The basic objection against quantum consciousness theories is that the de-coherence times for macroscopic quantum states are quite too short. This argument has been put in quantitative form by Mark Tegmark.

These counter arguments are however problematic. First of all, the notions of quantum coherence and de-coherence are problematic in standard physics framework since the non-determinism of the state function reduction is in conflict with the determinism of Schr\"odinger equation. The intuitive idea is however that one can estimate the de-coherence times as essentially lifetimes of quantum states. Secondly, the estimates for de-coherence times are based on standard physics, and it is quite possible that new physics is essential for understanding living matter. The belief that standard physics is enough is based only on the reductionistic dogma.

Penrose and Hameroff have proposed that some future theory of quantum gravitation makes it possible to replace the phenomenological notion of state function reduction with a more fundamental notion which they call Orch OR, that quantum gravitational effects make possible macroscopic quantum states of required long de-coherence time, and that micro-tubules are the systems, where these effects are especially important so that one might even speak about reduction of the consciousness to the micro-tubular level. Penrose and Hameroff have also proposed that micro-tubules could act as quantum computers. The quantum states involved would be quantum superpositions of tubulin conformations and quantum gravitation would somehow make these quantum superpositions stable. Long enduring quantum superpositions of the conformations of (say tubulin) molecules would allow to perform a multi-verse simulation for the conformational behaviour

of the molecules and this would certainly have evolutionary value.

\vm{\it 1. Macrotemporal quantum coherence is suggested by quantum classical correspondence}\vm

TGD inspired theory of consciousness leads to a first principle theory of state function reduction and preparation free of the logical paradoxes, allows precise definitions for the notions of quantum coherence and de-coherence, and predicts a mechanism making the lifetimes of macroscopic bound states much longer than predicted by the standard physics. By quantum-classical correspondence the argument can be formulated at space-time level and configuration space (world of classical worlds (WCW)) level. An especially relevant notion is negentropic entanglement which from the consistency with ordinary quantum measurement theory is described by density matrix proportional to unit matrix. In quantum computation entanglement matrix proportional to a unitary matrix gives rise to negentropic entanglement and by NMP this entanglement is stable against state function reduction by Negentropy Maximization Principle (NMP).

At imbedding space level causal diamonds (CDs) define the correlates for coherence regions. At the space-time level coherence regions are identifiable as space-time sheets. They indeed are coherence regions for both classical fields and induced spinor fields defining single particle limit of the quantum theory. By quantum criticality of TGD Universe there is no upper bound for neither the spatial or temporal size of the space-time sheet and one obtains a p-adic hierarchy of coherence lengths and de-coherence times. Finiteness of de-coherence time corresponds to the fact that energy flows to the space-time sheet from larger space-time sheet first and then back. Note that in the standard quantum field theory the entire Minkowski space M^4 is the natural identification for the coherence region, and it is difficult to understand how to describe the reduction to a smaller region of M^4.

\vm{\it 2. Macrotemporal quantum coherence from spin glass

degeneracy?}\vm

At WCW level the argument supporting macroscopic and
macrotemporal quantum coherence goes as follows. The basic
distinction
between TGD and standard physics is quantum spin glass degeneracy,
which
among other things implies that quantum bound states of, say, two
molecules
have enormous spin glass degeneracy absent in the free state. The
intuitive
expectation is that the system spends much longer time in bound
states than
in free states and this implies much longer de-coherence time than
expected
otherwise.

One can formulate this argument more rigorously using unitarity
conditions
implying that forward scattering amplitude for bound states is very
large
due to the spin glass degeneracy. The almost degenerate spin glass
states
differ only by their classical gravitational energy so that
gravitation is
indeed important. The importance of quantum gravitation is also
obvious
from the fact that genuine quantum gravitational states are state
functionals in the world of worlds rather than in world so that they
are
expected to represent in some sense higher abstraction level than
ordinary
quantum states in the hierarchy of consciousness.

\vm{\it 3. Hierarchy of Planck constants and dark matter hierarchy}
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The non-determinism of K\"ahler action and ensuing quantum
criticality
strongly suggests a dark matter hierarchy with levels labelled by
values
of (effective) Planck constant $h_{eff}=n\times h$ The implications
are
non-trivial already at the level of hadron physics and nuclear
physics and
imply that condensed matter physics and nuclear physics are not
completely
disjoint disciplines as reductionism teaches us. One condensed
matter

application is a model of high T_c superconductivity predicting that the basic length scales of cell membrane and cell as scales are inherent to high T_c superconductors.

Living matter as ordinary matter quantum controlled by the dark matter hierarchy has turned out to be a particularly successful idea. The hypothesis has led to models for EEG predicting correctly the band structure and even individual resonance bands and also generalizing the notion of EEG. Also a generalization of the notion of genetic code emerges resolving the paradoxes related to the standard dogma. A particularly fascinating implication is the possibility to identify great leaps in evolution as phase transitions in which new higher level of dark matter emerge.

It seems safe to conclude that the dark matter hierarchy with levels labelled by the values of Planck constants explains the macroscopic and macro-temporal quantum coherence naturally. That this explanation is consistent with the explanation based on spin glass degeneracy is suggested by the fact that both follow from the non-determinism of K\"ahler action and relate closely to quantum criticality.