Planck constant were present in the begining, evolution would mean a steady growth of k_d. The problem is that small values of $k_d = k_1 - k_2$ correspond to the Gaussian Mersennes defining cellular length scales. If these exotic weak physics were present from the beginning, large parity breaking in cellular length scales would have been present all the time.

2. An alternative and perhaps more realistic view is that the evolution means the emergence of exotic weak physics corresponding almost vacuum extremals in increasingly longer length scales. A possible mechanism could have been the induction of exotic $\hbar_0$ variant of weak physics at the nearest Mersenne length scale k_{next} by the dark variant of weak physics at level k so that one would have $k_d = k_{next} - k$. The simplest induction sequence would have been $89 \to 107 \to 113 \to 127 \to 151 \to 157 \to 163 \to 167$ corresponding to $k_d \in \{18, 6, 14, 24, 6, 6, 4\}$. A possible interpretation of exotic $\hbar_0$ physics is in terms of almost vacuum extremals and non-standard value of Weinberg angle: also weak bosons of this physics would be light. This sequence defines the minimal values for k_d but also larger values of k_d are possible and would correspond to steps between neighbours which are not nearest ones.

The following sketch about the basic steps of evolution relies on the latter option.

1. Elementary particle level

Magnetic bodies with size scale defined by the sizes of CDs assignable to quarks and leptons and possibly also weak bosons (already now the size of big neuron emerges) corresponds to the lowest level of hierarchy with the sizes of the basic material structures corresponding to the Compton lengths of elementary particles. The fundamental bio-rhythms corresponding to frequencies 10, 160, and 1280 Hz appear already at this level in zero energy ontology which suggests that elementary particles play a central and hitherto unkown role in the functioning of living matter.

2. $89 \to 107$ *step with* $k_d = 18$

The first step would have been the emergence of $k_{eff} = 107$ weak bosons inducing $\hbar_0$ weak physics in $k = 107$ length scale characterizing also ordinary hadrons. This in turn would have led to the emergence of exotic nucleons possibly corresponding to almost vacuum extremals. The reduction of the model for the vertebrate genetic code to dark hadron physics [20] is one of the most unexpected predictions of quantum TGD and assumes the existence of exotic- possibly dark- nucleons whose states with a given charge correspond to DNA, RNA, mRNA, and tRNA. The $\hbar_0$ variants of these nucleons would interact via weak bosons with hadronic mass scale. The exotic variants of the ordinary $k = 113$ nuclei would correspond to the nuclear strings consisting of exotic nucleons [14, 20] and define nuclear counterparts for DNA sequences. Their dark counterparts could define counterparts of DNA sequences in atomic physics length scales. Therefore a justification for the previous observation that genetic code could be realized at the level of hadron physics and that chemical realization would be higher level realization finds

justification. The anomalous properties of water could be also partly due to the presence of dark nucleons and the proposal was that the presence of exotic nuclei is involved with water memory [17] . The possible existence of the the analog of DNA-RNA transcription between ordinary DNA and its nuclear counterpart would have dramatic implications. For instance, one can imagine a mechanism of homeopathy based on this kind of transription process which would also allow a modification of genome by using dark nuclei to communicate the DNA sequences through the cell membrane to the target nuclei.

3. $107 \to 113$ *step with* $k_d = 6$

The next step would have been the emergence of $k_{eff} = 113$ weak bosons inducing $\hbar_0$ weak physics in $k = 113$ length scale characterizing also ordinary hadrons. Exotic variants of the ordinary nuclei possibly corresponding to almost vacuum extremals could have emerged interacting weakly (or actually relatively strongly!) via the exchange of weak bosons with mass scale of order 100 MeV. Also dark variants of the exotic $k = 107$ nucleons could have have emerged and formed exotic nuclei of size scale $k = 119$.

4. $113 \to 127$ *step with* $k_d = 14$

At this step weak bosons in electron mass scale would have emerged. Whether these weak bosons could have induced large parity breakings in atomic and molecular length scales is not clear. Viruses, which do not yet possess cell membrane could correspond to this level of hierarchy.

5. $127 \to 151$ *step with* $k_d = 24$

This step would have been fundamental since weak bosons in cell membrane length scale would have appeared. Note that by $113 - 89 = 24$ this step also leads from $k = 89$ weak bosons to $k = 113$ weak bosons. The weak bosons assignal to $k = 151$ could correspond to the weak interactions associated with almost vacuum extremals and $sin^2(\theta_W) = .0295$ could correspond to the weak physics in question.

$k_d = 24$ step for $k = 113$ $\hbar_0$ weak bosons would have produced them in $k_{eff} = 137$ atomic length scale with $L(137) \simeq .78$ Angstrom This could have naturally led to large parity breaking effects and chiral selection.

Dark $k_{eff} = 151$ electrons appearing in the TGD inspired model of high T_c super-conductivity would have been a by-product of this step. Whether dark electrons could have transformed to light $\hbar_0$ electrons (of mass .25 keV) with a common mass scale of order 10^2 eV with exotic weak bosons is an interesting question. The model of high T_c super-conductivity predicts the presence of structures analogous to cell membrane. This would suggest that cell membranes emerged and chiral selection emerged at this step so that one could not distinguish the emergence of molecular life as a predecessor for the emergence of cell membrane like structures. This would conform with the fact that DNA molecules are stable only inside cell nucleus. Note that for $k_{eff} = 151$ electron's CD has time scale $2^{24} \times .1$ seconds -that is 19.419 days (day=24 hours).

The smallest nanobes [6] appearing in rocks have size 20 nm and could have emerged at this step. The size of the viruses [7] is between 10-300 nm covers the entire reange of length scales assignable to Gaussian Mersennes, which suggests that smallest viruses could have emerged at this step. Also the smallest [5] [5] , which by definition have size smaller than 300 nm could have appeared at this stage.

6. The remaining steps

The remaining steps $k = 151 \to 157 \to 163 \to 167$ could relate to the emergence of coiling structure DNA and other structures inside cell nucleus. $k = 167$ would correspond to $k_d = 167 - 89 = 68$ to be compared with the value $k_d = 47$ required by 5 Hz Josephson frequency for the neuronal membrane for -70 mV resting potential. Note that $k_d = 48$ (state 1-2 of deep sleep) corresponds to $k = 163$.

