

%\begin{abstract}

The neural realization of long term memories has remained to a high extent a mystery in the framework of the standard brain science. The TGD based quantum model for memory have developed gradually from the basic realization that in TGD framework the identification of quantum states as quantum histories makes it un-necessary to store information about the geometric past to the geometric now. This has deep implications.

\begin{enumerate} \item It is possible to separate genuine geometric memory recall from apparent memory recalls such as feature recognition, associations, and implicit and procedural memories. There are no memory storages in brain and only memory representations abstracting the essential aspects of experience are needed.

\item The models of long term memory based on the assumption that information about the geometric past is stored in the recent state of the system predict that the new memories should mask the old ones. It is however known that childhood memories are the stablest ones. In TGD framework this ceases to be a problem.

Mirror mechanism provides a very general mechanism of long term memory. To remember something at a temporal distance T in the geometric past is to look at a mirror at a distance $cT/2$. If the mirror is quantum mirror only a timelike entanglement (allowed by the non-determinism of Kähler action) of the mental image of the geometric past with a mental image in brain now is needed. The un-necessity to communicate memories classically implies extreme generality of the mechanism: all kinds of memories: sensory, cognitive, verbal,.... can be recalled in this manner. Even the mechanism of memory recall by cue can be generalized since the notion of tele association makes in principle sense.

The basic objections against this over-simplified picture is that there is no guarantee that the reflected ME returns to the brain and that

there is
no control over the time span of long term memories. The notion of
magnetic
body allows a more realistic formulation.

\item Zero energy ontology (ZEO) brings in the possibility of
temporary
change of the arrow of geometric time at some level of the hierarchy
of
space-time sheets. This provides a justification for the notion of
negative
energy signals. Brain or the personal magnetic body generates
spontaneously
negative energy MEs with all fundamental frequencies. These MEs can
be also
curved and are parallel to the closed flux tubes defining the
personal
magnetic body and connect geometric now with the brain of the
geometric
past: multiple reflections are probably required to achieve this.
The
length of the closed magnetic loop defines the time span of the
corresponding long term memory. The sharing of mental images by
timelike
entanglement allows to communicate the desire to remember to the
geometric
past, and gives rise to the memory recall in the case of episodal
memories. In the case of non-episodal/declarative memories the
memory is
communicated from the brain of the geometric past by classical
communications using positive positive energy MEs which propagate
with an
effective phase velocity much lower than light velocity along closed
magnetic flux tubes and generate in the receiving end symbolic
representation of the memory.

\end{enumerate}

Macrotemporal quantum coherence is a further important piece of the
model.

The understanding of how macrotemporal quantum coherence is made
possible
by the spin glass degeneracy led to a concrete realization of the
mirror
model and also provided a connection with the ideas of Hameroff and
Penrose. When a bound state is formed the zero modes of the bound
state
entangled subsystems become quantum fluctuating degrees of freedom.
This
means that state function reduction and state preparation cease to

occur
in these degrees of freedom. The bound state is in a kind of long-
lasting
multiverse state, or state of \blockquote{oneness} experientially,
and the sequence
of quantum jumps defined by the duration of the bound state behaves
effectively as a single quantum jump. Macrotemporal quantum
coherence
making possible supercomputer like activities becomes possible.

The hierarchy of Planck constants emerging from the non-determinism
of
K\"ahler action implying also spin glass degeneracy provides a more
precise
view about the emergence of quantum coherence. Also a connection
with
quantum criticality and hierarchy of breakings of conformal
invariance
emerges.

The spin glass degeneracy associated with the join along boundaries
bonds
(the original space-time correlates for the bound state formation
replaced
later by magnetic flux tubes) lengthens the lifetimes of the bound
states
dramatically and solves thus the basic objections against quantum
consciousness. The spin glass degeneracy is broken only by
classical
gravitational energy of the system. The quantum jumps between
different
classical gravitational configurations involve the emission of
gravitational (equivalently Z^0) MEs and the intention to remember
is
realized as a transformation of p-adic ME to negative energy
gravitational
ME. The fact that classical gravitational fields couple to classical
gauge
fields with a coupling which is about 10^8 stronger than the
ordinary
gravitational coupling, could play an important role too. Water
clusters
and macromolecules with sizes in the range of cell membrane
thickness and
cell size are good candidates for generating gravitonic MEs
responsible
for all geometric memories. Also classical Z^0 interaction might
be
involved since gravitonic MEs can be regarded also as Z^0 MEs.

A neuro level model of long term memory is discussed. The model
conforms
with the basic facts known about the relationship of hippocampus and

long
term memory.

%\end{abstract}