Quantum model for self-organization

1. Ordinary self-organization

   (a) Haken's theory of self-organization involves also a model for pattern recognition. Basic notions:

      i. order parameter as analog of external parameter.

      ii. slaving hierarchy with master obeying slow dynamics controlling the faster dynamics of slave and accompanied by length and time scale hierarchies.

      iii. non-equilibrium phase transitions induced by a change of slow order parameter.

      iv. Langevin equation describes transition to a new attractor. In Focker-Planck equation symmetry breaking with a selection of new potential well takes place.

   (b) Criticality relating to the non-equilibrium phase transition can be treated in terms of catastrophe theory. Criticality is accompanied by long range correlations and fluctuations.

   (c) Fractal patterns relate to the criticality accompanying non-equilibrium phase transitions. The fractal patters are achieved by iteration of dynamical map, which can be seen as dynamics with discrete time based on iteration of function. Barnsley has book about fractals produced using iteration.

   (d) Dissipation acts as Darwinian selector of asymptotic self-organization patterns depending only weakly on initial conditions.

2. What TGD inspired quantum theory of self-oganization could look like?

   (a) Quantum TGD can be seen as "square root" of thermodynamics in Zero Energy Ontology. Also quantum self-organization could be seen in this manner. The exponent of Kähler function replaces the exponent of free energy and maxima of Kähler function those of free energy. So called M-matrix can can be seen as Hermitian square root of density matrix multiplied by unitary S-matrix and M-matrices form rows of unitary U-matrix defined in th espace of zero energy states.

   (b) Negentropy Maximization Principle replaces second law of thermodyna- mics as fundamental principle but implies it at ensemble level in the usual situation when entanglement entropy is non-negative.

   (c) For negentropic entanglement (NE) density matrix is proportional to unit matrix. NE accompanies entanglement with unitary coefficient matrix. Now p-adic entanglement entropy is negative. NE carries information: en- tangled state represents rule or concept with states of superposition representing the instances of the rule.

   (d) The geometric realization of hierarchy of Planck constants suggests strongly the assignment of NE to a system pair for which imbedding space is effectively replaced with its n-fold covering ($h_{eff} = n \times h$). In absence of negentropic pairing the degeneracy means high thermodynamical entropy. This explains the paradoxical looking finding that learning systems seem to produce high amounts of entropy.

3. TGD inspired quantum theory of consciousness leads to a new view about quantum jump. NMP and ZEO are essential elements behind this view.

   (a) State function reductions can occur at both light-like boundaries of causal diamond (CD) inside which the space-time surfaces reside. Arbitrary number of repeated reductions to a given boundary can occur. In standard QM these reductions would leave the state invariant. In ZEO they leave only the (say) positive energy part of zero energy states in superposition invariants whereas the parts with opposite energy change.

   (b) Also quantum superposition of CDs for which only the positive energy boundary is fixed is possible and quantum jumps lead to dispersion in the moduli space of CDs. In particular, the proper time distances between tips increases on the average. This gives rise to the experienced flow of time and arrow of time.

(c) The repeated sequence of state function reductions on the same boundary CD is iterative process and could have as space-time correlate formation of fractals and lead to an asymptotic self-organization pattern as fixed point or more general asymptotic state. Also dissipation is present as Darwinian selector since thermodynamics is present because

4. Slaving hierarchy, criticality, and order parameters are basic notions in the theory of Haken Haken. The have counterparts in TGD framework.

   (a) Slaving hierarchy is replaced with closely related p-adic length scale hierarchy and hierarchy of Planck constants interpreted in terms of dark matter.

   (b) There are two kinds of variables: quantum fluctuating degrees of freedom appearing in WCW line element and zero modes analogous to classical variables in quantum measurement theory: they appear in WCW metric as parameters. Zero modes appear naturally as control variables for quantum fluctuating variables and at critical values zero modes quantum phase transitions take place.

   (c) Criticality is replaced with quantum criticality. One can distinguish between criticality to the change of zero modes changing abruptly the situation in quantum fluctuating degrees of freedom and the situation in which change in quantum fluctuating degrees of freedom changes abruptly the situation in zero modes.

   (d) A generalization of catastrophe theory approach is needed. In 2-D situation critical is accompanied by 2-D conformal invariance. Now this conformal invariance generalizes considerably thanks to the fact the boundary of CD allows generalize conformal invariance by the metric 2-dimensionality of light-cone boundary. Also light-like 3-surfaces are metrically 2-D. A hierarchy of isomorphic subalgebras of conformal algebras suggests itself as defining a hierarchy of conformal symmetry breakings.