By their smallness also double and triple steps defined by $k_d = k_{i+n} - k_i$, $n > 1$, are expected to be probable. As a consequence, electrons can appear as dark electrons at all the Gaussian Mersenne levels. At these steps the dark electrons corresponding to primes $k_{eff} = 137, 139$ would appear. For $k = 137$ dark electron appears with CD time scale equal to 128 seconds- rather precisely two minutes. The model for EEG suggests that the exotic weak bosons appear in the scales $k_{eff} = 136, 137, 138$.

Further multisteps from the lower levels of hierarchy would give structures with size scales above the size of cell nucleus possibly assignable to organs and structural units of brain. The dark levels assignable to electron are expected to be of special interest. It is encouraging that the longest scale assignable to electron in this manner corresponds to $k = 205$ and length scale of 1.28 m defining body size. As a consequence dark electrons are predicted at levels $k = 137, 139, 141, 143, 145, 147$ coming as octaves.

Prokaryotic cells (bacteria, archea) without cell nucleus for which cell membrane is responsible for metabolic functions and genome is scattered around the cell could have emerged at this step. This would mean that the emergence of the cell membrane thickness as a fundamental scale is not enough: also the size scale of membrane must appear as p-adic length scale. The sizes of most prokaryotes vary between 1 μm and 10 μm: the lower bound would require $k = 163$. There also prokaryotes with sizes between .2 μm ($k = 157$ corresponds to .08 μm) and 750 μm. Cell nuclei, mitochondria, and other membrane bounded cell nuclei would have evolved from prokaryotes in this framework. The sizes of eukaryote cells are above 10 μm and the fact that multicellular organisms are in question strongly suggests that the higher multisteps giving rise to weak bosons and dark electrons in length scales above $L(167)$ are responsible for multi-cellular structures.

This scenario leaves a lot of questions unanswered. In particular, one should understand in more detail the weak physics at various length scales as well as various exotic nuclear physics defined by dark nucleons and dark variants of nuclei.

2.2.2 Division of the evolution to that of biological body and magnetic body

Electron's Mersenne prime M_{127} is the highest Mersenne prime, which does not correspond to a completely super-astrophysical p-adic length scale. In the case of Gaussian Mersennes $M_{G,k}$ one has besides those defined by k in $\{113, 151, 157, 163, 167, \}$ also the ones defined by k in $\{239, 241, 283, 353, 367, 379, 457, 997\}$ [1] . The appropriately extended model for evolution allows to distinguish between three kinds of values of k_{eff}.

1. The values of k_{eff} for which electron can appear as dark particle and thus satisfying $k_{eff} \leq 205$ (Table 5). These levels would correspond to structures with size below 1.25 m defined roughly by human body size and it is natural to assign the evolution of super-nuclear structures to the levels $167 < k_{eff} \leq 205$.

2. The values of of k_{eff} for which dark gauge bosons are possible in the model. This gives the condition $k_{eff} \leq 235$. These levels correspond to structures in the range 1.25 m-40 km. The identification as parts of the magnetic body can be considered.

3. The values of k_{eff} obtained by adding to the system also the Gaussian Mersenne pair $k \in \{239, 241\}$ allowing also the dark electrons. The lower size scale for these structures is 640 km.

4. The higher levels corresponding to k_{eff} in $\{283, 353, 367, ...\}$. The lower size scale for these structures is 3 AU (AU is the distance from Earth to Sun).

$k_{eff} > 205$ levels would correspond to the emergence of structures having typically size larger than that of the biological body and not directly visible as biological evolution. This evolution could be hidden neuronal evolution meaning the emergence of extremely low Josephson frequencies of the neurons modulating higher frequency patterns and being also responsible for the communication of long term memories.

2.2.3 Biological evolution

In principle the proposed model allowing multisteps between hierarchy levels defined by Mersenne primes and their Gaussian counterparts could explain the size scales of the basic structures below the size scale 1.25 m identified in terms of the $k_{eff} \leq 205$ levels of the hierarchy.

1. The emergence of cells having organelles

The appearance of the structures with $k_{eff} > 167$ (possibly idetifiable as magnetic body parts) should correlate with the emergence of simple eukaryotic cells and organisms, in particular plant cells for which size is larger than 10 μm, which could correspond to $k_{eff} = 171$ for electron and dark variants of weak gauge bosons. $k_{eff} = 177$ is the next dark electron level and corresponds to 80 μm scale. It seems natural to assume that these dark weak bosons do not transform to their $\hbar_0$ counterparts at these space-time sheets.

Cell nucleus would be the brain of the cell, mitochondria would be the energy plant, and centrioles generating microtubules would define the logistic system. Also other organelles such as Golgi apparatus, ribosomes, lysosomes, endoplasmic reticulum, and vacuoles would be present. These organelles would live in symbiosis by topologically condensing to $k_{eff} \geq 171$ magnetic body controlling their collective behavior. Centrosomes associated with animal cells would not be present yet but microtubule organizing centers would already be there.

The recent observations show that centrioles are not always in the characteristic T shaped conformation. Daughter centrioles resulting during the replication of mother centriole use first ours of their lifetime to roam around the cell before becoming mature to replicate. A possible interpretation is that they are also life forms and that magnetic body utilizes daughter centrioles to perform some control functions crucial for the future development of the cell. For instance, centrioles visit the place where axonal growth in neurons starts.

Cytoskeleton would act as a counterpart of a central nervous system besides being responsible for various logistic functions such as transfer of proteins along microtobuli. Centrioles give also rise to basal bodies and corresponding cilia/flagella used by simple cells to move or control movement of air or liquid past them. Centriole pair would be also used by the magnetic body to control cell division.

The logistic functions are the most obvious functions of microtubules. Magnetic body would control cell membrane via signals sent through the cell nucleus and communicated to the cell membrane along microtubuli. Basal bodies below the cell membrane and corresponding cilia/flagella would serve as motor organs making possible cell motion. Tubulin conformations representing bits would allow microtubule surface to represent the instructions of the magnetic body communicated via via cell nucleus to various proteins moving along the microtubular surface so that they could perform their functions.

