Do hydrogels learn in presence of irradiation and heating?

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Abstract

A research group in Aalto yliopisto led by professor Olli Ikkala has published an interesting article with title "*Programmable responsive hydrogels inspired by classical conditioning algorithm*". What is observed that a system consisting of hydrogel and Gold nanoparticles can get conditioned when it is heated in the presence of irradiation at blue and red wavelengths. Conditioning means that the system melting under heating learns to melt in the presence of only irradiation. The experimenters assume that the Gold nanoparticles forming chains during heating serve as a memory element in the learning.

A simple TGD based quantum model for the conditioning relies on TGD inspired general model of living systems extended recently to a model of quantum self-organization in which energy feed serving as metabolic energy feed induces generation of dark matter as $h_{eff} = nh_0$ phases of ordinary matter at the magnetic body of the system. In number theoretic vision the presence of these phases correspond to higher algebraic complexity and higher "IQ".

The light signal would generate Pollack effect, which in TGD framework means transfer of protons from photo-acids to dark $h_{eff} = nh_0$ protons at magnetic flux tubes parallel to nanoparticle chains. The "IQ" of the system or its magnetic body characterized by h_{eff} would increase and it would become able to self-organize. The energy from the heating would be stored to the nanoparticle chains taking the role of proteins as energy storage. Melting would be a self-organization process increasing complexity, and in absence of heating (and perhaps even in its presence) the gel phase would receive the energy needed from the nanoparticle chains. The conditioning in this sense would not be a passive mechanical response. The system would be macroscopic quantum system, and the energy feed would make possible for it to evolve to a higher level of complexity and conscious intelligence.

Contents

1 Introduction

A research group in Aalto yliopisto led by professor Olli Ikkala has published in Nature Communications an interesting article with title "*Programmable responsive hydrogels inspired by classical conditioning algorithm*" [I3] (see http://tinyurl.com/y6owxv8x).

The abstract of article gives some idea about what is involved.

Living systems have inspired research on non-biological dynamic materials and systems chemistry to mimic specific complex biological functions. Upon pursuing ever more complex life-inspired

non-biological systems, mimicking even the most elementary aspects of learning is a grand challenge. We demonstrate a programmable hydrogel-based model system, whose behaviour is inspired by associative learning, i.e., conditioning, which is among the simplest forms of learning. Algorithmically, associative learning minimally requires responsivity to two different stimuli and a memory element. Herein, nanoparticles form the memory element, where a photoacid-driven pH-change leads to their chain-like assembly with a modified spectral behaviour. On associating selected light irradiation with heating, the gel starts to melt upon the irradiation, originally a neutral stimulus. A logic diagram describes such an evolution of the material response. Coupled chemical reactions drive the system out-of-equilibrium, allowing forgetting and memory recovery. The findings encourage to search non-biological materials towards associative and dynamic properties.

1.1 The experiment

The basic elements of the experiment are following.

1. The system consists of sea weed gel and Gold nanoparticles.
2. Heating plus irradiation by blue and red light simultaneously leads to a formation of nanoparticle chains and heating of gel melting it. Formation of chains is due to the photoacid driven pH change.
3. Conditioning occurs in the sense that gel melts even when only irradiation is present.

There is an analogy with Pavlov's dogs based on correspondences heating $\leftrightarrow$ metabolic energy feed $\leftrightarrow$ food; irradiation $\leftrightarrow$ signal associated with the food - say sound of bell; melting $\leftrightarrow$ saliva secretion.

One can however criticize this interpretation.

1. The analogy with Pavlov's dog is not complete. Melting requires energy. Pavlov's dog does not get sated by the mere soud of bell.
2. Nanoparticle chain is assumed to serve as a memory element. Could a more appropriate interpretation be as a metabolic energy storage analogous to protein?
3. Can one model the system using only chemistry, and is conditioning a purely mechanical and passive process as behavioristic dogma states? Could conscious intelligence be involved as in the case of ordinary learning.

1.2 TGD based model briefly

I have already earlier applied TGD inspired model of living systes model simple systems exhibiting life-like properties. One such system consists of plastic balls [I2]: the TGD inspired model for the system is discussed in [L3].

The TGD based quantum model for the conditioning of hydrogel system relies on TGD inspired general model of living systems extended recently to a model of quantum self-organization [L9] in which energy feed serving as metabolic energy feed induces generation of dark matter as $h_{eff} = nh_0$ phases of ordinary matter at the magnetic body of the system. In number theoretic vision the presence of these phases correspond to higher algebraic complexity and higher "IQ".

