In the previous chapter the overall TGD based view about EEG was discussed.
According to this view, the basic function of EEG is to induce cyclotron
phase transitions at the magnetic body and thus to produce what might be
called higher level sensory qualia identified as emotions and cognitions.
In this chapter the relationship between EEG and nerve pulse patterns is
discussed in TGD framework.

The relationship between nerve pulse patterns and EEG (also ZEG) is one of
the basic challenges of the theory. The question is whether nerve pulse
patterns could give rise to EEG patterns and vice versa, and what could be
the underlying mechanisms. The deep difference between TGD and the
conventional neuroscience is the presence of the hierarchy of magnetic
bodies, cyclotron transitions, and MEs. This makes possible to consider
alternatives for the identification of EEG resonance frequencies as
resonance frequencies   of nerve circuits.

Nerve pulses generate EEG MEs and the frequency of the nerve pulses
determines   the rate at which EEG MEs are generated rather than the
frequency of EEG MEs. Pendulum metaphor suggests how spike patterns
amplify EEG waves at frequencies, which appear as resonances in the
autocorrelation function of the spike sequence: when the pendulum is kicked
at correct half of its period its oscillation frequency remains unchanged
but amplitude and phase suffer discontinuous changes. The EEG waves
generated by subsequent nerve pulses tend to interfere constructively
resulting in amplification if the EEG frequency corresponds to a resonance
frequency of the spike autocorrelation function.

\vm{\it 1. Generalization of the model for sensory receptor and new view
about hearing}\vm

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the basic challenges of the theory. The question is whether nerve pulse
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the underlying mechanisms. In TGD framework on ecan consider alternatives
for the identification of EEG resonance frequencies as resonance
frequencies of nerve circuits and dark matter hierarchy challenges the
earlier speculative TGD inspired models for sensory qualia and sensory
organ. An updating of the capacitor model of the sensory receptor by
replacing the capacitor with Josephson junctions between sensory organ and
its magnetic body must be considered. The question arises whether sensory
organs define not only sensory, but also corresponding cognitive and
emotional representations. The fact that nerve pulses tend to destroy the
temporal coherence of cognitive and emotional representations encourages
the identification of glial cells and their magnetic bodies as carriers of
higher level cognitive and emotional representations. The model of hearing
leads to further ideas. For instance, the transformation of the sensory
input to signals propagating along axonal microtubuli could make possible
to feed sensory input into brain and possibly back to sensory organs at
least in the case of vision and hearing.

\vm{\it 2. Features}\vm

Walter Freeman has identified spatially amplitude modulated synchronous
but non-periodic EEG patterns serving as correlates for conscious
percepts. The identification as MEs is possible and the spectrum of
durations for the synchronous time patterns encourages the interpretation
of these patterns as an electromagnetic realization of genetic code words.
A compression of memetic code words defined by the nerve pulse patterns
giving rise to   abstraction and classification would be in question. The
representation would be achieved by the amplitude modulation of the alpha
waves by higher harmonics of alpha frequencies. In the case of hearing the
contraction seems to be un-necessary and memetic code could perhaps

be
realized also at the level of features. This would explain the completely
exceptional role of the language in cognition.

\vm{\it 3. Synchronization}\vm

Synchronization in and between various cortical areas is known to occur
with millisecond precision. Also disjoint brain regions can be in
synchrony. This is difficult to understand without synchronizing agent
oscillating at kHz frequency. In TGD framework magnetic body is the natural
agent inducing the synchrony and MEs could induce the synchronization.
Synchronization would naturally occur at the frequency corresponding to a
duration of the bit of the memetic code.

{\it 4. Stochastic resonance}\vm

Concerning the mapping of EEG frequencies to nerve pulse patterns,
stochastic resonance promotes itself as a basic mechanism. In bistable
systems stochastic resonance allows to amplify very weak periodic signals
by utilizing white noise. Stochastic resonance is known to be relevant also
at the neuronal level as demonstrated by the autocorrelation functions for
spike sequences exhibiting peaks at the harmonics of the signal frequency.
Neuron is however far from being bistable system, and this raises the
question whether bi-stability might be present at some deeper quantal
level.

\vm{\it 5. Temporal codings}\vm

The conventional view that the information content of conscious experience
is determined completely by rate coding from nerve pulse patterns does not
seem plausible in TGD framework. Indeed, p-adic cognitive codes define an
entire hierarchy of binary codes associated with the p-adic frequencies and
frequency coding would apply only to the average intensity of the sensory

input. For high stimulus intensities the duration of the bit of the p-adic
cognitive codeword tends to become shorter. This is comparable to the
increase of the speech rate during a high state of arousal, and conforms
with the observed shift of EEG towards higher frequencies in this kind of
situation. There is a lot of experimental evidence supporting the existence
of various kinds of temporal codings, and these codings are discussed in
TGD framework.

\vm{\it 6. Scaling law}\vm

Scaling law provides bird's eye view about transitions which can represent conscious-to-us qualia at given level of the p-adic self hierarchy. The law relates two levels of self hierarchy corresponding to
mental images associated with magnetic bodies of astrophysical size and
with physical bodies, the latter with size not much larger than brain size.
Scaling law assumes that self sizes L at given p-adic level k are
between the p-adic length scales $L(k)$ and $L(k(next))$. Scaling law is of
form $L=v/f$ and relates ELF self size characterized by ELF frequency f
to the self size L and to the effective phase velocity v of the EEG
wave.

Scaling law is also suggested by the experimental work with the effects of
ELF radiation in water. Scaling law can be explained in terms of phase
transitions transforming large h_{eff} photons to ordinary ones and vice
versa. The chapter ends with the discussion about possible implications of
the scaling law concerning EEG.

TGD leads to a proposal that the values of h_{eff} are such that energy
spectrum of the cyclotron photons does not depend on the mass of the ion.
This implies a universal energy spectrum and there are reasons for the
hypothesis that biophotons result in the energy conserving

transformations
of dark photons to ordinary ones.