TGD based view about long memory recall as communication with geometric past allows also the realization of cellular declarative memories in terms of the conformational patterns. Memory recall corresponds to a communication with geometric past using phase conjugate bosons with negative energies reflected back as positive energy bosons and thus representing an "image" of microtubular conformation just like ordinary reflected light represents ordinary physical object. There would be no need for a static memory storage which in TGD framework would mean taking again and again a new copy of the same file.

Receptor proteins would communicate cell level sensory input to the magnetic body via MEs parallel to magnetic flux tubes connecting them to the magnetic body. We ourselves would be in an abstract sense fractally scaled up counterparts of receptor proteins and associated with dark matter iono-lito Josephson junction connecting the parts of magnetosphere below litosphere and above magnetosphere. The communication would be based on Josephson radiation consisting of photons, weak bosons, and gluons defining the counterpart of EEG associated with the level of the dark matter hierarchy in question.

3. The emergence of organs and animals

The emergence of magnetic bodies with k_{eff} in the range $(177, 181, 183, 187,\ 189, 195, 201, 205)$ allowing both dark electron and weak bosons could accompany the emergence of multicellular animals. Magnetic body at this level could give rise to super-genome making possible genetic coding of organs not yet possessed by plant cells separated by walls from each other. The super structures formed from centrosomes and corresponding microtubuli make possible complex patterns of motion requiring quantum coherence in the scale of organs as well as memories about them at the level of organs.

4. The emergence of nervous system

k_{eff} in the range $(187, 189, 195, 201, 205)$ allowing dark electrons and weak bosons gives size scales $(.25, .5, 4, 32, 128)$ cm, which could correspond to the scales of basic units of central nervous system. What would be of special interest would be the possibility of charged entanglement based on classical W fields in macroscopic length scales. The emergence of the new level means also the integration of axonal microtobuli to "text lines" at the magnetic flux sheets making possible logistic control at the multineuronal level. The conformational patterns of the microtubular surface would code nerve pulse patterns to bit patterns representing declarative long term memories. An interesting question is whether the reverse coding occurs during memory recall.

2.2.4 The evolution of magnetic body

For mammals with body size below 1.25 m the levels $k_{eff} > 205$ cannot correspond to biological body and the identification in terms of magnetic body is suggestive. The identification of EEG in terms of Josephson frequencies suggests the assignment of EEG with these levels.

1. The emergence of EEG

EEG in the standard sense of the word is possessed only by vertebrates and one should understand why this is the case. The value of Josephson frequency equal to 5 Hz requires only $k_d = 47$ so that something else must be involved. A possible explanation in the framework of the proposed model comes from the following observations.

1. Besides the maximal p-adic scale $k = 205$ for which electron and weak bosons appears as dark variants the model allows also levels at which only gauge bosons appear as dark particles. From Table 9 one finds that levels $k \in \{207, 211, 213, 217, 219, 221, 223, 225, 229, 235\}$ are allowed. Could it be that these levels and possibly some highest levels containing both electrons and gauge bosons as dark particles are a prerequisite for EEG as we define it. Its variants at higher frequency scales would be present also for invertebrates. The lowest Josephson frequency coded by the largest value of $\hbar$ in the cell membrane system determins the Josephson frequency.

2. The membrane potentials -55 mV (criticality against firing) correspond to ionic Josephson energies somewhat above 2 eV energy ((2.20,2.74,3.07,2.31) eV, see Table 1). For 2 eV the wavelength 620 nm is near to $L(163) = 640$ nm. Therefore the Josephson energies of ions can correspond to the p-adic length scale $k = 163$ if one assumes that a given p-adic mass scale corresponds to masses half octave above the p-adic mass scale so that the opposite would hold true at space-time level by Uncertainty Principle. Josephson frequencies $f_J \in \{5, 10, 20, 40, 80, 160\}$ Hz correspond to $k_d \in \{47, 46, 45, 44, 43, 42\}$ giving $k_{eff} \in \{210, 209, 208, 207, 206, 205\}$.

   (a) Cerebellar resonance frequency 160 Hz would correspond to $k = 205$ -the highest level for for which model allows dark electrons (also 200 Hz resonance frequency can be understood since several ions are involved and membrane potential can vary).

   (b) The 80 Hz resonance frequency of retina would correspond to $k_{eff} = 206$ -for this level dark electrons would not be present anymore.

   (c) 40 Hz thalamocortical frequency would correspond to $k_{eff} = 207$.

   (d) For EKG frequencies are EEG frequencies below 20 Hz 12.5 and heart beat corresponds to .6-1.2 second cycle (the average .8 s corresponds to $k_{eff} = 212$).

3. Even values of k_{eff} are not predicted by the model based on Mersenne primes allowing only odd values of k_{eff} so that the model does not seem to be the the whole truth. The conclusion which however suggests itself strongly is that EEG and its variants identified as something in the range 1-100 Hz, are associated with the levels in at which only dark weak bosons are possible in the proposed

model. Note that the size scales involved with EEG would be above the size scale of human body so that we would have some kind of continuation of the biological body to be distinguished from the magnetic body. The time scales assignable to the dark CDs would be huge: for instance, $k = 205$ would correspond to $T = 2^{42} \times .1$s making about 1395 years for electron.

2. Does magnetic body correspond to the space-time sheets carrying dark weak bosons?

The layers of the magnetic body relevant for EEG have have size of order Earth size. Natural time scale for the moment of sensory consciousness is measured as a fraction of second and the basic building blocks of our sensory experience corresponds to a fundamental period of .1 seconds. This scale appears already at $\hbar_0$ level for electron CD. The natural question concerns the relationship of the magnetic body to the $k > 205$ space-time sheets carrying only gauge bosons in the model and having size scale larger than that of biological body. Do they correspond to an extension of biological body or should they be regarded as parts of the magnetic body? The following observations suggest that they could correspond to layers of the magnetic body responsible for the fractal variant of EEG.