The light signal would generate Pollack effect [L1], which in TGD framework means transfer of protons from photo-acids to dark $h_{eff} = nh_0$ protons at magnetic flux tubes parallel to nanoparticle chains [L1]. The "IQ" of the system or its magnetic body characterized by h_{eff} would increase and it would become able to self-organize. The energy from the heating would be stored to the nanoparticle chains taking the role of proteins as energy storage. Melting would be a self-organization process increasing complexity, and in absence of heating (and perhaps even in its presence) the gel phase would receive the energy needed from the nanoparticle chains. The conditioning in this sense would not be a passive mechanical response. The system would be macroscopic quantum system, and the energy feed would make possible for it to evolve to a higher level of complexity and conscious intelligence.

2 TGD based model for the findings

TGD inspired view about living matter has now evolved to a proposal for a general model of quantum self-organization [L9] and it is of considerable interest to apply this model to the recent situation.

2.1 What learning and conditioning really are in TGD Universe?

Conditioning in the standard sense would be a purely mechanical process. In TGD Universe life cannot be however reduced to mechanical purely deterministic processes.

1. The magnetic body (MB) of the system would not learn to get heated or to get melted in presence of the irradiation. Rather, irradiation would raise the intelligence of system measured by $h_{eff} = nh_0$ and it would spontaneously self-organize by melting. Conditioning in mechanical sense would not be in question. This would apply also to ordinary conditioning.

2. Conditioning in TGD sense requires conscious intelligence. MB with dark matter must be involved. The MB of the system containing the MB associated with nano-particle chains and loaded with dark protons by irradiation inducing Pollack effect would be involved with the conditioning. Irradiation would "wake up" the system and nanoparticle chains would allow energy storage.

3. Irradiation would generate dark phases with $h_{eff} = nh_0$ inducing self-organization involving the melting of the gel phase using the metabolic energy resources generated during the heating period. The only thing needed would be the presence of large h_{eff} phases. System would take care of the rest.

2.2 The building bricks of the model

The basic building bricks of the model would be following.

1. Living systems are able to learn and get conditioned. An analog of living system should be present. In TGD Universe any self-organizing system is "living" and involves dark matter as large h_{eff} phases.

2. Pollack effect [L1] [L1] is a fundamental manner to build MB in TGD Universe. In Pollack effect the irradiation kicks ordinary protons to magnetic flux tubes to form dark proton sequences - dark nuclei. The proposal is that also a dark realization of genetic code with codons represented as 3-codon triplets is involved and that ordinary genetic code would be mimicry of this code [L2]. Also now gel and irradiation are present. Pollack effect induced by the metabolic energy feed associated with the radiation would generates dark proton phase and make the system intelligent.

3. Living system needs metabolic energy and must be able to store metabolic energy. Now the nanoparticle sequences possibly associated with dark flux tubes are excellent candidates for the analogs of proteins storing metabolic energy provided during the heating period.

4. Zero energy ontology (ZEO) plays a key role in TGD inspired model of living matter. The general model for the motor action and remote metabolism assumes that system sends negative energy to the geometric past and gets energy in this manner. Negative energy transfer is an intuitive manner to say that macroscopic state function reductions are involved in the process and change the arrow of time temporarily [L4]. Recent rather surprising experimental findings by Minev et al [L8] provide direct support for ZEO based view about quantum jump [L8].

Remark: Quite recently (towards end of 2019) I found a more precice formulation for the intuitive notion of remote metabolism, which strongly suggests that energy is conserved in ZEO. There is a decomposition to system and the energy energy source: call them A and B. Intuitively, A receives energy from B by sending negative energy to B. What does this really mean?

1. A "big" state function reduction reversing arrow of time takes place: this would correspond to sending negative energy signal to past. The energy of A+B in the final time reversed state at new passive boundary of CD would be shared in new manner such that one can say that A has received from B the metabolic energy.

2. Energy would be conserved. I have also considered the interpretation that the total energy of the system associated with CD increases [K3] [L10]: since CD itself breaks Poincare invariance, it seems that one cannot exclude this. However, the Poincare invariance is realized at the level of moduli space for the positions of the either boundary of CD, and one can assume energy conservation. Even the wave functions at the boundary of CD can be taken to be in the representations of Lorentz group acting as its isometries. Plane waves correspond to wave functions in the moduli space for the boundary of CD keeping second boundary fixed.

