

The connection between the general theory of qualia and quantum measurement theory and thermodynamics turned out to be a breakthrough in the development of the ideas related to qualia.

{\it 1. The notion of self and qualia}\vm

The notion of self has been problematic and the recent progress in this respect clarifies also the situation concerning qualia. In ordinary quantum measurement theory repetition of state function reduction leaves the state unchanged. In TGD state function reduction can occur at both boundaries of causal diamond (CD) and in this case the state remains invariant only at the boundary at which the repetition takes place. This allows to understand how the arrow of time and its flow correspond essentially the increase of the average temporal distance between the tips present in the superposition of CDs with second end localized at fixed light-cone boundary. Self can be identified as a sequence of state function reductions occurring at given boundary of CD. The act of free will corresponds to the occurrence of quantum jump to the opposite boundary of CD and changes the arrow of geometric time at the level of the hierarchy of CDs corresponding to self. Qualia must characterize to the experiences of self assignable to the repeated state function reductions.

The original model of qualia was based on the idea that all quantum jumps involve change of quantum numbers so that increments of quantum numbers would characterize qualia. This assumption does not make sense for the quantum jumps at the fixed boundary of CD but at the opposite boundary of CD flow of quantum numbers between two subsystems is possible. Hence the increments of quantum numbers or rather the rates for their change would characterize qualia. The capacitor model for sensory receptor, which emerged before the correct view about self, actually assumed this.

{\it 2. Model of qualia}\vm

One ends up with the following model of qualia.

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`\item Only the increments of zero modes and quantum numbers are experienced consciously. In the original model these increments were associated with quantum jumps: in the updated model their are associated with a flow of quantum numbers between two sub-systems at the non-fixed boundary of CD.`

`\item There are geometric qualia corresponding to zero modes expressing the result of quantum measurement in each quantum jump. All geometric information about space-time surface should reduce to geometric qualia. For instance, geometric data given by visual, auditory, and tactile senses should reduce to conscious information about zero modes or about increments of zero modes in quantum jump.`

`\item A further working hypothesis analogous to functionalism is universality: kinesthetic qualia depending on the quantum number increments are universal. Thus the increments of Poincare and color and electro-weak quantum numbers define what might be called universal kinesthetic qualia.`

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`{\it 3. Thermodynamics and qualia}\vm`

Thermodynamical approach to qualia suggested itself.

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`\item The sequence of the states assignable to the changing boundary of CD can be modelled as a statistical ensemble of Fock states, which suggests that thermodynamics is basically part of theory of consciousness. The ensemble of prepared states gives rise to a large number of statistical qualia. The relationship $dE = TdS - PdV + \mu dN + B \cdot dM \dots$ generalizes to TGD context: note however that in case of ME selves energy is replaced with the Super Virasoro generator L_0 associated with the light cone boundary of ME. Each intensive-`

extensive variable pair in the differential should correspond to a non-geometric quale, which results only when there is a gradient (flow) of the extensive variable in the direction of the subjective time. Super-canonical thermodynamics should obviously map ordinary thermodynamics to the level of conscious experience.

\item Statistical interpretation also suggests that an averaging over the increments occurs. The possibility of sub-selves makes possible to have sequences of sub-selves (mental images) of finite subjective time duration and this makes possible structured subjective memories (for instance, it becomes possible to remember the digits of a phone number).

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The thermodynamical expression for dE suggests a general classification of qualia consistent with the \blockquote{holy trinity} of existences implied by TGD. Emotions – such as pain and pleasure – can be identified as order-disorder qualia with the sign of the gradient of negentropy associated with negentropic entanglement defining the coloring of emotion. Kinesthetic qualia are associated with generalized forces: senses of force and torque, hearing, and intensity of color sensation would serve as examples. Generalized chemical qualia correspond to flows between two sub-systems for various quantum numbers such as those associated with charged particles, ions, molecules, Cooper pairs, etc. Chemical qualia and color vision would serve as examples. The fermionic generators of super-conformal algebras and states created by them are labeled by binary digits labeling spin like quantum numbers, whose increments could give rise to Boolean consciousness with intrinsic meaning (\blockquote{This is true}). The flows associated with these binary digits could define Boolean qualia.

{\it 4. How qualia are generated?}\vm

There are two basic mechanisms generating sensory qualia.

$\begin{enumerate}$ \item Quantum phase transition in which single particle transition occurs coherently for some macroscopic quantum phase produces qualia defined by the increments of quantum numbers in the transition. Quantum phase transition could be induced by the transition frequency: quantum phase transition leading to the generation of new kind of macroscopic quantum phase is in question. The magnetic quantum phase transitions at super-conducting magnetic flux tubes provide a basic example of this mechanism, and the quantum model of hearing relies on Z^0 magnetic quantum phase transitions.

\item The flow of particles with fixed quantum numbers between $\text{\textquoteleft}electrodes\text{\textquoteright}$ of what might be called a quantum capacitor induces qualia defined by the quantum numbers of the particles involved. The $\text{\textquoteleft}electrodes\text{\textquoteright}$ carry opposite net quantum numbers. Second electrode corresponds to the sub-self defining the quale mental image. Obviously cell interior and exterior are excellent candidates for the electrodes of the quantum capacitor. Also neuron and postsynaptic neuron. In fact, living matter is full of electrets defining capacitor like structures. The capacitor model applies to various chemical qualia and also to color vision and predicts that also cells should have senses.

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The emergence of zero energy ontology, the explanation of dark matter in terms of a hierarchy 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. 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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