1. The primary p-adic time scales (Compton times) $T(239)$ and $T(241)$ correspond to frequencies, which are $2^{\pm 1/2}$ kHz. The geometric average $k = 240$ corresponds to kHz frequency. Is the appearance of kHz scale a mere accident or do the frequencies assignable to the quark CDs correspond to Compton times $\propto \sqrt{2^{k_{eff}/2}}$?

2. One can apply scalings by 2^{k_d} to the triplet $(239, 240, 241)$ to get a triplet $(239+k_d, 240+k_d, 241+k_d)$. The results are summarized in Table 10. Clearly the frequencies in question cover also the EEG range. Note that these frequencies scale as $\sqrt{1/r}$ whereas Josephson frequencies scale as $1/r$.

k_d	f_1/Hz	f_2/Hz	f_3/Hz
0	707	1000	1412
4	177	250	354
6	89	1250	177
10	22.1	31.3	44.2
12	11.1	15.6	22.1
14	5.5	7.8	11.1
16	2.8	3.9	5.5
18	1.4	2.0	2.8
20	0.7	1.0	1.4
24	0.2	0.2	0.3

Table 10. The Compton frequencies obtained by scaling $2^{k_d/2}$ from the basic triplet $k_{eff} = (239, 240, 241)$. The values of k_d correspond to those predicted by the model based on Mersenne primes.

Also ZEG and WEG would appear but in much shorter scales dictated by k_{eff} and might accompany EEG. Somehow it seems that the effective masslessness of weak bosons below given scale is highly relevant for life. One can of course ask whether some larger Gaussian Mersenne could change the situation. There is a large gap in the distribution of Gaussian Mersennes after $k = 167$ and the next ones correspond to $M_{G,k}$, with k in $(239, 241, 283, 353, 367, 379, 457, 997)$ [1] . The twin pair $k = (239, 241)$ corresponds to a length scales $(1.6, 3.2) \times 10^2$ km and the minimum value for k_d are (72,74) ($167 \to (239, 241)$ transition).

3. Long term memory and ultralow Josephson frequencies

What determines the time scale associated with long term memory is a crucial question if one really wants to understand the basic aspects of consciousness.

1. Does the time scale correspond to the size scale of CD assignable to electron scaled by $r = \hbar/\hbar_0$? In this case relatively small values of r would be enough and $r = 2^{47}$ would give time scale of 10^{13} s for for electron's CD, which is about 3×10^5 years. This does not make sense.

2. Does Josephson frequency define the relevant time scale? In this case the long term memory would require the analog of EEG in the time scale of memory span. $k_{eff} = 205$ would give 6 ms time scale for memory from the assigment of $k_{eff} = 163$ to the Josephson photons at V=-50 mV implying $k_d = 42$. Minute scale would require $k_{eff} = 217$. The highest level $k_{eff} = 235$ allowed by the model involving only Gaussian Mersennes with $k \leq 167$ would correspond to a time scale of 77.67 days (day is 24 hours). For Gaussian Mersennes defined by $k_{eff} = (239, 241)$ the time scales become about (41.4,82.8) months (3.4 and 6.8 years). These scales should also define important biorhythms. The claimed 7 years rhythm of human life could relate to the latter rhythm: note that the precise value of the period depends on the membrane potential and thus varies. The presence of the scaled up variants of the by $k_d \leq 78$ allows longer time spans of long term memory and the scaling defined by $k_d = 167 - 163 = 4$ scales up the span of long term memories to (54.4,108.8) years.

4. Cultural evolution

Higher levels in the hierarchy would correspond mostly to the evolution of hyper-genome coding for culture and social structures. Introns are good candidate for the nucleodes involved. The development of speech faculty is certainly a necessary prerequisite for this breakthrough. Already EEG seems to correspond to dark layers of biological body larger than biological body so that one can cask whether the weak bosons and dark electrons in the length scales $k = 239, 241, 283, 353, 367, ...$ could be relevant for the collective aspect of consciousness and cultural evolution. Maybe the size scales $(175, 330)$ km and their scaled up variants by $k_d \leq 78$ might have something to do with the spatial scale of some typical social structure (not city: the area of New York is only 790 km^2).

2.3 Could insect colonies have "EEG"?

Only vertebrates can have EEG in 1-100 Hz range. According to the proposed model this means the presence of the $k > 205$ levels which can be regardd as a continuation of the biological body carrying dark weak bosons and having size scales larger than 1.25 m. That only vertebrates have EEG conforms with the empirical findings about the effects of ELF em fields on vertebrate brain.

This does not however imply that one could not assign EEG to the collective levels of consciousness. For instance, in the case of social insects forming colonies some kind of collective EEG might exist and explain the ability of the colony to behave like single organism. Indeed, ELF magnetic field and magnetic fields affect the behavior of honeybees just as ELF em fields affect the behavior of vertebrates [12] : the model for this findings led to a model for the fractal hierarchy of EEGs.

One could argue that insect brain is so simple (in the case of honeybee the number of neurons 1/1000 of number of neurons in human retina) that it is not possible to assign "personal" EEG to honeybee. The fact that a honeybee isolated from colony dies just as does the cell separated from organism, suggests that the relationship of insect to colony is like that of a cell to organism. Hence one could test whether colonies of social insects or their sub-colonies might possess an analog of ordinary EEG. What this would mean that ant colonies have sufficiently complex hyper-genome making possible collective variants of memory, sensory input, and intelligence, as well as the ability to realize collective motor actions. Even bacterium colonies have intricate social structures [13] so that one must remain open minded.

An objection against this line of thinking is that even in the case of collective EEG the proposed model assigns the Josephson frequencies with neurons. One might imagine Josephson frequencies at EEG range even in case of insects- say the queen of the nest. Since dark photons are in question the fields are very weak. I do not know whether any-one has got the crazy idea about checking whether beehive has EEG -certainly not any routine measurement! One an also imagine a fractal counterpart of EEG at the level of some individuals- say queen of the nest- at very low frequencies making possible long term memory.