3. To make this more precise one must define metabolic energy more precisely by introducing the hierarchy of Planck constants and the fact that the increase of h_{eff} of sub-system keeping other parameters constant increases it energy. Second law means that A tends to loose energy due to the decrease of h_{eff} for its sub-systems. This is true also for the time-reversed state but in opposite direction of geometric time so that with respect to standard direction of time the energy increases. This would be the general purely thermodynamical mechanism of remote metabolism.

2.3 How conditioning could take place?

What kind of model this picture one ends up from the elements identified above? It is best to proceed by making questions.

1. What does it mean to be living in this particular case?

   (a) Gel, nanoparticles chains, and their MB would form the system. Chain would be accompanied by flux tubes in contact with the MB of gel. MB would induce the melting in presence of irradiation.

   (b) Pollack effect is involved. pH is changed, which means that the density of protons is changed by the presence of photoacids. photoacids (see `http://tinyurl.com/y54h8dqs`) release protons in presence of irradiation. The liberated protons would go to magnetic flux tubes accompanying the nanoparticle chains and even give rise to dark realization of genetic code. The photons of irradiation at blue and red should have energies needed to transfer the protons of photoacids to dark protons at the flux tubes with non-standard value of h_{eff}. Irradiation would make the system intelligent.

   (c) photoacids are present also after conditioning so that flux tubes carrying dark protons are formed when the system is irradiated even if they are unstable against decay to ordinary protons. One can say that the system wakes up by radiation and it becomes intelligent, self-organizing, and able to learn. MB could induce melting of the gel as a self-organization process.

   (d) Why Gold nanoparticles would be needed? Here an interesting connection to the work of Hudson and other layman researchers emerges. Hudson and others [H1, H2] claimed that Gold has a phase, which they called White Gold, mon-atomic Gold, or ORMES. This phase of Gold was claimed to have properties suggestive of nanoscopic or even macroscopic quantum coherence. These claims were not taken seriously by science professionals. Since I had nothing to lose at that time anymore, I decided to construct a model for White Gold. Later this model led to a quantum view about living matter relying on the hierarchy of Planck constants [K1, K2, K4]. The recent view about White Gold explaining their suspected quantum coherence would be as Gold nanoparticles assignable to dark magnetic flux tubes carrying dark protons.

2. What the melting of gel is?

   Learned reaction to stimulus is in TGD framework self-organization process rather than just getting heated or reacting mechanically like automaton. What is called melting would be a

self-organization process in which the complexity of gel increases. Heat would transform to ordered energy: work would be done to achieve melting. Hence one should apply TGD based quantum view of self-organization to the situation [L9].

3. What is the source of the energy that the gel needs to melt?

   Does gel the energy directly as heat and/or from analogs of proteins storing metabolic energy. Since the melting occurs also in the absence of heating, the latter options seems to be correct. One can imagine two sources of the metabolic energy.

   (a) Could nanoparticle chains serve as a storage of metabolic energy being thus analogous to proteins. Nanoparticle chains dropping to a lower energy state would serve as a source of metabolic energy in absence of heating.

   (b) Could flux tubes carrying dark protons proposed to define dark variants of basic biomolecules (DNA, RNA, amino-acids, tRNA) [L2, L6, L5] serve as a storage of metabolic energy? This energy could be liberated as dark protons transform to ordinary ones. If they are transformed to protons of photoacids, the energies would correspond to the energies of blue and red photons. These energy levels should correspond to the energies assignable to the building bricks of the gel phase. The intuitive expectation is that the energy feed due to irradiation is small as compared to that needed by the melting of the gel. The presence of Gold nanoparticles would not be necessary.

4. What does the energy transfer from nanoparticle chain to the gel mean? One can imagine two options.

   (a) Melting could be analogous to motor action in TGD sense. ZEO suggests that gel sends negative energy to a receiver able to receive it and in this manner gets the energy needed to perform the motor action [L7]. Nanoparticle chain would be the receiving system. Nanoparticle chains would receive their energy during heating. In the model of experimenters nanoparticle chain would serve as a memory element rather than battery.

   (b) MB could induce transfer of positive energy from nanoparticle chains to gel. One would have only "small" state function reductions analogous to weak measurements and time evolution would be a sequence of unitary evolutions involving only weak measurements [L4, L11]: self as a generalized Zeno effect is the manner to state in the framework of TGD inspired theory of consciousness.

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