%\begin{abstract}

The quantum model of hearing has evolved through several twists and turns. The emergence of zero energy ontology, the explanation of dark
matter in terms of a hierachy of Planck constants requiring a generalization of the notion of imbedding space, the view about life
as something in the intersection of real and p-adic worlds, and the notion of number theoretic entanglement negentropy led to a breakthrough
in TGD inspired quantum biology and also to the recent view of qualia
and sensory representations including hearing allowing a precise quantitative model at the level of cell membrane. This also modified
dramatically the speculative ideas about the role of neutrinos in hearing.

Also in the recent view long range weak play a key role. They are made
possible by the exotic ground state represented as almost vacuum extremal of K\"ahler action for which classical em and Z^0 fields are
proportional to each other wheras for standard ground state classical
Z^0 fields are very weak. Neutrinos are present but it seems that
they do not define cognitive representations in the time scales characterizing neural activity. Electrons and quarks for which the time
scales of causal diamonds correspond to fundamental biorhythms, take
this role.

The ensuing general model of how cell membrane acts as a sensory receptor has unexpected implications for the entire TGD inspired view
about biology.

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\item TGD inspires two views about cell membrane: the wiews need not be
contradictory. For the first model cell is far from vacuum extremal, for
the second model nearly vacuum extremal with classical Z^0 fields in key
role.

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\item There are several constraints on the first model coming from the TGD
based identification of bio-photons as energy conserving decay products of
dark photons and one ends up to a new view about metabolism and gneralization to of the notion of Josephson junction so that Josephson
energy includes besides electrostatic energy also the difference of cyclotron energies at two sides of the membrane.   It seem that that the first model might be enough when generalized along lines inspired
by Pollack's findings about the fourth phase of water.

\item It has been clear from the beginning that the nearly vacuum extremals of
K\"ahler action could play key role key role in living systems. The reason
is their criticality making them ideal systems for sensory perception.
These extremals carry classical em and Z^0 fields related to each other
by a constant factor and this could explain the large parity breaking
effects characterizing living matter. The assumption that at least some
cell membranes are nearly vacuum extremals and that nuclei can feed their
Z^0 charges to this kind of space-time sheets (not true for atomic
electrons) in living matter leads to a modification of the model for the
cell membrane as Josephson junction. Also a model of photoreceptors
explaining the frequencies of peak sensitivity as ionic Josephson frequencies and allowing the dual identifications Josephson radiation as
biophotons (energies) and EEG radiation (frequencies) emerge since the
values of Planck constant can be very large.   Contrary to the original
believe, this model does not require non-standard value of Weinberg angle
and this model and first model allow a hybrid.

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\item DNA as topological quantum computer model plus certain simplifying assumption leads to the conclusion that the spectrum of net

quantum numbers of quark antiquark pair define the primary qualia assignable to a nucleotide-lipid pair connected by a magnetic flux tube.
The most general prediction is that the net quantum numbers of two quark pairs characterize the qualia. In the latter case the qualia would be assigned to a pair of receptor cells.

\item Composite qualia result when one allows the nucleotide-lipid pairs
of the membrane to be characterized by a distribution of quark-antiquark pairs. Cell membrane -or at least the axonal parts of
neurons- would define a sensory representation in which is a pair of this kind defines a pixel characterized by primary qualia. Cells would
be sensory homunculi and DNA defines a sensory hologram of body of or of
part of it. Among other things this would give a precise content to the
notion of grandma cell.

\item Josephson frequencies of biologically important ions are in one-one correspondence with the qualia and Josephson radiation could re-generate the qualia or map them to different qualia in a one-one and
synesthetic manner in the neurons of the sensory pathway. For large values of Planck constant Josephson frequencies are in EEG range so that
a direct connection with EEG emerges and Josephson radiation indeed corresponds to both biophotons and EEG. This would realize the notion
of sensory pathway which originally seemed to me a highly non-realistic notion and led to the vision that sensory qualia can be
realized only at the level of sensory organs in TGD framework.

\item At the level of brain motor action and sensory perception look
like reversals of each other. In zero energy ontology motor action can
be indeed seen as a time reversed sensory perception so that the model
of sensory representations implies also a model for motor action. Magnetic body serves as a sensory canvas where cyclotron transitions induced by Josephson frequencies induce conscious sensory map entangling
the points of the magnetic body with brain and body. \end{enumerate}

The model for hearing follows as a special case from the general model
for sensory receptor and representations.

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\item Concerning hearing, the basic questions relate to the precise identification of the hearing quale, to the representation of pitch of the sound at the magnetic body, and to the representation of various geometric data about sound. The electromagnetic charge of the quark pair (or equivalently electroweak isospin) looks like an excellent candidate in this respect so that charge increment would define one fundamental hearing quale.

This quale need not correspond to pitch. The vision about hearing as a frequency quale suggests that cyclotron transition frequency corresponds to the pitch. Sound frequency would be coded to an increment of cyclotron frequency and pitch would be a quale assignable to magnetic body rather than biological body. Hearing would in a well-defined sense represent a higher level sensory modality not understandable without the notion of magnetic body. The strength of the magnetic field would code for cyclotron frequency and therefore for the pitch. One of the mysteries related to hearing is the ability to hear frequencies much higher than the maximum rate of nerve pulses which is below kHz. The coding by Josephson frequencies and representation of them as quale of the magnetic body resolves this mystery.

\item At the quantative level the first challenge is to understand the typical hearing ranges (humans, mice, bats, sea mammals) and here the time scales of CDs associated with quarks and leptons give intriguing hints. Also their cyclotron frequencies are involved and large values of Planck constant are unavoidable. Josephson frequencies are given by the effective membrane potential (Z^0 potential must be included) divided by Planck constant and it is possible to represent arbitrarily low frequencies in terms of membrane potential by allowing Planck constant to have high enough values.

\item The extreme rapidity of signalling from hair cells to brain is one of the mysteries of hearing and here Josephson radiation (biophotons)

provides a direct neuronal window with practically instantaneous communication. Microtubules could be associated with the flux tubes along which Josephson radiation propagates and also microtubular conformational waves could be involved.

\item Hearing represent in many respects an exceptional quale: consider only music experience, language, internal speech, the understanding and production of speech, and right brain sings– left brain talks metaphor. This conforms with the assumption that magnetic
body is involved in essential manner with hearing. Zero energy ontology leads to a vision explaining basic aspects of music experience
and the notion of memetic code plus possible realization of genetic code
as temporal patterns could provide first principle understanding of language.

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