2.3.1 Do honeybees have long term memory?

The realization that insect colonies rather than insects might correspond to higher $k_{eff} > 205$ levels of the dark matter hierarchy came via an indirect route. The article "Why honeybees never forget a face?" of New Scientist [8] described evidence supporting the view that that honeybees might possess long term memory in the time scale of days.

Adrian Dyer of the University of Cambridge and colleagues trained honeybees to associate a sucrose drink with a photograph of a particular face. The insects were then tested on their memory and recognition skills by being presented with the picture of this face and the pictures of three other faces not associated with any reward. Of the seven bees tested, two lost interest in the trial and flew away. But the five remaining bees correctly identified the target face in more than 80 per cent of trials, even though the reward had been removed. Moreover, some bees remembered the face two days later, indicating that they had formed a long-term memory of it.

1. The conservative explanation is that the achievement is due to keeping the face-honey association intact in the absence of the stimulus which created it in a time scale of days. For this option the ability of honeybee to express the distance and orientation to the food source could be hardwired involving no conscious memory about the flight. Also the interpretation of the honeybee dance telling the distance and orientation of food source to advices where to fly would be completely "instinctive"- whatever this means.

2. A more radical option is that honeybee hive rather than honeybee has long term memories in the sense as long term memories are interpreted in TGD framework: that is as communications with the geometric past. In this case the span of long term memories is determined by the level of dark matter hierarchy as time scale defined by Josephson frequency assignable to level of dark matter hierarchy in question and a span of few days for long term memories forces the conclusion $k_d \geq 63$: the upper bound is $k_d = 78$ (see Table 5), when one allows only $k \leq 167$ Mersennes and this corresponds to 87.6 years.

One can ask whether the ability of honey bee queen to found a new honeybee colony could involve long term memory in the time scale of year. If this were the case, the queen would not face her formidable challenge alone: the former colony in the geometric past still exists as a conscious entity and could communicate advices to the queen. The magnetic body of the former colony could exist also in the geometric now, being physically associated with the queen. This magnetic body could serve as the conscious entity communicating to the queen the advices and commands making possible to construct the beehive. A more conservative explanation is that these activities are genetically hardwired and instinctive (leaving open what 'instinctive' really means if it actually means anything).

The distinguished social position and anatomy of queen are consistent with the hypothesis that queen has more massive connections than other bees with the magnetic body of beehive. For instance, it is known that the new hive is oriented in exactly the similar manner as the old. Either long term memory or passive magnetic coding of the orientation of the hive with respect to Earth's magnetic field made possible by the magnetite in the abdomen of queen could explain this. The neurons of queen could correspond to a very large value of $\hbar$ giving rise to the required low Josephson frequencies.

The colony would have sensory resolution in a time scale of a fraction of second and short term memory in minute time scale. The counterpart of EEG at the level of hive is highly suggestive and conforms with the finding that ELF magnetic fields with strengths in the range .1-1 mT ($2B_E - 20B_E$ affect honeybee dance [12] as does also the absence of Earth's magnetic field. Interestingly, 1-2 mT DC field causes epileptiform activity in the case of humans [10] (the change of the DC field used seems to be more important that the period it is applied). Could the beehive suffer a kind of epileptic seizure!

The intentional actions of the honeybee colony would be realized via magnetic flux sheets traversing the super-genes of the insects participating to the action in question. Workers, soldiers, etc.. would act

to some extent as organs of the colony being connected by hyper-genes of hyper-genome to larger units. Queen could act as the analog of a complex Grand Mother neuron in brain or a leader in human society.

This view can be criticized. Honeybee dance [4] is performed by forager bees and the dance represents among other things the angle between the lines connecting hive to the food source and sun as the angle between movement of bee and vertical direction (also other options are possible). The intricate pattern of the dance in turn codes for the distance to the food source. If beehive is a conscious entity using bees as its cells, why is honeybee dance needed at all? TGD based vision about the evolution of modern human society from a bicameral society in which individuals received advice and commands from "God" [18, 19] , suggests an answer to this criticism. The society able to survive must be maximally flexible and allow maximal individual intelligence and maximal freedom of individual actions consistent with the overall goals. This requires delegation of simple tasks to lower levels meaning also that communications between individuals become necessary (the development of language and other communications parallels the transition from bicamerality to modern society in the case of humans). The communication itself might however involve also the beehive. Foragers could be like the prophets of the bicameral society communicating in semitrance the advices of God to the colony.

It should be noticed in passing that honeybees have already earlier made a visit to TGD inspired theory of consciousness [16] . As discovered by topologist Barbara Shipman [2] , honeybee dance has a mathematical description in terms of a construct assignable to color group SU(3) of gauge interactions between quarks and gluons. This led her to propose that color interactions might have some deep role in living matter. This is in a sharp contrast to the fact that color interactions as establishment knows them are completely invisible above the length scale of 10^{-15} meters. The TGD based prediction that there exists an entire hierarchy of scaled up copies of QCD, in particular QCDs with confinement length scale of order cell size, changes completely the situation.

2.3.2 Honeybees as magneto-receptors of the beehive or magnetic cells as magneto-receptors of bee?

Earth's magnetic field has a crucial status in the model of living systems even at the lowest levels of dark matter hierarchy so that Earth's magnetic field is expected to play a role in the functioning of all cells, also bees and ants. This is indeed the case.

It is known that that bees have two navigation systems. The first system is based on the direction of sun and polarization of solar light but does not work on cloudy days. The second navigation system uses Earth's magnetic field and is used in cloudy days. Bees have in their abdomen magnetite (Fe_3O_4) particles of size about 30 nm and iron storage protein ferritin which correspond 10 to nm sized super-paramagnetic particles [11] . Magnetite particles and ferritin in principle make possible magneto-reception instead of a mere passive compass behavior.

The minimum option is that honeybee itself does not receive any neural information about the magnetic field but acts as a passive magneto-receptor of the bee colony or sub-colony (such as workers flying to the food source) and that the information contained by the receptor grid allows the sub-colony to deduce its position in the varying magnetic field. "BEEG" would mediate this information to the magnetic body of the (sub-)colony and the general mechanism based on Josephson currents does not require nerve pulse patterns to achieve this.

Since foreagers seem to act as individuals able to navigate in the magnetic field of Earth, it would seem that some cells of the honeybee could act as magneto-receptors so that the reaction of the magnetic particles would be coded to a neural signal. It has been proposed that the changes in the shape of the configurations formed by magnetite particles in a varying magnetic field induce changes in the shape of neuron and in this manner can induce neural signal. This mechanism could also induce the voltage perturbations coding the information to the Josephson current giving rise to the sensory part of EEG as a state of coherent ELF photons. Perhaps the genes expressing these neurons are activated only in foragers and ferritin makes possible the magneto-reception in this sense.

2.3.3 Social bacteria and magneto-tactic bacteria

Magneto-tactic behavior of bacteria [9] was discovered for 30 years ago by microbiologist Richard P. Blakemore and means that certain motile, aquatic bacteria orient and migrate along magnetic field lines. This ability could be purely passive compass mechanism made possible by the magnetite detected in the bacteria.

During last years we have learned that bacteria are not simple creatures having only single goal: to multiply and fill the Earth. Bacteria are able to communicate and act co-operatively [13] . This raises the question whether hyper-genes could appear already at this level and whether bacteria acting as a colony they individual bacteria could act as magneto-receptors of colony allowing it to detect even variations of the magnetic field much like individual cells in the brain of vertebrates or perhaps even in the abdomen of honeybee are believed to serve as magneto-receptors.

2.3.4 Great leaps in evolution as emergence of higher levels of dark matter hierarchy at level of individuals

The vision about great leaps in evolution led to the view that the emergence of EEG corresponds to the emergence of $k_{eff} > 205$ levels of dark matter hierarchy. On the other hand, the time scale of gene translation corresponds to that associated with the ordinary EEG, which forces to ask whether these levels are present already in the lowest life forms. Perhaps a more plausible option is that the .1 second time scale of electronic CD defines the time scale of gene translation and corresponds therefore to the standard value of $\hbar_0$. The findings about honeybees however support the view that $k_{eff} > 205$ levels are present but are associated with the honeybee colony rather than individuals. This however requires that the these levels have neuronal realization in terms of Josephson frequencies.

Therefore a more precise formulation of the hypothesis about great leaps in evolution would be that great leaps in evolution correspond to the emergence of a new dark matter level at the level of individual organism. If this view is correct then $k_{eff} > 205$ levels would correspond to a collective level of consciousness in the case of invertebrates down to bacteria, which are indeed found to form societies [13] . This conforms also with the fact that the genome of invertebrates is too small to allow realization of $k_{eff} > 205$ flux sheets as genes or even super-genes. The somewhat unexpected conclusion would be that all activities of invertebrates involving gene expression would be controlled by collective levels of consciousness: invertebrates would not be individuals in this sense. Viruses do not possess DNA translation machinery which is consistent with the absence of also collective $k_{eff} > 205$ levels. One can of course ask whether the queen of honeybee could be an exception to this rule.

If one believes that the time scale of gene expression corresponds to Josephson frequency then the explanation for the universality of the genetic code could be that $k_{eff} > 205$ levels controls gene expression: for $k_{eff} > 205$ wave length scale indeed corresponds to the length scale assignable to the magnetosphere of Earth. One could of course counter argue that it is more reasonable form magnetic Mother Gaia to delegate this kind of duties to the lower levels and that the CDs of electron and quarks are ideal for this purpose.

2.4 Dark matter hierarchy, hierarchical structure of nervous system, and hierarchy of emotions

One can ask how the structural and functional hierarchy of CNS and the hierarchy of emotions relates to the dark matter hierarchy. The basic picture wherefrom one can start is following.

1. The emergence of nervous system corresponds to the emergence of $k_{eff} < 205$ levels of dark matter hierarchy above $k_{eff} < 167$. For instance, worms and insects would correspond to this level.

2. Vertebrates have EEG and thus the most primitive vertebrates (reptiles) should correspond to $k_{eff} \geq 205$.

3. The emergence of new structures need not mean the emergence of new levels of dark matter hierarchy. Rather, the most reasonable criterion for the presence of these levels is the emergence of behaviors involving long term goals and the magnetic bodies of the parts of brain assignable to the control of this kind of behaviors would correspond to higher values of k_{eff}. Also the maximum span of memories at given level should be characterized by the value of k_{eff} associated with the brain structures involved (hippocampus, mammillary bodies). This picture conforms with the fact that already insects possess neurons, ganglia, and head containing the predecessor of cerebrum but correspond to $k_{eff} \leq 205$ most naturally.

For goal related emotions the maximal time scale assignable to the achievement of the goal might allow to identify the time scale characterizing corresponding level of dark matter hierarchy. The lowest level emotions would be "primitive" emotions not related to any goal and one can as whether they could be assigned to organs consisting of ordinary cells and correspond to $k_{eff} \leq 205$.

1. The time scale of planned behavior and of long term memories makes possible to estimate upper bounds for the values of k_{eff} assuming Josephson frequency hypothesis. $k_{eff} \leq 205$ would give the upper bound of 6 ms which corresponds to cerebellar resonance frequency 160 Hz. This time scale looks too short even for the simplest vertebrates and one must be very cautious here.

2. An alternative interpretation is as the shortest possible span for short term memory whose time scale is known to vary.

3. Cerebellar rhythm could be analogous to hippocampal theta rhythm and involved with the crebella memory storage and therefore would not tell anything about the span of the memory but would characterize the time resolution of memories and planned actions. The role of cerebellum in the fine coordination of motor actions indeed requires high time resolution.

Brain has anatomic division into midbrain, hindbrain, and forebrain [J5] . Midbrain and hindbrain (sometimes both are included in brain stem) is possessed by even the most primitive vertebrates and its emergence could therefore correspond to the emergence of $k_{eff} \geq 205$ levels and EEG. The emergence of these levels relates naturally to the emergence of long term planning of motor actions in motor areas. The emergence of limbic brain, which defines the most primitive forebrain, could mean the emergence of the Gaussian Mersenne defined by $k_{eff} = 239$ containing dark electron condensates level and goal related emotions. This conforms with the fact that for mammals forebrain and cerebral hemispheres dominate whereas for other vertebrates hindbrain and cerebellum are in the dominant role.

2.4.1 Reptilian brain as $k_{eff} \leq 205$ system?

Reptilian brain contains only the structures corresponding to brain stem (midbrain and hind brain, in particular cerebellum) and as far structures are considered would correspond to $k_{eff} \leq 205$ levels of the hierarchy. Cerebellum is not believed to contribute directly to our consciousness. The absence of higher looks however an unrealistic assumption since reptiles certainly have long term memories.

Simplest emotions correspond to emotions involving no goal. Moods like excitement, feeling good/bad/tired/strong, etc.. could represent examples of such emotions and could be experienced already by reptilians. Of course, the scaled up variants of these emotions could appear at higher levels of hierarchy and would relate to the states of magnetic bodies (degree of the quantum coherence of Bose-Einstein condensates!).

2.4.2 Limbic system

Limbic system is not possessed by reptiles [J3] . It is responsible for emotions, control of emotions, and also emotional intelligence. Limbic system corresponds to the brain of the most mammals. The limbic brain includes the amygdala, anterior thalamic nucleus, cingulate gyrus, fornix, hippocampus, hypothalamus, mammillary bodies, medial forebrain bundle, prefrontal lobes, septal nuclei, and other areas and pathways of the brain.

1. The sub-cortical part of the limbic system involves amygdalar and septal divisions. According to [J3] amygdalar division promotes feeding, food-search, angry, and defensive behaviors related to obtaining food. Septal division promotes sexual pleasure, genital swelling, grooming, courtship, and maternal behavior. These divisions are emotional mirror images of each other hand could correspond to $205 < k_{eff} < 239$.

2. The cortical part of the limbic system contains cingulate gyrus which is the newest part of the limbic system and belongs to thalamo-cingulate division which promotes play, vocalization (e.g., the separation cry), and maternal behavior. The time scale of memories would be shorter than 3.4 at this level.

3. Frontal lobes [J2] are often regarded as the organ of volition. The frontal lobes are involved in motor function, problem solving, spontaneity, memory, language, initiation, judgement, impulse control, and social and sexual behavior. Prefrontal lobes representing the extreme front part of frontal lobes belong also to the limbic system and are responsible for motivation and ability to pose long term goals. This ability distinguishes humans from other primates. For these reasons frontal lobes, in particular prefrontal lobes, could involve the highest levels of dark matter hierarchy in the case of humans. The Gaussian Mersenne levels $k_{eff} = (239, 241)$ could be assigned as lowest level in this hierarchy. The time scale of long term memories would be longer than 3.4 years at these levels.

Cortico-striatal emotions like sadness, hate, fear anger, surprise, embarrassment, happiness, contentment, and joy involve goal structures and failure or success to achieve the goal in essential manner and would involve prefrontal lobes.

These levels would naturally relate to collective levels of consciousness coded by hyper genes. Hence these emotions could also relate to goals not directly related to the fate of biological body. Mirror neurons are a crucial prerequisite of a social behavior (autistic children seem to lack them), which suggests that hyper genes are involved at least with them.

Social emotions (feeling embarrassed, ashamed, guilty, loved, accepted, ...) could be induced by the collective levels of dark matter hierarchy as punishments or rewards for social behavior very much like neurotransmitters are believed to provide rewards and punishments at neuronal level.

2.4.3 Neocortex and two kinds of intelligences

Neocortex is often assumed to be superior ("neomammalian") part of the brain and makes the majority of brain hemispheres. The species which are considered to be highly intelligent, such as humans and dolphins, tend to have large amounts of neocortex. The amount of neocortex is roughly proportional to the brain size for primates.

Neocortex cannot correspond to $k_{eff} \geq 239$ (defining Gaussian Mersenne) as a whole. The decomposition of sensory areas to layers is consistent with the presence of lower levels since it is time resolution which matters in the case of sensory representations. Same conclusion applies to sensory association areas. The fine tuning of the motor control performed by cerebellum is consistent with $k_{eff} \leq 205$. Intelligence understood in the conventional sense of the word is accurate, works fast, and is computer like. The part of neocortex responsible for ordinary intelligence would be a rapid and accurate processor of sensory and cognitive representations. Hence $k_{eff} < 239$ would naturally characterize sensory areas, secondary and primary motor areas, to hippocampal representation of declarative memories, and all association areas except dorsolateral prefrontal sensory-motor association cortex where short term memories are represented.

Emotional intelligence works slowly and is responsible for visions and holistic views and would thus correspond to higher levels of dark matter hierarchy. Limbic system is involved with emotions, motivation and long term planning and would thus be responsible for emotional intelligence. Indeed, the damage to frontal lobes [J2] need not affect ordinary intelligence but affects emotional intelligence.

2.4.4 The levels of dark matter hierarchy associated with short and long term memory

The first thing to ask is of course whether the notions of short and long term memory make sense in TGD framework. Indeed, it would seem that it is more natural to speak about hierarchy of memories with characteristic time scales coming as selected powers of two.

1. According to [J4] , the span of other than visual short term memories is 30-45 seconds. This requires $k_{eff} \in \{217, 218\}$.

2. Visual short term memories [J1] representing selected features of visual field are reported to have time span of few seconds. This suggests $k_{eff} \in \{213, 214, 215\}$.

3. Iconic visual memories representing entire visual field have much shorter time span of order 1 s: $k_{eff} \in \{211, 212\}$ would be appropriate for them,

4. Long term memories would correspond to $k_{eff} > 218$.

Hippocampus and mammillary bodies involved with long term memory recall are part of the limbic system. The hippocampal theta rhythm 4-12 Hz , which could corresponds roughly to $k_{eff} \in \{163, 162, 161\}$ has nothing to do with the span of long term memories but would define the time resolution of the memories: the moment of sensory experience indeed corresponds to 10 Hz frequency. The frequencies responsible for memory storage need not have anything to do with the ultralow frequencies characterizing the temporal distance of the past event associated with the memory recall and hippocampus could just build a kind of bit sequence which during memory recall is communicated from the geometric past to some part of the future brain or magnetic body.

Anterograde amnesia means an inability to restore long term memories. The damage of hippocampus or of mammillary bodies can induce anterograde amnesia. In the usual conceptual framework the explanation would be the inability to store new long memories. In TGD framework this would be inability to construct those cognitive representations which are communicated to the geometric future in long term memory recall. Retrograde amnesia seems to involve almost always anterograde amnesia and means loss of memories for some time span before the injury. A possible explanation is that injury can propagate also to the geometric past of the brain quantum jump by quantum jump.

During ageing memories tend to be lost but the memories of childhood are the most stable ones. A possible interpretation is that faster rhythms of the generalized EEG tend to disappear: kind of scaled up variant for the process of falling into sleep accompanied by silencing of higher EEG bands could be in question.

2.4.5 What about transpersonal levels of consciousness?

$k_{eff} > 245$ levels of dark matter hierarchy correspond to time span longer than 109 years and cannot relate to the biological body alone. They could relate to higher collective levels of the dark matter hierarchy and evolution of social structures. The memories extending over personal life span claimed by meditators could have interpretation in terms of $k_{eff} > 245$ transpersonal levels of consciousness. Also the "god module" located to temporal lobes could correspond to this kind of levels of dark matter hierarchy. If it corresponds to Gaussian Mersenne with $k_{eff} = 283$ the time scale of memories becomes huge: about 10^{14} years so that the notion of "god module" is indeed appropriate.

References

Mathematics

[1] Gaussian Mersenne. `http://primes.utm.edu/glossary/xpage/GaussianMersenne.html`.

[2] B. Shipman. The geometry of momentum mappings on generalized flag manifolds, connections with a dynamical system, quantum mechanics and the dance of honeybee. `http://math.cornell.edu/~oliver/Shipman.gif`, 1998.

Cosmology and astrophysics

[3] Age of the universe. `http://en.wikipedia.org/wiki/Age_of_the_universe`.

Biology

[4] Magnetic Bees. `http://www.abc.net.au/science/k2/trek/4wd/Over57.htm`.

[5] Nanobacterium. `http://en.wikipedia.org/wiki/Nanobacterium`.

[6] Nanobe. `http://en.wikipedia.org/wiki/Nanobe`.

[7] Virus. `http://en.wikipedia.org/wiki/Virus`.

[8] Why honeybees never forget a face? *New Scientist*, page 22, December 2005.

[9] S. Clement. Magnetic Microbes. `http://commtechlab.msu.edu/sites/dlc-me/curious/caOc96SC.html`, 1996.

[10] J. P. Dobson et al. Evocation of epileptiform activity by weak DC magnetic fields. *American Geophysical Union Meeting, Baltimore, Maryland. EOS*, (16), 1993.

[11] M. Desoil et al. Definitive identification of magnetite nanoparticles in the abdomen of the honeybee Apis mellifera. *Journal of Physics: Conference Series*, 17, 2005.

[12] J. L. Kirschvink. Constraints on biological effects of weak extremely-low-frequency electromagnetic fields'. *Phys. Rev. A. http://prola.aps.org/abstract/PRA/v46/i4/p2178_1*, 43(1991), 1992.

[13] S. Silberman. The Bacteria Whisperer. *Wired Magazine. http://www.wired.com/wired/archive/11.04/quorum.html*, April 2003.

Neuroscience and Consciousness

[J1] Visual short term memory. `http://en.wikipedia.org/wiki/Visual_short-term_memory`.

[J2] Frontal lobes. `http://en.wikipedia.org/wiki/Frontal_lobes`.

[J3] Limbic system. `http://en.wikipedia.org/wiki/Limbic_system`.

[J4] Short term memory. `http://en.wikipedia.org/wiki/Short_term_memory`.

[J5] J. S. Nicholis S. W. Kuffler and A. R. Martin. *From Neuron to Brain*. Sinauer, Massachusetts, 1984.

Books and articles related to TGD

[14] M. Pitkänen. Cosmic Strings. In *Physics in Many-Sheeted Space-Time*. Onlinebook. http://tgdtheory.com/public_html/tgdclass/tgdclass.html#cstrings, 2006.

[15] M. Pitkänen. DNA as Topological Quantum Computer. In *Genes and Memes*. Onlinebook. http://tgdtheory.com/public_html/genememe/genememe.html#dnatqc, 2006.

[16] M. Pitkänen. General Theory of Qualia. In *Bio-Systems as Conscious Holograms*. Onlinebook. http://tgdtheory.com/public_html/hologram/hologram.html#qualia, 2006.

[17] M. Pitkänen. Homeopathy in Many-Sheeted Space-Time. In *Bio-Systems as Conscious Holograms*. Onlinebook. http://tgdtheory.com/public_html/hologram/hologram.html#homeoc, 2006.

[18] M. Pitkänen. Semi-trance, Mental Illness, and Altered States of Consciousness. In *Magnetospheric Consciousness*. Onlinebook. http://tgdtheory.com/public_html/magnconsc/magnconsc.html#semitrancec, 2006.

[19] M. Pitkänen. Semitrance, Language, and Development of Civilization. In *Magnetospheric Consciousness*. Onlinebook. http://tgdtheory.com/public_html/magnconsc/magnconsc.html#langsoc, 2006.

[20] M. Pitkänen. Three new physics realizations of the genetic code and the role of dark matter in bio-systems. In *Genes and Memes*. Onlinebook. http://tgdtheory.com/public_html/genememe/genememe.html#dnatqccodes, 2006.

[21] M. Pitkänen. Are dark photons behind biophotons. In *TGD based view about living matter and remote mental interactions*, 2013.

[22] M. Pitkänen. Comparison of TGD inspired theory of consciousness with some other theories of consciousness. In *TGD based view about living matter and remote mental interactions*. Onlinebook. http://tgdtheory.com/public_html/pdfpool/consccomparison.pdf, 2013.

[23] M. Pitkänen. Sheldrakes Morphic Fields and TGD View about Quantum Biology. http://tgdtheory.com/articles/sheldrake.pdf, 2011.